A Review on Electronic Waste Pollution

Deepak Saini[1], Anupreet Kaur[2]

[1]*Department of Electronics and Communication Engineering, Punjabi University, Patiala, India*

[2]*Department of Basic and Applied Sciences, Punjabi University, Patiala, India*

[1]deepak_saini79@rediffmail.com

[2]anupreetchem@pbi.ac.in

***Abstract*— There is rapid growth of environmental pollution due the production of electrical and electronic products and their improper disposal. About 80% of e-waste from developed countries is illegally exported to developing countries because of the lower labor costs and lack of governmental regulations. The decreasing costs and increasing availability of electronic equipments like mobiles, televisions, computers and their accessories with advanced technology and the fast rate at which the outdated units are changed, has given rise to a new stream of waste known as Electronic waste (E-waste). E-waste contains two major types of substances: hazardous and non-hazardous both types have potential negative environmental impacts. It consists of various metals, metalloids, precious metals, halogenated compounds and radioactive elements. Metals and metalloids include Aluminium, Arsenic, Antimony, Barium, Beryllium, Cadmium, Chromium, Copper, Europium, Lead, Lithium, Iron, Manganese, Mercury, Nickel, Selenium, Silica, Tin, Yttrium, Zinc, etc. Precious metals include Gold, Indium, Silver, Palladium, Platinum, etc. Halogenated compounds like Polychlorinated Biphenyls (PCB), Tetrabromobisphenol (TBBA), Polybrominated Biphenyls (PBB), Polybrominated Diphenyl Ethers (PBDE), Chlorofluorocarbon (CFC), Polyvinylchloride (PVC) are present. Radioactive metal like Americium is found in the electronic scrap. This review article provides a concise overview current e-waste scenario.**

***Keywords*— E-waste, Heavy metal, Environmental pollution and Health risk**

I. INTRODUCTION

A. What is Waste

Rapid changes in technology, changes in media (tapes, software, MP3), falling prices, and planned obsolescence have resulted in a fast-growing surplus of electronic waste around the globe. An estimated 50 million tons of E-waste are produced each year in the world. The USA discards 30 million computers each year and 100 million phones are disposed of in Europe each year. The Environmental Protection Agency estimates that only 15-20% of e-waste is recycled, the rest of these electronics go directly into landfills and incinerators.

B. E-Waste Composition

- The various parts / materials / composition of e-waste may be divided broadly into six categories such as Iron and steel, used for casings and frames:
- Non-ferrous metals, especially copper used in cables, and aluminum
- Glass used for screens, windows
- Plastic used as casing, in cables and for circuit boards
- Electronic components
- Others (rubber, wood, ceramic *etc.).*

C. Components / Parts of Computer

The various components / parts of computers are as follows. Mother Board, SMPS (Switch Mode Power Supply), RAM (Random Access Memory), Hard Disk, Processors, Capacitors, IC‟s (Integrated Circuits), Main Board, Magnetic Touching Sheet, CD Drive, Floppy Drive and Diodes etc.. Components / Parts of Television: The various components / parts of televisions are as follows. Capacitors, Resistors, Transformers, STR (Supply Transformer Regulator), Integrated Circuits (IC‟s), LOT(Line output).

D. Components / Parts of Mobile Phone

The various components / parts of mobile phones are as follows. Lens, internal antenna, aerial, speakers, earpiece, microphone, microphone connectors, loud speakers, buzzers, ringers, charging blocks, system connectors, chassis, slide mechanism, ribbon cables, sim slot covers, readers, backup, battery, battery clip, covers, battery contacts, connectors and kea pad membrane etc.

E. E-Waste Scenario in India

The Indian information technology industry has a prominent global presence today largely due to the software sector. More recently, policy changes have led to a tremendous influx of leading multinational companies into India to set up manufacturing facilities, R&D centres and software development facilities. The domestic market is getting revitalized due to buoyant economic growth and changing consumption patterns. This growth has significant economic and social impacts. The increase of electronic products, consumption rates and higher obsolescence rate leads to higher generation of electronic waste (e-waste). The

increasing obsolescence rates of electronic products added to the huge import of junk electronics from abroad create complex scenario for solid waste management in India.

E-Waste Generation International

Sl. No.	Country	Total E-Waste Generated tones/ year	Year
1.	Switzerland	66,o42*	2003
2.	Germany	1,100.000	2005
3.	United Kingdom	915,000	1998
4.	U.S.A	2,124,400	2000
5.	Taiwan	14,036	2003
6.	Thailand	60,000	2003
7.	Denmark	118,000	1997
8.	Cannada	67,000	2008*
9.	India	8,00,000	2012

India is a developing county, from the last decades increase in population & change of lifestyle, the demand of using electronic products is increased. In India e-waste generation is growing at 15% & is expected to cross 8000000 tonnes per year in 2015. A Central pollution control board (cpcb) report said 65 cities in India generate more than 60-70% of the total e-waste, which comes from 10 states, that‟s are followed by Maharashtra, Tamilnadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab in the list of e-waste generating states in India [1], [2].the general consumption of electrical and electronic products such as computers, mobile phones, and televisions has been increased in the country. Sri Lanka is now dealt with the huge problem of e-waste both locally generated and internationally imported. Overall, these hazardous wastes are currently disposed hap hazard manner in roadsides, dump yards and sometimes in home gardens [3].

However, trading of used electronic items has become a common practice and the number of sales centers had increased notably within past few years [4]. This paper highlights the various sources of e-waste, disposal methods and management strategies for e-waste management. “Electronic waste” or “e- waste” consists of obsolete electronic devices. It is an emerging problem as well as a business opportunity of increasing significance, given the volumes of e-waste being generated and the content of both toxic and According to one estimate by the year 2012 the total outdated computers deriving from government infrastructure, corporate houses, industries and household is of the order of 2 million nos. producers and assemblers in valuable materials in them. The fraction including iron, copper, aluminum, gold and other metals in e-waste is over 60%, while plastic account for about 30% and the hazardous pollutants comprise only about 2.70% [5].

II. Hazardous Substances in E- Waste -Environmental and Health Effects

E-waste is much more hazardous than many other municipal wastes because electronic gadgets contain thousands of components made of deadly chemicals and metals like lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominated flame retardants, beryllium, antimony and phthalates. Long-term exposure to these substances damages the nervous systems, kidney, bones, reproductive and endocrine systems. Some of them are carcinogenic and neurotoxic. A study conducted by Greenpeace in 2005 in electronic recycling yards in Delhi clearly indicates the presence of high levels of hazardous chemicals including dioxins and furans in the areas where this primitive / unauthorized recycling takes place. Disposal of e-wastes is a critical problem faced and poses a threat to both health and vital components of the ecosystem.

There are number of channels through which e-waste goes to the environment. E-waste that is land filled produces contaminated leachates, which eventually pollute the groundwater. Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil, leading to contamination of water resources. Incineration of e-wastes can emit toxic fumes and gases, thereby polluting the surrounding air. Improper recycling and recovery methods can have major impacts on the environment. Crude forms of dismantling can often lead to toxic emissions, which pollute the air and there by also expose the workers to the harmful materials. The most dangerous form of recycling and recovery from e-waste is the open air burning of circuit boards (made of plastic) in order to recover copper and other metals. Extraction of metals through acid bath method or through mercury amalgamation also contributes to environmental degradation.

The toxic materials present in the equipments can be environmental as well as health hazard. Mercury will leach when certain electronic devices, such as circuit breakers are destroyed. Not only does the leaching of mercury poses problems, the vaporization of metallic mercury and dimethylene mercury is also of concern. The same is true for polychlorinated biphenyls (PCBs) from condensers. When brominated flame retardant plastic or cadmium containing plastics are land filled, both polybrominated diphenyl ethers (PBDE) and cadmium may leach into the soil and groundwater. It has been found that significant amounts of lead are dissolved from broken lead containing glass, such as the cone glass of cathode ray tubes, gets mixed with acid waters and are a common occurrence in landfills. The rapid growth and faster change in modules of computers, cell phones and consumer

electronics becomes major issue that enhances the amount of e-waste generation. Hazardous substances their occurrences and impact on environment and human health is as follows.

III. Initiatives in E Waste Management

The Secretariat of the Basal Convention (SBC) has taken a number of initiatives in e-waste management. A pilot project on e-waste management in the Asia and the Pacific Region has been supported by SBC in which India is participating. SBC has also facilitated a Mobile Phone Partnership Program (MP3) with public private partnership. The MP3 has evolved guidelines for environmentally sound management and trans boundary movement of mobile phones. GTZ and MAIT carried out two studies on E- Waste Generation, Disposal and Recycling of Electronic Waste in Delhi and also in other parts of India. The Department of Information Technology has implemented a project on "Environmental Management in Semiconductor and Printed Circuit Board Industry in India" in association with United Nations Environment Program (UNEP).

The electronic production processes were evaluated to explore environmental implications, promote cleaner production technologies and reduction of hazardous substances in the electronic products. The Central Pollution Control Board (CPCB) with the help of IRG-Systems South Asia Private Limited (IRGSSA) prepared a status report on "Management, Handling and Practices of E Waste Recycling in Delhi" during 2004- 2005. Based on these studies it was realized that guidelines for Environmentally Sound Management (ESM) of E-Waste is very much essential. As a first step towards ESM, guidelines have been published. The Hazardous Waste (Management and Handling) Rules, 1989 and amended in 2000 and 2003. These rules have been notified under Environment (Protection) Act, 1986 which talk about e-waste also. The Hazardous Waste (Management, Handling and Trans boundary Movement) Rules, 2008 has been notified under Environment (Protection) Act, 1986. This rule also deals with e-waste.

IV. Regulatory regime for e-waste

In India, there are no specific environmental laws or Guidelines for e-waste. None of the existing environmental laws have any direct reference to electronic waste or refer to its handling as hazardous in nature. However, several provisions of these laws may apply to various aspects of electronic wastes. Since e-waste or its constituents fall under the category of "hazardous" and "non-hazardous waste", they shall be covered under the purview of "The Hazardous Waste Management Rules, 2003". Given important objectives and guidelines, the important positive achievements of E-waste management and recycling are --- E-waste recycling firm started formally first in Karnataka. Parthasarathy‟s ISO 14001 model, developed with help from Germany‟s GTZ and Switzerland‟s EMPA uses a simple, indigenous method that manually dismantles goods like computers, printers, cartridges and other peripherals, segregates and pulverizes, all in an environmentally benign manner [6]. "Less than five percent of waste generated reaches the organized recycling sector", says P. Parthasarathy director of India‟s first e-recycling firm, the Bangalore-based E-Parisara. E-Parisara‟s 50-odd customers are all major corporate, including IBM, Lucent-Alcatel, Hewlett Packard, Intel, Infosys and Motorola. All players in this field, NGOs, Activists, E-recyclers and agencies are now preparing to go to the Indian government to request a comprehensive, law on e-waste generation, manufacturing, importing and exporting. 3. "The guidelines issued by the central pollution control board earlier this year on e-waste management are not mandatory. We want a separate law, " says Parathasarathy.

V. Policy Recommendations

A major component of the initiatives activities is to provide technical expertise for Informed policy making at various levels. Technical models for the management of e- Waste have been suggested and thoroughly discussed in various fore, allowing for Incorporating the concerns of the different stakeholders. Recently, the initiative has been involved in suggesting models for the management of e-waste in India through A concept note. The main objective of this concept note is to create a consensus Amongst all the stakeholders in arriving at an acceptable and feasible solution for India [7-8]. The aim is also to raise issues that stimulate the necessary debate to fine-tune The proposed models, paving the way towards a regulated and organized e-waste Management system in India. The concept note proposes that the various steps in Providing a new direction to WEEE management system in India is as follows: Conceptualizing and defining the necessary building blocks for a proper e- Waste management model in India [9-10].

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