



Low Energy Lighting (Updated to Dec. 16, 2009)

“We now know a thousand ways not to build a light bulb”

Reply by Thomas Edison when asked about his many failed attempts before his laboratory perfected the first practical light bulb

Incandescent light bulbs: yesterday's technology. Although Thomas Edison did not invent the electric incandescent light bulb, his research laboratory did perfect the first practical light bulb in 1878 by using tungsten for the filament. Since then the design of Edison's incandescent light bulb has changed little but the era of this vintage technology is fast drawing to a close – going the way of the old radio valve when the transistor was perfected. The modern replacements are compact fluorescent lamps (CFLs) and solid-state light emitting diodes (LEDs). A third type are Halogen lamps, a slightly more efficient type of incandescent globe but not nearly as energy saving as CFLs or LEDs. For this reason we do not recommend them as “low energy”. This guide examines these lighting systems with the viewpoint of maximising your energy savings.

Why should I replace my incandescent lighting? Besides the issue of energy savings many countries have already passed legislation to prohibit the sale of incandescent globes over the next few years. Australia has enacted a ban on the sale of the globes to take effect in 2010 and the European Union will also ban the sale of incandescents by 2010. The EU decision will apply to all 27 member states and, according to the conservation group WWF, will reduce EU domestic energy consumption by approximately 60%. This is equivalent to around 30 million tons of CO₂ annually. In the United States, the *Energy Independence and Security Act* of July 2007 effectively bans incandescent globes by requiring greater light bulb efficiency, phased in from 2012 through 2014. With these bans it is a foregone conclusion that the days (and nights) of the old incandescent globe are soon to end. The primary drawback with incandescent globes are that they are very inefficient with about 90% of the electrical energy being converted into unwanted heat, not light. The quality of the light is poor, compared to natural sunlight or full spectrum compact fluorescent globes and

they have a relatively short life span, with alternatives (as follows) lasting far longer.

1) T5 Fluorescent tubes The first practical fluorescent tube was sold in 1938 by General Electric. Unlike Edison's incandescent globe, fluorescent tube light, is not created from heat, the light is created from the chemical reactions that occur when electricity is applied to different gases enclosed in a glass vacuum chamber. Fluorescent tubes convert more of the input power to visible light than incandescent globes with far less heat being generated (2/3 to 3/4 less). While a 100-watt tungsten filament incandescent lamp may convert only 10% of its power input to visible white light, a standard T8 or T12 fluorescent tube converts about 22% of the power input to visible white light. A typical fluorescent lamp will last between 10 to 20 times as long as an equivalent incandescent lamp when operated several hours at a time. Standard fluorescent systems have been designated as either T8 or T12. However, as a result of concerns over energy efficiency, better lighting control and aesthetics, since 1995 new generation T5 and high-output T5HO fluorescent tube technology has been taking over from the traditional fluorescent tube. T5 tubes are more efficient than the older T8 and T12 systems and can deliver an energy savings of over 50% compared with a conventional 400-watt fluorescent system. T5HO tubes produce as much as twice the lumen output when compared to the standard T5 tube. Owing to conversion expenses they are most suited for new buildings where fluorescent lighting is to be installed. Another advantage of the T5 tube is significantly lower mercury content than the earlier T8 and T12 tubes - an important consideration when disposing of a spent tube.

The disadvantage of T5 Fluorescents: The main disadvantage for both T5 and T5HO tubes is that different fixtures are required and they are more expensive than the other fluorescent systems. However, as with other new lighting

systems, expect the price to significantly drop in the future.

2) Compact Fluorescent Lights (CFLs)

Although designs for CFLs were on the drawing boards since the 1970s, only recently has the technology advanced to the stage to being a superior alternative to the incandescent globe. It is a far more energy efficient light source and will last far longer than its predecessor- provided you take care to only purchase well-known brands (see below). CFLs are improved compact versions of the larger fluorescent light fittings seen in public and commercial buildings and typically use between one-fifth and one-third the power of equivalent incandescent globes. For example, a 15watt CFL globe can replace a 60watt incandescent globe. A 25watt CFL can replace a 100watt incandescent. This represents a significant savings for your electricity bill and your lighting costs could be reduced up to 66%. While the initial cost of a quality CFL lamp is much greater than an incandescent bulb (3 to 10 times) the extended lifetime and much lower energy usage for the same amount of light will compensate for the higher initial cost. The main problem with CFLs comes from the import and distribution of poor quality CFL globes.

Only purchase well-known brands: The CFL industry in Asia has launched a quality identification standard for Asian manufacturers to combat a rising problem of substandard and shoddily manufactured CFLs that are damaging the industry internationally, threatening a \$7 Billion (U.S. dollars) annual market. These globes tend to put out an inferior light, give off less illumination than stated, burn out prematurely and may give off odours and smoke if it overheats. They can also emit an irritating hum during operation. At an international CFL industry conference in May 2008 it was reported that half the CFL globes manufactured in Asia were substandard – producing much less light and/or burning out more quickly than advertised. The best way to avoid these products is to only purchase well-known name brands, such as OSRAM, Philips, National, Panasonic, GE, etc. Avoid obscure name brands sold at cheap prices.

What about the mercury? A concern for environmentally conscious consumers is the fact that CFLs contain around 3 to 5 milligrams of mercury which is required for the lamp to function. This is a valid issue but is often wildly overstated. To put the issue in perspective, 5 mg of mercury is one fifth of the mercury found in watch batteries and 100 times less than that found in a thermometer or dental amalgam filling. The fact is that the use of CFL globes will actually result in less mercury environmental contamination since supplying the extra electricity for incandescent globes via coal fired power stations emits far more mercury out through the smoke stack than CFL bulbs contain. As for what to do with expired CFL globes recycling programs now being established in Tasmania and other states to extract the mercury. It is important to note that no mercury is released from the globe unless it is broken and for this reason, disposing of unbroken globes in landfills must be avoided, as it will eventually get into groundwater. If a CFL globe is inadvertently broken a small amount of mercury vapour and particles can be released (the same applies to all fluorescent tubes) but can be cleaned up by the householder by following the advice of the Department of the Environment, Waters, Heritage and the Arts (DEWHA):

- *Open nearby windows and doors to ventilate the room.*
- *Use a brush to carefully sweep up the pieces and then use a paper towel, preferably moist, to wipe up any remaining glass fragments and phosphor powders.*
- *Use disposable gloves.*
- *DO NOT use a vacuum cleaner because this can spread the contents of the bulb and contaminate the cleaner.*
- *Place all of the pieces of the light bulb and clean-up materials into a sealed plastic bag for disposal in your waste bin or in accordance with the advice of your local waste disposal authority.*
- See:
<http://www.environment.gov.au/settlements/waste/lamp-mercury.html>

In summary, the vastly improved energy efficiency of CFLs and the fact that less mercury is emitted by power stations if they are

used means that CFLs offer an environmentally sensitive choice of lighting.

CFL and fluorescent tube disposal: Presently DEWHA is investigating the issue of CFL disposal and a nation-wide program is in the planning. For the moment it is advised to contact your local recycling / hazardous waste disposal site for their advice. **MOST IMPORTANTLY** intact fluorescent globes of any type should not go to landfill where their contents will eventually leach into the environment. In Tasmania there are plans to implement state-wide collections. This will consist of special bins placed at disposal/recovery sites for All TYPES of lighting globes, including incandescents. The contents are then picked up for recycling of the mercury, metal and glass at a central facility. In Hobart, *Lightsnlamps* at 41 Victoria St and *Sustainable Living Tasmania*, 1st Floor, 71 Murray St., operate a collection service in conjunction with CMA recycling for domestic quantities of fluoro / CFL tubes and globes.

What are other disadvantages of CFLs? Many CFLs cannot be dimmed, some of the older ones take a perceptible amount of time to reach full brightness and do not work well in touch lamps or in motion sensor regulated exterior lighting or in situations where they are frequently turned on and off as this significantly shortens their life. They can be more sensitive to low temperatures. These shortcomings are being addressed in ongoing CFL research so it is recommended to ask your local lighting supply shop about your specific requirements.

What about the health issues? There has been much attention in the media about possible health hazards from exposure to fluorescent light in the ultra-violet (UV) frequency range, especially for people with light sensitivity problems, such as Lupus sufferers. The advice from DEWHA is that eight hours exposure to a typical office fluorescent light is equivalent to just over one minute of sun exposure according to a 1993 study. DEWHA advises that people with light sensitivities who have problems consider using a different lighting source, such as halogens although they are not as energy efficient as CFLs. Here again, it is important not to

purchase inferior quality CFL bulbs as the quality of their light may be a health issue as well. Ultraviolet radiation emission testing by the Australian Radiation Protection and Nuclear safety Agency (ARPANSA) tested 24 different brands of CFL globes and found all were well within the safe limits used to set exposure limits to naturally daytime UV levels. For close work ARPANSA recommends the use of double envelope or encapsulated CFLs for desk top use at distances closer than 30 cms.

3) Halogen lamps Halogen lamps are incandescent lamps with tungsten filaments, but their compact envelopes are filled with an inert halogen gas. This technology enabled the manufacture of a desirable very small bulb that would otherwise have instantly burned out owing to the intense heat produced. Their small size tricked many people into believing that they are energy efficient, however, these bulbs are not efficient, having a nominal (about 25%) higher efficiency than a standard incandescent bulb, but more often cause major additional space heating losses, especially when inserted as downlights into ceiling cavities. It has become commonplace to see an array of halogen lights in one room consuming several hundred watts combined. They do have the advantage of a constant light output for the entire life of the bulb. Halogen lighting systems are available in both 240-volt mains power and 12-volt (using a transformer).

Disadvantages of Halogens: Halogen lighting, both 240V and 12V, however, run extremely hot and can cause fires if not fitted correctly, or if ceiling insulation is installed over the fittings.. There is also a burning risk if inadvertently touched while lit. Any surface contamination, such as fingerprints, can damage the quartz envelope when it is heated and can create a hot spot on the bulb surface when the light is put on. It is worthwhile to note that all this heat is 'lost' energy that you will be paying for in your electricity bill. Both 240V and 12V halogen systems are relatively inefficient in terms of light output per watt. In addition the 12V transformer will also contribute an additional energy loss. This means that the halogen 'low voltage myth' that the 12V systems are energy saving is false, especially when compared to CFLs. The main advantage of halogen lighting is architectural

(aesthetic), they are not an energy saver. In fact they can consume more power than do older incandescents owing to the multiple units usually installed and the way they are often imbedded into ceiling spaces. Where halogen lights are already installed, changing light fittings to more sensible ones will incur some costs. One alternative option is to partly de-lamp an area, so that some of the less used light units are simply removed.

If installing a new lighting system, then consider halogen lights to be outdated, inefficient technology. There are much better lighting choices.

4) LED lighting Light Emitting Diodes (LEDs) are only a few millimeters in length and are quite technologically advanced compared to other forms of lighting. A LED light bulb is manufactured by packing dozens of individual LEDs together in the one light bulb to combine their intensity. A LED is not a globe in the conventional sense but an electronic semiconductor that has the ability to convert electricity directly into light without heat being created. For this reason LEDs are extremely long-lived and can last hundreds of thousands of hours. LEDs have been available in red, amber, yellow, green or blue with a white light LED developed in 1997. LED technology is currently undergoing further technological research and advances with the aim of developing a super-bright white light LED that can actually replace the other light sources used today. LEDs can be considered the preferred lighting option of the future because of their extremely long service life, low energy consumption, low maintenance costs and relative lack of environmental hazards (mercury). Most importantly, they require far less energy to manufacture than all other light systems, thus reducing their environmental impact. LEDs are now available to fit into most lighting fixtures – the conventional light bulb socket, a 240 volt or 12 volt halogen light socket, and as a LED tube that fits in the standard T8 fluorescent light fitting.

Disadvantages of LEDs: LED lights offer very efficient lighting and can be purchased at a number of outlets, but being an emerging technology the key disadvantage is high price owing to low manufacturing volume. Just as a

\$5 CFL costed \$30 ten years ago, it is estimated that it will be several years until LED manufacturing volumes have matured to a stage of competing with the unit cost and flexibility offered by CFLs. However, research is ongoing to develop a range of LED globes of sufficient intensity and spread of light to be able to compete with CFL technology – and at a competitive cost. Watch this space! For competitive priced LED lights it is worth checking internet sites for LED suppliers, many of which offer much lower prices than street-front shops. Already a number of sites offer a wide range of LED lights, including replacements for fluorescent tubes and conventional light bulbs.

Lighting Suppliers: A wide range of specialist lighting shops and hardware outlets stock a range of the above lighting systems. A good starting point is to consult your region's Yellow Pages under the lighting & Accessories – Wholesalers and or manufacturers section.

Non lighting options

Reducing the energy costs of lighting can be done by means other than buying new technology. De-lamping areas that are over-lit is one option. Another is the surprisingly reduced lighting needs of a room painted in light rather than dark colours. White or off-white painted rooms are increasingly being chosen by architects owing to the added versatility – white paint neatly offsets wall paintings, vase flowers and other room appointments.

Resources

<http://features.csmonitor.com/environment/2008/10/15/eu-bans-incandescent-light-bulbs/>

http://en.wikipedia.org/wiki/Fluorescent_lamp#Luminous_efficacy

http://www.popularmechanics.com/blogs/home_journal_news/4217864.html

<http://www.ledlighting.com.au/Home.html>

http://ecmweb.com/ops/electric_fluorescent_lamp_coming/
<http://www.ledshoponline.com/>

Tube/globe Disposal: CMA recycling through *Lightsnlamps*, 41 Victoria St. Hobart and *Sustainable Living Tasmania*, 1st Floor, 71 Murray St., Hobart.

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