The Scourge of Electronic Waste

“Cradle to Grave” Circuit

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There was a time when people wrote letters and waited expectantly for the postman to bring in some news of relatives settled far away. But today at the click of a mouse you can send letters and talk to your relatives and friends overseas. At the click of a button you can send messages. What’s more, you carry your own communication and music system with you wherever you go.

During the past few decades, there have been radical changes in human lifestyle. Electronic goods and gadgets have become essential components of urban households and are now increasingly making their way into rural areas as well. LCD TVs, desktop computers and laptops, fancy mobile phones, i-pods and i-pads, digital cameras, and fax-photocopy machines have become widely prevalent.

Thanks to a marketing blitzkrieg by manufacturers and our own fetish for possessing the newest models of electronic gadgetry, companies are all too happy to keep their assembly lines running. But do we ever sit down to think about the fate of these gadgets at the end of their useful life? These electronic goods turn into a neglected obsolete heap of hazardous elements. The problem has today taken on mammoth proportions in India too. Waste management, which is already a neglected area in India, is becoming more complicated with the invasion of electronic waste.

Aakanksha Tyagi

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Burgeoning Burden of Waste

Electronic waste is a popular informal term for electronic products near the end of their useful life. E-waste or WEEE (Waste Electrical and Electronic Equipment) is waste consisting of broken or unbroken electric and electronic appliances.

The term electronic encompasses a wide range of home and business electronic goods, including television, monitor, computers, computer peripherals, audio and stereo equipments, VCR's and DVD players, video camera, fax and copy machines, cellular phones, wireless devices etc (Saxena et al., proceedings of RAWM, 2009). In most cases e-waste comprises relatively of expensive and essentially durable products such as house appliances, IT and telecommunication equipments, lightning equipments, toy and sports equipments, medical devices, monitoring and control instruments. Most of these devices are made up of hazardous elements, heavy metals and harmful

Contents of a personal computer

- Plastics
- Mercury
- Arsenic
- Cadmium
- Lead
The growing quantity of e-waste is alarming. Keeping in mind the Indian scenario we need sophisticated e-waste management technologies with the ability to fix the current problems and also with the flexibility to take care of future changes in quantity and quality of e-waste flows.

India as a developing economy is becoming an important stream of e-waste in terms of both quantity and toxicity. According to a recent study by Dwivedy and Mittal (2010a), the total WEEE estimates during 2007-11 will be around 2.49 million MT. The study reports the current annual growth rate of e-waste in India to be within 7-10%.

Consumers bought almost 900 million mobile phones in 2006 and over a billion in 2007 (UNEP estimates). The UNEP study also predicts that by 2020 the amount of e-waste from dumped mobile phones in China will be about seven times larger than it was in 2007, and in India it will be eighteen times higher. At present India alone produces 1,700 tons of e-waste from mobiles. Most of these discarded mobile devices end up in landfills or are given to local collectors, who extract precious metals in an environmentally hazardous manner.

Hazardous Waste
Most often, the discarded electronic goods end up in landfills along with other municipal waste or are openly burnt releasing toxic and carcinogenic substances into the air. Electronic waste, especially computer waste, consists of heavy metals like Cadmium, Mercury, Barium and Lead. Toxic chemicals such as Poly Vinyl Chloride (PVC), dioxin and furans released from burnt computers, Poly Chlorinated Biphenyls (PCBs) released from older capacitors and transformers, lead from batteries, etc. get accumulated in the waste.

Given the fact that these chemical elements are non-biodegradable and persist in the environment for a long time, they pose serious risks for environmental and human health. This makes e-waste the top priority in waste management.

According to the United Nations, global e-waste production is 40 million tons per year. It is estimated that the total waste generated from electric and electronic equipments in India is approximately 146,000 tons per year and increasing every year (CII, 2006). However, according to reports put out by the Union ministry of environment and forests (MoEF), by the end of 2012, India would have generated a whopping eight lakh tonnes of e-waste – up eight times in the past seven years. Considering the growth rate, the volume of e-waste is expected to reach nearly 1.72 million MT by 2020. The Central Pollution Control Board has also said that India is expected to exceed by 8 lakh tons of e-waste this year, which is double of what it was last year.

The top most e-waste generating cities are Mumbai, Delhi, Chennai and Bangalore. Currently, with the introduction of smart phones and its easy affordability the situation seems to be getting grimmer. The major e-waste generators are individuals,
small businesses, large corporate organizations, government organizations, various institutions and original equipment manufacturers. Industry estimates say, 70% of e-waste generated is from businesses and 30% from consumers. An extremely high obsolescence rate of 30% per annum makes nearly 30,000 computers obsolete in Bangalore city from IT industry alone (Rai. A.K., Proceedings of RAWM, BHU 2009).

It is also worth noting that huge quantities of precious metals are dug out of the Earth for manufacturing of electronic goods. Computers and mobile phone production uses up to 3% of the world’s gold and silver every year and 13% of palladium, 15% of cobalt and huge quantities of copper, nickel, steel, and aluminum also. These mining and manufacturing activities also have negative environmental consequences; they spew tons of carbon dioxide into the atmosphere.

Additionally, considerable quantities of e-waste are reported to be imported (Agarwal, 1998; Toxic Link 2004). Developed countries such as the US, dispose their waste to India and other Asian countries. This is conducted under the name of donations from developed nations. Though the Indian Supreme Court banned the import of hazardous waste in 1997, 600 tons of e-waste still entered the country in the last six months under the guise of charitable or re-usable materials. The major reasons of this import are cheap labour and lack of occupational standards in developing countries. This appears to be a form of neo-colonism in which hazardous waste and toxic substances of developed countries flow towards the world’s poor nations.

Handling E-Waste

Currently, in India, e-waste processing is being handled in two ways: formal and informal recycling. According to a recent study, the Indian recycling industry recycles 19,000 million tons e-waste every year. Of which, 95% electronic waste is recycled in the informal sector and only 5% goes for formal recycling.

There is a very well-networked informal sector in the country (Sinha and Mahesh, 2007) involving key players like vendors, scrap dealers, dismantlers and recyclers. However, the disposal and recycling of computer specific e-waste in the informal sector are very rudimentary. The process followed by these recyclers is product reuse, refurbish, conventional disposal in landfills, open burning and backyard recycling (Dixit, 2007).

Of late, formal recycling is being pursued in a big way. Some initiatives have been taken to dismantle and dispose electronic items in the most environmentally sound manner; they also comply with occupational health and safety norms of the workers. Some major e-waste recycling companies are Trishyiraya (Chennai), Infotrek (Mumbai) and E-parisaraa (Bangalore). Sony (Electronics Company) has been on the recycling bandwagon way before the recycling rules came in to effect.

But, as already mentioned, this is the story of just 5% of the e-waste generated in India; the remaining 95% is sold to scrap dealers in underground/informal recycling markets like Seelampur, Mayapuri, Shastri Park, Meerut, Noida, etc. According to the recent report by Toxics Link (2012), a leading environmental NGO, about 1 tonne of e-waste is daily passed through the hands of about 300 dismantling units alone at Seelampur in Delhi.

There are 25000 recyclers working in Delhi NCR only. Similar trends are observed in Ferozabad, Mumbai, Bangalore, Chennai, and Pune. Workers working in informal recycling units, especially children, get exposed to hazardous chemicals that pose serious health risk. Environmentally sound recycling of e-waste requires sophisticated technology and processes that are not only very expensive, but also need specific skills and training for the operation. Whereas,
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in the informal sector workers are poorly protected.

Presently, around 23 recycling facilities in varying levels of infancy have come up in the organized or the formal sector to address this problem, which when fully operational could recycle 60% of the estimated annual e-waste inventory (Jain, 2010b).

Environmental Hazard

Environmental hazard caused by electronic waste is not much talked about. There is no exclusive study done in India to understand the effect of e-waste on environment and ecosystem services. Most of the e-waste generated in Indian cities lands up in garbage bins and eventually in landfill sites, without any segregation mechanism.

In the landfill sites, non-biodegradable electronic waste remains untreated for a long time. It becomes a source of contaminated leachate, which pollutes the ground water and may also contaminate drinking water supply. Acids and sludge obtained from melting computer chips cause acidification of the soil. The pollutants being non degradable and toxic, may enter the biological food chain by absorption from plant roots via soil and ground water contamination. Bioaccumulation of heavy metals and other organic pollutants is a grave threat to life of higher animals and also humans.
### Environmental & Health Hazards Posed by E-Waste

<table>
<thead>
<tr>
<th>Substance</th>
<th>Occurrence in E waste</th>
<th>Environmental and Health relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Halogenated compounds</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCB</td>
<td>Condensers, transformers</td>
<td>Cause cancer, effect on immune system, reproductive system, nervous system, endocrine system, and other effects. It is persistent and bioaccumulates.</td>
</tr>
<tr>
<td>CFC</td>
<td>Cooling unit, insulation foam</td>
<td>Combustion of halogenated substances may cause toxic emission.</td>
</tr>
<tr>
<td>PVC</td>
<td>Cable insulation</td>
<td>High temperature processing of cables may release chlorine, which is converted to dioxin and furan.</td>
</tr>
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### Heavy metals and other metals

<table>
<thead>
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<th>Substance</th>
<th>Occurrence in E-waste</th>
<th>Environmental and Health relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>Small quantities in the form of gallium arsenide with light emitting diodes</td>
<td>Acutely poisonous on a long term perspective and injurious to health.</td>
</tr>
<tr>
<td>Barium</td>
<td>Getters in CRT</td>
<td>May develop explosive gases (hydrogen) if wetted.</td>
</tr>
<tr>
<td>Beryllium</td>
<td>Power supply boxes which contain silicon controlled rectifiers, beamline components</td>
<td>Harmful if inhaled.</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Rechargeable NiCd batteries, printers, photocopiers, machines</td>
<td>Acutely poisonous and injurious to health on a long term perspective.</td>
</tr>
<tr>
<td>Chromium VI</td>
<td>Data tapes, floppy disc</td>
<td>Acutely poisonous and injurious to health on a long term perspective cause allergic reactions.</td>
</tr>
<tr>
<td>Gallium arsenide</td>
<td>Light emitting diode (LED)</td>
<td>May develop explosive gases (hydrogen) if wetted.</td>
</tr>
<tr>
<td>Lead</td>
<td>CRT screen, batteries, printed wiring boards</td>
<td>Cause damage to nervous system, circulatory system, and kidneys cause learning disabilities in children.</td>
</tr>
<tr>
<td>Lithium</td>
<td>Li-batteries</td>
<td>May develop explosive gases (hydrogen) if wetted.</td>
</tr>
<tr>
<td>Mercury</td>
<td>Fluorescent lamps that provide backlight in LCDs, in alkaline batteries and mercury wetted switches</td>
<td>Acutely poisonous and injurious to health on a long term perspective.</td>
</tr>
<tr>
<td>Nickel</td>
<td>Rechargeable NiCd batteries or NiMH batteries, electron gun in CRT</td>
<td>May cause allergic reactions.</td>
</tr>
<tr>
<td>Rare earth elements</td>
<td>Fluorescent layer (CRT screen)</td>
<td>Irritates skin and eyes.</td>
</tr>
<tr>
<td>Selenium</td>
<td>Older photocopying machines</td>
<td>Exposure to high level may cause adverse health effects.</td>
</tr>
<tr>
<td>Zinc sulfide</td>
<td>Used in interiors or CRT screen, mixed with rare earth metals</td>
<td>Toxic when inhaled.</td>
</tr>
<tr>
<td>Toxic organic</td>
<td>Condensers, liquid crystal display</td>
<td>May cause when inhaled.</td>
</tr>
<tr>
<td>Radioactive</td>
<td>Medical equipments, fire detectors etc.</td>
<td>Substances</td>
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<td></td>
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(Source: Saxena et al, Proceedings of RAWM, 2009)

Incineration of e-waste can also emit toxic fumes and gases, thereby polluting the air. Some of the electronic waste is obtained by scrap dealers and disposed off without recourse to any occupational standards. Such practices increase the risk of occupational hazard manifold. Improperly managed electronic waste causes many health disorders. People who are involved in waste handling get severely affected. The disposal and recycling of e-waste in India, particularly computers and related waste, has become a serious problem since the methods of disposal are very rudimentary and pose grave environmental and health.
E-waste Focus

- Improvement in product, product design and methodology to achieve easy-to-recycle goods.
- Regular eco-toxicological monitoring of hazardous chemicals.
- Extending producers’ responsibility to the post-consumer stage of the product’s life cycle and also its disposal.
- Polluters pay principle.
- Industries must enlist all chemicals in the product information and possible health hazards.
- Maintenance of national level inventory for e-waste.
- Development of national policy on e-waste and its strict implementation.
- Strict measures on illegal import of e-waste.
- Capacity building, training and awareness programmes.
- Setting up of government regulatory agencies.
- Encouragement and support to research in hazardous waste management and NGOs working in this field.
- Phasing out uncontrolled dumping of hazardous waste and promotion of waste segregation at individual level.

In most cases e-waste comprises relatively of expensive and essentially durable products such as house appliances, IT and telecommunication equipments, lightning equipments, toy and sports equipments, medical devices, monitoring and control instruments.

Central Institute of Plastics Engineering & Technology (CIPET), Bhubaneswar:
- A programme on “environment management system for information technology in India” has been implemented.
- A project on “development of lead-free X-ray absorbing coating material for CRT TV” has been successfully implemented in March 2011.

Despite such a wide range of environmental legislations and measures taken in the country, the problem of e-waste is still a neglected one. There are several grey areas that need to be addressed.

The growing quantity of e-waste is alarming. Keeping in mind the Indian scenario we need sophisticated e-waste management technologies with the ability to fix the current problems and also with the flexibility to take care of future changes in quantity and quality of e-waste flows. Producers, industries, government agencies and also civil society must work in concurrence.

Government agencies along with the NGOs must adopt technical, administrative and legal measures, promote the use of environmental friendly designs, adopt good marketing approaches, undertake capacity building activities such as training and awareness programs, establish a knowledge base and conduct studies that will develop inventories as well as policy measures for e-waste management.

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hazards. The situation is aggravated as current e-waste management and disposal methods suffer from a number of drawbacks like adequate legislations, lack of funds, poor awareness and reluctance on the part of the government and the corporate organizations to address the critical issue. In addition, besides handling its own e-waste, India now also has to manage the waste being dumped by other countries.

To deal with this serious problem the Indian government has taken many steps and has come up with innovative measures. The Ministry of Environment and Forests is the nodal agency for policy, planning and coordinating the environment programmes, including electronic waste. The management of e-waste was covered under “management, handling and trans-boundary movement” rules 2007, part of EPA 1986 and Environment and Forests Hazardous Wastes management rules 2008. India is also a signatory to the Basel Convention on the control of trans-boundary movement of hazardous waste.

A notification on E-waste (Management and Handling) Rules, 2010, under EPA 1986 has been notified in May 2011 to address the safe and environment friendly handing, transporting, storing, and recycling of e-waste. In May 2012, new rules were issued by the MoEF, which would hopefully help in bringing some relief.

The Department of Information Technology has also taken several significant steps to deal with the issue of electronic waste in India. In order to address the urgent need of cost-effective and environment friendly technology of e-waste disposal, DIT has initiated many R&D projects:
- Project entitled “development of processing technology for recycling and reuse of electronic waste” has been implemented at the National Metallurgy Laboratory in March 2011.
- A testing and certification facility has been created at CMET, Hyderabad, India for hazardous raw materials used for manufacturing electronic components. This certification would help Indian companies to export their products to the European Union.
- Another project on novel recovery and conversion of plastics from WEEE to value-added products is being carried out at the