



Plan and Implement the E-waste Handling with Green Supply Chain Management in Electronics Industries in India

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1.0 Abstract

Electronic waste, or e-waste, is an emerging problem as well as a business opportunity of increasing significance, given the volumes of e-waste being generated and the content of both toxic and valuable materials in them. The fraction including iron, copper, aluminum, gold and other metals in e-waste is over 60%, while pollutants comprise 2.70%. Given the high toxicity of these pollutants especially when burned or recycled in uncontrolled environments. The Basel Convention has identified e-waste as hazardous, and developed a framework for controls on trans-boundary movement of such waste.

Waste in electronics industries is now electronic. Electronic waste or e-waste is one of the rapidly growing environmental problems of the world. In India, the electronic waste management assumes greater significance not only due to the generation of our own waste but also dumping of e-waste particularly computer, mobile phones & electronics gadgets waste from the developed countries.

The aim is to identify, plan and implement the e-waste handling and management in India.

India as a developing country needs simpler, low cost technology keeping in view of maximum resource recovery in an environmental friendly methodologies.

1.1 Why E-Waste is a Problem – Some facts are as below:

- *Consumer electronics comprises 5 to 7 percent of the total municipal solid waste stream.*
- *The consumer electronics waste stream is growing three to four times faster than the solid waste stream.*
- *An estimated 100 million computers became obsolete in the India. by 2008 (according to the survey).*
- *More than 10,000 computers and televisions, mobiles A DAY become obsolete and are put aside.*

- *Computers that became obsolete by 2008 contain an estimated 3.2 billion pounds of lead (according to a study)*
- *E-waste presents different challenges than household hazardous waste or solid waste recycling because of its weight, volume, storage needs, and costs.*
- *E-waste poses a long-term threat to public health and the environment because it is the largest source of heavy metals and organic pollutants in the solid waste stream.*

2.0 – Definitions of Electronic waste

Electronic waste, generally known as ‘E-waste’ can be defined as electronic equipments / products connects with power plug, batteries which have become obsolete due to advancement in technology changes in fashion, style and status nearing the end of their useful life.

Table 1 – Definition of Green or Environmental Supply Chain Management

Researcher(s)	Definition
Beamon, 1999	The traditional supply chain is defined as an integrated manufacturing process wherein raw materials are manufactured into final products, via distribution, retail, or both, then delivered to customers. The full integrated, extended supply chain contains all of the elements of the traditional supply chain, but extends the one-way chain to construct a semi-closed loop that includes product and packaging recycling, re-use, and/or remanufacturing operations (p.337).
Bowen et al., 2001	The term ‘Green supply indicates supply management activities (such as cooperative recycling and packaging waste reduction) that are attempts to improve the environmental performance of purchased inputs, or of the supplier that provides them. Two main types of green supply can be identified. The first is termed Greening the supply process , while the second is Product-based green supply (p.175).
Zsidisin & Siferd, 2001	Environmental supply chain management (ESCM) for an individual firm is the set of supply chain management policies held, actions taken, and relationship formed in response to concerns related to the natural environment with regard to the design, acquisition, production, distribution, use, reuse, and disposal of the firm’s goods and services (p. 69).
OECD (2001)	Any appliance using an electric power supply that has reached its End of life.

Rao, 2002	The concepts pertaining to greening the supply chain or supply chain environmental management (SCEM) are usually understood by industry as screening suppliers for their environmental performance and then doing business with only those that meet the regulatory standards (p. 632).
EU WEEE Directive (EU, 2002a)	Electrical or electronic equipment which is waste including all components, sub-assemblies and consumables, which are part of the product at the time of discarding. Directive 75/442/EEC, Article 1(a) defines waste as any substance or object which the holder disposes of or is required to dispose of pursuant to the provisions of national law in force.
Basel Action Network (Puckett and Smith, 2002)	E-waste encompasses a broad and growing range of electronic devices ranging from large household devices such as refrigerators, air conditioners, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users.
Wang et al., (2004)	Green supply chain management is the sustainable development model for modern enterprises and it is from cradle-to-reincarnation. They argued that the major elements involved in the green supply chain include green design, green material selection, green manufacturing, green packaging, green marketing, green consumption, and green recycling.
SINHA (2004)	An electrically powered appliance that no longer satisfies the current owner for its original purpose.
StEP (2005)	E-waste refers to “. . .the reverse supply chain which collects products no longer desired by a given consumer and refurbishes for other consumers, recycles, or otherwise processes wastes.”
Hervani et al., (2005)	Green supply chain management (GSCM) is described as Green Supply Chain Management = Green Purchasing + Green Manufacturing/ Materials Management + Green Distribution/ Marketing + Reverse Logistics. They represented a framework (system model) based on one activity implementation and Operation of SCM/PMS (p.334). GSCM should promote the sharing of environmental responsibility and lend itself to achieving a reduced environmental burden caused by industry (p.336).

3.0 – Classification of e-waste

E-waste encompasses ever growing range of obsolete electronic devices such as computers, servers, main frames, monitors, TVs & display devices, telecommunication devices such as cellular phones & pagers, calculators, audio and video devices, printers, scanners, copiers and fax machines besides refrigerators, air conditioners, washing machines, and microwave ovens, e-waste also covers recording

devices such as DVDs, CDs, floppies, tapes, printing cartridges, military electronic waste, automobile catalytic converters, electronic components such as chips, processors, mother boards, printed circuit boards, industrial electronics such as sensors, alarms, sirens, security devices, automobile electronic devices.

The three components that will be studied as part of waste electrical and electronic equipment (WEEE) are Personal computer / TV / Mobile phones which will serve as indicator components. The study will trace these components from its origin to its final end of life. For example from the sources where the components are imported unloaded, traded, transported, dismantled, recycled, reused, repaired, processed and disposed.

Table 2. Product categories and examples of products covered by WEEE and RoHS

SN	Category	Products	Label
1.	Large household appliances	Refrigerators and freezers, Electric stoves, Microwaves, Washing machines and dryers, Air conditioners	HH
2.	Small household appliances	Vacuum cleaners, Irons, Toasters, Coffee Machines, Clocks	HH
3.	IT and telecommunications equipment	Personal computers, Laptop computers, Phones, Cellular phones, Calculators	ICT
4.	Consumer equipment	Televisions, Radios, Video cameras, Audio amplifiers, Musical instruments	CE
5.	Lighting equipment	Luminaries for fluorescent lamps, Straight fluorescent lamps, Compact fluorescent lamps, Low pressure sodium lamps, High intensity discharge lamps	Lighting
6.	Electrical and electronic tools	Drills; Saws; Sewing machines; Equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making holes, punching, folding, bending or similar processing of wood, metal and other materials; Tools for riveting, nailing or screwing or removing rivets, nails, screws, or similar uses.	E & E tools
7.	Toys, leisure, and sports equipment	Electric trains and car racing sets; Video games; Computers for biking, diving, running, rowing, etc; Sports equipment with electric or electronic components; Coin slot machines	Toys
8.	Automatic dispensers	Automatic dispensers for hot drinks, hot or cold bottles or cans, solid products, money, and all other kinds of products	Dispensers
9.	Medical devices		Medical
10.	Monitoring and Control instruments		M& C

SOURCE: Council Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) and restriction of hazardous substances (RoHS), Annexure 1A & 1B

4.0 The Hierarchy for Handling E-Waste

The Hierarchy for handling e-waste from source of e-waste generation, stockpiling, collection, handling, brokering, processing and production of other items from where there are chances of e-waste generation. Some terminologies are discussed as :

4.1 Generation & Stockpiling: Different “economic actors” purchase, use and then stockpile or discard electronic waste. These range from manufacturers such as MNC’s to large and small businesses, households, institutions and non-profit organizations.

4.2 Collection: There is a wide variety of possible collection alternatives for WEEE. A variety of entities are providing these services including electronics industry, private or non-profit recycling services, and the public sector through the solid waste management and recycling infrastructure.

4.3 Handling & Brokering: WEEE are consolidated and made ready for processing. It also includes sorting to determine what equipment can be refurbished or reused as a whole unit and what equipment must be disassembled for commodity processing.

4.4 Processing: It includes WEEE usage as feedstock for new production or refurbished for resale.

Outputs from dismantling activities include scrap commodities such as glass, plastics and metals, which are primary elements of electronic hardware.

4.5 Production: Processed commodities or refurbished items come back as new products for sale and consumption by end users. There are many different players and industries involved in this position.

5.0 International perspective

The Basel Convention defines waste by its disposal destination or recovery processes. For example, virtually any material that will be recycled or processed in order to reclaim a metal, or to reclaim an organic or inorganic substance for further use, is deemed a waste. Electronic components that are used without further processing are not likely to be defined as a waste.

The Convention has provided for two lists. List A, is presumed to be hazardous and thus covered by the Basel Convention; and List B, is presumed to be non-hazardous and thus not subject to the Basel Convention. The waste listed in List A is waste that poses serious threats to environment and human health. As a result of their adverse effects these substances require special handling and disposal processes.

The Annexure VIII hazardous waste list has the following entries applicable to e-waste:

A1180: Waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries included in List A, mercury-switches, glass from cathode-ray tubes and other activated glass, and PCB-capacitors, or contaminated with Annex I constituents (for example, cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annexure III. From the above we can gather that at the very least, circuit

boards, CRTs, and other electronic boards or components and assemblies containing lead based solders and copper beryllium alloys (which include most computer circuit boards and much other electronic equipment), are indeed hazardous wastes according to the Basel Convention. Likewise, whole, used, discarded computers, printers, and monitors that contain such circuit boards or CRTs that are not to be re-used directly are to be considered as hazardous waste and subject to the Basel Convention. To date, the United States is the only developed country in the world that has not ratified the Basel Convention^[2]. In fact, US officials have actively worked to defeat and weaken the Basel waste export ban.

6.0 – Present situation in India continental - Indian Scenario

Preliminary research by the Basel Action Network (BAN) reveals that besides China, most e-waste exports are to Indonesia, India and Pakistan where they are processed in operations that are extremely harmful to human health and the environment. Hazardous waste such as outdated printed circuit boards, floppies and tonnes of copper sludge.

Mumbai, the financial nerve-centre of India, is India's largest port city. The Mumbai -Pune industrial belt is one of the manufacturing hubs of the country. As a result, Mumbai is not only the port of import for new and used electronics; it is also home to a large user and manufacturer base, both generating large volumes of ewaste.

There is hardly any attention paid to the management of the e-waste generated in this industrial belt which incidentally also houses large number of Info tech parks in New Mumbai and Pune. There is an urgent need therefore to have a well orchestrated mechanism on the collection, treatment and disposal of the e-waste.

There is an estimate that the total obsolete computers originating from government offices, business houses, industries and household is of the order of 2 million nos. Manufactures and assemblers in a single calendar year, estimated to produce around 1200 tons of electronic scrap. It should be noted that obsolescence rate of personal computers (PC) is one in every two years. The consumers find it convenient to buy a new computer rather than upgrade the old one due to the changing configuration, technology and the attractive offers of the manufacturers. Due to the lack of governmental legislations on e-waste, standards for disposal, proper mechanism for handling these toxic hi-tech products, mostly end up in landfills or partly recycled in a unhygienic conditions and partly thrown into waste streams. Computer waste is generated from the individual households; the government, public and private sectors; computer retailers; manufacturers; foreign embassies; secondary markets of old PCs. Of these, the biggest source of PC scrap are foreign countries that export huge computer waste in the form of reusable components.

With extensively using computers and electronic equipments and people dumping old electronic goods for new ones, the amount of E-Waste generated has been steadily increasing. At present Bangalore alone generates about 8000 tonnes of computer waste annually and in the absence of proper disposal, they find their way to scrap dealers.

Example – E-Parisaraa, an eco-friendly recycling unit on the outskirts of Bangalore which is located in Dobaspet industrial area, about 45 Km north of Bangalore, makes full use of E-Waste. The plant which is India's first scientific e-

waste recycling unit will reduce pollution, landfill waste and recover valuable metals, plastics & glass from waste in an eco-friendly manner. E-Parisaraa has developed a circuit to extend the life of tube lights. The circuit helps to extend the life of fluorescent tubes by more than 2000 hours. If the circuits are used, tube lights can work on lower voltages. The initiative is to aim at reducing the accumulation of used and discarded electronic and electrical equipments.

7.0 Electronic Waste: The Dangers

7.1 What are the specific dangers of electronic waste?

The specific dangers of electronic waste are the effects that lead, cadmium, mercury, hexavalent chromium, plastics, PVC, and brominated flame retardants have on human health and the environment. The dangers posed by each of these substances are discussed as below:

7.2.1 Lead – In humans, lead can cause damage to both the central and peripheral nervous systems and the kidneys. It can also cause damage to the blood system. The effects of lead to the endocrine system have also been observed and its serious negative effects on the development of the brain in children have been well documented. In addition, lead accumulates in the environment and has high acute and chronic toxic effects on plants, animals and microorganisms.

Consumer electronics constitute 40% of lead found in landfills. The main concern regarding the presence of lead in landfills is the potential for the lead to leach and contaminate drinking water supplies. So what are the main sources of lead in computers? The main sources of lead in computers are: the soldering in printed circuit boards and other electronic components, and the glass panels in computer monitors (cathode ray tubes). Statistically speaking,

7.2.2. Cadmium – In electrical and electronic equipment, cadmium is found in certain components such as surface mounting device (SMD) chip resistors, infrared detectors and semiconductors. Older types of cathode ray tubes contain cadmium, and it is also used frequently as a plastic stabilizer.

7.2.3 Mercury – It is estimated that 22% of the world's yearly consumption of mercury is used in electrical and electronic equipment. Mercury is commonly used in thermostats, position sensors, relays and switches (i.e., on printed circuit boards and in measuring equipment) and discharge lamps. Mercury is also used in medical equipment, data transmission devices, telecommunications devices, mobile phones, batteries, switched housing, and printed wiring boards. By the year 2004, 315 million obsolete computers will contain more than 400,000 pounds of mercury.

7.2.4 Plastics – Based on the estimate that over 315 million computers will become obsolete between 1997 and 2004, there will be more than **4 billion pounds of plastic** present in this waste stream. (Plastics make up about 13.8 pounds per computer on average.) An analysis commissioned by the Microelectronics and Computer Technology Corporation (MCC) estimates that electronics plastic scrap amounts to more than **1 billion pounds per year (580,000 tons per year)**. This study also estimates that the largest volume of plastics used in electronics manufacturing (26%) is polyvinyl chloride (PVC), a plastic that creates more environmental and health hazards than most other types of plastic. While many computer companies have recently reduced or phased out the use of PVC, there is still a large volume of PVC

residing in computer scrap that will grow, according to estimates, up to 250 million pounds per year.

7.2.5 PVC – The use of PVC in computers has been mainly limited to cabling and computer housings in the past; however, most of the newer computer moldings are now being made of acrylonitrile butadiene-styrene (ABS) plastic. In earlier years, PVC cabling was widely used for its fire retardant properties, but the fumes from the cabling were found to be a major contributor to fatalities. For safety reasons, low-density alternatives, such as polyethylene and thermoplastic olefins, are now often substituted in place of PVC.

PVC is a difficult plastic to recycle and it also contaminates other plastics in the recycling process. Of more importance, however, is the fact that the production and burning of PVC products generates dioxins and furans, which are persistent organic pollutants.

7.2.6 Brominated Flame Retardants – Brominated flameretardants are a class of brominated chemicals that are commonly used in electronic products as a means for reducing flammability. In computers, they are used mainly in four applications: (1) in printed circuit boards, (2) in components such as connectors, (3) in plastic covers, and (4) in cables. They are also used in the plastic covers of TV sets and in domestic kitchen appliances.

8.0 – Enablers & Objectives

The objective of the Rapid WEEE Assessment is to identify and quantify the WEEE generation, reuse, recycle and final disposal in different cities in India, adopting uniform approach and methodology. The main objective as follows:

The goal of this study is the qualitative & quantitative analysis of WEEE recycling system. The main objectives of this study are as follows:

- To estimate the existing and future quantity of WEEE in the city (study area)
- To examine the existing WEEE recycling system
- To study the problems/risks posed by the recycling system at present/future
- To evaluate the capacities/capabilities of existing stakeholders and infrastructure for reuse, recycle and disposal of e-wastes
- To analyze the environmental and social sustainability of present system
- To determine the e-trade economics

The study should include the identification of stakeholders, classification of organization as organized/unorganized sector, further their geographical location should be determined in terms of their operating base coverage.

1st group: - The Importers, Manufacturers
The distributors, traders, retailers

The consumers – Individual households, Business sector, IT sector, BPO, technical Institutions Railways, Airlines, Defence establishments, Transport Corporations, etc

2nd group: -

The collectors – Scrap dealers, Big Bazaars or malls who are buying the e-waste

The Recyclers – disassemblers, dismantlers, material recoverers,

8.1 Identification of market systems - A market survey for the evaluation of market information from various sources should be gathered to understand the penetration rate & the replacement rate of the three components.

8.2 Inventorization - Inventory of obsolescence rate of each electronic product (Personal computer / TV / Mobile phones) using scenario analysis. Checking obsolescence rate from data of primary survey using “tracer technique”. Identify a tracer from each product and follow it from the start of dismantling process till its final disposal.

8.3 Analysis of existing WEEE recycling system & quantification of WEEE - This will include description & documentation of each process used in dismantling of an e-product, the location details. Carry out photo documentation and geographical setting of each step. Estimate the quantity of material dismantled at each step. Estimate the quantity of e-waste for a particular year based on market projections & obsolescence rate.

8.4 Environmental impacts of present recycling system - This will include the assessment of local environmental impacts caused to air, water & soil. Determination of the hazardous waste generation, its handling, treatment (if any) & disposal. Identification of eco-friendly technology for the management of the hazardous wastes generated in the processing of e-waste.

8.5 WEEE Trade economics - Trade economics governs the movement of WEEE along the value chain in the city. Estimate input cost in terms of raw material cost & labor cost. Find out the selling price, operating margin and trade turnover.

8.6 Occupational Health & Safety and Social sustainability - Under this assessment, city team needs to collect information on present treatment and disposal practices being adopted for WEEE in their respective cities. This assessment will be conducted in WEEE handling localities as well as land fill in city which include descriptive and visual proofs so as to ascertain the facts indicated.

The health /social problems faced due to the recycling of WEEE should be assessed.

8.7 Outputs/Deliverables

- Qualitative & quantitative database of the three components
- A report on the existing WEEE management system
- A manual of suggested improvements to methodology used for similar city studies proposed for other cities.

Table 3 Initiatives tackling the WEEE issues from various perspectives

Initiatives	Description
Basel Convention and Basel Ban	A global agreement regulating movements of hazardous wastes, including WEEE, between countries, in force since 1992. However, an Amendment to the Convention, commonly known as the Basel Ban, which calls for prohibiting the export of hazardous waste from OECD to non-OECD countries, is still to come into force.
StEP initiative (solving the e-waste problem)	A UN-led initiative started in 2004 at the “Electronic Goes Green” Conference in Berlin to build an international platform to exchange and develop knowledge on WEEE systems among countries to enhance and coordinate various efforts around the world on the reverse supply chain (StEP 2005).
Basel Action Network (BAN), Silicon Valley Toxics Coalition (SVTC) and computer take back campaign	A network of non-governmental organisations (NGOs) in the US working together on WEEE issues, including international advocacy for the Basel Ban, domestic collection and recycling events as well as investigative research to promote national solutions for hazardous waste management.
WEEE Forum	Founded in 2002, the WEEE Forum is a group of representatives of voluntary collective WEEE take-back systems in Europe, taking care of individual producers' responsibility in Europe.
National Electronics Product Stewardship Initiative (NEPSI)	A multi-stakeholder dialogue to develop the framework of a national WEEE management system in the USA. The NEPSI dialogue includes representatives from electronics manufacturers, retailers, state and local governments, recyclers, environmental groups, and others
Electronics Product Stewardship Canada (EPS Canada)	EPS Canada was created to work with both industry and government to develop a flexible, workable Canadian solution. An industry-led organization, the founding members are 16 leading electronics manufacturers.
ERP (European Recycling Platform)	Set up at the end of 2002 by Hewlett Packard, Sony, Braun and Electrolux to enable the producers to comply with the WEEE directive. It aims to evaluate, plan and operate a pan-European platform for recycling and waste management services.
Seco/Empa e-waste programme	A project set up in 2003 by seco (Swiss State Secretariat for Economic Affairs) and implemented by Empa (Swiss Federal Laboratories for Materials Testing and Research) in cooperation with a number of local partners and authorities, to assess and improve WEEE recycling systems in different parts of the world by analysing the systems and by exchanging knowledge on recycling techniques and frameworks.

Table 4 Assessment indicator system to measure and compare WEEE management systems

Aspect	Criterion	Indicator
Structural framework	Politics and legislation	Ratification of Basel Convention and Ban Amendment Status of a national waste legislation Status of a national e-waste legislation Corruption perception index
	Economy	Capital cost (industrial investments) Secondary raw material market
	Society and culture	Civil and political liberties NGO activities Recycling culture Environmental awareness in society
	Science and technology	Knowledge in WEEE recycling technologies Research in WEEE management / recycling technologies
Recycling system	Material flow	WEEE generation per capita Closed loop recycling management
	Technologies	Efficiency of material recovery Quality of recovered material
	Financial flow	Financial coverage Externalities coverage Financial incentives for eco-design
	Impacts	Environment Final disposal of WEEE in unsave landfills Emissions of hazardous substances
	Human health	Health and safety implementation at workplaces Exposure of neighbouring population to hazardous substances
	Labour	Number of jobs generated Income distribution

Conclusions

E-waste is an emerging issue, driven by the rapidly increasing quantities of complex end-of-life electronic equipment. The global level of production, consumption and recycling induces large flows of both toxic and valuable substances.

Awareness and readiness for implementing improvements is increasing rapidly, there are many obstacles to manage end-of-life products safely and effectively in industrializing countries:

The lack of reliable data poses a challenge to policy makers wishing to design an e-waste management strategy and to an industry wishing to make rational investment decisions.

The lack of a safe WEEE recycling infrastructure in the formal sector and thus reliance on the capacities of the informal sector may pose severe risks to the

environment and human health. However, collecting and pre-processing can be handled efficiently by the informal sector and — at the same time — can offer numerous job opportunities.

The lack of international standards for simple but efficient WEEE management systems delays their implementation.

References

- Best Management Practices For Electronic Waste, Santa Clara County Department of Environmental Health San Jose, California
- Massachusetts Department of Environmental Protection Regulation 310-CMR 19.017.
- US National Safety Council, “The Electronic Product Recovery and Recycling Baseline Report,” May 1999.
- A National Workshop on Electronic Waste Management” organized by CPCB/MoEF/EMPA /GTZ in New Delhi during March, 2004
- E-waste in India – Praveen Dalal
- <http://praveen-dalal.blogspot.com/2006/03/corporate-social-responsibility.html>
- *Analysis of Five Community Consumer/Residential Collections End-Of-Life Electronic and Electrical Equipment*, U.S. Environmental Protection Agency Region I, USEPA-901_R-98-003, April 1999
- Agarwal R, Ranjan R, Sarkar P. Scrapping the hi-tech myth: computer waste in India. Toxics Link. New Delhi;2003
- EU. Waste electrical and electronic equipment; 2004
- *Management of the Waste Stream, Used Personal Computers*, Federal Ministry for Agriculture, Forestry, Environment and Water Management, Second OECD Workshop on Environmentally Sound Management of Wastes Destined for Recovery Operations, Vienna, Austria, 28–29 September 2000.
- BUWAL. Ordinance of 14 January 1998 on the return, the taking back and the disposal of electrical and electronic equipment (ORDEE); 2004.
- Culver J. The life cycle of a CPU; 2005.
- EU. Directive 2002/96/EC of the European parliament and of the council of 27 January 2003 on waste electrical and electronic equipment (WEEE) — joint declaration of the European parliament, the council and the commission relating to article 9. Official Journal L037:0024-39 [13/02/2003; 2002a
- EU. Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS). Official Journal L037, 13/02/2003 p. 19–23; 2002b
- EEA. Waste electrical and electronic equipment (WEEE). Copenhagen European Environment Agency; 2003.
- OECD. Extended producer responsibility: a guidance manual for governments. Paris OECD; 2001.
- Puckett J, Smith T. Exporting harm: the high-tech trashing of Asia The Basel Action Network. Seattle Silicon Valley Toxics Coalition; 2002.