

# E-Waste generation and management in India

Tanvi Pradhan

1st year B.Tech. Electrical Engineering, KIIT, Bhubaneswar, Odisha

## INTRODUCTION

With the advancement in Science and Technology every next second new electronic gadgets like mobile phones, tablets, I-pods, note-book, LED TV, Plasma TV are launched and due to the invention of these modern gadgets we have become slaves of gadgets. As the demand of these electronic gadgets has been continuously increasing the companies have increased the production. But the problem arises when these gadgets stop working and we need to dispose them off. The waste of these electronic gadgets is referred to as the E-waste or the Electronic waste. The growth of e-waste has significant economic and social impacts. The increase of electrical and electronic products, consumption rates and higher obsolescence rate leads to higher generation of e-waste. The increasing obsolescence rate of electronic products also adds to the huge import of used electronics products. 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.

This paper gives an account of E-waste and the strategies and the ways to fight the problem of disposal of e-waste. It also gives a brief idea about the harmful impacts of the e-waste, the system to control this hazardous e-waste, sources of e-waste and finally the E-waste management.

## WHAT IS E-WASTE?

E-waste comprises of wastes generated from used electronic devices and household appliances which are not fit for their original intended use and are destined for recovery, recycling or disposal. Such wastes encompasses wide range of electrical and electronic devices such as computers, hand held cellular phones, personal stereos, including large household appliances such as refrigerators, air conditioners etc. Electronic waste or e-waste or e-scrap or waste electrical and electronic equipment (WEEE) can be defined as the discarded waste computers, office electronic equipments entertainment device electronics, mobile phones, television sets and the refrigerators. The term E-waste is loosely applied to consumer and business electronic equipment that is near or at the end of it's useful life. It is a waste consisting of any broken or unwanted electrical or electronic appliance.

Waste generated from the following electronic equipments is generally referred to as the E-waste:

- IT and Telecom equipments like computers, laptops, tablets and the systems used in the BPO call centres.
- Large household appliances like washing machines, microwave ovens ,refrigerators, television etc
- Small household appliances like PC's, mobile phones, MP3 players,I-Pods, Tablets etc
- Consumer and lighting equipments like bulbs , CFL ,fluorescent tube lights.

- Toys, leisure and sports machines
- Medical devices like CT scan machine, MRI etc
- Monitoring and control devices

## E-WASTE PRODUCTION IN INDIA

The Indian electronic waste industry is booming at a very rapid pace. It is expected to increase at a rate of 20% annually. With increasing per capita income, changing life styles and revolutions in information and communication technologies, India is the second largest electronic waste generator in Asia. A MoEF'2012 report says that Indian electronic waste output has jumped 8 times in the last seven years i.e. 8, 00,000 tones .The future projection of E-waste in India as per the Dept. Of Information Technology is shown in Fig. 1. India has majorly two types of electronic waste market called organized and unorganized market. 90% of the electronic waste generation in the country lands up in the unorganized market. Electronic waste accounts for 70% of the overall toxic wastes which are currently found in landfills which is posing toxic chemical contamination in soil and other natural resources. Indian PC industry is growing at a rate of 25% annually.

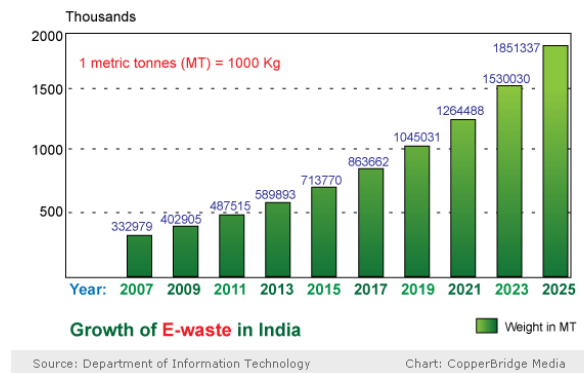


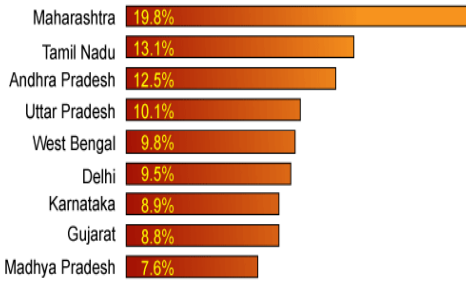
Fig 1. Projection of E-waste generation in India.

Out of the total electronic waste generation in India, only 40 % of these are taken into the recycling processes and rest 60% remains in warehouses due to inefficient and poor collection systems. Generally, people hand over electronic waste to unauthorized recycling centres/ scrap dealers etc. for quick money. The e-waste scrap is managed through various management alternatives such as reuse of equipment from second hand dealers, back yard recycling (manual dismantling and segregation into plastic, glass and metal) and finally into the municipal dumping yard.

MAIT (Manufacturers Association for Information Technology) study says that waste from discarded electronics will rise dramatically in the developing world within a decade, with computer waste in India alone to grow by 500 per cent from 2007 levels by

2020. Over 100,000 tonnes from refrigerators, 275,000 tonnes from TVs, 56,300 tonnes from personal computers, 4,700 tonnes from printers and 1,700 tonnes from mobile phone.

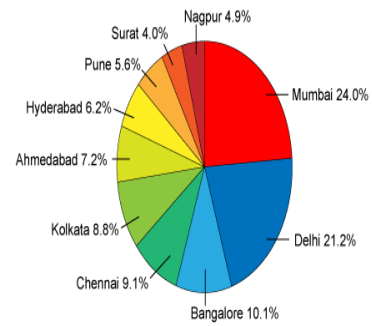
Sixty-five cities in India generate more than 60% of the total e-waste generated in India. Ten states generate 70% of the total e-waste generated in India. Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab in the list of e-waste generating states in India (Fig. 2). Among top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur (Fig.3).



State-wise E-waste Generation in India (Tonnes/year)

Source: Department of Information Technology Chart: CopperBridge Media

Fig 2. State wise contribution to E-waste in India.



City-wise E-waste Generation in India (Tonnes/year)

Source: Department of Information Technology Chart: CopperBridge Media

Fig 3. Major E-waste generating cities in India

**ELECTRONIC WASTE SUBSTANCES**

E-Waste contains several different substances and chemicals many of which are toxic and likely to create adverse impact on environment and health if not handled properly. However classification of E-waste as hazardous or non-hazardous depends on the extent of hazardous constituents in it.

Some Hazardous substances found in E waste their sources and their impact on human health is given in the table 1.0.

Table 1. Hazardous substances found in E-waste their sources and impact on human life

| Hazardous Substances | Source  | Impact on human health   |
|----------------------|---|--|
| Lead                 | Mechanical breaking of CRTs and removing solder from microchips release lead as powder and fumes.                         | A neurotoxin that affects the kidneys and the reproductive system. High quantities can be fatal. It affects mental development in children.  |
| Plastics             | circuit boards, cabinets and cables   | Carcinogens BFRs or brominated flame retardants give out carcinogenic brominated dioxins and furans. Dioxins can harm reproductive and immune systems.   |
| Chromium             | Used to protect metal housings and plates in a computer from corrosion  | Inhaling hexavalent chromium or chromium 6 can damage liver and kidneys and cause bronchial maladies including asthmatic bronchitis and lung cancer.   |
| Mercury              | It is released while breaking and burning of circuit boards and switches.   | Affects the central nervous system, kidneys and immune system. It impairs foetus growth and harms infants through mother's milk. Mercury in water bodies can form methylated mercury through microbial activity. Methylated mercury is toxic and can enter the human food chain through aquatic. |
| Beryllium            | Cadmium is released into the environment as powder while crushing and milling of plastics, CRTs and circuit boards.       | A carcinogen. Long-term exposure causes <i>Itai-itai</i> disease, which causes severe pain in the joints and spine. It affects the kidneys and softens bones.  |
| Acid                 | Sulphuric and hydrochloric acids are used to separate metals from circuit boards  | Fumes contain chlorine and sulphur dioxide, which cause respiratory problems. They are corrosive to the eye and skin.  |
| Sulphur              | found in lead acid batteries  | Cause damage to liver, kidney heart, eye and throat irritation.  |
| Cadmium              | light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments, and nickel cadmium batteries. | Can leach into the soil, harming microorganisms and disrupting the soil ecosystem. inhalation of can cause severe damage to the lungs and also known to cause kidney damage  |
| Americium            | Some detectors  | Radioactive and carcinogenic.  |

Some non-hazardous materials found in e waste are presented in Table 2:

Table 2. Non-Hazardous substances found in E-waste and their sources.

| Non-Hazardous Substances | Source   |
|--------------------------|--|
| Tin                      | Solder, coatings on component leads.   |
| Copper                   | Copper wire, printed circuit boards tracks, component leads.   |
| Aluminium                | Nearly all electronic goods using more than a few watts of power (heat sinks),electrolytic capacitors. |
| Iron                     | Steel chassis, cases, and fixings.   |
| Germanium                | Transistorized electronics (bipolar junction transistors).   |
| Silicon                  | Diodes, Transistors and IC's.  |
| Zinc                     | Plating.   |

**EFFECT OF E-WASTE ON ENVIRONMENT:**

The E waste may also pollute ground water, soil and air if not disposed properly. The heavy metals like cadmium, lead etc may leach from the waste and may pollute the ground water. When E-waste is disposed off on the ground the hazardous substances mix with the soil and lowers the pH of the soil making the soil acidified. The presence of metals like cadmium, mercury, lead causes air pollution leading to severe environmental impacts like global warming, hole in the ozone layer.

**DEALING WITH E-WASTE**

There are basically four ways in which e-waste has been treated till date , but none has been found to be fully satisfactory. Land filling:

It is one of the most widely used methods for disposal of e-waste. In land filling, trenches are made on the flat surfaces. Soil is excavated from the trenches and waste material is buried in it, which is covered by a thick layer of soil (Fig. 4 and 5). Modern techniques like secure landfill are provided with some facilities like, impervious liner made up of plastic or clay, leachate collection basin that collects and transfer the leach ate to waste water treatment plant. The degradation processes in landfills are very complicated and runs over a wide time span. The environmental risks from land filling of e-waste cannot be neglected because the conditions in a landfill site are different from a native soil, particularly concerning the leaching behavior of metals. Mercury, cadmium and lead are the most toxic leach ates. Lead has been found to leach from broken lead-containing glass, such as the cone glass of cathode ray tubes from TVs and monitors. Cadmium also leaches into soil and ground water. In addition, it is known that cadmium and mercury are emitted in diffuse form or via the landfill gas combustion plant. Landfills are also prone to uncontrolled fires, which can release toxic fumes. Therefore, land filling does not appear to be an environmentally sound treatment method for substances, which are volatile and not biologically degradable (Cd, Hg, ), persistent (Poly Chlorinated Biphenyls) or with unknown behaviour in a landfill site (brominated flame retardants).

**Incineration**

It is a controlled and complete combustion process, in which the waste material is burned in specially designed incinerators (fig. 6) at a high temperature (900-1000°C). Advantage of incineration of e-waste is the reduction of waste volume and the utilization of the energy content of combustible materials. Some plants remove iron from the slag for recycling. By incineration some environmentally

hazardous organic substances are converted into less hazardous compounds. Disadvantage of incineration are the emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion. E-waste incineration plants contribute significantly to the annual emissions of cadmium and mercury. In addition, heavy metals not emitted into the atmosphere are transferred to slag and exhaust gas residues and can re-enter the environment on disposal. Therefore, e-waste incineration will increase these emissions, if no reduction measures like removal of heavy metals are taken.



Fig 4. E-waste transportation.



Fig 5. Land filling with E-waste.

**REUSE OF E-WASTE**

It constitutes direct second hand use or use after slight modifications to the original functioning equipment. It is commonly used for electronic equipments like computers, cell phones etc. Inkjet cartridge is also used after refilling. This method also reduces the volume of e-waste generation. We can use above mentioned



methods for treatment and disposal of e-waste. The better option is to avoid its generation. To achieve this, buy back of old electronic equipments shall be made mandatory. Large companies should purchase the used equipments back from the customers and ensure proper treatment and disposal of e-waste by authorized processes. This can considerably reduce the volume of e-waste generation.



Fig 6. Incineration of E-waste



Fig 7. Recycling of E-waste

## Re-cycling

Monitors & CRT, keyboards, laptops, modems, telephone boards, hard drives, floppy drives, Compact disks, mobiles, fax machines, printers, CPUs, memory chips, connecting wires & cables can be recycled. Recycling involves dismantling i.e. removal of different parts of e-waste containing dangerous substances like PCB, Hg, separation of plastic, removal of CRT, segregation of ferrous and non-ferrous metals and printed circuit boards. Recyclers use strong acids to remove precious metals such as copper, lead, gold. The value of recycling from the element could be much higher if appropriate technologies are used. The recyclers working in poorly-ventilated enclosed areas without mask and technical expertise results in exposure to dangerous and slow poisoning chemicals. The existing dumping grounds in India are full and overflowing beyond capacity and it is difficult to get new dumping sites due to scarcity of land. Therefore recycling is the best possible option for the management of e-waste (fig.7).

## REGULATORY REGIME FOR E-WASTE

Considering it necessary in the public interest to enable the recovery and reuse of useful material from e-waste, thereby reducing

the hazardous wastes destined for disposal, and to ensure the environmentally sound management of all types of waste electrical and electronic equipment, the Government introduced the E-waste (Management and Handling) Rules, 2010 with effect from 1.5.2012.

The rules are applied to every producer, dealer, collection centre, refurbisher, dismantler, recycler, auctioneer, consumer or bulk consumer involved in the manufacture, sale, and purchase and processing of electrical and electronic equipment or components.

According to the Rules, the producers of electrical and electronic equipments including large and small household appliances, computers, toys, leisure and sports equipments, and medical devices shall be liable for collecting any e-waste generated during manufacture and will have to channelize the same for recycling or disposal. They will set up collection centres for e-waste generated from the 'end of life' products in line with the principle of the 'Extended Producer Responsibility' and ensure that such e-waste is channelized to a registered refurbisher or dismantler or recycler. They have to ensure that all electrical and electronic equipments are provided with a unique serial number or individual identification code for product tracking in the e-waste management system. They shall also finance and organize a system to meet the costs involved in the environmentally sound management of e-waste generated from the 'end-of life' of its own products and 'historical waste'<sup>128</sup> available on the date from which the rules come into force. The producers will also have to provide contact details of dealers and authorized collection centres to consumers so as to facilitate return of e-waste.

Dealers have to make provision for collecting e-waste by providing the consumer a box, bin or a demarcated area to deposit-waste and ensure the same is transported back safely to the producer or the authorized collection centre. The dealers, refurbishers, dismantlers and recyclers have to get registered with the SPCB or CPCB, whichever may apply, and ensure that the storage, transport, dismantling and refurbishing of e-waste does not cause any adverse effect on health or environment. All the stakeholders have to register with the concerned SPCB or Pollution Control Committee (PCC), maintain records of the e-waste handled and also file annual return to the concerned SPCB or PCC.

The Rules also clearly stated the responsibilities of the consumers and bulk consumers. They have to ensure that e-waste is deposited with the dealers or authorized collection centres. They may also avail the pick-up or take back services provided by the producers. As per these Rules, any person operating a collection centre, individually or collectively, is required to obtain authorization from the SPCB or PCC concerned. To ensure e-waste management in an environmentally sound manner, they have to make certain that the storage system is secure and that the transportation to the producer, refurbisher or to the registered recycler is safe.

## CONCLUSIONS

Rapid technology change, low initial cost, increased purchase power, high obsolescence rate have resulted in a fast growing problem of E waste. Bringing E waste in regulatory regime alone will not solve the problem of E-waste. There is need to make aware people also about the environmental aspects of E-waste. Awareness campaign about e-waste should be arranged in schools and college highlighting the measures that an individual can take to reduce the E-waste. Government should also take stringent actions to enforce the "E-waste (Management and Handling) Rules, 2010". Poor quality electronic gadgets which do not last long like Chinese gadgets

should not be allowed in the market.

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