

Reducing E Waste & Recycling: Current Scenario

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Abstract

The growth of Electronic technology in this ever growing world has invaded in all sphere of our life. No step can be thought of without the help of electrical and electronic equipments. Every new coming day we are witnessing development of new electronic product which is aimed to ease out our life. The electronic escalation predetermined its intense enlargement leads the world towards modernization and technological superior. The very new development evades the market and as a side effect the ongoing technology becomes outdated and the products based on those become waste as soon as they lose their use. Thus the lifetime of the electronic equipment getting its expiring dates as earlier as the new development is being witnessed. Modernization of life shows the extreme growths of our lifestyle but a major question arise is "What about the ancient and out dated product". As technology is reinstated, the disposition procedure of outdated equipment becomes a challenge. E-Waste is the term used to indicate the electronic device which is no longer in existence and has been taken over by a newer and latest technology developed product. . These Electronic devices get junk and gets dumped into the garbage. The electronic equipments mostly consist of hazardous substances also and when dumped in the garbage leads to degradation of environment and threat to even human health. Out of the several reasons these also adds as reasons for the global warming. So that all the techno creators must have an intention to invent a new

electronic device keeping and suggesting measures of safe and purposeful disposition. He developed and aware developing countries are aware of these situations and are taking steps for its redressal. Out of the various options the recycling the products is one option to protect the equipments from getting obsolete and this when worked upon will lead to a situation which will make environment nontoxic and maintain the environment safe. This paper highlights the points why e-waste is so harmful and the information about the waste management and measures being exercised in India. The various suggestive remedies for the E-Waste problem are also dealt herein. The major thrust of this paper is to attenuate the E-Waste volume and to make our world safe and healthy.

Keywords: E waste, E-Product, EEE, Hazards, Recycle.

Introduction

In recent decades, the use of electronic and electrical devices has increased significantly, leading to rapidly rising amounts of waste electrical and electronic equipment (WEEE), often also called e-waste, throughout the world. E-waste is a highly complex waste stream as it contains both very scarce and valuable as well as very toxic components. It also lacks a uniform international definition. In this article, we have chosen to use the terms WEEE and e-waste interchangeably. According to the definition put

forth by the Solving the e-Waste Problem Initiative, e-waste is “a term used to cover almost all types of electrical and electronic equipment that has or could enter the waste stream. Although e-waste is a general term, it can be often considered to cover almost any household or business item with circuitry or electrical components with [a] power or battery supply”.

As these days the availability of E-Goods in market is increasing, this psychologically creates temptation in people to update their household electronics items with high fascinate models for various reasons. . Throwing of old products into the dustbin as there is no buyer in market for the obsolete ones , this cannot be proper way of disposal. These get added into the E-Waste categories. These E-Wastes creates problem either directly or indirectly for the living being and environment which includes atmosphere. Out of various options the Recycling of E-Product may be effective tool for reduction of E-Waste. These days various techniques and technology are available for recycling the waste. Recycling is a functional method to collect back some of the usable product forms the waste. Aim of this paper is to present and make a revolt of these wastes into wealth.

E-WASTE

E-Waste is defined as an Electronic Waste which consists of Electric and Electronic product which is unsalvageable and expired appliances. Each and every need of the people is handled by the way of EEE Electronic and Electrical Equipments like Mobile Phones, Pc, Laptop, I pad, home appliances etc. E-Product makes people life very easy, very proficient and time saving.

The dependence and frequent use of E-Product have resulted in increase in production of these products and hence the product in usage after its life turns to waste. Due to the advance machinery and changes of modern life style, it makes the product to soon reach their life span and no other option other than to dump it in garbage remains. The dumping of E-Waste into garbage makes harm to both human and environment's health and wealth. E-Waste is being identified as one of the fastest emerging

global problems. The hazards of these problems are not very well known to the people, they are less aware in this area. These E-Wastes contains valuable, recyclable and toxic substances.

Constituents of E-Waste

E-Waste contains the materials which doesn't have any other chance for manipulation and cannot be recovered, recycled and or , disposed comes under this category. The table below shows the basic materials , its hazards and products .

. Table showing Materials , Possible hazards and products responsible for it.

Materials	Hazards	Product
Lead	Nervous system, Blood system, reproductive system, kidney , plant, animal, micro organism	Glass panels gaskets in pc monitor, solders in PCB and other components
Cadmium	Kidney, air, plant, animal, water bodies	SMD chip resistor, infra red ,semi conductor chip, cathode ray tube
Mercury	Brain, kidney, animal, plant, water bodies, sea foods	E-Product, thermostats, sensors, switches, mobile phones, batteries, CRT
Hexavalent chromium/ chromium V129	DNA, Environment	Steel Plates
Plastic	Brain, Kidney, Lungs, Heart, Plants, Animals, Air, Water	PVC, Cabling, Computer Molding, Home Appliances
Brominated Flame Retardants	Plants, Animals,	Plastic Housing, Circuit Board, Prevents from flammable
Barium	Brain Swelling, Muscle Weakness, Damage to heart, Liver and Spleen	CRT Monitor
Beryllium	Lung Cancer, Skin Disease	Mother Board, Finger Chips
Toners	Respiratory	Plastic Printer

	System	Cartridge
Phosphor	Dismantle CRTs by hand	CRT Monitor

These substances are harmful to human health and environment. Thus their handling and proper disposing is of utmost importance. The main point is that E-Waste contains some precious metals such as gold, silver, platinum etc. which can create new avenues of business in form of extraction of these metals from these wastes.

Classification of E-Waste

The E-waste contains various electronic equipments. These electronic equipments are broadly categorized into the following ways

Table showing Classification and Products

Classification	Products
Home Appliances	Refrigerator, AC, Washing machine, vacuum cleaner, kitchen appliances, Watches, Mixie, Grinder, fan, TV, Radio etc.
IT and Telecommunication Equipment	PCs, Printer, telephone, Fax machine, etc
Consumer Equipment & Monitoring, Control Instruments and Automatic Dispensers	Video Camera, Amplifier, Mobile Phone, I pad, Video games, Electric aeroplane, toy robot, Smoke detector, heating regulators, thermostat, Soft drink equipments etc
Lighting Equipment & Electrical and Electronic Tools	CFL, Sodium Lamp, Drills, Saws, Sewing Machine etc
Medical Device	X ray, Scan, Radio therapy, Cardiology, laparoscopy

E-Waste Management in INDIA:

Indian electronics and IT Industry are rapidly growing and this rapid growth is converting into compilation of waste product which is referred as E-Waste. In India E-Waste generation is growing at a rate of 15% and was expected to cross 800,000 tones mark by 2012 itself. By

2015, 2 Billions PC s is expected to invade Indian home and the country expected e waste to be about 450 million. E-Waste assumes significance in India due to generation of the country own E-Waste and dumping of E-Waste from developed countries in name of modernization. US exports 50,000 tones of E-Waste to India every Year. In name of globalization and free marketing the developed countries are seeking place for dispose their E-Waste in under developed and developing countries like India, China, Pakistan etc

As per recent survey 3, 30,000 tones of E-Waste is being generated annually in India and will touch nearer to 10,00,000 tones in 2014-15. In India due to lack of proper infrastructure, legislation and framework only 5% of the E-Waste is recyclable and 95% are not recyclable. The important factor to be kept in mind is that recycle process must be done in safe manner without affecting the environment freedom.

Pai chart showing 5% -Recyclable 95%-Non Recyclable materials in E wastes

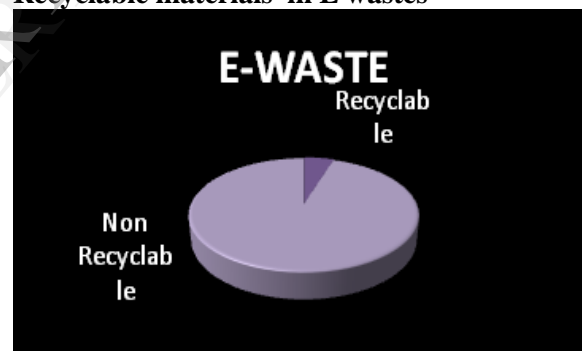


Figure 1

In India E waste generated from various major states and cities can be viewed as shown in the subsequent graphs..

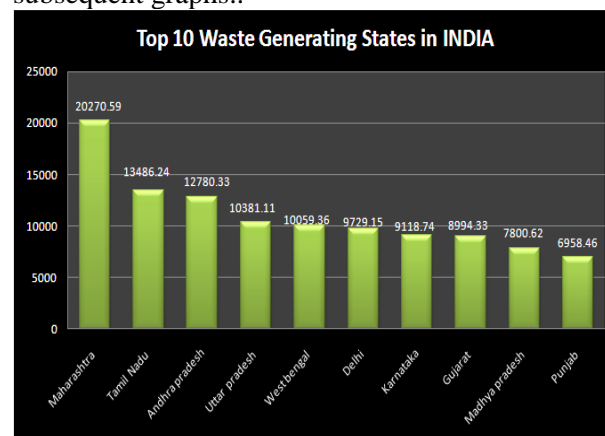


Figure 2



Figure 3

According to reported survey it denotes the importance of the E-Waste problem. Many techniques and technology are needed to make India safe.

India is expected to have an 11% share in the global consumer electronic market by 2015. By 2012, India is having around 600 mn mobile subscribers, 60 mn PCs and 143 mn TVs.

Table showing growth of Mobile , PC and TV



Figure 4

In 2012, 7.1 mn computers, 16 mn TV sets and ~190 mn mobile handsets are expected to be a part of the e-waste pool in India. This would translate into 1 mn tons of e-waste in 2012.

Table showing Potential Waste for PC , TV and Mobile and its rate of increase



Figure 5

The average lifespan of most electronic gadgets has been constantly reducing. This fast obsolescence of electronic gadgets results in generation of e-waste. E-waste is a term used to categorize electronic items which have reached end-of-life for their current users. Such items often contain materials that have economic value but can pose environmental risks if they are land filled or incinerated.

Types of E Wastes

Recyclable and Non Recyclable

Recyclable and Non Recyclable components:

It is clear that only 5% of the products are ready for recycle. Every E-Product will have its life and disposal date. According to their life time the product should be handed.

Table showing product and life expectancy

Product	Life expectancy
Mobile & Camera	1 to 3 years
PC and Laptops	5 years and 3 years
TV , Refrigerator and Washing Machine	10 – 15 years
IT accessories	Very fast

Society change their life style as per availability and current market trends The innovation is making life easier day by day and these are generating E wastes. The E wastes can be of different types.

Table shows the recyclable and non recyclable product from the collected E-Waste

RECYCLABLE	NON RECYCLABLE
Amplifiers	Batteries
Audio and video players & recorders	Cardboard
Cameras	Contaminated Equipments
Cell phones	Broken CRT Screen
Computers	Harm Plastics
Copiers	Smoke Detectors
Fax machines	Stryrofoam
Gaming Accessories	Steel chassis
Monitors	Transistors
Pagers and PDAs	Solder
Printers	Hairdryers
Radios	
Receivers	
Scanners	
Speakers	
Telephones	
Tuners	
Turntables	
Televisions	
Video projectors	

From above table it is clear that the E-Waste is the collection of valuable, recyclable and toxic substances. There are many highly valuable and precious metals in E-Waste. By recycling the e-Waste one can collect the precious metals. It is the new upcoming business in today's world. Table below shows the hazardous and non hazardous materials founded in E-Waste. It can be seen that the waste product contains many metals which are hazardous and some are nonhazardous. In recycling the recyclers must take utmost care about the hazardous e-wastes.

Table showing possible Hazard and Non Hazard Metals

Hazardous	Nonhazardous
Americium	Tin
Mercury	Copper
Surplus	Aluminum
BFR	Iron
Cadmium	Germanium
Beryllium	Silicon
oxide	Nickel
Lithium	Lithium
Zinc	Zinc
Gold	Gold

RECYCLING TECHNIQUES

The recycle of E-Waste must be handled correctly because it has potential to harm the human health and environment. The under mentioned measures can be taken to overcome or minimize these hazards.

- Land filling
- Incineration
- Pyrolysis
- Recycle
- Reuse

Land filling: A Land filling site is known as tip, dump, or rubbish dump. It is a place for the disposal of waste materials by burial and it is the oldest waste treatment method. Traditionally, a landfill is one of the common methods of waste disposal organization. It is used for waste management process mainly as temporary storage, consolidation and transfer, sorting, treatment and recycling. Modern techniques like secure landfill are provided with some facilities like impermeable liner made up of clay or plastics, leachable collection basin that collect and transfer the leachable to waste water treatment plant.

The land filling will have the following advantages

- Indispensable disposal are provided.
- Well-suited and presently required with all other technology options for lasting waste.
- Skill to desire landfill gas byproduct for industrial use, power production.
- Include bioreactor landfills on future.
- Costs incurred incrementally as landfill expands.

However there will be some disadvantage which can be summarized as

- Costs have increased with liner, LCR s system and stricter regulations.
- Public sitting issues
- Long post closure care obligations and unknown
- Long term limitations on site land use

Incineration: In this process the waste treatment involves the combustion of organic substances contained in waste materials. Incineration of waste materials converts the

waste into ash, flue gas, and heat. Heat generated by this process can be further used to generate electric power.

These will have advantages as follows

- i. Minimum of land is needed compared to the dimensions of waste dispose sites.
- ii. Waste weight get reduces to 25%
- iii. Waste volume get reduces to 10%
- iv. Use of this method is eco-friendly
- v. Decreases the volume of pollution, traffic, noise and cost for water transportation.

The disadvantages will be

- i. Very expansive to control air pollution
- ii. Very high technical principles require skilled workers, it increases high wages.
- iii. Increase in air pollution , destroy ozone layer
- iv. Causes fire and harm to object around it
- v. Pollute near by atmosphere.

Pyrolysis: Pyrolysis is a process of thermo chemical decomposition of organic material at elevated temperature without presence of oxygen. Pyro means fire and lysis means separating. Pyrolysis typically occurs under pressure and at operating temperature typically above 4300C. Synthesis gas, pyrolysis liquid and solid char are produced .

Advantages will be

- i. Reduces greenhouse gas emissions and waste going to landfill.
- ii. Produces a marketable product (electricity).
- iii. Less water pollution.
- iv. High revival rate of property.
- v. Low risk of health consequences.
- vi. Commercially proven technology.

Disadvantage for this will be

- i. Technology is still growing.
- ii. Markets are so far to be developed for char product and pyrolysis liquids.

Recycle: Recycling of e-waste is only solution to eliminate the hazards of e-waste disposal and it aims at reuse solution and increases longevity of the product for a profitable business. E-waste consists of broken and unwanted electrical or electronic devices and peripherals. E-waste usually finds a place in landfills or incineration. Both of these are harmful to the environment and human health. Recycling or processing e-waste to extract the minerals trapped inside and

reusing the rest of the components is a viable solution to solve the menace of e-waste.

The recycle will have advantages as

- i. Eradicate health and environmental hazards
- ii. protection of resources
- iii. Energy efficiency
- iv. Economic growth
- v. Decreases the amount of greenhouse gas emissions

Disadvantages will be

- i. Some hazardous material makes harm to environment.
- ii. Recycle are done by burning, melting and acid stripping.
- iii. Make harm to near by surroundings.

Reuse: Reuse of e-product is using the same product with some modification or alteration making it up to date. The most commonly reuse E products are computer, cell phone, television, washing machine etc. By reuse the same product reduces the volume of e-waste generation. Large company may also use these techniques to get back the unused e-product form the customers, and then modernizes some of the techniques to that product then resell it.

Reuse will have advantages of

- i. Energy and raw materials savings.
- ii. Reduced disposal needs and costs.
- iii. Refurbishment can bring sophisticated, sustainable, well paid jobs to underdeveloped economies.
- iv .Cost savings as a reusable product is often cheaper than the many single use products it replaces.
- v. Some older items were better handcrafted and appreciate in value.

The reuse disadvantages will be

- i. Reuse often requires cleaning or transport, which have environmental costs.
- ii. Items like Freon appliances or infant auto seats, could be less energy efficient& prove costlier when used.
- iii. Reusable products need to be more durable than single-use products, and hence require more material per item.
- iv. This is particularly significant if only a small proportion of the reusable products are in fact reused.

Sorting and preparing items for reuse takes time, this is inconvenient for consumers and costs money for businesses.

Table showing Typical common methods for Recycle

E-WASTE	MATERIAL	MANAGEMENT PRACTICES
Plastic	Casing, front panel, rear panel	Shredding , melting
Printed circuit board	Fire inhibitors, electronic parts	De-soldering, open burning
Miscellaneous	Chips, electric wires, broken glass	Chemical stripping, open burning
Liquid	Chemical, acid	Sewerage system

E waste Sectors

Hazards of E-Waste are known clearly hence E-waste are handled by two sectors these are

Formal sector and Non Formal Sector

Formal Sector

Mostly e-products are imported from developed countries to India and in turn turn to be e waste. In recent years large amount of E-Waste are being exported from western countries to Asian countries for disposal for economical reasons. It shows that in western countries the recycling process is becoming economically non-feasible due to rising cost of man power . Therefore, western countries find easy way to dispose their waste to escape from the crisis of E-Waste by shifting to developing countries

Non Formal Sector:

In India 95% of the waste are recycled and these are mainly recycled by the use of non formal sectors. The imported materials are reaching to India by illegal routes. These wastes are imported for recycling at small units in Non-Formal sector. These units use primitive, non-scientific, non-environment, non-eco friendly methods. E-Waste are said to be hazardous because of toxic substances present in it. The extraction of metals in non-formal units is

carried out by dipping the printed circuit board (PCB) in the acidic/alkaline solutions and heating and burning of PCB. These process are harmful to the environment. E-Waste contains precious metals which are extracted by unskilled operation.. In India non-formal sector units includes rag-pickers, scrap dealers, whole sellers, recyclers etc. The operation in non-formal sector ranges from .Collection to Segregation and Disassembly

In Collection rag pickers, small scrap dealers collect the E-Waste from various sources. Most of the sources are encouraged in putting the E-Waste in recycling chain instead of storing the e-waste or disposing in garbage. Collection of waste are used for effective purpose. E-Waste are collected from small to large scale dealers ranging from government offices, schools, universities, laboratories, industries ,houses etc. In Segregation the collected waste is separated in various categories depending on constitution, segments, materials, crystal and fabric .These categories are based on the marketability for higher profitable returns.

In .Disassembly is segmentisation of electronic / electrical equipment/ appliances in its constituents. It can be in two ways namely Non-Destructive and Destructive.

Non-Destructive: It repossesses certain disassembled parts for recycle. The composition of various electronic components has also gone a significant change in last few decades, which makes majority of de-soldered components obsolete for re-use.

Destructive: This method is used to separates each material type for recycling process

Recycling of PCB:

The PCB (Printed Circuit Board) forms basic constituent of e product. It contains 3-5% of rich metals such as gold, silver, and platinum. The precious metal gold found in ICs, gold plated terminals and other components etc. To remove the gold from PCB, the non-formal unit uses lead solder but in causes air pollution. Copper get removed by open burning the PCB. During de-soldering, PCB acid bath process is used and these acids when thrown causes soil

pollution. To remove the paint, caustic soda bath and scrubbing process is done. The fine powder is sold to market for profits. This one is the most curious process in recycling.

Formal Sector: To minimize the e waste technology for recycle is also. The main goal of this process is “While recycling one should see that the process must not do any harm or hazards to the environment The preservation of environment and hygiene and health is the main aim. It manages the e-waste in an environment sound manner by using improved efficient technology and enhanced resource recovery. The methods used in formal sector are mainly Disassembly and Segregation. Disassembly and segregation is used to remove the hazardous materials from the total e waste.. The methods are eco friendly and take care and safety of the workers involved. The developed and proven technology are used for recovery of resources.

Recycling of PCB: The PCB gets grounded into fine conducting particles, by physical impaction and removal , shredding, fragmentation and granulation it can be rectified. The mechanical process granulation is used to make PCBs into fine powder. By using the magnetic separation technique the materials iron, nickel, cobalt is separated from PCB powder. The aluminum can be separated by using eddy current separation technique. The hydrometallurgical methods are used to recycle the metals from PCBs. Electro refining process is used for refining copper.

Recycle of Computers

The top most products in E-Waste is computer which can be desktop , laptop of in any form. The benefits of recycling computer components are listed below. The under mentioned table gives a view of peripherals and the amount of metals found in each component .The computer components and its metals are detailed by this table. It shows the availability of organic and non organic metals which can reuse and recycle. The computer can have some metals that cannot be recycled. While recycling the metals one must see that it does not harm environment and human health.

Table showing constituents and recyclable or non recyclability

Constituents of E-Waste	Recyclable / Non Recyclable
Metal	100 % Recyclable
Glass	99 % Recyclable
Plastic	100 % Recyclable
PVC	Recyclable
Fiber Glass	NON Recyclable
Circuit Boards	Recyclable

Managing E Waste :

The following points shows the benefits of controlling the e-waste which will help to reduce the volume of e-waste.

Stock Organization: Proper control and sound material management in manufacturing process will effective manage e waste. Each organization have certain control over their stock to reduce the magnitude of harmful materials used for manufacture.

Production-Process Alteration : Fruitful alteration can be made in the production process. This is done by changing the materials used to manufacture the product . Use of more proficient use of input materials in the production process can be alternatively thought .

Volume reduction : Many techniques have emerged for reduction of volume. The volume reduction techniques for removal of hazardous portion of a waste from a non-hazardous portion can be exercised. By reducing the volume , one can cut the cost of disposing of a waste material.

Recovery and reuse : The recovery and reuse technique used to estimate the cost to dispose the waste. This estimation can provide a comparison of amount of cost to reduce the raw material. Waste can be recovered by the on-site, or at an off-site recovery facility. Inter industry exchange can also be exercised for such.

Product design : Minimization of hazardous wastes should be taken care at the product design stage itself. The measures may be addressed while product design, using renewable

materials & energy and using safer non-renewable materials.

Major Known E-Waste Handling (Management) Companies in India:

Every year millions of electronic items become outdated and give rise to E-waste. These wastes if not properly recycled, might cause dangers to the . Effective management of e-waste is highly essential to prevent air and water pollution and this service is offered by several companies in India. Top three companies in India that offer this service are briefly dealt below:

E-Parisaraa Private Limited : E-Parisaraa is the first government approved E-waste Management Company in India and they are in this service right from the year 2005. They offer services like collection and inspection of e-waste upon paying the producer and they offer destruction certificate and destruction pictures as a evidence towards the E-Waste offered by their customers. They ensure data security to their customers since they have possibilities of complete destruction of data tapes, degaussing and data wiping of the crucial data in the old computers of their customers. Lack of documentation is real threat for estimation of e waste.

Earth Sense Recycle Private Limited : Earth Sense Recycle Private Limited is the joint venture between the E-Parisaraa Private Limited and M/S. GJ Multiclave India Private Limited, which is a bio-medical waste handling and management company. The company came in existence in the year 2000 . The company recycles all types of e-wastes. Some of the e-waste products handled by them are floppies, toner cartridges, CDs, tube lights, batteries, CFL's, etc

Trishyiraya Recycling India Private Limited : This private limited company is operating from the city of Chennai. It is engaged in the management and recycling of various types of wastes like chemical waste, cable waste, electronic waste, electrical waste and telecommunication waste. The customer list belonging to different sectors like electronic

equipment manufacturing, automobile industries, mobile phone manufacturers, software companies, computer peripheral and computer manufacturers, telecommunication companies and electrical & electronic component exporters and manufacturers are in their clientage.

Responsibilities

The main issue needed for environment , health and hygiene is to adopt intelligent practice to handle rising bulk of E-Waste. The responsibilities of government, government agencies, industries and public in general is significant for reduction of e waste.

Responsibilities of the Government and government agencies

Government should provide strict laws and implementation and control for e-waste

Government must educate and create awareness about hazards and its effects among the masses.

Government should organize well developed agencies in each state , district and low down the order. These agencies must take care for the hazardous waste disposal in their district and area.

Government should provide strict laws and action against the dumping of waste by outsider.

Government should support and encourages the NGO and researches for solving the e-waste problems.

Government should posses' action for manufactures and retailers to provide recycling service.

Responsibilities of the Industries

Manufactures retailers should take care for recycling and disposal of their own product.

Industries must take responsibilities to provide the output characteristics of wastes; management should provide options for hazardous substances.

While manufacturing e-product use re-generatable materials.

Offer take back services and make use of these product by remanufacture it.

Caution should be provided during the manufacturing companies and it should be pasted in the material body itself.

Responsibilities of Public

Ask the manufacture about the reuse and recycling

Find options before buying a new e-product

Buy the product having durable, repairable and warranty avoid buying use and throw product.

If the appliances are not useful for our needs then sold it or donate to proper institute.

Think about the hazards for a while before disposing the unusable product from home.

Avoid buying non certified and guaranteed products.

Be vigilant about e waste hazardous effects

Help government, Industry and NGO do their work.

Conclusion

In India the production from the domestic manufacturers and imports or dumping for developed countries are the two main reason after use generation / development of e-waste. A correct estimate about e waste in India is next to impossible. The recycling and reuse Postpones the e waste to some extent but selection and adhering to the duties can help reduce the e waste and safeguard from the hazardous environmental , health and hygiene degradation. The volume of e-waste increases the risk of those hazards for the environment which is bound with it. Reuse and recycle of e-product is the better solution than disposing. It reduces the volume of toxic and hazardous substances. The techno creators, researchers must work hard to invent a new electro device and find correct ways of disposing off the e wastes . By taking care for this hazard we can make our environment clean and green.

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