

CFL Bulbs: Environmentally Friendly And Sustainable?

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We should be using Nature's inexhaustible sources of energy - the sun, wind and tide. I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil or coal run out before we tackle that.

(Thomas Edison, as cited in Galacho, 2008).

GREENHOUSE GAS EMISSIONS AND FLUORESCENT BULBS

Each one of us today is being bombarded with messages to become environmentally conscious and reduce the impact of climate change. As weather systems become unpredictable, with longer, hotter summers, extended droughts, and shorter and milder winters, all of us are experiencing the wrath of nature arguably resulting from human activities. Humans have exploited the depths of the earth to extract precious metals and generated a seemingly insatiable need for liquid gold (oil) in order to develop economically and technologically (see, for example, **the Stern Report, 2006**). Fertile land has been claimed and deforestation has been undertaken to create more space for dwellings and make factories for newer, generally compact products for the expanding human population. The life-cycle of products has considerably decreased and there is now a common practice, for example, of buying newer models rather than fixing or retaining the older version of mobile phones, television, cars or other electronic products. The human race is steadily realising the detrimental and, in many instances, irreversible damage our actions have caused to the planet.

A number of initiatives can and are being adopted by individuals at home and within many industrial sectors to curb the application of equipment and practices that produce greenhouse gas emissions. Most of us are attempting '*to do our bit*' for the ecological environment so that our future generations are, at least, not worse off than the current generations and can enjoy the same, if not better, access to natural landscapes, a clean environment and resources. Of innumerable environmental initiatives, this paper focuses on only one: fluorescent light bulbs, now commonly known as compact fluorescent lamps (CFL); 'compact' due to their smaller size. The aim of this paper is two-fold: first, to document the positive and negative characteristics of using fluorescent bulbs; and second, to raise awareness and debate about the potential negative health effects resulting from prolonged exposure to fluorescent bulbs. Please note that in this paper, the terms CFL bulbs, long-life bulbs and fluorescent bulbs are used interchangeably.

A majority of domestic and commercial bulbs fall into one of two main categories (Choice, 2000): incandescent (e.g., tungsten filament, tungsten halogen); or fluorescent (e.g., fluorescent tubes, compact fluorescent, the latter also known as long-life bulbs). Installation of fluorescent bulbs is being mass-marketed by both government and non-government bodies as an easy first step for both domestic and commercial, individuals and enterprises, respectively, to limit their ecological footprint. As highlighted in the next section, it has been shown that use of CFLs, when compared with traditional incandescent bulbs, will reduce the overall contribution to greenhouse gas emissions. Print media sources, announcements and commentary on television and radio are, accordingly, urging consumers to switch from traditional incandescent counterparts to CFLs.

Approximately 150 million CFL bulbs were sold in 2006 in the United States (**MSNBC, 2007**), and just less than half that number, 70 million, in Australia (**Hopkins, 2008**). In 2007, Wal-Mart alone had targeted to sell 100 million bulbs (**Masamitsu, 2007; MSNBC, 2007**). Since the start of 2008, the United States Environmental Protection Agency (US-

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EPA), along with major businesses and retailers such as Wal-Mart, have been actively promoting the increased sale of CFLs “*as a way to save energy and fight global warming*” (Shogren, 2008). A legislator in California has proposed to ban completely, the sale of incandescent bulbs by 2012 (Masamitsu, 2007; Stevens, 2008; see also Deutsch, 2007; Anonymous, 2007a; Matthiessen, 2007, for replacement of incandescent bulbs in the U.S.). These sentiments have been reinforced by the U.S. President, Barack Obama (Norington, 2009; Galbraith, 2009). The same deadline has also been announced for the United Kingdom (Stevens, 2008; see also DEFRA, 2009). Saving 5 million tonnes of carbon dioxide per year by 2012 has been conveyed as a selling point by the UK government (DEFRA, 2008). Similar intentions were being conveyed by European manufacturers and retailers (Anonymous, 2007a). In 2009, these intentions were translated into action with the European Union passing new regulations on lighting systems along with a deadline of 2012 to phase out incandescent bulbs (Zeller Jr, 2009).

Australia, however, is attempting to replace traditional bulbs with fluorescent alternatives by implementing “*Minimum Energy Performance Standards for lighting purposes*” (Australian Government, 2008a; see also MEPS, 2009; Hopkins, 2008). The argument posed by the Australian Government is that use of CFLs will save “*30 terawatt hours of electricity, and 28 million tonnes of greenhouse gas emissions between 2008 and 2020*”. Furthermore, savings of approximately A\$380 million in the Australian economy are also being predicted (Australian Government, 2009). This paper, however, questions the complete banning of incandescent bulbs on the basis of potential consequences (economic and physiological) of using CFLs, as discussed in the next section.

The next section presents the main advantages and weaknesses in the argument about using the CFLs. This is followed by a discussion of the measures being undertaken by the manufacturers, retailers and (non-)government associations to address any potential health effects of using CFLs. The last section summarises the paper and future research areas.

ADVANTAGES AND WEAKNESSES OF USING CFLs

Electricity has become the basis of progress and survival for human development. It is now the essential energy that drives our activities at home, in offices and factories. From using electric toothbrushes first thing in the morning, to communicating (via mobile or landline phones, computers) professionally and personally, and operating machinery, we need to use some form of electric current. Air-conditioners and heaters give comfort during summers and winters, respectively. Humans are so dependent on use of electrical products that it is unthinkable to live without them. Our hunger for electricity has, however, come at a cost: increased emissions of greenhouse gases at the point of electricity production at coal plants, to all of our consumption patterns that use electricity. The demand for electricity has grown exponentially compared to its production and, consequently, electricity providers have steadily increased the price of electricity usage in a futile attempt to stabilise, if not decrease, its usage both domestically and commercially. This trend can be witnessed worldwide, one such example being in the state of Victoria, Australia. Between December 2007 and January 2008, letters were mailed to all domestic users about an increase in basic electricity rates and putting pressure on consumers to be vigilant and reduce their electricity consumption. By the last quarter of 2009, the author had received notification of an additional three price rises.

As early as 1992, manufacturers of tungsten halogen bulbs were being asked by the Food and Drug Administration (FDA) in the U.S. to “*redesign their products to shield users from ultraviolet (UV) radiation*” (FDA, 1992, p. 3). This step was undertaken by the FDA following a study conducted in Australia which showed that prolonged, close-range exposure to the light from tungsten-halogen bulbs increased the risk of skin cancer and could cause sunburn (FDA, 1992). The FDA wanted the manufacturers to redesign their bulbs and, furthermore, to provide warnings to consumers on the packaging. Another type of halogen bulb, the quartz, was also being linked to cancer concerns (Time Magazine, 1992). The U.S. Consumer Product Safety Commission (CPSC) issued a warning to consumers, not to use the 500-watt halogen bulbs near residential fixtures as the high temperatures resulting from their usage could result in a fire, especially if they came in close contact with flammable material (CPSC, 2003). Towards the end of the twentieth century, consumers were being asked to be 'green' and move from halogen-type varieties of bulbs to their technologically-advanced and environmentally-friendly fluorescent counterparts. The pressure for this move strengthened as governments and communities became aware of the greenhouse gas emissions, primarily, from use of incandescent bulbs and lamps. It has been suggested that households (12%) and commercial sectors (25%), collectively, contribute more than 35% of greenhouse gas emissions from lighting alone (Australian Government,

2008a). This is a staggering number and any reduction in this percentage will only be good for combating the impacts of global warming.

Most books or magazine articles on '*green ways*' recommend replacing incandescent bulbs with CFL ones as the right and easiest way to reduce the energy bill and mitigate detrimental impacts on the ecological environment (see **Ha, 2007; McKay and Bonnin, 2007**). One of the most significant selling points, and the precursor of increased usage of CFLs, was their cost-effectiveness in the long-term as they can save approximately \$50 over their life as compared to incandescent bulbs (**Gupta, 2005; Australian Government, 2008a; Snopes.com, 2008; REUK, 2007; Eartheasy, 2000-2008; EnergyStar, 2008**). Once properly installed, these bulbs have to be changed less frequently (**Fehrenbach, 2007**) compared to their incandescent counterparts due to their long life (**REUK, 2007; Eartheasy, 2000-2008; Bloch, 2008**). From the author's perspective, as the CFLs have to be replaced less frequently, in the long-term, it will reduce the number of incandescent bulbs going to the landfill.

The potential positive environmental impacts of using CFLs have only recently been advertised. Hence, customers (domestic and industrial) until recently, were changing one of their lifestyle choices primarily to save money. Noah Horowitz, a senior scientist with the Natural Resource Defense Council, mentioned "*people concerned about the environment and their health can buy these CFLs with a clear conscience*" (**MSNBC, 2007**). The CFLs use less power (**Eartheasy, 2000-2008; REUK, 2007; EnergyStar, 2008**). Manufacture of fluorescent bulbs creates less air pollution during the production process as it requires less coal (as a fuel) for the manufacturing plant, consequently decreasing overall greenhouse gas emissions by approximately 450 pounds for each bulb (**Fehrenbach, 2007; Stevens, 2008; Shogren, 2008; Australian Government, 2008a; MSNBC, 2007; REUK, 2007; Eartheasy, 2000-2008**). Laboratory testing has also proved that CFLs "*produce better light*" (**Masamitsu, 2007, p. 90; see also Eartheasy, 2000-2008**). Reinforcing the benefits of using CFLs as compared to their incandescent counterparts, Wendy Reed, responsible for managing EPA's energy star rating program, remarked (Shogren, 2008):

The compact fluorescent light bulb is a product people can use to positively influence the environment to prevent mercury emissions as well as greenhouse gas emissions. And it's something that we can do now, and it's extremely important that we do it. And the positive message is, if you recycle them, if you dispose of them properly, then they're doing a world of good.

The main concern when changing any habit is the uncertainty of the outcome and the balance of cost versus benefit. In the case of long-life bulbs, it is the initial cost of buying them. People living on tight budgets find it difficult to foresee and calculate the long-term financial benefits of using CFLs in lieu of their higher sale price (see **Familar, 2009**). In the case of organisations, however, the scenario is only slightly different as their main aim is to have a profitable bottom-line, therefore, initiatives that do not have an immediate return are generally put on the back burner unless implementation of those initiatives results in either a more profitable bottom-line or positive publicity. Another reason for the lack of enthusiasm in the uptake of CFLs has been that many people dislike the time it takes for them to shine on full power (**Snopes.com, 2008; Choice, 2000**). Unlike the incandescent bulbs that instantly shine with full brightness, it can take up to a minute for the CFLs to light up. CFLs also do not always "*work with dimmer switches [and] can interfere with radios, cordless phones, and remote controls*" (**Snopes.com, 2008; see also Farah, 2008; Eartheasy, 2000-2008**). When used as cupboard lights, or where they are frequently switched on and off, it has been found that CFLs are less effective in the long-term, hence, it is preferred that traditional incandescent bulbs be used in these situations (Eartheasy, 2000-2008).

CFL bulbs, even though requiring less energy to manufacture, are more complex in their structure, have multiple components and longer processing stages (**REUK, 2007**). Mercury (also known as quicksilver), the eightieth element on the periodic table, is an integral component of CFLs and is the reason for their long-life. All energy saving bulbs contain mercury, a neurotoxin, a substance detrimental and even fatal for humans (**Shogren, 2008; REUK, 2007**). Mercury can also "*damage the kidneys and liver*" (**MSNBC, 2007**). Gary Goland, Chairman of the People's Environmental Protection Alliance, when talking about the effects of mercury, said (Vaughan, 2008): "*The mercury in the fluorescent lights is very hazardous, not just a little bit hazardous, very, very hazardous to both the environment and your health*". Approximately 5 milligrams of mercury is contained in each CFL (**Johnson, 2008; DEFRA, 2009; REUK, 2007; Eartheasy, 2000-2008**) which, in itself, is very small and not harmful to human or most other life forms.

[It should be noted that the bulbs manufactured and sold in Australia are not standardised to European levels of 5 milligrams of mercury, but contain a higher percentage (see Australian Government, 2008a)].

When we throw the used or broken CFLs or incandescent bulbs into the household rubbish, they go into landfills. Approximately 99% of the 70 million CFLs and their fluorescent alternatives disposed of in Australia find their way into a landfill (**Hopkins, 2008**). Nevertheless, mercury from broken CFLs in landfills can be toxic (**MSNBC, 2007; REUK, 2007; Vaughan, 2008**) as broken CFLs release a cocktail of dangerous gases, specifically “*mercury vapour and mercury containing phosphor powder*” (Snopes.com, 2008). If not disposed of correctly, the mercury vapour can be inhaled by the rubbish collectors (Shogren, 2008; REUK, 2007) putting their health at risk, not to mention being absorbed in the soil (Shogren, 2008) and underground watertables. These energy-saving and environmentally friendly bulbs, thus, become dangerous once they are burnt out and need to be disposed of. The majority of current users throw away the bulbs along with other household rubbish, being generally unaware of the detrimental effects. The health impacts during manufacture also need to be acknowledged and discussed as they can result in detrimental health effects for the employees. This has become evident in China where employees are being poisoned by mercury, which, unfortunately, they are attempting to overlook. This was highlighted in medical tests of the workers and the comments made by them, such as those of a young female employee (**Sheridan, 2009**):

In tests, the mercury content in my blood and urine exceeded the standard, but I was not sent to hospital because the managers said I was strong and the mercury would be decontaminated by my immune system.

Experts in the United Kingdom claim that prolonged exposure to energy-saving bulbs can result in migraine headaches and other health problems, such as, “*nausea, dizziness, physical pain for those suffering with lupus*” (**Stevens, 2008; see also Farah, 2008**). Nonetheless, there is no media coverage and publicity by either government, non-governmental or industry organisations (specifically manufacturers) about the detrimental health and environmental effects of CFL disposal, hence, this issue is raised in this paper. The author has questioned whether this is due to lack of awareness amongst these parties, or whether the government is focused on short-term results of reducing greenhouse gas emissions and, similarly, manufacturers on profits. Once again, it should be emphasized here that the majority of the drawbacks mentioned in this section can be changed relatively easily with increasing awareness and education about long-term economic and safe disposal/recycling benefits amongst users. As the community is getting more concerned about the environment, they are also compromising on their choices and are changing their habits by replacing their home and office lighting options.

MEASURES AND INITIATIVES OF CFLs DISPOSAL

Ideally, CFLs need to be disposed of in the same manner as batteries (that also contain mercury) in a recycling or toxic waste depot, rather than in household rubbish (**Snopes.com, 2008**). This is supported by comments and highlighted by experts in the field such as Dr. David Spurgeon, an Environmental Scientist. He said (BBC, 2008): “*Because these light bulbs contain a small amount of mercury, they could cause a problem if they are disposed of in a normal waste-bin. It is possible that the mercury they contain could be released either into the air or from land-fill when they are released into the wider environment. That's a concern, because mercury is a well-known toxic substance*”. “*There is an enormous amount of mercury that's going to enter the waste stream at present with no preparation for it*”, words spoken by Ellen Silbergeld, Professor of Environmental Health Sciences at Johns Hopkins University and Editor of the Journal of Environmental Research. However, to date, few of us have been able to dispose of the batteries from our watches, walkman, ipods and remotes securely. In 2007, in the United States, nearly 620 million fluorescent bulbs were discarded and, of those, approximately 20% were recycled (Grover et al., 2007). It is alarming to multiply this number by the global population using different types of CFLs.

During January 2008 in Victoria, Australia, a local council collaborated with a non-governmental association and initiated a program where the residents in the Council's area could replace all their household incandescent bulbs with their energy-efficient counterpart free of charge (**City of Glen Eira, 2008**). Later in the year, the Council applauded the community's efforts as, according to the Council, it had resulted in savings of 234 tonnes of carbon dioxide and A\$24million from electricity bills (**Glen Eira News, 2008**). No information regarding disposal of the bulbs was, however, provided to the community members either verbally or on the brochure mailed to all the houses. As part of an Earth Day program, Santee Cooper provided free fluorescent light bulbs in the U.S. with the underlying message to

conserve energy (**Gaston, 2008**). As part of its 'Light for Less Program' the New Jersey Natural Gas Company also gave away CFLs to families and individuals (**njresources.com, 2004**). Oklahoma's (U.S.) largest homebuilder has already got onto the energy-efficient bulbs bandwagon by installing only CFLs in all new houses built (**Anonymous, 2008a**). All these freebies and the limited or no education about their disposal can only lead to more harm than benefits for the community and the ecological environment alike. Similar messages were being echoed by various U.S. environmental groups (**Anonymous, 2008c**). The head of the US-EPA acknowledged that adequate measures had not been undertaken to address the recycling of the CFLs (**Shogren, 2008**). Wendy Reed, responsible for managing EPA's energy star rating program, concurred with the head of the EPA's remarks, and commented (Shogren, 2008):

I share your frustration that there isn't a national infrastructure for the proper recycling of this product.

The US-EPA (2008) has taken the initiative and created a website that contains information about retailers and recycling centres that accept CFLs (**see also Northwest Energy, 2008**). The US-EPA is encouraging all community members (domestic and commercial) to recycle all bulbs containing mercury once they have burnt out. If the consumer is unable to recycle the CFL bulbs (as their local council or retailers may not provide this service), the US-EPA is requesting that these bulbs be disposed off securely in the household trash. [The fluorescent bulbs should be placed in double plastic bags and sealed before being mixed with other garbage collected weekly]. Again, in the United States, IKEA, the Swedish home furnishing chain, has been advertising programs where its customers can drop-off their burnt-off CFLs in their recycling bins (MSNBC, 2007; **see also Shogren, 2008**). No such initiative has been advertised in IKEA's Australian catalogue, for example, or their stores, and this raises the question, "Why?"

Eco Lights Northwest is "*the only company in Washington State that recycles fluorescent lamps*" (Shogren, 2008). Increasing drop-off points for CFLs are being observed in the U.S., however, not all the options are easy to access or free to the public (**Holt, 2008; see also Farah, 2008; Anonymous, 2008b**). Adding inconvenience to the mix when educating the public about safe disposal methods can only lead to the failure of the program. In the UK, the Waste Electrical and Electronic Equipment (WEEE) Regulations in force since July 2007 mandate disposal of CFLs waste (**Recolight, 2008; see also DEFRA, 2008, 2009**). Accordingly, the onus is being passed on to the manufacturers and retailers who sell the products to educate and inform the public about disposal of CFLs and other WEEE regulations. Since the second quarter of 2007, Wal-Mart has also been working with its CFLs suppliers and manufacturers and has requested that they "*reduce the amount of mercury in energy-saving bulbs*" (MSNBC, 2007; **see also The New York Times Company, 2007**). In early 2008, the first mercury recycling plant opened in Melbourne, Australia, and aims to recycle mercury from CFLs and dental amalgams (**Hopkins, 2008**). Their potential customers cover organisations from Australasian and South East Asian countries. Another company offering collection and recycling of fluorescent tubes in Australia is SITA Environmental Solutions (**SITA, 2006**). Further drop-off places across various Australian States have also been initiated by the Australian government (2008b). If one does accidentally break a CFL bulb, it is imperative to take immediate precautions to reduce any exposure or contact with mercury vapour or components, respectively. **Eartheasy (2000-2008; see also Australian Government, 2008a; 2008b; Johnson, 2008; DEFRA, 2009; Recolight, 2008; Bloch, 2008; BBC, 2008)** have outlined the following steps that should be undertaken in such a scenario:

- ✿ Open a window and leave the room for 15 minutes or more,
- ✿ Use a wet rag to clean it up and put all of the pieces, and the rag, into a plastic bag,
- ✿ Place all material in a second sealed plastic bag,
- ✿ Call your local recycling centre to see if they accept this material, otherwise put it in your local trash,
- ✿ Wash your hands afterwards.

It, nevertheless, needs to be acknowledged that a number of websites with information about CFLs disposal are emerging (**see, for example, Baskind, 2007; Bloch, 2008; LampRecycle.org, 2000-2003; Snopes.com, 2008**). In this digital age, when all of us are relying on the Internet to gain awareness about various products and services, enhancement of websites is not surprising. The next section briefly summarises the main themes of this paper and the future research areas.

CONCLUSION AND FUTURE RESEARCH AREAS

The aim of the paper was to document the positive and negative characteristics of using fluorescent bulbs, and raise

awareness of the potential negative health effects resulting from prolonged exposure to CFLs. There is little doubt that global warming and climate change is a fact and that each one of us needs to change our habits to reduce our individual impact on the ecological environment. Using energy efficient CFLs is arguably the right first step as the overall benefits outweigh the costs. Nonetheless, our efforts will only be successful if all stakeholders work together and follow proper CFLs recycling (preferably) or disposal methods. Even though replacing incandescent lights with CFLs is seen as a positive step, one should carefully consider the long-term impacts and practicality of this decision. For certain industries (e.g., cupboard lights in the hospitality sector) and domestic users (e.g., individuals with health issues or those regularly using night lights), use of incandescent bulbs may be the preferred and safer option. If the governments enforce their requirement to completely stop the sale of incandescent bulbs in preference to CFLs, it is likely that the manufacture of the former will eventually stop. **All manufacturers calculate the cost-effectiveness of their production output and, accordingly, reduced sales of incandescent bulbs along with government pressure will result in decreased demand for them, forcing manufacturers to discontinue their production. Is this response really practical and feasible?** Governments, even though generally working on utilitarianism principles, also have the responsibility to think about, for instance, minority groups such as people whose health may be impacted by exposure to CFLs. The governmental, non-governmental and environmental agencies also need to address other long-term environmental pollution challenges created by misuse or wrongful disposal of CFLs. Commercial and domestic consumers are trying to do the right thing by installing CFLs. Simultaneously, it is the responsibility of the government and non-governmental agencies to spread awareness about the potential negative effects of using CFLs and to implement initiatives for recycling and safe disposal. The need for more open and two-way communication to enhance public awareness of the side-effects of using CFLs was also raised by **Adrian Harding of the Environmental Protection Agency**. He emphasised that the message about the importance of safe waste disposal should come from all fronts: retailers, local authorities and the government (**BBC, 2008**). The producers of the CFLs must continue their efforts to replace mercury with alternative material that has less harmful effects both for humans and the ecological environment during manufacture, use and disposal. Silicate has been found to be an environmentally friendly alternative (**Wu, 1997; Wald, 2007**). Light emitting diodes or LEDs are another alternative that is proving to be more efficient than CFLs. Use of LEDs has been taken up in Buckingham Palace, UK (**Rosenthal & Barringer, 2009; see also Anonymous, 2007b, 2008d**). The high cost of LEDs, nevertheless, is a deterrent to their uptake (**Vestel, 2009**). More research needs to be undertaken to ensure technology addresses growing energy demands whilst reducing greenhouse gas emissions. Lack of publicity about potential health effects puts a question mark on the choices that customers (both domestic and industrial) can make when using and disposing of the CFLs. The author believes that people in this era want to do the right thing to save the environment for the present and future generations and, like initiatives carried out with paper and aluminium can recycling, for instance, will be willing to dispose of CFLs in a safe manner. The author recognises the current efforts and initiatives being implemented by government agencies in an attempt to reduce greenhouse emissions, however, questions whether this is only a short-term view. Whilst trying to reduce emissions in the immediate future (in this case by installing CFLs), are governments ignoring the potential long-term detrimental impacts of their decisions on the community and the environment?

The next step is to undertake semi-structured interviews with manufacturers, retailers and government officials to obtain their perspectives and understanding of the health effects from the usage of and prolonged exposure to CFLs. Focus groups with consumers (domestic and commercial) will also be conducted to identify their level of awareness of the positive and negative effects of using CFLs. Once the consumers are made aware of the potential negative impacts of using CFL alternatives, they should be asked whether or not they will continue using them. Consumer enthusiasm and willingness to properly dispose of or recycle the used or burned out CFLs, if provided with realistic and practical alternatives (for instance, not having to drive out to a hazard material location), also need to be explored.

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