INFOSHEET 3

School lighting

Lighting typically accounts for at least 50% of a school's electricity consumption.

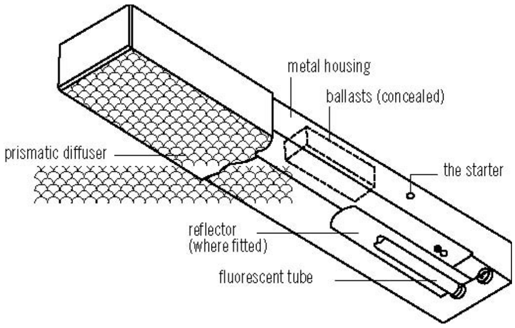
TYPES OF LIGHTS

Incandescent lamps (traditional light globes)

Light globes have poor efficiency because they lose a significant proportion of energy as heat. They have a short life of about 1000 hours, creating increased maintenance, but are cheap to buy.

Fluorescent tubes

Fluorescent lamps have a life of between 8000–16 000 hours and present the most efficient form of artificial interior lighting available.
Fluorescent tubes are the most common form of lighting in schools and are usually mounted in a fitting (called a luminaire) comprising a reflector and diffuser.



The diffuser reduces glare and evenly distributes the light from the tube. The overall light output depends on the efficiency of all components. They should be kept clean so that light levels do not deteriorate.
One, two or even three tubes can be contained in each fitting. Other components found in fluorescent light fittings are the ballast and the starter which are usually mounted behind the reflector.
Ballasts control the voltages applied to the tubes but also contribute to energy consumption. Standard magnetic ballasts for 1200 mm tubes operate at about 9W, low loss ballasts and super low loss ballasts at 5W and 3W respectively. Low loss ballasts cost about $6. Newer electronic ballasts are also available (at higher cost—$30), some of which allow fluorescent tubes to be dimmed.
When fitting new fluorescent lamps or replacing components, always purchase efficient varieties.
The most efficient fluorescent tubes have a 'triphosphor' coating. They are recommended because they produce about 15% more light for the same electrical energy and have a longer useful life than standard tubes. Schools can purchase triphosphor tubes in bulk (box of 25) for about $3.00 each. When replacing fluorescent tubes the starter should also be replaced.
The table below provides examples of triphosphor lamps.

Make	Model/code (1220 mm tube)	Claimed life expectancy
Philips	TLD new generation	13 000 hours
OSRAM	Lumilux plus	12 000 hours
General Electric	Polylux XL	15 000 hours

Compact fluorescent lamps

Compact fluorescent lamps can save energy where they replace incandescent lamps in high use areas. These lamps use significantly less energy than an incandescent globe to produce equivalent light. A 15W compact fluorescent lamp can replace a 75W globe. Because of their extended life, these lights are ideal for areas where maintenance access is difficult. Most compact fluorescent lamps can be dimmed.

Gas discharge lamps

Sodium or mercury vapour lamps and metal halide lamps are high intensity discharge lamps used for large interior or exterior space. High pressure sodium (HPS) lamps combine high light output and efficiency with a long lamp life. This is a big advantage in high installations. They are available in higher power and light outputs (typically 150, 250 and 400 Watts) than fluorescent lamps. Because HPS lamps do not give well-balanced colour, they are best suited for external lighting.
Mercury discharge lamps give a slight blue colour light and are commonly used in halls and gyms. However for the best colour and efficiency for indoor applications, metal halide lamps are best.


Mercury discharge lamps are often used in school halls

Extra low voltage (12V)

Extra low voltage (ELV) lights, also known as dichroic lamps use halogen lamps fitted into a small reflector. These lamps were originally designed to light displays but have become popular in more general applications. ELV lamps require a transformer and heavier wiring than lights that operate at 240V. Although they are marginally more efficient than incandescent globes ELV lamps cannot match the efficiency of fluorescent lamps. Typically many more ELV lamps are installed than would have been required for other lamp types. In general it is recommended that ELV lamps not be used in schools.

LIGHTING LEVELS

The light level produced by any lamp is a function of the power rating (in watts), its efficiency and the efficiency of the luminaire. Lighting costs depend on power and usage.
The light intensity in various parts of a school must be sufficient for comfort and safety. Light levels can be measured with a small meter in units called lux. These meters can be purchased at electronic stores at a nominal price. The Standards Association of Australia specifies lighting levels for schools in AS 1680.2.3

AREA	Illumination Level (LUX)
General purpose classrooms (at desks and blackboard)	240
Physical education: *class area* *change rooms*	 240 80–100
Technical studies/computers	320
Science/home economics/music/art/trades	320
Assembly hall (auditorium area)	100
Libraries: *reading areas* *shelves*	 320 240
Office and administration	320
Corridors, foyers	80

Effective lighting can be energy efficient and cheaper to operate through the implementation of energy-saving measures. Taking advantage of recent developments in lighting technology can often reduce energy consumption by 30–60% for the same standards of lighting, especially where lighting installations are 10 or more years old.

ENERGY EFFICIENT LIGHTING STRATEGIES

To save energy used for lighting, the following general rules apply:

- maximise the use of natural daylight;
- do not over-light non critical areas;
- use energy efficient lamps and control technology; and
- do not light unoccupied areas.

Maximising natural light

High windows reduce the number of lights used during daytime

Caretakers can help by checking that blinds and curtains are open in the morning so that staff do not switch on lights unnecessarily. Lights are frequently switched on first thing in the morning when daylight is still insufficient and then left on all day. Often, as the day brightens up, some or all of the lights can be switched off. When daylight is good, the lighting is then usually left off for the rest of the day.
Install skylights (sealed for summer) in unheated areas such as toilets, changing rooms, corridors and vestibules, so that lights can be switched off. There are now selective skylights that allow more light (and heat) through in winter and at the beginning and end of the day but reduce light (and heat) transmission in the middle of bright sunny days.

Regular maintenance

Dirt and dust on light fittings reduces light output. Clean light fittings when replacing lamps (see next page).
Older types of opal plastic diffusers become discoloured with age absorbing more than 50% of the light output from the tubes. Replace with new prismatic diffusers.
Tubes with blackened ends are past their economic life. Replace with triphosphor tubes.

Use energy efficient lamps

The installation of efficient light sources provides an excellent way of reducing lighting costs. The options for changing to energy efficient lights include:

- replacing incandescent light bulbs with compact fluorescent lamps;
- upgrading older fluorescent tubes with fewer efficient triphosphor tubes; and
- replacing mercury vapour with high pressure sodium or metal halide lamps.

Replacing incandescent lamps with compact fluorescent lamps

Even though compact fluorescent lamps are more expensive to buy, the running costs are about one fifth that of incandescent globes. The pay back period can be quite short where lights are on for extended periods of time.

Example:
A 15W compact fluorescent lamp costing $22 which replaces a 75W incandescent will save about $12 per year and be paid back in 1.8 years.

Upgrading fluorescent tubes and luminaires

Replacing older 40W fluorescent tubes with 36W triphosphor tubes has the dual benefits of increased light output and lower power consumption. Schools may choose to replace old tubes as they deteriorate but it is best to replace all the lamps in a room at one time. The latter approach can open the opportunity for obtaining further energy savings through delamping and ensures that all lamps in the room should last for a few years.

Triple tube fittings often only require one or two triphosphor lamps

Delamping

When replacing old tubes and cleaning fittings, it is often possible to reduce the number of tubes required in classrooms and other areas. (circulation areas; above shelving etc). Delamping involves removing one or more tubes from the existing fluorescent fittings in areas where lighting levels are higher than those specified in the Australian Standards (AS1680.2.3). The use of high efficiency triphosphor tubes often allows about a 30% reduction in the number of tubes required in a typical classroom.
About $9 is saved annually for each 36W tube removed.

LAMP REMOVED	ESTIMATED ANNUAL SAVINGS (PER LAMP)*
36W fluorescent tube	$7.00
75W incandescent globe	$14.00
400W mercury vapour lamp	$77.00

**Based on an assumed electricity tariff of 16 cents/kWh, and an annual usage of 1200 hours.*

Efficient polished aluminium reflectors can sometimes be retro-fitted into existing fluorescent lamp housings. This can increase the effective light output and may allow for a further reduction in the number of tubes required.

Replacing mercury vapour lamps

When replacing mercury discharge lights, in external applications consider compatible high pressure sodium lamps that can give similar light output for less energy consumption. For example, you may be able to install 150W HPS lamps in place of 250W mercury lamps.
For interior applications metal halide lamps can replace mercury vapour lamps.
Direct substitution of lamp-for-lamp is not always a simple matter. If you have any doubts contact the manufacturer or consult the Sustainable Energy Authority.

Low loss ballasts

When installing new fittings, ensure your electrical contractor is using low loss ballasts. Low loss magnetic ballasts will save about 60c per tube each year at a cost of $9 instead of $5 for standard ballasts.
Electronic ballasts with a consumption of only 2W are available but generally have a long payback. These do however have the added advantage of eliminating the flicker that some people find annoying in fluorescent tubes.

Lighting controls

It is always cheaper to turn lights off than to leave them on. Money and energy are wasted when lights are left on in empty rooms, or when daylight is available to do the job.

Note: It is a myth that it is cheaper to leave fluorescent lights on than to switch them off (even for a short time).

Lighting controls can reduce the dependence on people to switch lights off.
In areas where lights are regularly left on, it may be worth installing key switches, time switches or occupancy sensors.

Key lock switches
Switches that require a key to operate can replace the standard switch in areas rarely needing lighting during the day. This enables only authorised staff to switch on these lights.

Time Switches
Time Switches can control the period of time that lights are switched on. Several types are available. Push-button or time delay switches that provide a pre-set time period of light (from 10 seconds to 30 hours) after they are switched on are available. For example in day-use toilets that have a small amount of natural light, a 5-minute timer can reduce energy consumption significantly.

Time switches

Lighting controllers
Lighting management controllers are devices that provide centralised remote and local control of electrical loads by switching the existing power supply off or on.
Seven day, time-of-day scheduling, holiday scheduling and manual override control can be programmed into a central controller or computer.
Some schools have a system in which switching is linked to the bell times. In Tasmania and Queensland these systems have been in use for some years. Some models can also be used to control gas or electric heating and security systems.

Voltage reduction technology
There are technologies that can be wired into the lighting power supply to reduce the voltage applied to all lights. The reduced voltage leads to less power consumption in exchange for an overall reduced light output. These devices may be appropriate where rooms are uniformly overlit and delamping is deemed inappropriate.

SENSORS
Can be used to automatically switch lights by detecting light levels and/or room occupancy.

Occupancy sensors
Movement sensors can be installed to turn lights off in unoccupied rooms. The most effective sensors use an ultrasonic detector to pick up small movements from people in the room. If movement ceases the lights are switched off. Occupancy sensors become more economic where a larger number of lamps are installed in rooms where lighting tends to be left on for long periods of time.


An ultra-sonic occupancy sensor

Three types of sensors can detect occupancy.
- passive infra-red sensing—used for small areas with infrequent occupancy. Useful for security purposes (low sensitivity);
- ultrasonic sensing—useful for classrooms and offices (medium sensitivity);
- microwave sensing—used for large internal areas or external areas with infrequent occupancy (high sensitivity).

Sensors should cover all the occupied areas to avoid false switching.

Note: Occupancy sensors are not suitable in areas where unexpected switching off could cause safety problems, e.g. in technology rooms.

Rooms used at night should not be left totally dark if automatic controls switch off lighting. Minimal lighting should still be available.

Cost benefit of occupancy sensors

Are occupancy sensors economic? The answer to this question will depend on:

- the number and power of lamps in the room;
- how long the lights are left on when the room is unoccupied;
- your electricity tariff; and
- what return on investment you consider worthwhile.

Example:
A classroom with 32 fluorescent tubes of 36W each is estimated to have the lights on while unoccupied for about 10 hours per week.
Power consumption including 9W ballast is 45W per tube.
If the school room is used 40 weeks/year:

Energy saved = number of tubes x power x hours x weeks =
32 x 45 x 10 x 40/1000 = 576 kWhs/year

For a tariff of $0.16 per kWh

Cost saving = **$92 / year**

Ultrasonic sensors can be installed for about $200 if a number of classrooms are wired at one time.

Return on investment = 50% (simple payback of about 2 years)

Daylight-linked controls

A sensor positioned in the ceiling can measure the light levels reflected from surfaces below and automatically adjust the lighting system to provide an acceptable level of illumination.
Suitable only in areas subject to daylight such as window zones and areas with skylights.
Rewiring of lighting may be required.
Some light sensors control on/off switching of the bank of lights along the window side of rooms. Others are more sophisticated and expensive being able to dim lamps to maintain a pre-programmed light level. To dim fluorescent lamps, generally electronic ballasts must be installed.

There are several technical issues to consider before installing time switches or sensors. Seek advice from electrical contractors.

ENERGY PRICING

All operating cost quoted in these info sheets are based on a standard school day and are approximate only. The operating costs are based on an assumed peak electricity tariff of $0.16/kWh , natural gas tariff of $0.95/MJ and a LPG prince of $0.70/litre. Schools should check with their electricity and gas retailer for tariffs applicable to their particular schools.