

**PERILS OF ELECTRONIC WASTE: ISSUES AND MANAGEMENT STRATEGIES****Bina Rani<sup>1\*</sup>, Upma Singh<sup>2</sup>, Raaz Maheshwari<sup>3</sup>, A K Chauhan<sup>3</sup>**<sup>1</sup>Department of Engineering Chemistry & Environmental Engineering, PCE, Sitapura, Jaipur, Rajasthan<sup>2</sup>School of Applied Science, Gautam Buddha University, Greater Noida, UP<sup>3</sup>Department of Chemistry, SKGC, Sikar, Rajasthan\*Corresponding author: [drRaazecoethics151260@gmail.com](mailto:drRaazecoethics151260@gmail.com); [drRazgreenchemacs@gmail.com](mailto:drRazgreenchemacs@gmail.com); [binaraj\\_2005@rediffmail.com](mailto:binaraj_2005@rediffmail.com)**ABSTRACT**

Electronic waste or e-waste is one of the most popular growing issues of the world. The term e-waste is for the collection of old discarded computers, TVs, Refrigerators,, radios – basically any electrical or electronic appliance that has reached its end-of-life. While e-waste contains both valuable materials such as gold, palladium, silver and copper, it also contains harmful metals like lead, cadmium and mercury. In the absence of suitable techniques and protective measures, recycling e-waste can result in toxic emissions to the air, water and soil and pose a serious health and environmental hazard. In India, e-waste is mostly generated in large cities like Delhi, Mumbai and Bangalore. In these cities a complex e-waste handling infrastructure has developed mainly based on a long tradition of waste recycling. But the problem is that these recycling processes are extremely harmful and have negative impacts on the worker's health and the environment. There is no generally accepted definition of e-waste, in most cases, e-waste comprises of relatively expensive and essentially durable products used for data processing, telecommunication or entertainment in private households and businesses. Public perception of e-waste is often restricted to a narrower sense, comprising mainly of end-of-life information and telecommunication equipment and consumer electronics. The world is consuming more and more electronic products every year. This has caused a dangerous explosion in electronic scrap containing toxic chemical and heavy metals that cannot be disposed of or recycled safely. So the concept is that how this e-waste should preventfully recycled so that there should be prevention on environmental damage. E-waste is assuming serious proportions in India and urgent steps need to be taken to mitigate this problem. This paper highlights the problem posed by e-waste in India. It also recommends some steps for a swift solution to this grave danger.

**Keywords:** CRT; PCB; PVC;BFR; Pollution; Hazards; Electronic gadgets; Environment**1. INTRODUCTION**

If we look around, we could easily pick out loads of equipments and devices that could qualify as potentially hazardous and non-biodegradable electronic waste. The television, the cellular phone, the refrigerator, the computer and printer sitting on our desk, are eventually going to end up in a landfill where they will leach out dangerous carcinogens and chemicals, poisoning the soil and dirtying underground water aquifers. The result will be huge amounts of money spent on cleaning up our landfills and health risks that could include cancer, lead poisoning/ or various other diseases. All obsolete electronic devices such as computers, TVs, Cellular phones, calculators, audio and video devices, printers, scanners, copiers, processors and fax machines, besides refrigerators, air conditioners, washing machines, microwave ovens, DVDs, CDs, Chips, automobile catalytic converters, industrial electronics such as sensors, alarms, sirens, security

devices and automobile electronic devices, once disposed also add up to the e-waste pile. The ipod and the iphone, glamorous products for the young generation providing thousands of songs at the touch of a bottom and conveniently fitting in the pocket, can spend thousands of years in a landfill. Apple has sold over 180 million ipods to date! One can imagine the staggering e-waste problem once these devices start getting disposed off.

The magnitude of the problem is really huge, and scary. According to the United Nations Environmental Programme (UNEP), global e-waste generation is growing by about 40million tonnes a year. A report titled "Recycling – From E-Waste to Resources", released in February, 2010 by the UNEP, predicts that by 2020 in South Africa and China e-waste from old computers will have jumped by 200 to 400% from 2007 levels, and by 500% in India. The spectre of hazardous e-waste mountains looms large especially for developing countries with serious consequences for the environment and public health. In accordance with a recent

study published in *Environmental Science & Technology*, within six to eight years, developing countries will be disposing of more old computers than the developed countries. And by 2030, these countries will be disposing of two to three times as many computers as the developed countries, perhaps resulting in up to 1 billion computers being dumped worldwide every year. India especially needs to be on guard. A study titled "Electronics Recycling and E-Waste Issues", estimates that e-waste from TVs will be 1.5 to 2x higher in India, and that from discarded refrigerators will double or triple in India.

Apart from domestic e-waste, the country also has to contend with tonnes of e-waste from developed countries landing on its shores either through charity or delivered to scarp-yards for recycling. About 80% of the e-waste generated in the US is exported to India, China and Pakistan. Once e-waste reaches the country it is recycled in a most unorganized manner. E-waste contains many hazardous substances like heavy metals, PVC plastics, brominated flame retardants (BFRs), etc that are toxic to humans. In India, recycling being mainly a backyard operation, precious metals are reclaimed from circuit boards and wires using very primitive methods. To obtain copper, for example, the insulation is simply burnt off, producing a host of toxic chemicals from the burning plastic. To obtain gold and other metals from circuit boards, litres of nitric acid and cyanide are used, which end up being dumped into local water or soils. Seeking to make a producer of electrical and electronic equipment responsible for the collection and appropriate disposal of e-waste generated at the end-of-life of its products, the Indian government has recently come out with the draft of a set of rules called the E-waste (Management and Handling) Rules 2010. The rules have been made available for public comment on the website of the Ministry of Environment and Forests. The rules also propose to ban the import of used electrical and electronic equipment for charity in the country. But it is incumbent on the general populace in the country as well to be more sensitive to the issue. Perhaps we could think of the ways to extend the use life of electronic items. This is the first principle of e-waste management; early scrap is a luxury that the country can do without.

## 2. THE PROBLEM OF ELECTRONIC WASTE

Most people are not aware of the potential negative impact of the rapidly increasing use of computers, monitors, and televisions. When these products are placed in landfills or incinerated, they pose health risks due to the hazardous materials they contain. While relatively small increases are currently occurring in the numbers placed in the municipal waste stream, these products are being purchased at a rapidly increasing rate, and many outdated computers are currently in storage in people's basements and closets (Figure 1). In this massive amount of stored electronic waste were to enter the municipal waste stream, the toxins in it could result in severe negative environmental and health impacts. In addition,

valuable materials from the computers would be lost due to the lack of effective recycling. E-waste constitutes only 1.5-8 per cent of municipal solid waste, yet it is accumulating at a rate three times that of other solid waste.

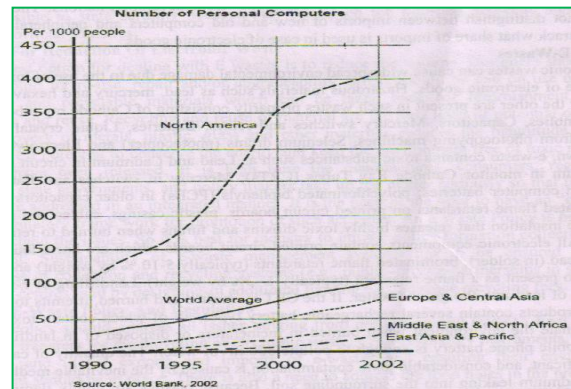


Figure 1

## 3. E-WASTE IN INDIA

As there is no separate collection of e-waste in India, there is no clear data on the quantity generated and disposed of each year and the resulting extent of environmental risk. The preferred practice to get rid of obsolete electronic items in India is to get them in exchange from retailers when purchasing a new item. The business sector is estimated to account for 78% of all installed computers in India. Obsolete computers from the business sector are sold by auctions. Sometimes educational institutes or charitable institutions emanating each year from business and individual households in India will be around 1.38 million. According to a report of Confederation of Indian Industries, the total waste generated by obsolete or broken down electronic and electrical equipment in India has been estimated to be 1,46,000 tons per year. The results of a field survey conducted in Chennai, a metropolitan city of India, to assess the average usage and life of the PCs. TVs and cellular phones showed that the average household usage of the PC ranges from 0.39 to 1.70 depending on the income class in the case of TV it varied from 1.07 to 1.78 and for cellular phones it varied from 0.88 to 1.70. the low income household use the PC for 5.94 years, TV for 8.16 years and the mobile phones for 2.34 years while, the upper income class uses the PC for 3.21 years, TV for 1.13 years and cellular phones for 1.63 years. Although the per capita waste production in India is still relatively small, the total absolute volume of wastes generated will be huge. Further, it is growing at a faster rate. The growth rate of the cellular phones (80%) is very high compared to that of PC (20%) and TV (18%). The public awareness on e-waste and the willingness of the public to pay for e-waste management as assessed during the study based on an organized questionnaire revealed that about 50% of the public are aware of environmental and health impacts of the electronic items. The willingness of public to pay for e-waste management ranges from 3.57% to 5.92% of the product cost for PC,

3.94% to 5.95% for TV and 3.4% to 5% for the cellular phones. Additionally considerable quantities of e-waste are imported. However, no confirmed figure are available on how substantial are these transboundary e-waste streams, as most of such trade in e-waste is camouflaged and conducted under the pretext of obtaining 'reusable' equipment or 'donations' from developed nations. The government trade data does not distinguish between imports between old and new computers and peripheral parts and so it is difficult to track what share of imports is used in case of electronic goods.

#### 4. IMPACT OF E-WASTE

Electronic wastes can cause widespread environmental damage due to the use of toxic materials in the manufacture of electronic goods. Hazardous metals such as lead (Pb), mercury (Hg) and hexavalent chromium [Cr (VI)], in one form or the other are present in such wastes primarily consisting of Cathode Ray Tubes (CRTs), Printed Board Assemblies, Capacitors, Mercury Switches and Relays, Batteries, Liquid Cr tetardants on printed circuit boardsystal Displays (LCDs), Cartridges from photocopying Machines, Selenium drums (photocopier) and Electrolytes. Although it is hardly known, e-waste contain toxic metals such as lead and cadmium in circuit boards; lead oxide and cadmium in monitors, cadmium in computer batteries; polychlorinated biphenyls (PCBs) in older capacitors and transformers; brominated flame retardants on printed circuit boards, plastic castings, cables and poly vinyl chloride (PVC) cable insulation that releases highly toxic dioxins and furans when burned to retrieve copper from the wires. All electronic equipment contain printed circuit boards which are hazardous because of their content of lead (in solder), brominated flame retardants (typically 5% to 10% by weight) and antimony oxide, which is also present as a flame retardant (typically 1% to 2% by weight). Landfilling of e-waste can lead to the leaching of lead into the groundwater. If the CRT is crushed and burned, it emits toxic fumes into the air. These products contain several rechargeable battery types, all of which contain toxic substances that can contaminate when burned in incinerators or disposed of in landfills. The cadmium from one cellular phone battery is enough to pollute 600m<sup>3</sup> of water. The quantity of cadmium in landfill sites is significant, and considerable toxic contamination is caused by the inevitable medium and long term effects of cadmium leaking into the surrounding soil. Because plastics are highly flammable, the printed wiring board and housings of electronic products contain brominated flame retardants, a number of which are clearly damaging to human health and environment.

#### 5. IMPACT OF INFORMAL RECYCLING

The accrued electronic and electric waste in India is dismantled and sorted manually to fractions such as printed

wiring boards, cathode ray tubes, cables, plastics, metals, condensers and other, nowadays invaluable batteries like batteries. It livelihood for unorganised recyclers and due to awareness, they are risking their health the environment as well. The valuable materials are processed directly reusable components and to secondary raw materials in a variety of refining and conditioning process. No sophisticated machinery or personal protective equipment is used for the extraction of different materials. All the work is done by bare hands and only with the help of hammers and screwdrivers. Children and women are routinely involved in the operations. Waste component does not have any resale or reuse value are openly burnt or disposed off in open dumps. Pollution problems associated with such backyard smelting using crude processes are resulting in fugitive emissions and slag containing heavy metals of health concern. CRT breaking operations result in injuries from cuts and acids used for the removal of metals and respiratory problems due to shredding, burning, etc. They use strong acids to retrieve precious metals such as gold. Working in poorly ventilated enclosed areas without masks and technical expertise result in exposure to dangerous and slow poisoning chemicals. Polychlorinated biphenyls (PCBs) in older capacitors and transformers; and brominated flame retardants (BFRs) on printed circuit boards, plastic castings, cables and poly vinyl chlorides (PVC) cable insulation can release highly toxic dioxins and furans when burned to retrieve copper from the wires. On a broader scale, analyzing the environmental and societal impacts of e-waste reveals a mosaic of benefits and costs. Proponents of e-waste recycling claim that greater employment, new access to raw materials and electronics and improved infrastructure will result. These will further boost the region's advance towards prosperity. Yet the reality is that the new wealth and benefits are unequally distributed, and the contribution of electronics to social growth is sometimes illusory. Most e-waste "recycling" involve small enterprises that are numerous, widespread and difficult to regulate. They take advantage of labour costs due to high unemployment rates, internal migration of poor peasants, and lack of protest or political mobilization by affected villagers who believe that e-waste provide the only viable source of income or entry into modern development pathways. They are largely invisible to state scrutiny because they border on the informal economy and are therefore not included in official statistics.

#### 6. STRATEGIES FOR REDUCTION OF ELECTRONIC WASTE

The best option for dealing with E-wastes is to reduce the volume. Designers should ensure that the product is built for re-use, repair and/ or upgradability. Stress should be laid on use of less toxic, easily recoverable and recyclable materials which can be taken back for refurbishment, remanufacturing, disassembly and reuse. Recycling and reuse of material are the next level of potential options to reduce e-waste. Recovery of

metals, plastic, glass and materials reduces the magnitude of e-waste. These options have a potential to conserve the energy and keep the environment free of toxic material that would otherwise have been released. It is high time the manufactures, consumers, regulators, municipal authorities, state governments, and policy makers take up the matter seriously so that the different critical elements are addressed in an integrated manner. It is need of the hour to have an “e-waste policy” and national regulatory framework for promotion of such activities. An e-waste policy is best created but those who understand the issues. So it is best for industry to initiate policy formation collectively, but with user involvement. Sustainability of e-waste management systems has to be ensured by improving the effectiveness of collection and recycling systems (e. g. public-private-partnership in setting up buy-back or drop-off centres) and by designing-in additional funding e.g., advance recycling fees.

## 7. NEED FOR E-WASTE POLICY AND REGULATION

The policy should address all issues ranging from production and trade to final disposal, including technology transfers for the recycling of electronic waste. Clear regulatory instruments, adequate to control both legal and illegal exports and imports of e-waste and ensuring their environmentally sound management should be in place. There is also a need to address the loop holes in the prevailing legal framework to ensure that e-wastes from developed countries are not reaching the country for disposal. The Port and custom authorities need to monitor these aspects. The regulations should prohibit the disposal of e-wastes in municipal landfills and encourage owners and generators of e-waste to properly recycle the wastes. Manufactures of products must be made financially, physically and legally responsible for their products. Better management of restricted substances may be implemented through measures such as

- Specific product take-back obligations for industry
- Financial responsibility for actions and schemes
- Greater attention to the role of new product design
- Material and/or substance bans including stringent restrictions on certain substances
- Greater scrutiny of cross-border movements of Electrical and Electronic Products and e-waste
- Increasing public awareness by labelling products as ‘environmental hazard’

The key questions about the effectiveness of legislation would include:

- What is to be covered by the term electronic waste?
- Who pays for disposal?
- Is producer responsibility the answer?
- What would be the benefits of voluntary commitments?

- How can sufficient recovery of materials be achieved to guarantee recycling firms a reliable and adequate flow of secondary material?

A complete national level inventory, covering all the cities and all the sectors must be initiated. A public-private participatory forum (E-Waste Agency) of decision making and problem resolution in e-waste management must be developed. This could be working group comprising Regulatory Agencies, NGOs, Industry Associations, experts, etc. to keep pace with the temporal and spatial changes in structure and content of e-waste. This working group can be the feedback providing mechanism to the government that will periodically review the existing rules, plans and strategies for e-waste management. Mandatory labelling of all computer monitors, television sets and other household/industrial electronic devices may be implemented for declaration of hazardous material contents with a view to identifying environmental situation through regulations. Though an important step; are usually only modestly effective because of the lack of enforcement. While there has been some progress made in this direction with the support of various agencies, enforcement of regulations is often weak due to lack of resources and underdeveloped legal systems. Penalties for non-compliance and target for collection or recycling are often used to ensure compliance.

## 8. CONCLUSION

E-waste has emerged as perhaps the most critical waste disposal issue of the twenty-first century. The problem is exacerbated by the increasing rate of computer and television production in the world including India, and by relatively short life spans of recent computer models. Additionally, the number of computers currently in storage would result in a massive influx of toxins to the municipal waste stream if they were land filled. The presence of lead, mercury, BFRs, and chromium along with other hazardous chemicals may lead to potentially severe negative health effects if exposed to the environment through conventional disposal. Although there is some debate about the specific type and level of risk involved with each substance, there is little doubt that these hazardous chemicals will cause significant harm over the course of the twenty first century if they are not disposed of properly. The potential risks to the developing nervous systems of babies and children are particularly significant.

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