E- Waste

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Abstract: Electronic Waste is a Waste Electronic Goods which are not fit for their originally intended use. E- Waste is growing three times faster than other wastes. The typical electronic product disposed may contain more than 1, 000 different substances, some of which are potentially hazardous to human and environmental health. If old equipment is not properly recycled, these substances could seep into air, soil, and water. The composition of e-waste is very diverse and differs in products across different categories. The characteristics, scale and complexity of the e-waste situation creates a significant challenge. The presence of elements like lead, mercury, arsenic, cadmium, selenium and hexavalent chromium and flame retardants beyond threshold quantities in e-waste classifies them as hazardous waste. Due to the lack of adequate governmental legislations on e-waste and resources required for implementation, standards for disposal, proper mechanism for handling, these toxic hi-tech products mostly end up in landfills or partly recycled in unhygienic conditions and partly thrown into waste streams. The paper discusses the classification and sources of e- waste, toxic constituents in e-waste, effect of e- waste constituent on health, treatment and disposal options. The problem of e – waste recycling is additionally complicated due to adoption of unethical practices by corporate world and IT companies. Most of the corporations are selling the waste to informal recyclers to make some quick money without realizing that they are putting people and the environmental at greater risk. The collection and recycling system in India is inefficient, if not non – existent. In order to improve the efficiency of the collection system, corporations have to start a voluntary take back scheme of their end-of-life products.

Keywords: E- Waste, hazardous, health

1. INTRODUCTION

E- Waste is a collective name for discarded electronic devices that enter the waste stream from various sources. Electronic equipment or products become obsolete due to advancement in technology, changes in fashion, style and status, nearing the end of their useful life. As technology rapidly evolves, people are constantly upgrading to new equipment and disposing their old equipment. Much of the e-waste is burned or dumped on land or in water. At household level, 65% of the individuals look for best monetary or exchange value for their old products. Only 2% of individuals think of the impact on environment while disposing off their old electrical and electronic equipment. At corporate/ business level, 60% of the companies/ offices look for best monetary value for their old computers while selling them. Only 6% of the organizations were found to be disposing off their computers in environmentally friendly manner. 11% of the replaced computers enter E-waste stream through scrap dealers. 21% of the replaced computers enter E-waste stream through second hand market. 48% of the replaced computers enter E-waste stream exchange and buy back scheme. The total E-waste inventory is increasing every year with high obsolescence rate. This increase has been mainly attributed to E-waste from computers and TVs at the moment. The trend analysis shows that there is gradual increase in E-waste till 2011. However, there is a sudden increase in E-waste after 2011. Further, the period starting from 2009 to 2012 gives three years to policy makers, planners and implementers to plan, design and implements E-waste management system in the country. E-wastes contain over 1000 different substances many of which are toxic and potentially hazardous to environment and human health, if these are not handled in an environmentally sound manner. Lack of environmentally sound E-waste recycling infrastructure. Majority of E-waste recycling is occurring in informal sector. Therefore, E-waste has significant economic and social impacts. Environmental issues and trade associated with E-waste at local, trans-boundary and international level has driven many countries to introduce interventions to be followed in management of E-waste

2. CLASSIFICATION OF E- WASTE

The electronic and electrical goods are largely classified under three major heads:

- White goods- comprising of household appliances like air conditioners, dishwashers, refrigerators and washing machines;
- Brown goods- comprising of TVs, camcorders, cameras, etc.
- Grey goods- like computers printers, fax machines, scanners, etc.

Waste from the white and brown goods is less toxic as compared with grey goods. The grey goods not only have a more toxic composition but are comparatively more complex to recycle and dispose.

E- Waste also classified into following categories:

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- Computer Peripherals like Monitors, CPUs, Key board, Mouse, Circuit boards, CDs, Floppies, Laptops, Servers etc.
- Telecommunications Devices Phones, Cell phones, Pagers, Fax machines, Routers, Transmitters.
- Industrial Electronics like Sensors, Alarms, Automobile, Electronic devices, Medical devices.
- Lighting Devices such as Fluorescent tubes
- Wet and Dry Batteries.

2.1 Sources of E- Waste in India are as follows:

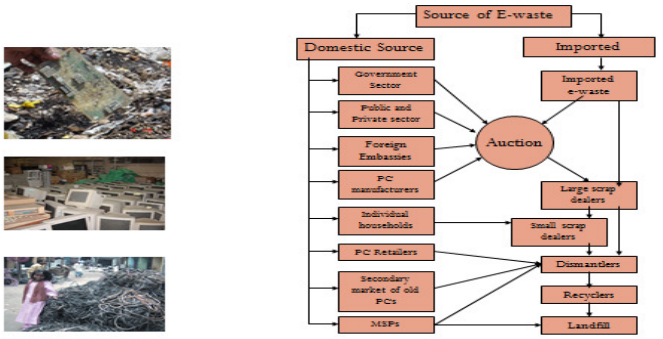

Fig. 1. Sources of E-Waste

3. TOXIC CONSTITUENTS IN E-WASTE ARE

Table 1. Components vs. Constituents

Components	Constituents
Printed circuit boards	Lead & Cadmium
Cathode ray tubes (CRTs)	Lead oxide & Cadmium
Computer batteries	Mercury
Switches & flat screen monitors	Cadmium
Plastic cable	Brominated flame casings
Cable insulation / coating	PVC

Material Composition of Personal Computer are as follows: Copper 7%, Plastic 23%, Lead 6%, Aluminium 14%, Mercury 0.01%, Cadmium 0.09%, Ferrous Metal 20%, Glass 26%, Zinc 2%, Other 1.9%

3.1. Constituents Impact

Lead: The leach ability of lead has been the most significant concern for the solid waste community when discussing the potential of E-Wastes being potentially hazardous. The leaching of lead results from the presence of the element in the solder that is used to make electrical connections on the printed wire boards. Lead is also found in cathode ray tubes (CRTs).

Mercury: Some devices, such as laptop, computers and Mercury vapor bulbs, do contain this element and have a potential of leaching.

Cadmium: Cadmium in E-Waste is mainly limited to their presence in rechargeable Nickel-Cadmium batteries.

Brominated Flame Retardants (BFRs): Recently, the solid waste community has been examining the potential of BFRs to leach from E-Wastes. BFRs are added to electronics, as well as other municipal wastes such as foam padding and carpets, to prevent them from igniting when exposed to high temperatures. Most electronics contain some form of BFR. **Potential Problems of BFRs** have been found to be absorbed by human fat and tissue and to bioaccumulations in animals and can cause poor brain development

3.2. Effect of E-Waste Constituent on Health

Table 2. E-Waste Constituent vs. health Effect

Source	Constituent	Health Effect
Solder in PCBs, Glass Panels & Gaskets in Monitors	Lead (Pb)	Damage to central and peripheral nervous systems, blood systems & kidney damage.
Chip Resistors & Semi- Conductors	Cadmium (Cd)	Toxic irreversible effects on human health, accumulates in Kidney & liver, causes neural damages, Teratogenic.
Relays, Switches & PCBs	Mercury (Hg)	Chronic damage to the brain, Respiratory & Skin disorders due to bioaccumulation in fishes.
Corrosion Protection of untreated & Galvanised steel plates	Hexavalent Chromium (Cr) VI	Asthmatic bronchitis, DNA damage.
Cabling and Computer housing	Plastic including PVC	Burning produces toxins which causes reproductive and developmental problems, immune system damage, interferes with regulatory hormones.
Plastic housing of electronic equipment & circuit	Brominated flame retardants (BFR)	Disrupts endocrine system functions
Front Panel of CRTs	Barium (Ba)	Short term exposure causes muscle weakness, damage to heart & liver.

Motherboard	Beryllium (Be)	Carcinogenic (lung cancer), Inhalation of fume & dust cause chronic berylliu disease or beryllicosis, skin diseases

4. STATUS OF E-WASTE IN INDIA

2003: BAN/Toxics Link reports on E-waste generation and imports in India. Outcome: E-waste a new subject in India both for generators & regulators. Domestic Source (Dismantling/ retrofitting of obsolete E-products, manufacturing process). Imported (Scrap dismantling/ reprocessing, Donations). No estimates of actual amount of E-waste in India. No methodology for baseline estimates. No intervention

2004: Indo - Swiss Pilot Assessment in Delhi: Management, Handling & Practices of E- waste .Recycling in Delhi (IRGSSA/ Toxics link) under guidance from CPCB/ ASEM

2005: National level E-waste inventory study (CPCB/ GTZ)- Findings disseminated in national workshop held on 5th June 2005. TOR for city team for E-waste assessment was finalized (Mumbai/ Pune). Standardized/uniform approach & methodology for E-waste invention. Initiatives in Bangalore (HAWA/ GTZ) & by NGOs (Toxics link) & SPCBs.

2006: City level assessment – Mumbai/ MPCB/ UNEP (Completed in Dec 2006). City Level Assessment – Pune/ MPCB/ UNEP (Completed in Dec 2006). ESM Guidelines (TOR) – CPCB. Training & capacity building – HAWA/ GTZ. Information dissemination through workshops – MPCB/ KPCB/ HAWA GTZ/ Toxics link/ Other Agencies

2007: ESM Guidelines (draft submitted and MoEF task force constituted to finalize) .E-waste inventory updated by MAIT/ GTZ (Dec 2007). Training & capacity building – HAWA/ GTZ. Information dissemination through workshops – HAWA GTZ/ Toxics link/ NGO's/Other Agencies. Proposed E-waste model (Toxics link)

2008: Final ESM Guidelines (March 2008). Part inclusion of E-waste in Hazardous Waste Rules. E-waste book (TERI)/ Initiative with mobile phone companies. EOI for E-waste management in NCR (DPCC)

2009: ELCINA/ DSIR Report "Status & Potential for E-waste Management in India" (Feb 2009). Registration of E-waste recyclers initiated (4 registered E-waste recycling facilities, others awaiting…..). MPCB/ MMRDA project "Feasibility Study and Business Model for E-waste. Management for Mumbai Metropolitan Region" (completed in June 2009).

4.1. Need for Evaluation of Hazard Potential are: The use of these items is going to increase in the coming years due to advancement in technology and increase in demand. E-waste creates serious worker, community and environmental problems at the waste end. Often, these hazards arise due to the improper recycling and disposal processes used. To address risk – assessment of risk from various end of life management option is a must. . Following methodology was adopted for characterization of e-waste streams are

- Sample Collection
- Dismantling and Segregation
- Estimation of different metal fractions
- Estimation of Relative Hazard Potential and Importance Factor of different fractions in e-waste

5. TREATMENT & DISPOSAL OPTIONS

1. Recycling, Reuse and Recovery Option:

- Reduce the hazardous content of the E-waste through recycling and recovery
- Recover E-waste fractions, which act as secondary raw materials
- Dispose non reusable E-waste fractions

2. Disposal Option
- Landfilling
- Incineration

5.1. Existing E-waste Treatment Systems in India

This treatment system is used at three levels as per CPCB's guidelines:

1. First level treatment – Primary E-waste generator
2. Second level treatment – Secondary E-waste generator
3. Third level treatment – Tertiary E-waste generator

The entire e-waste treatment is being carried out in an unregulated environment, where there is no control on emissions. The characteristics of emissions from e-waste treatment in semi- formal and informal sector in India are as follows:

1. Generation of mixed e-waste fractions along with hazardous waste after dismantling
2. Generation of effluents during metal extraction ex. Acid bath process for copper extraction from printed circuit board
3. Air emissions due to burning of printed circuit board
4. Inefficient secondary raw material generation

All the three levels of WEEE/ E-waste treatment systems are based on material flow.

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1. The material flows from first level to third level treatment. Each level treatment consists of unit operations, where E-waste is treated and output of first level treatment serves as input to second level treatment.
2. After the third level treatment, the residues are disposed of either in hazardous waste landfill or incinerated.
3. The efficiency of operations at first and second level determines the quantity of residues going to hazardous waste landfill site or incineration. Most of the E-waste treatment facilities in other countries consist of first and second level treatment at one place, while third level treatment is geographically located at other place.
    - Guidelines for collection systems for E-waste
    - Guidelines for collection systems for storage areas
    - Guidelines for dismantling/ segregation/ recycling/ treatment & disposal
    - Procedure for setting-up & management of integrated E-waste facility
    - Procedures for compilation with the existing regulations & guidelines

5.2. 3R Policies & Strategies in India are:

- Reduce – reduce the generation of waste Cleaner Production & waste Minimization
- Reuse – as such repair/refurbish and reuse
- Recycle – recycle to recover valuable materials waste of one resource for other.

Minimize Generation of Wastes and Maximize Utilization of Wastes. The wastes for recycling includes: Used oil, Lead wastes including lead acid battery scrap, Non-ferrous metal wastes such as aluminum, brass, copper, nickel, tin, zinc etc.,

Dumping Incentives : Cost to recycle a single PC in US: $20, Cost of export to India: $5, Margins in recycling: Importer: $3-5, Recycler: $4, Worker: <$1, Recycling in India :$2

5.3. Electronic Waste as Resource: Existing regulations inadequate to address all issues of e-waste. E-waste contains precious metals - makes it economically viable for recovery. E-waste recycling is still mostly in the unorganized and informal sector. Recycling essentially involves dismantling and segregation, export of the components for recycling in other countries. New recycling units coming up to do end to end recycling in ESM, need to encourage to do complete recycling. Guidelines for Environmentally Sound Management of e-waste available in CPCB website. Formal Recyclers Development of Environment Sound Recycling Facilities. Dovetailing the Informal recyclers with Formal one. Establishment of Collection Centers. Registration of advanced recycling units – ESM. Control in Import e-waste. Producer Responsibility to be mandated. Dedicated Regulatory regime to address ESM of e-waste, EPR and RoHS.

6.0. E-Waste Challenges: At the end of the fast paced road of Electronic innovation lies a mountain of electronic waste. Safe Disposal of mountains of old PCs, Monitors is a snowballing problem we have only begun to face, Lack of awareness and information, Attitude of people, Willingness, No promotion of Reuse or Recycle, While businesses see India as a technology hub, environmentalists claims India is the world's dumping ground for electronic waste. We need Safe collection, Safe Transportation, Safe Dismantling, Safe Segregation, Safe handling and Management, Scientific Disposal of e-waste.

6.1. E - Waste if used as a secondary source has several opportunities such as: Every ton of **Steel recycled** makes the following savings: 75% of the energy needed to make steel from virgin material, 40% of the water required in production, 1.28 tons of solid waste, Reduction of air emissions by 86%, Reduction of water pollution by 76%. Every ton of **Aluminium recycled** makes the following savings: 6 tons of bauxite, 4 tons of chemical products, 14MWh of electricity, It takes 70% less energy to recycle Plastics, It takes 40% less energy to recycle Glass, Every ton of Paper recycled saves 17 fully grown trees.

6.2. Creating Awareness through workshops: Sectors identified and prioritized include Electroplating, textile dying, leather tanning etc. Waste Minimization Circles (WMC) established in clusters. Clean technologies are adopted in highly polluting industries. Technologies for large, medium and small scale units developed and adopted. National Cleaner Production Centre. CDM waste reduction and reduction in carbon footprints.

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