

COMPACT FLUORESCENT LAMPS, AN ANTICIPATORY MIND TO MERCURY

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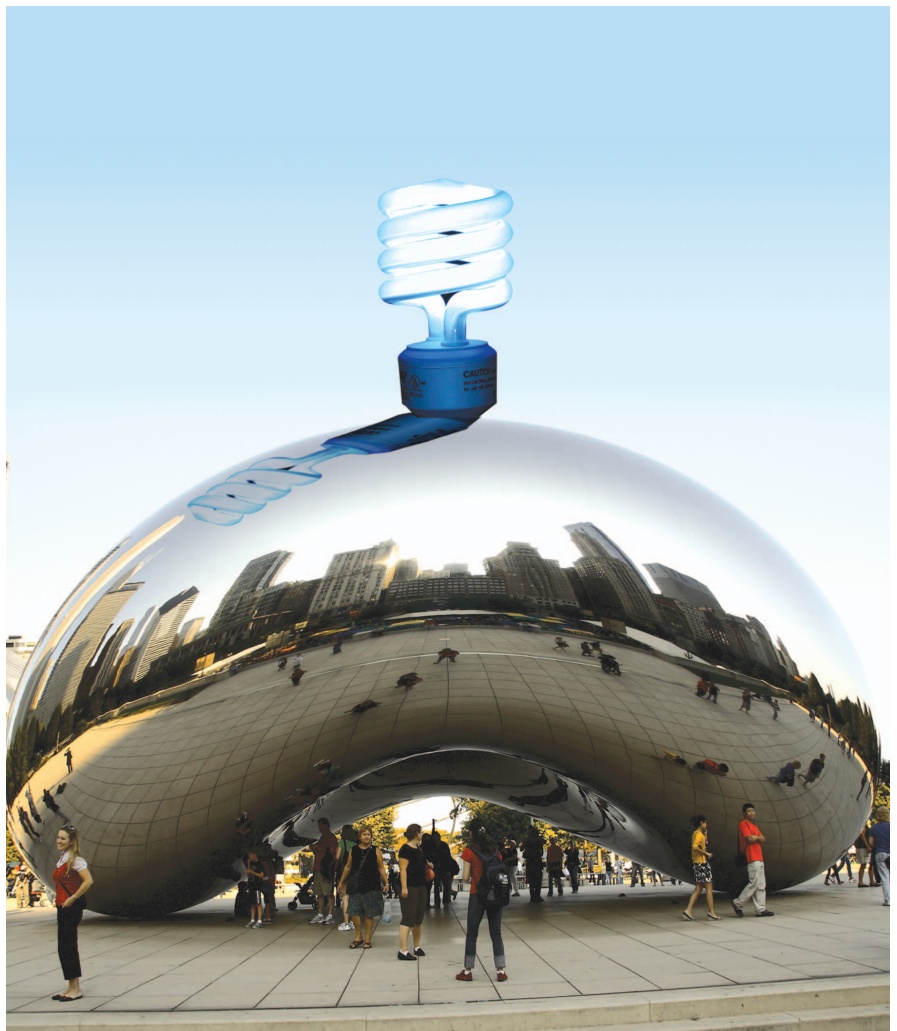


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The compact fluorescent lamp (CFL) was invented by Ed Hammer, an engineer working for General Electric, in response to the 1973 oil crisis and introduced worldwide in the 1980s. CFLs present an advantage to the consumer relative to traditional or incandescent bulbs. For instance, CFLs provide the same intensity of light as incandescent bulbs, but use about 75% less energy and generate approximately 75% less heat, cutting home cooling costs. Also, they last up to ten times longer than a standard incandescent bulb. CFLs also have a positive impact on the environment, because of its lower energy requirement, just one bulb can prevent more than 400 lbs of greenhouse gas emissions over its lifetime. On the other hand, CFLs contain an average of 4 mg of mercury, an extremely toxic element that has detrimental effects on our health and the environment. Because of this, the disposal of CFLs has to be managed carefully, and it is indispensable to recycle of such bulbs. The purpose of this paper is not to discredit the use of CFLs but to raise consciousness that, like other daily materials, we should be aware of the risks and consequences that they have if they are not used or disposed off as suggested by law and the manufacturer.

CFL composition

The composition of a fluorescent lamp basically consists of a sealed glass tube. This tube contains an amount of mercury and a gas that usually is argon. These two elements are kept

under low pressure inside the tube. The tube is also coated with phosphor, the element used to produce the visible light. Moreover, it also contains two electrodes at the end of each side of the tube. These electrodes are connected to an electrical circuit that includes a starter and ballast. The ballast regulates the flow of power through the lamp, and the starter is responsible for letting the current flow through to the electrodes at each end of the tube.

When the lamp is turned on, a current passes through the electrical circuit to the electrodes; each electrode has a filament that is going to be heated by such current. The heated filament excites the electrons, ionizing the gases (mercury and argon) in the sealed glass tube. The ionized mercury vapor generates a radiant energy ultraviolet light. Then the phosphor coated in the tube emits visible light in response to the radiation of the ultraviolet light.

Looking at the benefits

The utilization of CFLs presents a long-term benefit for the consumer. Although CFLs are more expensive than incandescent bulbs, in the long term the utilization will save money for the consumer as the lamps use 50% to 80% less energy and last up to ten times longer in comparison to incandescent bulbs. For instance, according to Energy Star, if an 18 W compact fluorescent lamp is used to replace a 75 W incandescent bulb, the consumer will save about 570 kWh over its lifetime. At 8 cents per kWh, that is equal to a US\$45 savings. Moreover,

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the electricity used over the lifetime of a single incandescent bulb costs five to ten times the original purchase price of the bulb itself.

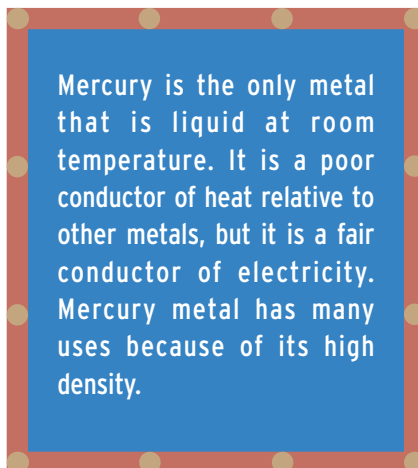
In addition, the replacement of a single incandescent bulb with a compact fluorescent lamp will keep a half-ton of CO₂ out of the atmosphere over the life of the bulb. Saving electricity reduces CO₂ emissions, sulfur oxide, and high-level nuclear waste. Also, according to Energy Star, if every American home replaced just one light bulb with a compact fluorescent bulb, we would save enough energy to light more than 3 million homes for a year, more than US\$600 million in annual energy costs, and prevent greenhouse gases equivalent to the emissions of more than 800,000 cars. Moreover, if this implementation would take place, an average of 90 power plants over the United States could be retired.

The magic of mercury

In order to understand the negative effects of mercury, it is important to understand mercury itself. Mercury is the only metal that is liquid at room temperature. It is a poor conductor of heat relative to other metals, but it is a fair conductor of electricity. Mercury metal has many uses because of its high density. It is used in barometers and manometers. It is also used in thermometers, since mercury has a high rate of thermal expansion that is fairly constant over a wide temperature range.

Health effects examination

When a compact fluorescent lamp is broken, the mercury in it is released to



the environment in vapor form. This mercury can be very dangerous for our health, since nearly 80% of this vapor travels via the respiratory system to our blood stream. There are several kinds of illnesses related to the exposure of mercury. Some of the illnesses associated with this exposure are cancer, depression, insomnia, and memory damage. These illnesses can cause damages in organs such as the kidneys, and may also damage the central nervous system. Another important fact is that when mercury enters the body, it reaches the brain where it remains and accumulates.

Avoiding exposure

When CFLs are improperly disposed of, or broken, they release mercury vapors that are harmful to human health and ecological systems. That is why the U.S. Environmental Protection Agency (EPA) has important guidelines regarding this problem. When a com-

pact fluorescent lamp breaks, the EPA recommends to leave the room where the lamp broke for at least 15 min. The person may then enter the room and use rubber, nitrile, or latex gloves to cautiously collect the glass pieces and powder. These residual materials must be cleaned with wipes and placed in a glass jar or sealed plastic bag. It is important to know that the use of a vacuum cleaner or a broom to clean up the broken bulb on hard surfaces, is dangerous because will disperse the mercury in the area.

Case of study: Puerto Rico

In order to investigate how aware people are about facts such as the mercury content in CFLs, its health and environmental effects, and the prevention of such problems, a survey was carried out among 100 Puerto Ricans. This survey helped determine what information society needs to know in order to become conscious about the hazards that CFLs may produce, and, moreover, to recognize the importance of the proper handling and recycling of such lamps.

Investigative survey

The survey consisted of nine questions and the answers led to several conclusions. The results are shown in Table 1. First, people seem to prefer CFLs instead of incandescent lamps. This interest in CFLs is, perhaps, a result of the concern people have about the ascending price of petroleum. As a consequence, people are looking for options to reduce energy consumption. With CFLs' popularity rising, an important worry arises: do people know about the health and environmental hazards? According to the survey, more than 50% of people don't read the manufacturer's label and warnings, and 34% of homeowners don't know that Hg is the symbol for mercury. This means that a significant number of people aren't aware of the content of mercury in CFLs, therefore, they probably don't take the necessary precautions when handling and disposing of such lamps.

Considering some other questions, in Puerto Rico there are approximately 10 to 15 CFLs per home, and among the 100 people surveyed only 3% of them recycle such light bulbs. This indicates that an alarming amount of mercury is reaching the dumping sites and soils of Puerto Rico.

Other important information obtained from the survey is that the majority of

Table 1. Survey: management of compact fluorescent lamps.

Survey	Homeowner	Student	Total
People who knew what Hg means	33%	46%	79%
People who prefer CFL instead of incandescent bulbs	48%	50%	98%
People who have recycled at least one time	42%	27%	69%
People who manage to correctly dispose of the CFL	3%	0%	3%
People who throw the CFL in a trash container	47%	50%	97%
People who knew that mercury can be a danger to their health	42%	48%	90%
People in favor of a compulsory recycling program	47%	45%	92%
People who read the label of a product before using it	26%	11%	37%
Average number of bulbs by home			10–15

people are in favor of the implementation of a compulsory recycling program. This leads to the conclusion that if people are well informed and drastic measures are taken, such as the implement of a compulsory recycling program, the emission of mercury from sources such as CFLs can be reduced or eliminated. If this can be accomplished, the previously mentioned problems and other environmental and health issues could be significantly reduced.

Evaluating the impact

In 2000, Puerto Rico's Planning Board/Census Office found that there were 1,418,476 housing units in the country. Moreover, each house has approximately 10 to 15 CFLs, thus there are millions of these bulbs distributed among the houses of Puerto Rico. Alarmingly, this means that, if not recycled, all these millions of light bulbs will be reaching the municipal landfills and liberating their mercury content in the soil, air, and eventually the waters. A summary of possible mercury exposure in Puerto Rico is shown in Table 2.

Most of the landfills in Puerto Rico are near bodies of water like the ones located in the towns of Cabo Rojo, Ponce, Barranquitas, Jayuya, and Mayagüez, among others. The harmful effects on water are evident in the water quality reports carried out by the Water and Sewer Authority of Puerto Rico. For instance, in Mayagüez, a city on the west coast, a mercury concentration of 0.3 ppb was detected in 2007. According to the Environmental Quality Board of Puerto Rico, the toxin reached the limit of the maximum permitted concentration. The report informs that the main sources of the contaminant are nearby landfills and factory waste products, among others.

Solid waste and landfills

Puerto Rico is a small island with a population of about 4 million. The management of solid waste on the island is a significant problem. A while ago, there were 64 active dumping sites in the country. In April 1994 some amendments to the federal regulation (subtitle D in the Resource Conservation and Recovery Act of the EPA) were made and it was necessary to close 32 dumping sites. Meanwhile, another three dumping sites have been closed, since they have reached the maximum waste capacity. According to the Solid Waste Authority, 8,100 tons of solid waste is generated daily in the island which corresponds to 4.9 lbs of solid waste per person. Currently, there are 29 dumping sites that

Table 2. Summary of total possible mercury exposure in Puerto Rico.

Housing unit in Puerto Rico	Approximately 1,418,476
Bulbs per house	10–15 bulbs
Presence of mercury in bulbs	Approximately 4 mg
Total presence of mercury in Puerto Rico	56,739,040 mg–85,108,560 mg 56.73904 kg – 85.10856 kg

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are insufficient for the proper disposal of solid waste in Puerto Rico. Besides, all of them are rapidly reaching their limits of waste capacity and some of them will be closed less than seven years.

Solid waste authority

There are only three recycling centers in Puerto Rico where CFLs can be recycled: ONYX Environmental Services, Safety Kleen Environmental Systems, and Enivronics. These companies recycle the CFLs, but people must deliver the lamps to the company. However, the companies are

willing to go and collect the bulbs if there is a considerable amount. For many people, these recycling sites are far away but other companies are helping the progress of recycling lamps. Companies such as Home Depot and the Puerto Rico Electric Power Authority are accepting fluorescent lamps from the public in order to appropriately gather them and deliver to the recycling center companies.

Law and regulations

The Universal Waste Regulation (40 CFR Part 273) presents the standards and requirements for the universal waste management for certain wastes including mercury-containing batteries, pesticides, lamps, and thermostats. A used lamp becomes a universal waste on the date it is discarded. A small quantity handler of universal waste must manage lamps in a way that prevents the release of any universal waste or component of a universal waste to the environment, as follows:

- A small quantity handler of universal waste must immediately clean up and place in a container any lamp that is broken, and must place in a container any lamp that shows evidence of breakage, leakage, or damage that could cause the release of mercury or other hazardous constituents to the environment.
- Containers must be closed, structurally sound, compatible with the contents of the lamps and must lack evidence of leakage, spillage, or damage

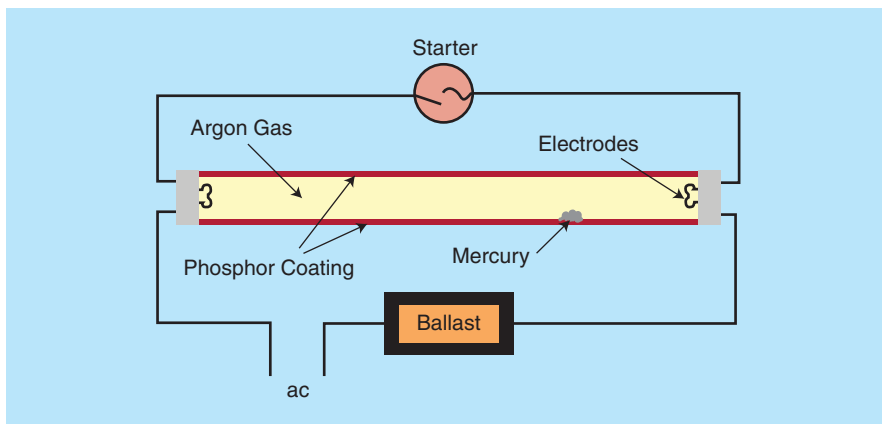


Fig. 1 Diagram for a compact fluorescent lamp.

that could cause leakage or releases of mercury or other hazardous constituents to the environment under reasonably foreseeable conditions.

In addition, different states have been adopting other regulations as in the case of California and Florida: In California, AB 1699 (LS: 03): The Mercury Recycling Enhancement Act of 2003 prohibits any person from disposing of a fluorescent lamp in a solid waste facility. Moreover, in Florida, the following prohibitions are in effect:

- Effective 1 January 1996, any mercury-containing device or device components that contain mercury shall not knowingly be disposed of in landfills or incinerated in any manner prohibited by Section 403.7186, F.S.

- Spent mercury-containing lamps or residuals shall not knowingly be incinerated in any municipal or other incinerator.

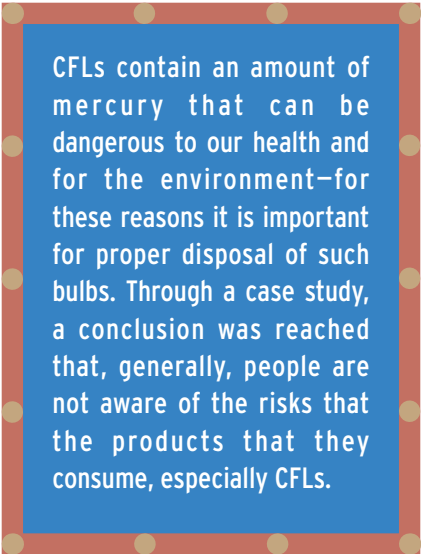
Conclusion

People are being encouraged to replace regular or incandescent bulbs with CFLs. The reason of this change is because CFLs present more advantages relative to incandescent bulbs. One reason for this change is that CFLs are more effective because they produce the same amount of illumination with less power.

On the other hand, CFLs contain an amount of mercury that can be dangerous to our health and for the environment—for these reasons it is important for proper disposal of such bulbs. Through a case study, a conclusion was reached that, generally, people are not aware of the risks that the products that they consume, especially CFLs, imply. It is necessary to educate society about CFLs in general, and most importantly, about the potential damages that they may cause to our health and the environment if they are handled inappropriately.

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Read more about it

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