About e-waste

What is e-waste?

In the simplest of terms, Electronic Waste – e-waste for short – or Waste Electrical and Electronic Equipment ("WEEE"), includes all types of electronic equipments/ products which have become obsolete or have been discarded due to:

- Advancement in technology
- Changes in fashion, style, status or perception
- Nearing the end of their useful life

The term 'e-waste' is generally understood to refer to any old, obsolete, end-of-life appliances using electricity which have been disposed off by their owners. E-waste thus would include discarded old computers, television sets, refrigerators, radios, telecommunication equipment, laboratory equipment, and other handheld gadgets – basically any electrical or electronic appliance that has reached its end-of-life.

E-waste has been one of the fastest growing waste streams in the world. While e-waste contains valuable materials such as aluminium, copper, gold, palladium and silver, it also contains harmful substances like cadmium, lead 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 hazards.

Electronic Waste: An Alarming Global Phenomenon



Computer Waste – Largest Component of E-Waste in India

Computer waste is the most significant of all e-waste due to the quantity as well as rate at which it is generated. The computer hardware sector has displayed a phenomenal growth in the past few years keeping pace with the rapid growth in the software sector. And given the continuous innovations and technological up gradations that take place in the hardware segment, obsolescence risk remains a key area of concern for companies that have made huge investments in their IT systems.

This obsolescence could be brought about by several factors such as the perception that superior efficiencies could be achieved by investing in superior IT equipment, or due to the poor design of computers that do not facilitate easy upgradability, or due to the steady decline in prices of computers and computer peripherals, making it them more affordable to increasing number of businesses.

The most disturbing aspect of computer waste – or techno-trash, as it is also known - is the rate at which it is accumulates. According to a study by the Manufacturers Association for Information Technology ("MAIT"), together with GTZ, the German Technical Cooperation agency, India generated 330,000 MT of electronic waste in 2007, while an additional 50,000 MT was illegally imported into the country. By 2011, it is estimated that e-waste generated in India would touch 470,000 MT.

E-waste Recycling: The Indian Scenario

Increasing Demand in the Brown Goods/ White Goods Segment

Though organized e-waste recycling is an established industry overseas, it is a phenomenon that is still gaining currency in India.

With the Indian economy having registered a sustained growth rate of eight percentage points-plus in the past, changing economic trends have resulted in a significant rise in the disposable incomes and the rise of an Indian consumer with a greater propensity to spend. This has translated into a massive demand for consumer durables – especially white goods such as television sets, microwave ovens, air-conditioners, cellular phones, etc.

The following table shows government-released data representing actual as well as estimated levels of penetration of consumer durables in India:

Penetration of Consumer Durables

(No. of Households Owning Goods per '000 Households)

Particulars	1995-96	2001-02	2005-06	2009-10(E)
Cars	16.1	30.0	50.2	91.4
Motorcycles	29.3	70.8	147.6	282.6
Colour TV	72.0	145.6	213.0	314.0
Refrigerators	86.1	134.0	160.7	224.9
White Goods	149.4	247.1	319.1	451.7

Source: NCAER

The IT Hardware Industry

The electronics industry has emerged as the fastest growing segment of Indian industry both in terms of production as well as export, with the household segment, e-governance projects of the Government, education, media and the BFSI segments being the key growth drivers behind this segment. As per NASSCOM data reproduced below, contribution of hardware stream to the domestic IT industry revenues has grown at a CAGR of 20.2%, from $4.9 Billion in FY04 to $8.5 Billion in FY07, and is expected to contribute around $12.0 Billion in FY08, constituting roughly 18.8% of the total industry revenues.

Total Domestic IT Industry Revenues

Particulars ($ Billion)	FY04	FY05	FY06	FY07	FY08 (E)	CAGR
Software products and Engg. services	3.0	3.8	5.3	6.6	8.5	30.1%
IT Services	10.4	13.5	17.8	23.5	31.0	31.2%
ITeS-BPO	3.4	5.2	7.2	9.5	12.5	40.8%
Hardware	4.9	5.7	7.1	8.5	12.0	20.2%
Indian IT industry total	**21.7**	**28.2**	**37.4**	**48.1**	**64.0**	-

Source: NASSCOM

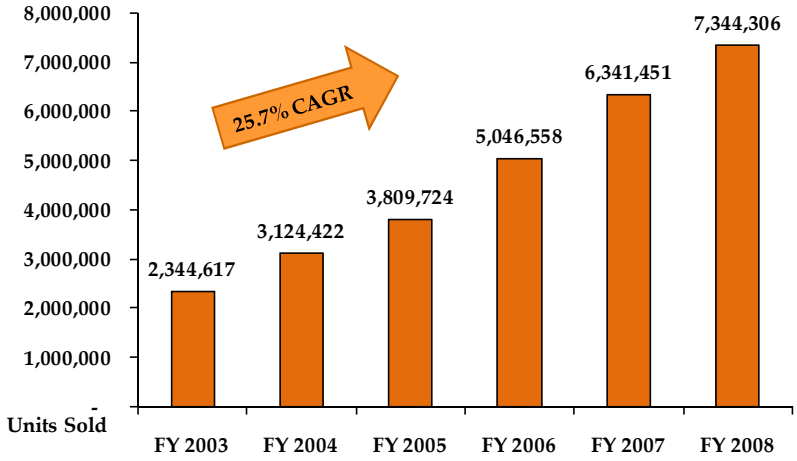
Manufacturers' Association for Information Technology - 'MAIT', in short – an organisation that represents hardware manufacturers and vendors in the IT industry, undertakes regular studies of various industry trends, and publishes findings thereof periodically. MAIT's industry performance review ("the 'ITOPS' programme"), conducted by leading market research firm IMRB (India Market Research Bureau) is a bi-annual exercise and involves data collation from over 24,600 end-users spread over 22 cities, with data projected to the 'all India urban market'.

As per the 'IT Industry FY 2008 annual performance review' conducted by MAIT, total PC sales during FY 2008 stood at 7,344,306 units, with western India accounting for approximately 31% of the total. For 1st quarter-ending 2009 (April – June 2008), MAIT reports domestic computer sales at approximately 2.075 Million units.

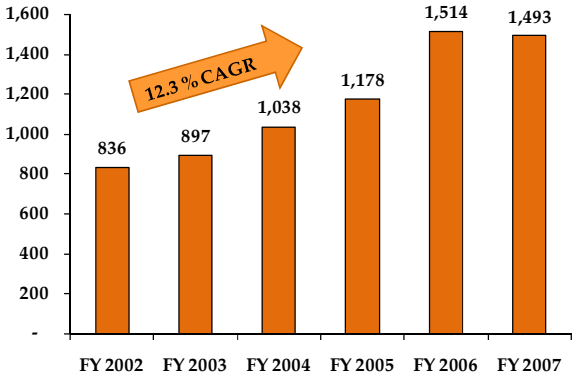
Based on MAIT-IMRB research, the following table shows trends in computer and computer peripherals' sales in India over a span of six years:

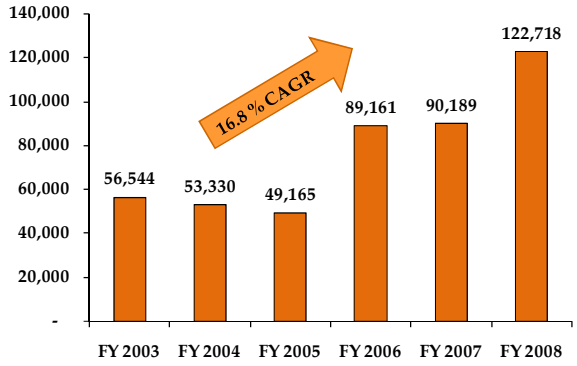
(All data being number of units sold, unless indicated otherwise)

PC Sales in India

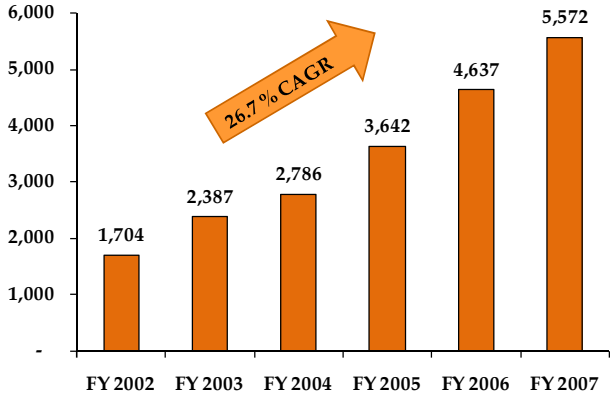


Printers ('000 units) **Servers**

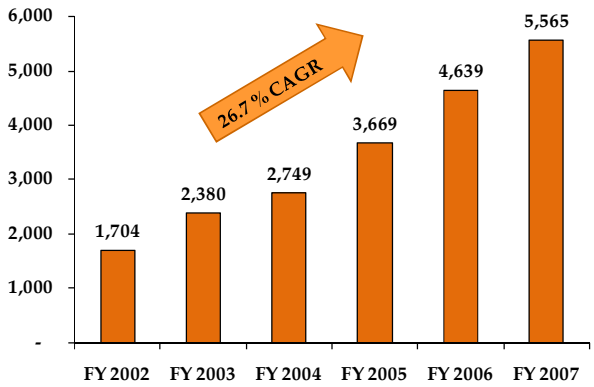




PC Monitors ('000 units)



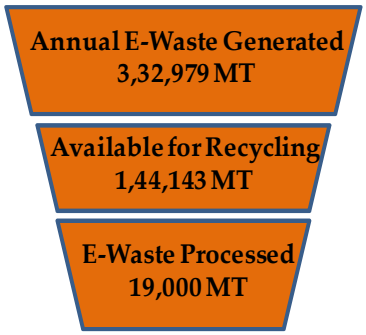
Keyboards ('000 units)



E-Waste Statistics in India

MAIT reports that India generated 332,979 tones of e-waste in 2007, while an additional 50,000 tones are illegally imported into the country. Though the Foreign Trade Policy of India does not permit import of electronic waste, it often finds its way into the country through illegal means or through misdeclaration. Of the total e-waste generated, only about 40% finds its way to the recycling stream while the remaining 60% remains in warehouses/ storages of companies due to poor/ inefficient collection system followed by them. A significant portion of the e-waste that finds its way into the recycling stream – especially television sets and cellular phones - are refurbished and resold. Only about 19,000 tones, representing slightly over 5% of the total e-waste generated in the country is ultimately processed. The MAIT study estimates that India would generate approximately 470,000 tones of e-waste by the year 2011. The study also brought out that around 94% of the organisations polled did not have any policy on disposal of obsolete IT products/ e-waste.

Key statistics relating to the extent of e-waste generated, available for recycling and ultimately processed is given below:

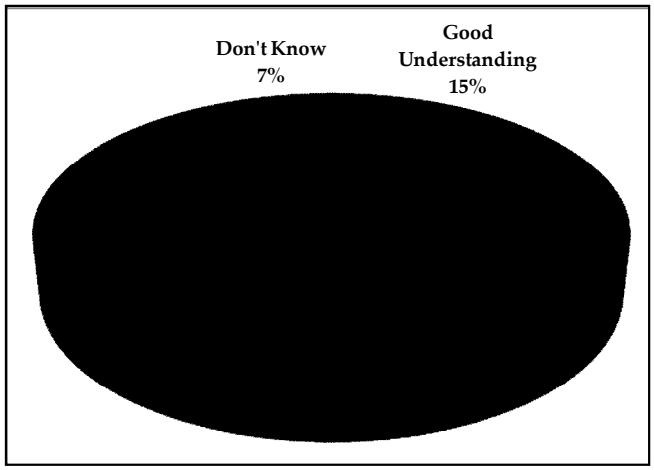


E-Waste Generation in India - Breakup

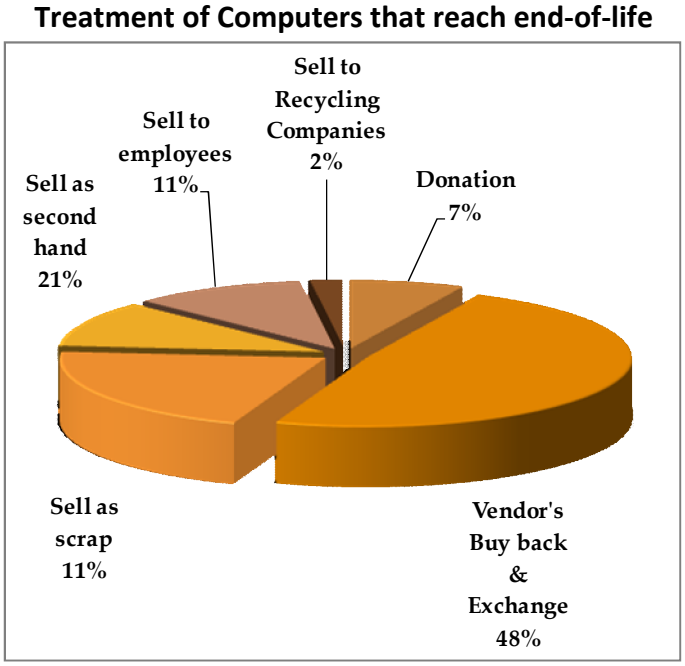
Components	Generated	Avail. for Recycling	Processed
Computers	56,324	24,000	12,000
Cellular Phones	1,655	143	7,000
Televisions	2,75,000	70,000	-
Imports	-	50,000	-
Total	**3,32,979**	**1,44,143**	**19,000**

All data in MT; Source: MAIT

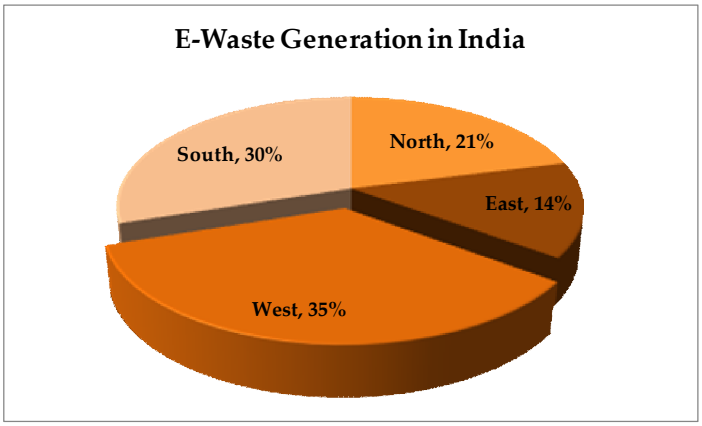
The MAIT study further reports that out of the total corporate polled, around 94% of them did not have any proper policy in place governing safe disposal of obsolete IT products/e-waste. Though a number of corporate were aware about the environmental threats arising on account of improper disposal of e-waste, the level of awareness and depth of understanding was found to be lacking.



Due to lack of proper awareness of safe disposal of e-waste, most e-waste components are not recycled in an environmentally safe manner and usually enter landfills causing severe ecological and health hazards. MAIT estimates that roughly 80% of the computers that are replaced enter the e-waste stream, either directly through scrap or via second hand markets, exchange or buy back schemes.



Of the total e-waste generated in the country, MAIT reports that the western region accounts for the largest proportion at 35%, followed by the southern region at 30%. The regional spread in e-waste generation in India is shown in the following chart:



Sixty five cities in India generate more than 60% of the total e-waste generated in the country. Ten states generate more than 70% of the total quantum of e-waste. 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

producing states in India. Among top ten cities generating e-waste, Mumbai (~11,000 tonnes per annum) ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur.

The E-Waste Recycling Industry in India

Scrap-dealers Using Crude and Unsafe Methods to Recycle E-Waste





E-waste Hazards

WEEE equipments are made up of a number of components – some containing toxic substances which can have an adverse impact on human health and the environment if not handled properly. Often these hazards arise due to the improper recycling and disposal processes used.

For instance, Cathode Ray Tubes (CRT) has high content of carcinogens such as lead, barium, phosphor and other heavy metals. When disposed carefully in a controlled environment, they do not pose any serious health or environmental risk. However,

breaking, recycling or disposing off CRTs in an uncontrolled environment without the necessary safety precautions can result in harmful side effects for the workers and release toxins into the air, soil and groundwater.

Another dangerous process is the recycling of components containing hazardous compounds such as halogenated chlorides and bromides used as flame-retardants in plastics, which form persistent dioxins and furans on combustion at low temperatures (600-800 degrees centigrade). Copper, which is present in printed circuit boards and cables act as a catalyst for dioxin formation when flame-retardants are incinerated. The PVC sheathing of wires is highly corrosive when burnt and also induces the formation of toxins.

Land-filling of e-waste, one of the most widely used methods of disposal, is prone to hazards because of leachate which often contains heavy water resources. Mercury, cadmium and lead are among the most toxic leachate. Mercury, for example, will leach when certain electronic devices such as circuit breakers are destroyed. Lead has been found to leach from broken lead-containing glass. In addition, landfills are also prone to uncontrolled fires which can release toxins.

Anatomy of a computer – A storehouse of toxic substances

A computer is a storehouse of several toxic substances. Key components of the computer are broken down by the kabadies, often in a crude and hazardous manner to extract whatever worth that is possible from them. Key items of computer waste that finds their way to scrap dealers are:

Monitors

Scrap dealers least prefers the monitors once they enter the post-consumer phase unless the cathode ray tube (CRT) is in working condition. The recovered CRT is procured by TV mechanics, which in turn use it in portable TV sets.

Circuit boards and motherboards

Circuit boards and motherboards are used to recover working components manually after which the boards are heated to recover thin copper sheets. In some recycling units they are cut into 5-10 mm bits and then they are exported for recovery.

Printers

The most important components recovered from a printer are the motor and the circuit boards.

Hard disks

Hard disks are either resold or broken to recover the steel casing, actuator (magnet), platter, and circuit board inside. These are sold separately.

Plastics

Nearly 20 per cent of a computer is made up of plastics – primarily Alpha Butadiene Styrene (ABS) used for making CPU and keyboard housings. In recent years, even polycarbonate is used to enhance the aesthetics. ABS plastics are a high quality plastic and harder than most other varieties. Their hardness and the requirement of specialised equipment for their recycling discourage its retrieval. ABS plastics from computer components are separated and sold on weight basis to plastic recyclers. These recyclers collect ABS plastics from various other sources, and after pelletising them, pack them off to Mumbai or Delhi where the pellets are recycled into chairs and trays. According to experts from the Central Institute of Plastics Engineering and Technology (CIPET) there is very little chance of this coming back to the manufacturing stream.

Mechanism Employed for Recovery of Components from Computers		
Computer Component	**Recovered Component**	**Mechanism Employed**
Monitor	Cathode ray tube, circuit board copper, plastics	Dismantled using screw drivers; the broken CRTs are usually dumped at landfills
Hard disk	Steel, aluminium, actuator (magnet), platter, circuit board	Broken using hammers
Circuit board	Capacitor, condenser, gold, copper, chipped board	Gold recovery through acid treatment Copper recovery through heating Crushing of boards by custom-made crushers
Printer	Motor, plastics	Dismantled using screw drivers
Cables and wires	Copper, aluminium	Burning or stripping

Toxic elements of a computer	
Toxic Constituents	**Components of PCs**
Lead and cadmium	Printed circuit boards

Lead oxide and cadmium	Cathode Ray Tubes (CRTs)
Mercury	Switches and flat-screen monitors
Cadmium	Computer batteries
Poly Chlorinated Biphenyls (PCBs)	Capacitors and transformers
Brominated Flame Retardants (BFRs)	Printed circuit boards, plastic casing cable
Poly Vinyl Chloride (PVC)	Cable insulation releases highly toxic dioxins and furans when burned to retrieve copper from the wires.

E-waste management: key challenges in India

While the overall challenges regarding management of e-waste in India are the same faced by other developing economies, the vast geographical diversity and economic disparities between regions often make e-waste management challenges unique in India. A few of the key challenges faced are:

- Rapidly increasing e-waste volumes, both domestically as well as generated through imports. Imports are often disguised as second-hand computer donations towards bridging the digital divide, or as metal scrap
- Limited accuracy in the estimates of the quantity of e-waste generated and recycled
- Low level awareness among consumers about the hazards of incorrect e-waste disposal
- Widespread e-waste recycling in the informal sector using rudimentary techniques such as acid leaching and open air burning resulting in severe environmental damage
- E-waste workers have little or no knowledge of toxins in e-waste and are exposed to serious health hazards, etc.

E-waste Recycling: The Global Scenario

E -waste has been widely recognized as one of the rapidly growing environmental problems of the world. United Nations Environment Programme ("UNEP") estimates that up to 50 million tones of electronic waste is being generated globally on an annual basis, comprising more than 5% of all municipal solid waste. In developed countries, e-waste equals 1% of the total solid waste generation and is expected to grow to 2% by 2010. In the United States alone, it accounts up to 3% of the total municipal waste generation. In the European Union, e-waste is growing three times faster than average

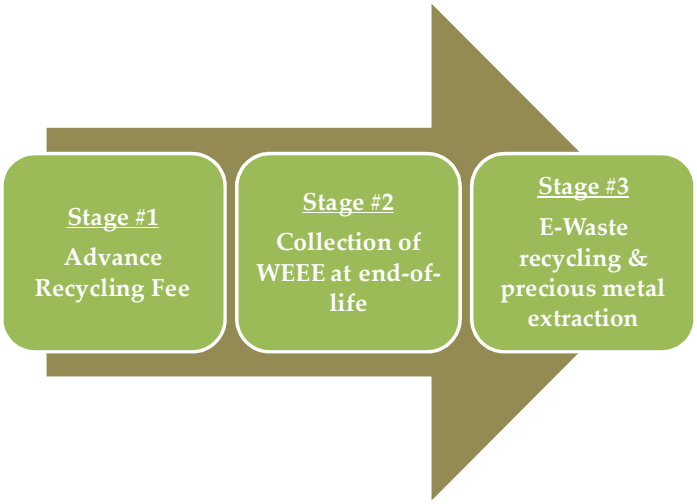
annual municipal solid waste generation. It is estimated that the total amount of e-waste generation in EU ranges from 5-7 million tons per annum or about 14-15 kgs per capita, and is expected to grow at a rate of 3% to 5% per year. In developing countries, e-waste accounts for up to 1% of the total municipal solid waste generation. In countries like China and India, though the annual generation per capita is less than 1 kg, it is growing at an exponential pace. Given the above scenario, e-waste recycling has been an activity that has been attracting significant global attention.

An Overview of Key Recycling Legislation

The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal (the "Basel Convention") of 1989 is an international treaty that was designed to reduce movements of hazardous wastes between nations, and specifically to prevent transfer of hazardous waste from developed countries to less developed countries. In the 1990s, some European countries banned the disposal of e-waste in landfills, paving the way for creation of an e-waste processing industry in Europe. In Switzerland the first electronic waste recycling system was implemented in 1991, beginning with refrigerators initially, gradually bringing all other electric and electronic devices into the system. A specific legal framework was introduced in 1998, with the Ordnance on the Return, the Taking Back and the Disposal of Electrical and Electronic Equipment ("ORDEEE") coming into force. The European Union implemented a similar system under the Waste Electrical and Electronic Equipment Directive (2002/96/EC) (the "WEEE Directive"), imposing the responsibility of disposal of waste electrical and electronic equipment on the manufacturers of such equipment. The WEEE Directive has since been transposed in all national laws in all member countries of the European Union. The Restriction of Hazardous Substances Directive ("the RoHS Directive") is another piece of legislation (2002/95/EC) adopted by the European Union to control the hazardous substances in e-waste.

The E-Waste Recycling Life-Cycle

Though individual countries might have their own domestic laws governing specific aspects of e-waste management, the overall mode of execution of an e-waste recycling model in developed countries in current times includes the following three broad stages – collection of Advance Recycling Fee at the point-of-sale of EEE components, disposal of WEEE at dedicated collection points at their end of life and the final recycling/ safe disposal of e-waste by recyclers. This activity flow can be pictorially captured as follows:



Stage #1: The first step in e-waste recycling takes place at the time of buying new electric or electronic products, when the customers are charged an Advance Recycling Fee ("ARF", or Advance Disposal Fee, "ADF") which contributes towards the expense incurred for all processes required for a safe disposal of the article at the end of its life. The amount of ARF is defined by the type of the product and is included in the sales price and is usually stated separately in the invoice. This introduction of ARF enables customers to return retired equipment free of charge at designated collection sites.

Stage #2: The second step in the process is at the time of returning the various end-of-life appliances. Customers are not allowed to dispose off WEEE through other than certain dedicated collection points. Retailers, traders and manufacturers are obliged to take back WEEE free of cost and independent of any purchase for all types of products that they deal in. In other words, if a retailer sells only computers belonging to a certain brand, he would be obliged to take back computers of all brands, but not televisions or refrigerators.

Stage #3: The final stage in the process is the recycling of e-waste material. This broadly involves segregation of e-waste (e.g., into monitors, keyboards, CPUs, etc.), and the dismantling of equipments in order to obtain recyclable material. E-waste is subjected to processes such as crushing, shredding, and magnetic/ eddy current/ air separations in order to segregate recyclable material from the e-waste.

The final step in the recycling process is extraction of precious materials and safe disposal of hazardous waste. After subjecting the e-waste to crushing, shredding, etc. material that contain precious metals such as the printed circuit boards is usually sent to refineries such as Umicore in Belgium, Boliden in Sweden, etc. where it is subjected to

refinement and precious materials are extracted. The hazardous components of e-waste are sent to authorised waste treatment and disposal facilities for their safe treatment/ disposal.

Overview of Regulatory Framework

E-waste trade comes under the broad regulatory framework related to environment, foreign trade and local rules & regulations. The following section makes a reference to some of the relevant rules and regulations which facilitate this trade.

Regulations and Their Scope

Electronic waste is being partly covered under the broad regulatory framework related to hazardous waste in India. The Ministry of Environment and Forests, Government of India, is the nodal agency at the central level for policy, planning, promoting and coordinating the environmental programs. The Environment (Protection) Act 1986, umbrella legislation covers hazardous waste and provides broad guidelines to address it. The policy statement on the abatement of pollution issued by the government of India in 1992 reiterated its commitment towards waste minimization and control of hazardous wastes. India is a signatory to Basel Convention on the control of trans-boundary movement of Hazardous Wastes and Disposal. India ratified and acceded to it in 1992. The ratification of this convention obliges India to address the problem of trans-boundary movement and disposal of dangerous hazardous wastes through international cooperation.

The Ministry of Environment and Forests ("MoEF") has issued the following notifications related to hazardous waste:

1. Hazardous Wastes (Management and Handling) Rules, 1989/ 2000/ 2002
2. MoEF Guidelines for Management and Handling of Hazardous Wastes, 1991
3. Guidelines for Safe Road Transport of Hazardous Chemicals, 1995
4. The Public Liability Act, 1991
5. Batteries (Management and Handling) Rules, 2001
6. The National Environmental Tribunal Act, 1995
7. Bio-Medical Wastes (Management and Handling) Rules, 1998
8. Municipal Solid Wastes (Management and Handling) Rules, 2000 and 2002
9. The Recycled Plastic Manufacture and Usage (Amendment) Rules 2003

The Hazardous Wastes (Management and Handling) Rules, 1989 were introduced under Sections 6, 8, and 25 of the Environment (Protection) Act of 1986 (referred to as "HWM Rules, 1989"). The HWM Rules, 1989 provide for the control of generation, collection, treatment, transport, import, storage and disposal of wastes listed in the schedule annexed to these rules. The rules are implemented through the various Pollution Control Boards and Pollution Control Committees in the states and union territories. There were a few inherent limitations to the implementation of the HWM Rules, 1989, which led to amendments to these Rules being introduced in 2000, 2002 and 2008, widening the definition of hazardous waste by incorporating e-waste and harmonizing the list of hazardous waste materials with that of the Basel Convention.

Besides these rules, in 1991, the Ministry of Environment and Forests (MoEF), New Delhi issued guidelines for management and handling of hazardous wastes for (a) generators of waste, (b) transport of hazardous waste, and (c) owners/operators of hazardous waste storage, treatment and disposal facilities. These guidelines also established mechanisms for the development of a reporting system for the movement of hazardous waste (the manifest system) and for the first time, established procedures for closure and post-closure requirements for landfills.

In addition to these direct rules dealing with issues of hazardous waste management, the Government has moved to enact legislation and additional incentives for industries to comply with environmental provisions and bring out market forces into the business of environment. In this vein, the Public Liability Act 1991 was adopted to require industries dealing with hazards to ensure against accidents or damages caused by release of pollutants.

Batteries (Management and Handling) Rules, 2001 apply to every manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer and bulk consumer involved in manufacture, processing, sale, purchase and use of batteries or components thereof. These rules confer responsibilities on the manufacturer, importer, assembler and re-conditioner; they govern the registration of importers, the customs clearance of imports of new lead acid batteries, procedures for registration/ renewal of registration of recyclers and also the responsibilities of consumer or bulk consumer and responsibilities of auctioneers.

In 1995 publication of guidelines for Safe Road Transport of Hazardous Chemicals that established basic rules for Hazardous Goods Transport and provided for establishment of a Transport Emergency Plan and for provisions on Identification and assessment of Hazards.

The National Environmental Tribunal Act, 1995, provides for expeditious remedies to parties injured by environmental crimes. Legislation on the Community's Right to Know, 1996, has been adopted to provide more access to information regarding potential hazards from industrial operations.

Bio-Medical Wastes (Management and Handling) Rules, 1998, provides a ten category listing of biomedical waste there control of generation, collection, treatment, transport, import, storage and disposal of wastes listed in the schedule annexed to these rules.

Municipal Solid Wastes (Management and Handling) Rules, 2000, provides for collection, segregation, storage, transportation processing and disposal of municipal solid wastes.

The recycled plastic Manufacture and Usage (Amendment) Rules 2003. These rules essentially deal with plastic recycling and products made out of plastic recycling.