E-Waste Management: An Approach Towards Environmental Sustainability

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Abstract

E-Waste is electronic waste that is generated from electronic equipment which is near or at the end of its useful life. It is fruitless gift given by the world with the help of Technology Advancement. It includes mobiles, desktops, PCBs, ICs etc. The concept of 3 R's i.e. Reduce, Reuse and Recycle; should be implemented to reduce E-Waste. Hence, in this paper, we have discussed the problem of E-Waste and its management in today's smart world.

Keywords

E-Waste, Mobile Phones, PC, Laptop, PCB, IC

I. Introduction

E-Waste is the upcoming waste for the future generations. It is growing exponentially due to the advancement of technology in terms of adoption of smart phones and Tablets instead of simple mobiles and Desktops/Laptops respectively [1]. It is harmful because it contains Cadmium, Mercury, and PVCs etc. There are two categories by which E-waste can be classified, they are based upon Electrical Articles and based on their reason of being waste. This paper includes the figures showing the growth rate of E-Waste and the core recycling process used for its recycling. Methods can be used for management are landfilling, incineration, recycling and reuse [2]. It can be checked by citizen, industries, NGOs as well as Government.

II. Electronic Waste (E-Waste)

Electronic wastes comprise from 2 to 5 percent of the municipal solid waste stream. This rapidly growing segment of our waste is one of substantial concern because of its hazardous and toxic materials content. Rapid technological advances and lower product prices for more powerful machines are contributing to shorter product life spans and frequent replacement. Electronic equipments quickly lose their resale value. Yet, consumers are likely to store their old electronics, believing that it still has value. Between 2000 and 2005, the Organization for Economic Co-operation and Development (OECD) notes a 22% growth in Information and Communications Technology (ICT) in China. Computers are only one part of the e-waste stream though, as we see that in the EU in 2005, fridges and other cooling and freezing appliances, combined with large household appliances, accounted for 44% of total e-waste, according to UNU's Study supporting the 2008 Review of the Waste Electrical and Electronic Equipment (WEEE) Directive [1]. Between now and 2020, WRAP estimates that electronic waste in the UK will total more than 12 million tons. A quarter of this will comprise of IT equipment, consumer electronics and display screens. This 12 million tons will include precious metals, which at the time of writing, have a total estimated market value of £7bn [4]. In fig.1, monthly data of the year 2012 is shown. It shows the collection of recycled data.

III. Classification of E-Waste

E-Waste can be categorized into different types or categories on basis of electronic/electrical article and other is reason behind considering an article a waste.

A. Criterion 1: Based Upon Electrical Articles

1. Computers and Accessories

It is such a complex system that the number of mouths that opened have a different reason of discarding them. It may be because some viruses have ruined them, if not this then it's too slow in functioning and last but not the least is newer technology, so why not seek for a better one. Keyboards or Mouse or Cathode tubes, the units of the computer are also discarded individually which generates E-Waste.

1. Televisions

Most of the people came up with 2 reasons which are- T.V sets were either not working properly or they wanted a bigger or better one.

2. Cell Phones

The cell phones are more preferably purchased as a trend nowadays than a need. No one is interested in older models and wants to have the most recent one in their hands.

B. Criterion 2: Based on their reason of being waste

1. Type 1

Those electrical articles which are working, but retired due to the newer technologies.

2. Type 2

It's E-Waste which is actually a waste means which can't function anymore. Total amount of E-Waste should be equal to Type-2 E-Waste.

3. Type 3

Articles in which only a certain part is not working properly, but whole article is replaced by a new one [5].

IV. Related Facts and Figures

- 80-85% of electronic products are discarded in landfills or incineration.
- 20-50 million metric tons of E-Waste are disposed worldwide every year.
- Only 12.5% of E-Waste is recycled currently.
- E-Waste represents 2% of America trash for landfills but it equals 70% of overall toxic waste which contains lead and it cause damage in nervous system [6, 2].

Fig. 2 shows the growth of E-Waste in previous years.

V. Concept of Recycling

Monitors & CRT, keyboards, laptops, modems, telephone boards, hard drives, floppy drives, Compact disks, and mobiles, fax

machines, printers, CPUs, memory chips, connecting wires & cables can be recycled. Their recycling process involves dismantling i.e. removal of parts containing harmful components, separation of plastic, segregation of ferrous and non-ferrous components. Fig. 3 shows whole recycling process of E-Waste [9].

Some facts related to recycling are discussed below:

* Cell phones contain high amounts of precious metals like gold or silver. Phones dumped by Americans contain $60 million in gold/silver every year.
* For every 1 million recycled phones, 35000 pounds of copper, 750 pounds of silver, 75 pounds of gold, and 33 pounds of palladium can be extracted.
* The Centre for Materials for Electronics Technology (CMET) at its laboratory come out with a technology, which has been to extract 150gms of gold from 1 ton of discarded PCBs [10].

VI. Management of E-Waste

A. Sustainable Product Design

Hazardous waste can be minimized at product design stage by keeping the following steps:

1. Rethink the product design i.e. some efforts should be made to design a product with a fewer amount of hazardous content.
2. Use of renewable materials and energy i.e. using bio-based plastics made from plant- based chemicals not from petrochemicals.
3. Use of non-renewable materials that are safer i.e. many materials can be used which are non-renewable, thereby designers could ensure the product is built for re-use, repair and/or upgradeability.

B. Volume Reduction

It includes the techniques that separates hazardous portion of waste from non-hazardous portion and thereby reducing the volume. There are two techniques to reduce waste-stream volume which are discussed below:

1. Segregation of wastes i.e. waste which contains different types of metals, it can be treated separately so that the metal value in the sludge can be recovered.
2. Concentration of waste i.e. it increases the possibility that after concentration material can be recyclable or reusable. Methods of waste concentration are gravity and vacuum filtration, ultra filtration, reverse osmosis, freeze vaporization.

C. Recovery and Reuse

This technique is capable of eliminating waste disposal costs, reduce raw material costs. A number of physical and chemical techniques are available which can be adopted to reclaim a waste material. These are reverse osmosis, electrolysis, condensation, electrolytic recovery, filtration, centrifugation etc. [7, 12].

VII. Responsible Bodies for E-Waste Management

A. Industries

Industries can adopt their own policies while handling E-Waste. Creating computer components and peripherals of biodegradable materials. Looking at green packaging options. Utilizing technology sharing particularly for manufacturing and de-manufacturing. Industries must design clean electronics with longer lifespan, that are safe and easy to recycle and will not pose threat to workers and the environment with hazardous chemicals. Manufacturers should take complete life cycle responsibility for their products and, once they reach the end of their useful life, they should take their goods back for re-use, safe recycling or disposal [9].

B. Citizen

Donating electronics for reuse to various organizations. E-Waste should never be dumped with garbage [10]. Update the older electronics items rather than buying new equipment. Return your equipment to the manufacturer when you have finished with it. Support the companies that are making clean products, if you are buying a product. Think twice before buying any product whether you really need a new one or not.

C. Government

Setting up regulatory agencies in each state or country coordinating with the regulatory functions of government and federal authorities pertaining e-waste. Government should make strict laws on disposal and management of e-waste by both public and private institutions. Existing laws should be reviewed periodically [3].

VIII. Conclusion

We concluded that E-Waste is basically a waste which came to existence due to number of reasons like technology advancement, updation, improper working which can be partial also, but truly the actual waste is that which can't work anymore not those which can be repaired. Every citizen, manufacturer and government can play against the E-Waste generating scenario. E-Waste can be managed by adopting number of techniques like volume reduction, recovery and reuse and sustainable product design. E-Waste can be recycled using different techniques like landfilling and incineration.

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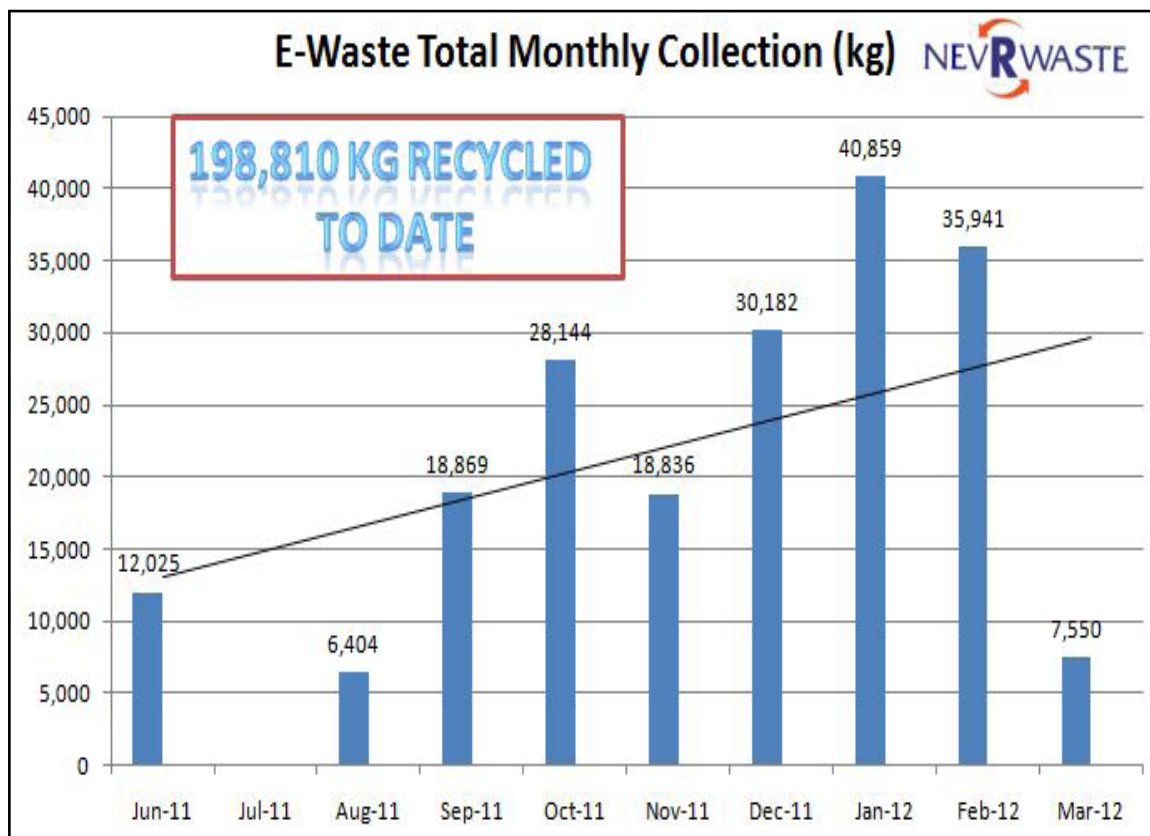

Fig. 1: Monthly Data of 2012 [11]

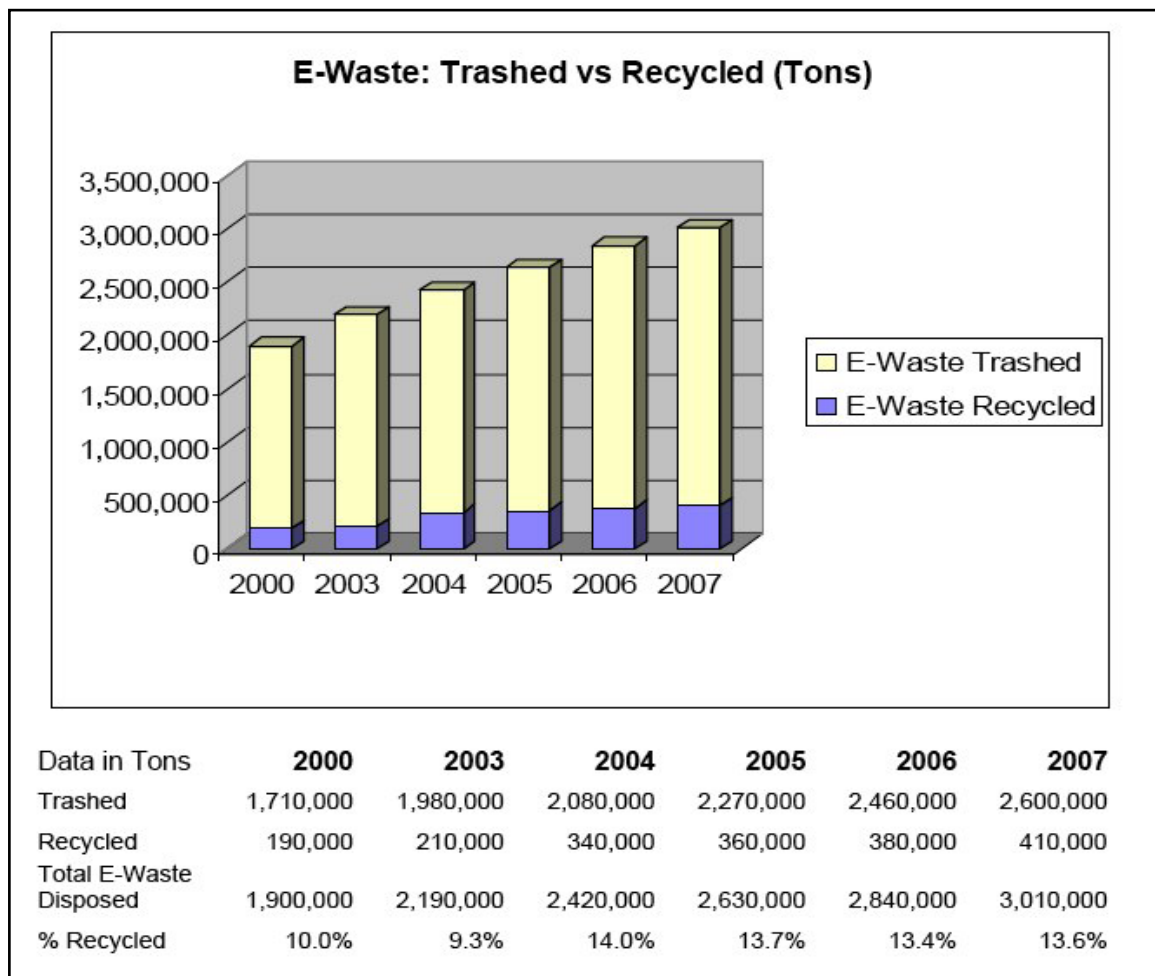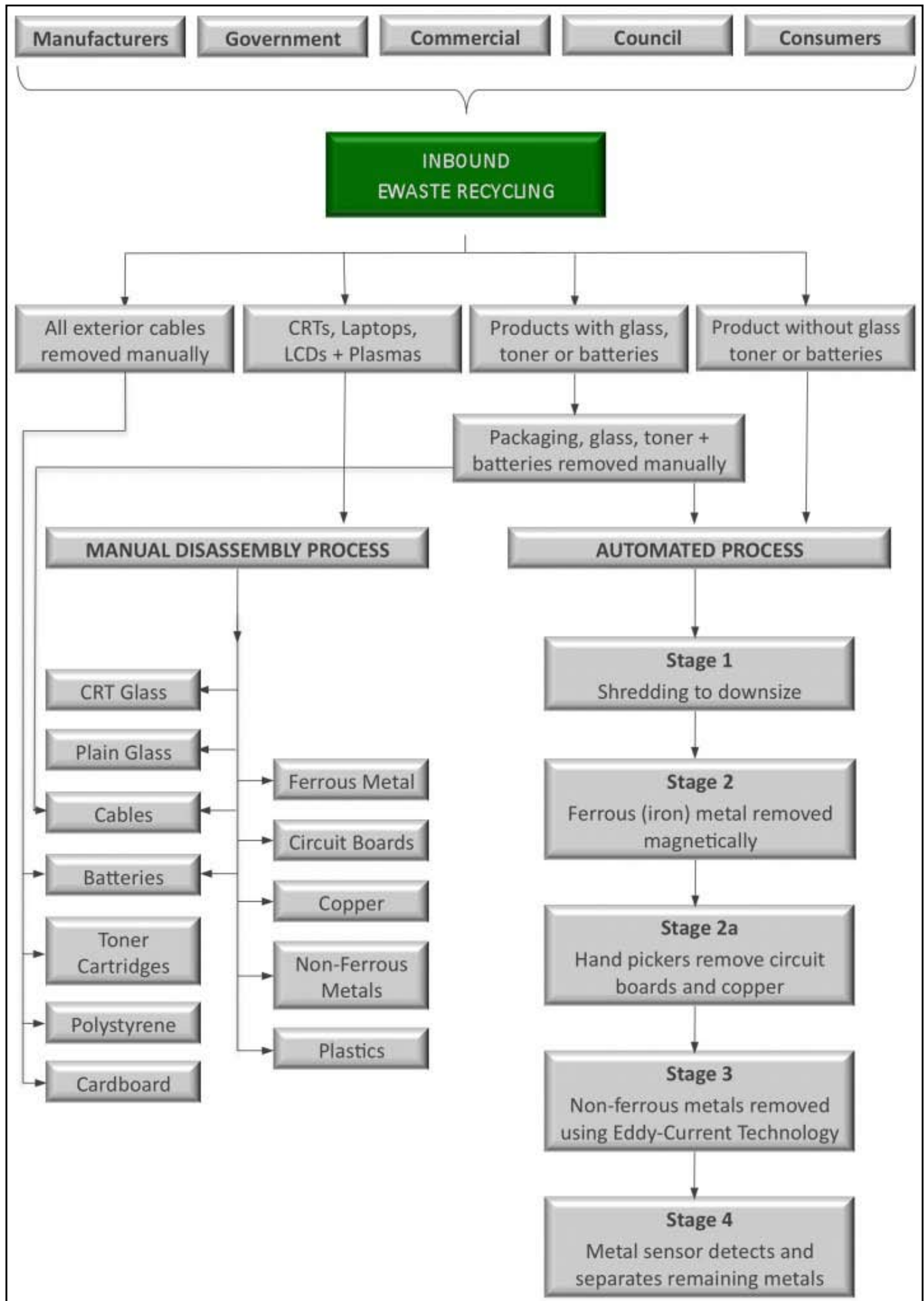| Data in Tons	2000	2003	2004	2005	2006	2007
Trashed	1,710,000	1,980,000	2,080,000	2,270,000	2,460,000	2,600,000
Recycled	190,000	210,000	340,000	360,000	380,000	410,000
Total E-Waste Disposed	1,900,000	2,190,000	2,420,000	2,630,000	2,840,000	3,010,000
% Recycled	10.0%	9.3%	14.0%	13.7%	13.4%	13.6%

Fig. 2: Growth Rate of E-Waste [8]

Fig. 3: Core Recycling Process

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