



Full Length Research Article

ENERGY SAVINGS BY EXCESSIVE USE OF CFLs ENSUING DISASTROUS ECOSYSTEM

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ABSTRACT

Compact Fluorescent Lights have steadily increased in sales volume as because it provide maximum light output, more efficient than traditional light bulbs with minimum energy consumption. Development of fluorescent lamps that could fit in the same volume as comparable incandescent lamps required the development of new, high-efficacy phosphors that could withstand more power per unit area than the phosphors used with older, larger lamps. But CFLs contain toxic element, toxic fumes, fire hazard, and health hazard. Excessive use of CFLs may some disastrous on this ecosystem. This paper highlights that despite their large energy savings, consumers should be careful when using CFLs.

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INTRODUCTION

The parent to the modern fluorescent lamp was invented in the late 1890s by Peter Cooper Hewitt. That time these lamps were used for photographic studios and industries. Major industrial countries of the world faced energy crisis in the period 1970s. Fluorescent lamps are electrical discharge lamps that contain low-pressure mercury vapor and an inert gas, usually argon. The inside of the glass is coated with a fluorescent made with phosphor powder. The mercury vapor is excited by an electrical current between two electrodes and emits UV light. The UV light causes the phosphor coating to fluoresce and emit visible light. CFLs can be replaced a 100 watt incandescent bulb with a 22 watt CFL & same amount of light as CFLs use 50 - 80% less energy than incandescent lights. CFLs use 1/3 the electricity and last up to 10 times as long as incandescent bulbs, they are much less expensive to operate. For home use, most individuals prefer soft- or warm-white (~2,700 Kelvin) in the living areas and bedrooms and cool white (3,500 to 4,000, Kelvin) in the kitchen and in work and reading areas.

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The majority of lighting needs in the country are met by highly inefficient incandescent lamps (ICL). In warmer seasons or locations, incandescent lights make a space warmer than necessary and may drive us to turn on the air conditioning, thus leading to even more energy consumption. Using CFLs can also lower pollution generally and greenhouse gases specifically. It arrives effortlessly in our homes, and we seldom directly experience the pollution that results from the burning of fossil fuels (mostly coal) to generate it. India sold 300 million CFLs in 2010, and considering that the average life of a CFL in India is 4 years, about 300 million CFLs would have entered the waste stream in 2014 alone.

Characteristics of CFLs

In a CFL, an electric current is driven through a tube containing argon and a small amount of mercury vapor. This generates invisible ultraviolet light that excites a fluorescent coating (called phosphor) on the inside of the tube, which then emits visible light. A fluorescent lamp generates light from collisions in a hot gas ('plasma') of free accelerated electrons with atoms— typically mercury — in which electrons are bumped up to higher energy levels and then fall back while emitting at two UV emission lines (254 nm and 185 nm). The thus created UV radiation is then converted into visible light by UV excitation of a fluorescent coating on the glass

envelope of the lamp. The chemical composition of this coating is selected to emit in a desired spectrum.

amount of vapour could briefly be well above the limits allowed in the general environment, and could exceed the

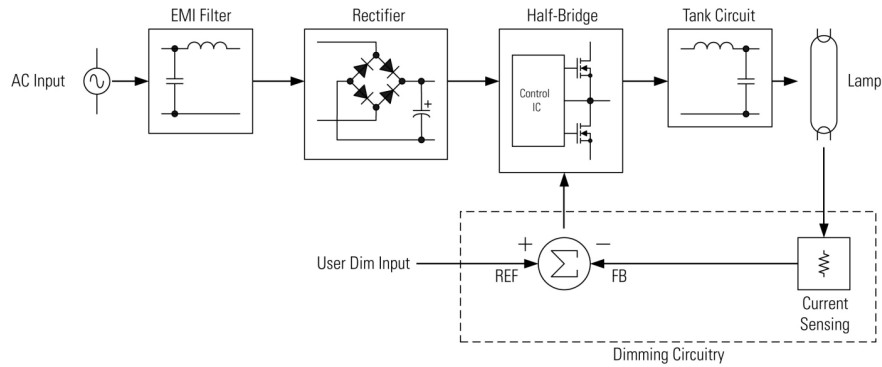


Fig. 1. CFL electronic ballast block diagram

Types of CFL

There are two types of CFL
Integrated and Non-integrated lamps

Integrated lamps combine the tube and ballast in a single unit. These lamps allow consumers to replace incandescent lamps easily with CFLs

Non-integrated lamps

- **bi pin tubes** –conventional ballasts
- **quad pin tubes** –electronic ballasts & conventional ballasts with starter

Depending on our needs, there are various CFLs:

- Twin Tube Lamps:** These have two parallel tubes are called Twin Tube Lamps. They are designed to fit into lamps, task lights, recessed ceiling lights and wall lights.
- Quad Tube Lamps:** These give nearly the same light output as twin-tube CFLs equivalent wattage. They are only half the length, however. This type of bulb fits better in smaller lamps and similar applications.
- Triple Biax Lamps:** These types of lamps generate even more light in a shorter bulb. Because they provide a high amount light output from a bulb that takes up a very small amount of space they are commonly used in fixtures designed for incandescent bulbs, such as table lamps.
- Spiral Lamps:** The shape of a spiral lamp is a continuous tube in a spiral shape. This is one of the most common forms, typically used in residential homes in lamps.
- F Lamps:** F lamps have two twin tubes, aligned top to bottom instead of side to side like a Quad tube making the shape of the bulb resemble an F.
- Circular (Circline) Lamps:** for reading lamps and other lamps which use a circular light.

Harmful effects of CFLs

Effects of Mercury

When the tube of a fluorescent light bulb breaks, the mercury vapour inside is released into the air. In an average room, the

levels allowed in the workplace. However, these limits are designed to protect adults who are exposed to such levels regularly during a 40-year work life, so they are not applicable for a very short-term exposure. Most of the mercury released from the CFL turns liquid very quickly so, shortly after the breakage, the level of mercury vapour becomes too low to cause any harm to adults, even those who are particularly sensitive. CFLs contain an average of 5 mg (range of 0.9 to 18 mg) of mercury. Breaking a single CFL bulb in a room can result in mercury vapor levels 300 times in excess of what the EPA has established as safe for prolonged exposure. Serious health effects are associated with mercury exposure. Unborn and young children, elderly and those with weakened health are particularly vulnerable. Mercury affects the nervous system. Neuro-pathways of children are still developing and exposure can result in permanent damage.

Fire risk

Bulb end-of-life hazards: When CFLs burn out they can create acrid plastic smoke and carcinogenic fumes. The power required from the supplier by a CFL is typically twice what the wattage the bulb states. This "Power Factor" can negate a great part of the savings at the grid level. Also, CFLs create an effect known as "harmonic distortion" by placing an uneven load on the electricity grid, setting up harmonic distortions in the power lines and power stations

Flicker effects

High frequency flickers lights could become hazardous to health. This flickering can cause problems for some individuals with light sensitivity. Low-frequency flicker can induce seizures in people with photosensitive epilepsy, and the normally unnoticeable 100–120 Hz flicker from fluorescent tubes powered by electromagnetic ballasts are associated with headaches, fatigue, blurred vision, eyestrain, and reduced visual task performance for certain populations. Newer fluorescent lights without magnetic ballasts have essentially eliminated flicker. Flicker can also produce hazardous phantom array effects - which may lead to distraction when driving at night, for example - or stroboscopic effects, which may result in the apparent slowing or stopping of moving machinery in an industrial setting. Some people who suffer from flicker sensitivity may not be aware that flicker is the

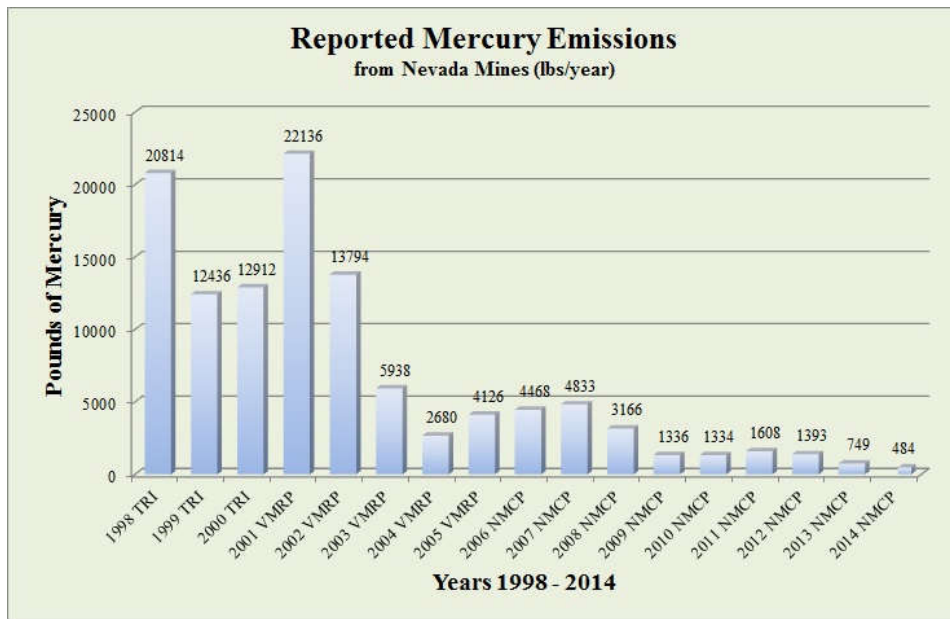
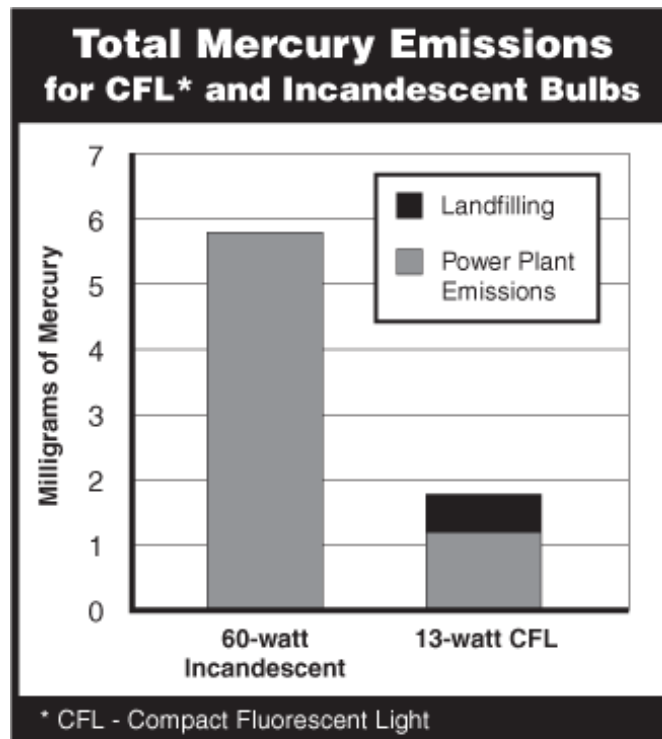


Fig. 2. This chart displays total mercury emissions using data from the Nevada Mercury Control Program (NMCP), the Voluntary Mercury Reduction Program (VMRP), and data from the US EPA's Toxic Release Inventory (TRI). Bureau of Air Quality Planning updated December 9, 2015



Source: www.energystar.gov

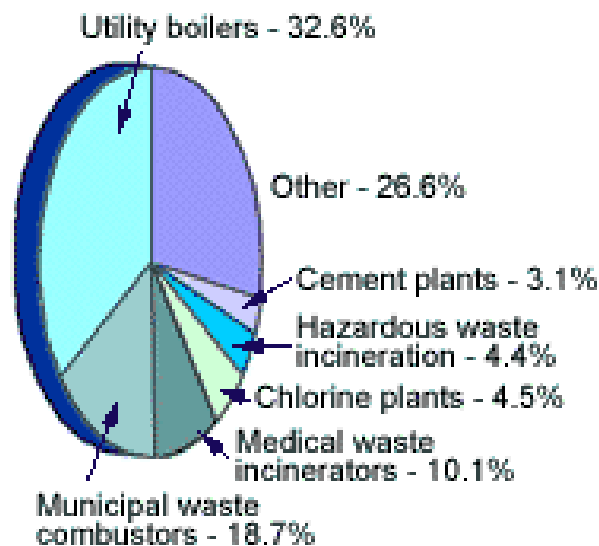
Fig. 3.

reason they are suffering, or even that the light source responsible for their suffering is flickering. Furthermore, not all human observers are equally sensitive to the potential effects of flicker. Populations that tend to be more susceptible to the effects of flicker include children, people with autism, and migraineurs. CFLs can damage paintings and textiles which have light-sensitive dye and pigments.

Harmful effects to skin

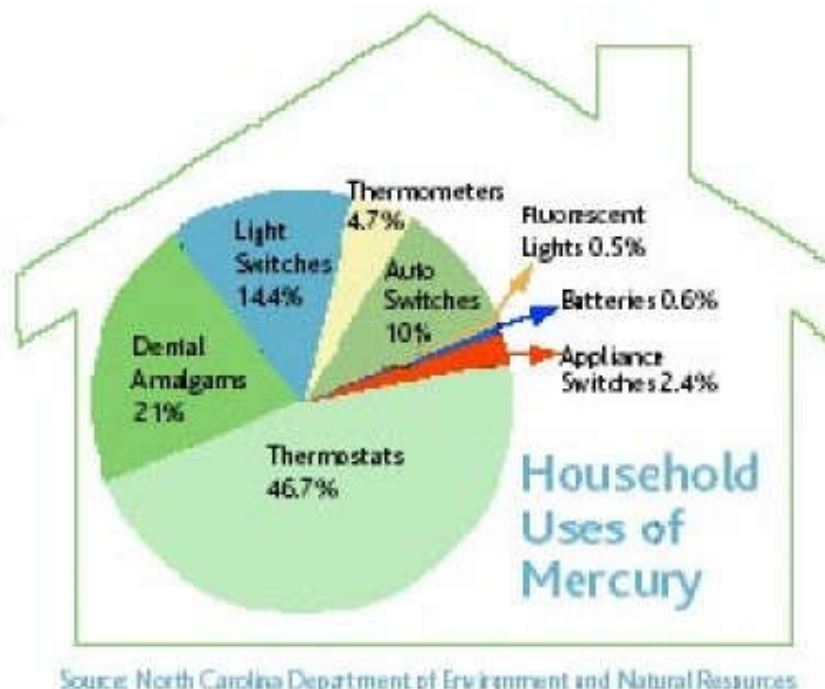
CFL may be harmful when in close proximity to the skin. The effects of exposure on healthy human skin tissue cells, Cells exposed to CFLs exhibited a decrease in the proliferation rate, a significant increase in the production of reactive oxygen species, and a decrease in their ability to contract collagen.

Sources of Mercury Emissions



1994-95 EPA Data

Fig. 4.



Source: North Carolina Department of Environment and Natural Resources

Fig. 5.

According to ANSES Report 2010, following skin diseases are linked to ultraviolet radiation. 3.1% of the population suffer from solar urticaria, a skin disorder affected by ultraviolet light. Some patients are directly affected by CFLs

- **Idiopathic Photodermatos is:** People with photodermatos may develop skin rashes upon exposure to the sun. Polymorphous Light Eruption is the most common type of photodermatos. It is most likely due to an abnormal immune system reaction to the sun. It is estimated that 10-20% of Europeans can be affected from the first three decades with a female prevalence.

It is estimated that this response to aggression by UVA, mainly solar, without sunburn, depends on the production of abnormal proteins in the epidermis and dermis.

- **Solar urticaria:** It is a rare condition in which exposure to ultraviolet or UV radiation, or sometimes even visible light, induces a case of urticaria or hives that can appear in both covered and uncovered areas of the skin.
- **Chronic actinic dermatitis:** is a condition where a subject's skin becomes inflamed due to a reaction to

sunlight . most patients have a long history of contact allergies and their skin is abnormally sensitive to UVA and visible radiation Diagnosis can occur at any age, ranging from soon after birth to adulthood.

- **Lupus erythematosus:** It is a chronic autoimmune disease often exacerbated by sun exposure. It is an erythematosus rash affecting the face forming an aspect of butterfly wing on the cheeks and cheekbones. The long UVA (360-400 nm) are the causal element. UV component, chronic exposure to CFL could possibly be a problem. Systemic lupus is an important condition in that skin flares can be associated with internal disease activity.
- **Porphyrias:-** These are a group of rare diseases in which chemical substances called porphyrias accumulate, leading to either skin changes or neurological symptoms or sometimes both. Porphyrias are classified in two ways, by symptoms and by pathophysiology. Symptomatically, acute porphyrias primarily cause brain and nerve involvement, often with severe abdominal pain, vomiting, neuropathy, and mental disturbances. Cutaneous porphyrias cause skin problems, often after exposure to sunlight, because porphyrias react with light
- **Skin cancer:** They are due to the development of abnormal cells that have the ability to invade or spread to other parts of the body. There are three main types: basal-cell skin cancer (BCC), squamous-cell skin cancer (SCC) and melanoma. Greater than 90% of cases are caused by exposure to ultraviolet radiation from the Sun. This exposure increases the risk of all three main types of skin cancer Exposure has increased partly due to a thinner ozone layer. The UV light may be from either the sun or from other sources, such as tanning devices. Tanning bed or sun tanning bed is a device that emits ultraviolet radiation Regular tanning beds use several fluorescent lamps that have phosphor blends designed to emit UV in a spectrum that is somewhat similar to the sun. Smaller, home tanning beds usually have 12 to 28 100 watt lamps while systems found in tanning salons can consist of 24 to 60 lamps, each of 100 to 200 watts. Melanoma, also known as malignant melanoma, is a type of cancer that develops from the pigment-containing cells known as melanocytes Melanomas typically occur in the skin but may rarely occur in the mouth, intestines, or eye. The primary cause of melanoma is ultraviolet light (UV) exposure in those with low levels of skin pigment. Melanoma is the most dangerous type of skin cancer. Globally, in 2012, it occurred in 232,000 people and resulted in 55,000 deaths. Melanoma is more common in men than women.

Ultraviolet radiation

The UV portion of the spectrum is divided into three regions: UVA (315 – 400 nm) UVB (280 – 315 nm) UVC (100 – 280 nm). Some fluorescent lamps emit ultraviolet radiation. The Health Protection Agency of the United Kingdom has

conducted research concluding that exposure to open (single envelope) Compact Fluorescent Lamps (CFLs) for over 1 hour per day at a distance of less than 30 cm can exceed guideline levels as recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Not all open CFLs produce significant UV emissions. However, close proximity to bare skin can result in exposure levels similar to direct sunlight. In 2009, Natural Resources Canada released a report describing the possible UV exposure from several types of lamps.

The report states that at 3 cm distance, the recommended daily exposure to ultraviolet radiation for skin and eye damage (if looking directly at the lamp) was attained between 50 minutes and 5 hours depending on the type of lamp. The report observes that such a close distance is unlikely in actual use. The report also states that most bare spiral lamps tested gave off more UV than the 60 watt incandescent lamp tested, but that the encapsulated (double envelope) CFLs emitted less UV radiation. At 30 cm distance, the recommended maximum daily exposure was attained between 3 hours and 6 hours, with little difference between the studied 60 Watt incandescent lamp and any bare-spiral CFL. The report states that the threshold limit values used represent otherwise healthy individuals who are not experiencing any hypersensitivity conditions or exposed to substances that increase UV sensitivity. Outdoor sunlight can supply the maximum recommended daily UV exposure in 20 to 100 minutes. Ultraviolet radiation emitted by fluorescent lighting can increase an individual's exposure to carcinogenic radiation by 10 to 30 per cent per year, with an associated increased probability of contracting squamous cell carcinoma by 4 percent.

Electromagnetic radiation

The electronic ballasts in fluorescent lamps emit electric and magnetic fields in the low-frequency range. Some fluorescent bulbs emit high frequency fields (30-60 kHz). Electric fields of this intensity have been associated with biological effects diabetes and cancers.

Disposal

CFLs release hazardous amounts of mercury into the air when they break and thus must be recycled or disposed of at a proper facility. A recent environmental agency report estimates the potential cost to recycle one disposal container (wheelie-bin) of approximately 240 liters or 63.4 US gallons of CFL bulbs at \$1,300. This cost ultimately falls on the taxpayer.

Drug/chemical induced photosensitivity

Amiodarone is a cardiac antidysrhythmic agent that causes a burning, prickling sensation with erythema in approximately 50% of individuals on high dose. The wavelengths responsible are UVA and visible light. Unsightly slate-grey skin pigmentation may also develop. Phenothiazine-derivative drugs have an antipsychotic action, thought to act by blocking dopaminergic transmission within the brain. They produce skin discomfort, erythema and blistering elicited by exposure to UVA. Unsightly skin discolouration may also occur

Conclusion

The Bureau of Indian Standards has amended the existing CFL Standard IS15111 by fixing mercury limit to less than 5 mgs in CFLs of less than 26 watts. Industry has taken a further step to reduce it to less than 3.5 mg by end of 2014. This has been made possible by using pill insertion of mercury amalgam. The states which saw the greatest success of the Bachat Lamp Yojna scheme were Kerala and Haryana where 126 million and 56 million CFLs were sold respectively under the scheme. India's CFL use has been growing at over 20% annually. At the same time, a lack of awareness amongst domestic consumers and informal recyclers has led to disposal of CFLs in a potentially dangerous manner. CFL labels indicate the level of mercury in the bulb and inform the consumer about the hazards of improper disposal. The Ministry of Environment and Forest has prepared guidelines on safe disposal and recycling of mercury from used lamps. Central Pollution Control Board in association with Lighting Industry will implement the guidelines. Under these guidelines, one of the important factors for action is decided to appoint "Lamp Recycling Units" (LRUs). Like mercury, phosphor powder, glass, plastic etc, and sent back to factories for reuse. For the time being, unbroken CFL bulbs, can be put in a polythene bag and handed over to the garbage collector personally, informing him that the bag contains CFL lamp. It is proposed that Local Municipal authorities should arrange to inform and train the garbage collectors about mercury safe handling. Till the recycling system is put into place, the local civic authority should provide a specified safe dumping place (preferably a concrete well) which will be sealed once full. Govt. should take proper steps to promote use of another type i.e. LED instead of CFLs and aware of the drawbacks of the said lamps and save our ecosystem.

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