



## Review Paper

# E-Waste Toxicity, Expulsion and its Status in IRAN: A Review

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## Abstract

*The wide application of electronic devices in modern life which aims to improve the life quality and facilitate the affairs, in particular, increase the rate of out of use e-devices day after day. By the end of the useful life of E-devices, exceptional methods should be considered for their expulsion because they include some specific materials and compounds. E-Waste is described as the dark side of modern digital age and caused many problems for environment. Hereunder, the most important included compounds and materials in E-Waste and its dangers for environment will be described. Then the most common methods for its ex pulsing are investigated along with their effects, and some suggestions are presented in order to improve the management of E-Waste in the final chapter, which emphasize the reduction of waste volume as the main solution, considered 2-5 % of urban disposal correct treating of E-Waste is too important. Computer monitors, and CRTs of old TVs contain four lb (1.81 Kg) Lead in average, and their expulsion should be performed, through special methods at the end of their useful life. In addition to Lead, these devise also contain Chromium, Cadmium, Mercury, Beryllium, Nickel, Zinc and flame retardants and in case of not being excluded or recycled in a right way, the existing toxic materials in E-devices would be dangerous. Increasing the duration of useful life of E-device, dedicating them to low-income individuals, and updating them can be followed by economic use of the costs and precious recourses. Besides the prevention of environment pollution, the right recycling of electronic equipment, which is out of use, can bring back costly materials into the cycle. This paper illustrates E-waste, its hazard and treatment method, then E-waste condition in Iran is investigated and finally recycling computer-as a major E-waste item, and its economic benefits in Iran will be discussed as a case study. At the worst case-if only 50 percent of end-of-life available computer in Iran could be recycled 75 million dollar will be gained in the case of recycling*

**Keywords:** E-waste, E-cycling, solid waste, hazardous wastes.

## Introduction

According to the waste-management rules approved by Islamic Consultative Assembly on May 10, 2003, the unsafe materials contained in E-Waste definition is the exceptional wastages include: all the waste with high risk of at least one dangerous characteristic such as toxicity, pathogenicity, explosion and flammability, corrosion and so on, which need to be cared in a unique way<sup>1</sup>.

Although electronic wastes contain deadly materials, people are rarely aware of the matter. Poisonous materials such as lead and cadmium which are used in construction of circuit boards, lead oxide, cadmium and mercury in flat-panel monitors, cadmium in computer batteries, the plastic materials used in computer cases, ordinary cables and those which produce toxic oxides instead of PVC while burning (in order to take out the copper from the wire) are existed in E-devices.

Because of such risks, the recycling of electronic waste causes some environmental problems besides it would be legally

prosecuted. The burning and burying of computer waste also cause substantial problems through polluting the environment and especially soil and water contamination. Polluted water kills fish and other marine life, and the polluted soil leads to a reduction of the amount of land available for growing food<sup>2</sup>. In case of being buried, the contained toxic materials in the waste would enter watercourses and groundwater; whereas burning them would enter the toxic materials and oxides into the air. That's why the recycling of computers would be followed by serious environmental and positional problems, especially when recycling industry does not obey the employee-related security rules because of its low profitability.

According to this definition, the electronic waste is also included in special wastages. In this part, some of the most important materials and compounds contained in E-Waste are mentioned along with the harms they would cause<sup>3</sup>.

**Hazards:** E-wastes contains the wide range of hazardous materials whom each one could cause serious damage on

environment or human and nature health; most harmful elements and contaminant in E-waste are listed as below:

**Chlorofluorocarbon (CFC):** Chlorofluorocarbons are compounds of colour, flour, carbon and sometimes, hydrogen. They are mainly applied in cooling unites and insulators. Since the entrance of these materials to the atmosphere and their aggregation in stratosphere layer destroys the ozone layer, their application in the industries is stopped nowadays. Increasing the possibility of human skin cancer, and genetic disorders in many other animates are also among the effects of CFCs. Since the convention in Montreal chlorofluorocarbon are less commonly used<sup>4</sup>.

**Dioxin:** Dioxin and freons include wide groups of chemical materials containing 75 various dioxin compounds and 135 dependent compounds, which are known as freons. Dioxins are mainly found in PCDD (polychlorinated dibenzodioxins) and PCDF (polychlorinated dibenzofurans) compounds. Although Dioxin is never produced directly, it appears unwontedly as a sidelong product in some factories such as insecticide manufacturers and while burning some materials. The toxic effects of dioxins on health of humans and animals are perfectly known. These materials aggregate in the body, and they may cause embryonic disorders, reproduction and growth reduction, and harms in the immunity system. The most known and toxic dioxins are TCDDs 2, 3, 7 and 8. As the harmful effects of Dioxin recognized, several countries implemented regulation design to reduce or control exposure of dioxin sine 1970<sup>5</sup>.

**Lead:** After the iron, aluminium, copper and zinc, lead is considered as the most usable metal. Lead tends to accumulate in soils and sediments, due to low solubility; it can remain accessible to the food chain and to human metabolism far into the future<sup>7</sup>. It is also called lead is one of the environmental threat that affect health of children<sup>6</sup>. This metal is used in soldering in electronic industries. It is also applied in lead-acid batteries, the cables of circuit boards, cathode ray monitors, etc. nausea, diarrhea, convulsion, coma and even death, are all among the effects of short-term exposure to large quantities of Lead. The other symptoms include anorexia, gastric pains, constipation, weariness, insomnia, bad temper and headache. Besides, the long-term exposure to lead in industrial centres can cause kidney injury. The effect of lead on children is far more dangerous, and it can hurt their nervous system or cause blood and brain problems in them. Lead is the most dangerous material accompanying copper in E-Wastes<sup>8,9</sup>.

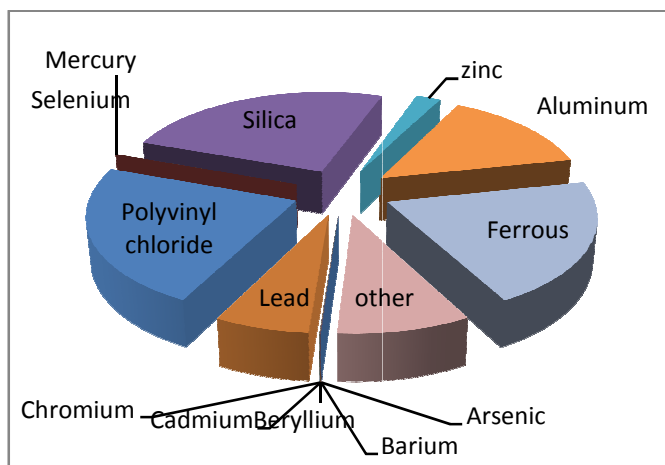
Techniques used for removal of heavy metals, like chemical precipitation, lime coagulation, ion exchange, reverse osmosis and solvent extraction are expensive and non-environmental friendly, as compared to adsorption<sup>10</sup>.

**Mercury:** Mercury is known as one of the most harmful metals applied in electronic industry. Breathing or swallowing this heavy and toxic metal can cause liver and brain injuries. Organic mercury primarily affects the nervous system<sup>11</sup>.

Mercury is usually found in batteries, switches, temperature adjusters and fluorescent lamps. Environmental effects of mercury in animals include death, reduced fertility, slower growth and development<sup>12</sup>.

**Polyvinyl chloride (PVC):** PVCs are among the most usable groups of plastics, which are widely applied in construction of electronic products, home appliances, pipes, etc. it contains more than 56% chlorine, and it produces the considerable amount of hydrogen chloride gas while burning, which generates acid hydrochloric compounded by water. Breathing this gas can cause respiratory problems. PVC combust produces CO, which is odourless, colourless and narcotic gas<sup>13</sup>. Safe disposal of plastics waste is a serious concern all over the world<sup>14</sup>.

Figure-1 Accomplished composition for E-Waste and investigates a computer as an example<sup>15</sup>.



**Figure-1**  
**E -Waste Composition (computer as an example)**

## Material and Methods

**Waste expulsion methods:** There is many various methods' foe expulsion of E-Waste among which burying them in the ground is the most dangerous one and recycling is the one which is mostly adapted to environment.

The recycling of the products containing unsafe ingredients, for example, the halogenated materials in plastic compounds of E-Waste produces Dioxins and Freon. Since metal and plastic parts are next to each other in electronic waste, the recycling process for plastics and its contained halogenated materials produces toxic risky gases, especially the plastics which are resistant to heat. The environmental problem of recycling is not limited to halogenated materials. The propagation of harmful gasses in the air should be also considered while recycling those E-Wastes types, which contain heavy natal such as lead and cadmium. Of course, through adoption of precautionary

methods, the amount of polluting materials can be decreased considerably. Another recycling issue is right and appropriate separation of components. For instance, if the separation is performed in a wrong way, some dangerous materials such as PCBs in Capacitors might be spread through recycled metals or other separated components from the waste. The ratio of air pollution (compared to the transmitted harmful materials to the environment per thousand tons waste), has been calculated for E-Waste as a sample, and it indicates that the propagation of lead through recycling the computers, and TVs is the most compared with other types of E-Waste.

By and large, it can be said that copper and lead are the main pollutants in recycling process. Some of the recycles use the different parts of E-Waste also as a furnace fuel.

**Burning inside the furnace:** One of the E-Waste removal methods is to burn them in a furnace. Since electronic components contain various materials, burning them can be considered as a potential propagator of different pollutants in environment. The gasses produced by burning the E-Waste inside the furnaces, would cause far worst environmental damages if it happens without pollution controlling plans. For example, it performed investigations on the issue have indicated that if the copper in circuit boards and cable's burns in the furnace along with heat opposed materials, it would act as a catalyst to produce Dioxin. Burning heat resistant materials in lower temperature (for example, example 600°C- 800°C), will produce extremely toxic materials such as PBDD and PBDF.

PVC which is also considerably found in E-Waste would be corrosive while burning and compounding with dioxin. In addition to production of toxic gases, burning the waste inside the furnace is a waste of valuable materials that could be reused in the production cycle.

**Burning in open space:** A search for the published reports for on incineration of E-Waste yielded 50 primaries studied and three reviews<sup>16</sup>. Since the burning process is performed in a lower temperature in this method, far more polluting gasses are produced compared to the burning inside the furnace. Breathing the smoke derived by this burning process can cause asthma attacks, respiratory infections, and other problems such as coughing, sneezing, pain in chest and eye irritation.

Long-term exposure to this smoke would be followed by diseases such as emphysema and cancer. For example, when PVC burns, Hydrogen Chloride gas is produced. Breathing this gas and its combination with the water into the lungs produces hydrochloride acid, which erodes the lung tissues and causes many respiratory problems. Burning the waste in a lack of Oxygen produces Carbon Monoxide breathing, which is harmful for health. The remaining particles from the waste burning process which can be spread easily like ash, would enter the body through breathing and endanger human's health.

**Burial in the ground:** More than 220 papers have been published that addresses health hazard associated with landfill sites<sup>16</sup>. However the source of contamination that caused human health effects in these studies are not known<sup>17</sup>. Burying is one of the most common ways of waste expulsion. Since the landfill, sites are generally leaking the leachate of E-Waste, which contains dangerous materials and heavy metals pollutes the soil and water resources. Soil has a major emphasis on improving the productivity of agricultural systems; leading to the understanding that increasing soil carbon stocks in degraded lands is essential for enhanced productivity also Pressmud like other organic materials affects the physical, chemical and biological properties of soil<sup>18,19</sup>. Soil has chemical properties as on its compositions like C, K, S, P, Ca, Mg, and Na<sup>20</sup>. Burial in the ground also has too many economic and environmental disadvantages<sup>21</sup>. Even well insulated trenches are not completely without leaking. It should be considered that the older trenches leak more. Mercury, cadmium and lead are among the materials that are usually found in such trenches. For example, burying components such as circuit boards produces mercury containing leachate or lead is contained in leachate of broken glasses of cashed ray tubes, TVs or monitors.

Burying the heat-resistant plastics or those which contain cadmium causes the leakage of PBDE and cadmium containing leachate into soil and water resources. Burying the condensers causes a leakage of harmful polychlorinated biphenyl. In addition to the leakage of leachate, evaporation is also considered as the other environmental problem of burying waste. For instance, materials such as mercury and its compounds like diethyl mercury enter the air from the landfill sites. Besides, the landfill sites are generally prone to fire, and if it happens the derived gases buy such a fire are too toxic. Separation of dangerous materials from E-Waste, limitation of waste burying to those which can't be recycled or reused, improving the situation of landfill sites and planning needed schemes in order to reduce the harmful effects of burying on environment, are all among the ways which considerably decrease the negative effects of these methods.

**Export- the best way of escape:** What is known is that E-Waste recycling involves complex processes and its more costly to recycle<sup>20</sup>. Some countries exports their E-Waste to the Asian developing countries. The E-Waste is mostly produced by developed countries around the world. Exporting these types of waste to non-developed countries is the best way for industrial to get rid of its related issues. At the late 80s and the early 90s, the majority of people held demonstrations against this issue in most of the countries, so that the basel convention international rules were approved. However, presently, a new issue was raised due to the trade of this waste by the name of recycling. Right now, the electronic materials are being sent to Asian countries to be recycled. That's why in 1994, Basel Convention forbade the export of any dangerous waste from rich country to developing ones in any name \_such as recycling.

**E-Waste in Iran:** According to one of the environment experts in Iran Environment Organization-Mr. Asilian, there is still no plan to recycle the electronic waste specially the contained toxic materials in computer hardware. According to this proposal, although computer components contain toxic materials, their recycling is far more expensive than throwing them away and as a result the needed predictions are not adopted yet. More than 4 million computers are outdated in Iran while Recycling and Environment Organizations still have no plan to gather and recycle E-waste. Just the people of Tehran and Shiraz are among the vanguards of E-Waste recycling in Iran.

## Conclusion

Besides the precious metals such as Gold, Palladium and Silver which are applied in construction of these sets, some other rare materials such as “indium” are also contained in combination of different parts of more than 1,000,000,000 electronic equipments such as LCDs, computers or mobile phones, which are sometimes more prized than gold and silver. During the last five years, the “Indium” metal has become six times more expensive and right now the price of silver has as well increased; though the global mine of this metal is getting empty gradually, just few factories in USA, Belgium and Japan are able to recycle this prized metal, and the rest used amount of it in E- sets would be annihilated forever. Now, there are about 3 to 4 million outdated TVs in the country, besides a large number of telephones, electronic components and video sets, which are beside included in this statistic and many of which contain valuable metals in their structure. In most electronic boards and mother boards, especially the ones in mobile phones and computer sets which include many components and equipments, a large amount of Gold and Silver have been used because of their conductivity. According to a performed research, it has been said that in addition to materials, 240 kg fuel, Twenty-two Kg chemical substances and 1500 litre of water are needed in order to construct a monitor<sup>22</sup>. Considering this fact, it seems that reusing these computer equipments can cause a considerably economic use of natural resources.

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