



BEST PRACTICES FOR E-WASTE MANAGEMENT IN DEVELOPING NATIONS

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1. INTRODUCTION

In the race of technological advancements in the country it is not surprising for computers and other electronic equipments to become obsolete within few years. The e-Waste has been mounting rapidly with the rise of the information society. It is the fastest growing segment of the municipal solid waste stream because of increased affordability of new products and technological achievements which make it easy to purchase of new electronics rather than repairing or upgrading old products. The growth of end of life electronic products depends on economic growth of the country, population growth, market penetration, technology upgradation and obsolescence rate.

The waste from electrical and electronic equipment (WEEE) – also known as e-Waste typically consists of electronic products coming to the end of their useful life such as computers, televisions, mobile phones, VCRs, CD players, DVD players, refrigerators, air conditioners, microwave ovens, tube lights and other consumer electric and electronic components. The huge range and complexity of component materials in the electronic products makes it difficult and expensive to dispose of or recycle them safely with profit making business. Some of the materials used in electronic devices are of high value and highly recyclable - such as gold and platinum while many others are non-renewable - such as plastics which are currently either discarded or recycled to form lower grade material. The biggest concern with e-Waste is the presence of toxic materials such as lead, cadmium, beryllium, mercury and arsenic, toxic flame-retardants, PVC containing plastics, printer cartridge inks and toners that pose significant health and environmental risks when WEEE is disposed of.

The e-Waste is disposed of in one of the four ways landfilling, incineration, recycling or exportation. Each process has an environmental impact as well as affects the health and safety of the worker. Disposal in landfills is a common practice but eventually it results in leaching of toxic metals in soil and subsoil aquifers thus many countries (especially European countries) have undertaken legal measures to check the disposal in municipal landfills. The incineration process release heavy metals and other toxicants contained in electronic subassemblies and components as air emissions. Recycling process is considered the best way for disposing of electronic components only if the process employs environmentally sound recycling. It is considered that the developed nations usually have technological resources and infrastructure for environmentally sound recycling whereas developing nations lack the regulations as well infrastructure for proper recycling. The obsolete electronics are exported to developing countries like India, China, Pakistan and Africa due to cost benefits. This exportation is creating ecological footprints in developing and underdeveloped countries of the technological advancements in industrialized nations. It is cheap to export the obsolete electronics in developing nations rather than recycling these products in developed nations (1). The imported obsolete electronics in developing nations creates e-Waste trade chain employing several informal workers, collectors, segregators, middlemen, scrap dealers and recyclers who manage

to take components apart, reuse the functional components and recycle the non-functional components by burning, acid dipping and other unprofessional techniques. The spent acids and other chemicals, solid wastes after burning and other wastes are disposed of in open drains which eventually end up in rivers.

1.1 Objectives

The world economy is undergoing fundamental changes driven by globalization of businesses and growth of ICT sector worldwide. Under globalization the developing economies are struggling to develop and match their pace with industrialized nations. The income patterns will affect the technological achievements in the country. The objective of this paper is to present the e-Waste situation in the developing economies, best practices and activities undertaken by these regions to tackle the growing e-Waste stream. The paper focuses mainly on the major issues regarding e-Waste management like trends and inventorization, practices adopted for collection, reuse, reduction and recycling, policies and legal framework and measures adopted for minimization of electronic wastes by creating awareness among consumers, collection mechanisms and waste to art techniques, extending life by reuse and policy formulation. The paper specifically targets the low and middle income economies as they are competing with developed nations in technological development. The low employment status, lack of awareness and lack of regulatory policies is increasing the unsafe e-Waste management practices in developing countries.

2. GENERATION PATTERS OF e-WASTE IN DEVELOPING NATIONS

2.1 Global e-Waste Statistics

The Greenpeace, 2008 report predicts the global WEEE arising from PCs, mobile phones and televisions will be around 5,504,737 MT in the year 2010 and 9,762,935 MT by the year 2016. The UN estimates that some 20-50 MT of e-Waste is generated worldwide each year, comprising more than 5% of all municipal solid waste (2). The electronic waste forms 1% of solid waste on an average in developed countries and is expected to grow to 2% by 2010. However in developing countries, the e-Waste can range from 0.01% to 1% of solid waste. The developing countries will be the fastest growing segment of the e-Waste market with the potential to triple output over the next five years with China, the leading country. The electric and electronic equipment forms 6% of the U.S. gross domestic product (GDP), the growth is easily eclipsed by that of China's where the GDP is growing in excess of 8% a year in comparison to 3% for the United States. The computer sales continue to grow at 10% globally plus rates annually, sales of DVD players is doubling year over year. However the lifecycle of these products is shortening with 10 years life of a television set and 2 to 3 years for a computer. The manufacturers and governments are not able to keep pace with electronic waste policy and practice. As a result, a high percentage of electronics are ending up in the waste stream releasing dangerous toxins into the environment (3).

The worldwide market for electronic waste will rise at an AAGR (average annual growth rate) of 8.8% from \$7.2 billion in 2004 to \$11 billion in 2009 (4). At some places the e-Waste is found stored in attics, garages or disposed of with mixed waste in landfills and incinerators, thousands more electrical and electronic products have reached the end of their lives are exported, often illegally, for dumping in Africa, Asia countries like Pakistan, India, China. The quantities of e-Waste generated are predicted to grow substantially in future, both in industrialized countries and in developing countries which are expected to triple their e-Waste by 2010. The California regulators report that about 20 million pounds of electronic wastes is shipped in the year 2006. The major e-Waste destinations are Malaysia (7.9 million), Brazil (3.6 million), South Korea (3.5 million), China (2.3 million), Mexico (1.8million), Vietnam (0.7 million) and India (0.2 million) (5). The e-Waste is growing concern in South America as the usage of personal computers in the region grows around 15% a year (6).

3. CURRENT PRACTICES

In most of the developing nations the import of used electric and electronic equipment (UEEE) and brand new electric and electronic equipment (EEE) is persisting due to absence of manufacturing units in these countries. For example in Cambodia UEEE and EEE are imported for meeting the domestic consumption. Some imported UEEE have low quality/improper functioning components which have to be repaired or disposed of. Besides simple repairing, some broken/non functional EEE was sent to overseas for repair according to the negotiation between the shop owner and customer. Due to lack of public awareness the residues are disposed of close to the dismantling shops by burning or in municipal dust bin (7). In Republic of Moldova there is chain of electrical/ household appliances store departments and PC companies importers (8). In Indonesia, the preliminary inventory showed that cities around Jakarta deals mostly with trading of used electronics, recycling facilities in East Java have melting facilities to get metal ingot (Copper, Zinc) and used electronics are imported from US for re-export purposes to China, Taiwan and Hong Kong (East Java zone). The major activities were dismantling (TV, CPU & PC monitor), checking the working condition and polishing (CRTs), crushing (TV casing & PC monitor) and melting/ packing (metal parts). There was no restriction for importing of used electronic products in 65 ports of Batam island. The central distributor/ retailer of used products in Eastern Indonesia were Para-Pare (South Sulawesi) & Wakatobi Islands (South-East Sulawesi) (9). In China the main sources of wastes can be categorized into domestically generated waste from government, manufacturing defects, institutions and households and imported waste from other countries (10). The estimated discard number each year in China is 4 million refrigerators, 5 million washing machines and 5 million televisions (11). The discarded electronic products are collected by individual collectors and 80% of them enter second hand goods market for resale and other are dismantled and sent to south east China for recycling (12). By an estimate about more than two million computers are junked every year in SAARC countries producing 1,550 tonnes of electronic scrap every year (13).

The developing countries usually lack the proper storage spaces and disposal areas for e-Waste, thus either the waste is mixed in domestic landfill, burned with household waste or stored in attics for years. For example in Republic of Moldova as there is no landfill for dumping of toxic wastes thus 650,000 luminescent tubes were in stock (8). Also in South Africa the majority of computer waste is landfilled either in permitted hazardous waste disposal sites where disposal is paid for or is disposed in municipal landfill in local general waste disposal site. The statistics on e-Waste in South Africa is scarce but the industry players guesstimate that more than half a million PC's are disposed off on a landfill site countrywide (14). In Union of Myanmar, e-Waste is not an issue as the obsolescence rate is less and also the Customs Department has issued a notification that inhibits the import of UEEE and monitors illegal trafficking of e-Wastes (15). In Philippines, e-Waste is included under Hazardous Wastes (HW) category of the Republic Act 6969, not as a separate classification. The regulated community includes waste generators, transporters, waste treaters, disposal facility, importers and exporters. The importation of electronic assemblies and scrap is allowed as recyclable material for e.g. electronic assemblies containing PCBs & electronic components such as TVs, VCR and stereo etc. Under the Republic Act 9003, e-Wastes is considered among Special Wastes category that are handled separately from other commercial and residential wastes and it includes household hazardous wastes (HH batteries, lead acid batteries, spray canisters etc.) consumer electronics (worn out and discarded goods), white goods, bulky wastes etc. The importation/exportation of scheduled wastes for final disposal is not allowed in Malaysia, is only allowed for recycling and recovery of wastes. The export of scheduled wastes will be allowed only if local facilities do not have the capacity to carry out recycling and recovery. The recovery facilities can be partial if it entails processes like separation, crushing & sorting, and full recovery is further treatment processes like melting and electrolysis in licensed facility (16).

3.1. Management at End of Life

- *Collection* - The proper collection of wastes is the prerequisite for management of e-Waste. The source of e-Waste varies from household to offices and businesses and the waste composition differs depending on its source of generation. The e-Waste collection is usually done by the informal sector in developing nations due to lack of legislation and take-back policies. However in some countries like in Slovenia the collection points at municipal wastes collection centers are in groups of five and network of producer's collection points occurs. The quantity of EEE is 28kT of EEE/ year which is equivalent to 14kg/capita. The amount of WEEE collected in the year 2005 is 2kg/capita (17).
- *Dismantling* - The segregation and dismantling of e-Wastes is also performed by the informal sector in countries like India, Pakistan, Afghanistan, China, Thailand and Vietnam for commercial as well as residential wastes. In Malaysia currently the commercial e-Wastes is dismantled and separated into various parts and components for resale/recycle/recovery locally while the residential e-Wastes is discarded as garbage and disposed off in landfill (18).

- *Reuse & Recovery* – Reuse and refurbishment of the components or equipments forms a common practice in the developing regions as it extends the useful life thus minimizing the generation of waste. For example in Union of Myanmar the old computers and VCRs are reused or recycled by small private industries while some used appliances are donated to areas where there is lack of resources. The practice of repairing or upgrading is emphasized as it extends the usefulness of product (19). Also the GTZ study in Yemen predicts that the e-Waste recycling does not take place and the people are not aware of the precious metal in computer hardware. The process like reuse, reassembling and repair of components is more valuable than using the precious metals as secondary raw materials. The obsolete electrical and electronic devices are repaired until they get totally broken. The life span of computer is between 8-10 years. The Al-Ahmar Company is the authorized reseller of HP and is only company in Yemen which collects outdated computers from big buyers of new computers (20).
- *Disposal* – The recycling processes usually have low recycling rates as for the informal sector the major thrust for recycling is precious material extraction due to which the other hazardous components are usually dumped in landfill and for the formal recycling units the efficiency is less as the collections targets are not met and lack of efficient technologies. The management of e-Wastes in Philippines includes: remanufacture, repair, upgradation, dismantling into basic components, segregation of e-scrap for further recovery outside country and smelting of solder dross. The treatment process includes cement fixation of residual wastes with traces of metals and cement kiln co-processing of PWB (plastic) without metals (21). Presently, the recycling of end-of-life electronics and related components in Malaysia is undertaken by private companies that recover items such as toner cartridges and personal computer parts on a commercial basis.

4. BEST PRACTICES

4.1 Inventorization

The quantification and inventorization of e-Waste is much difficult and different from MSW as the e-Waste may be stored for long periods, significant quantities of e-Waste may be transported from point of generation to distant locations for processing, e-Waste products or components may have a second life, type and quantity of e-Waste generated may differ while generation of MSW is more or less stable. Some of the non-OECD countries have taken the lead for inventorization of the current situation of e-Waste in the country.

- For the implementation of Strategic Plan of Basel Convention and Ministerial Statement for meeting Global Waste Challenge BCRC- Argentina initiated a project for preparing a national inventory and technical directives to deal with e-Waste. The concerned

countries are Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela.

- In Thailand the e-Waste inventory is being finalized covering products like computers, televisions, notebooks, air conditioner, mobile phone and refrigerator. The sampling was done through questionnaires for households, offices including companies, institutions, hotels and apartment, and recyclers including collectors, second hand shops, repair shops, dismantlers and recyclers. The data is verified by analyzing usage/ purchase pattern, disposal rates at present and in future, quantity of UEEE repaired, dismantled, reassembles and exported and generation and management of residues generated by processing, recycling, repairing and dismantling (22).
- The project for environmentally sound management of electrical and electronic wastes provides an opportunity to Cambodia to undertake inventorization of UEEE, strategic planning and activities for management of UEEE and its residues. The inventory will include primary data and secondary data on imported EEE like TV, AC, Refrigerator, PCs, Mobiles and washing machines from the year 2004-2006 (23).
- In Indonesia, the preliminary inventory on Electronic and Electrical wastes was an initial step as a part of national inventory of hazardous wastes. The survey respondents were traders, consumers, distributors, inter-islands traders, government agencies, electronic survey centers, shops selling refurbished goods and scrap collectors. The 80 large and 150 SMEs of electronic sector were interviewed for predicting the e-Waste generation pattern. The preliminary inventory focused on identification of refurbishment/ reconditioning facilities located in Bogor, Depok, Tangerang, Bekasi (cities around Jakarta), recycling/ recovery of e-Wastes in Batam & East Java, influx of e-Waste in Batam & Eastern Indonesia (24).
- MAIT-GTZ study to inventorise the e-Waste in India reveals that a total of 3,30,000 MT of e-Waste is generated in India while an additional 50,000MT is imported into India. This study considers the e-Waste generated from computers, televisions and mobile phones. However 19,000MT of this is recycled due to high refurbishing and reuse of electronic products in the country and also due to poor recycling infrastructure. It is estimated that e-Waste generated in India will touch 4,73,000 MT by 2011.

4.2 Initiatives Undertaken

Many developing countries have undertaken government, voluntary, international and industry based projects for management of electronic wastes.

- *Government Initiatives* - The generation of WEEE is increasing in Turkey and almost all of the e-Waste ends up in regular waste stream as there is very little information and awareness on WEEE. The EC project for Istanbul Metropolitan Municipality aims to implement sustainable management system for WEEE. The projects aims to improve

collection and handling systems, minimization of WEEE, increased life cycle through reuse and refurbishment, improved treatment and neutralization of toxic wastes found in EEE. The project will establish plans and proposals for implementing WEEE management regulations, voluntary agreements, administrative and financial tools, training of staff for reduction of WEEE. The activities planned are database on EEE & WEEE, operate a separate WEEE collection system, assessing market for reusing WEEE, prepare an EIA and conduct public awareness campaigns. The project duration is Nov. 2006-Apr. 2009 (25).

- In China a Working group was established comprising of members from National Development and Reform Commission, Ministry of Commerce, sector associations and companies for research and standardization of policy on recycling and reuse of electronic products and exchange of overseas best practices (26).
- The Phare project for the implementation of WEEE Directive in Slovak Republic was implemented with Slovak Environmental Agency (SEA), Centre of Waste Management and Basel Convention Bratislava. The scope of the project was to create institutional and organizational conditions for sound implementation of Directives on WEEE and Directive on RoHS in EEE. The recommendations of the project were to introduce collection system for WEEE for municipalities, take back of EEE at retailers stage, compliance schemes to support municipalities financially, to introduce qualitative targets for collection covering whole territory of Slovakia, to nullify fees for recycling fund for non-household EEE, possibility to introduce clearing house and to strengthen position of commissioned organization for registration, collection and processing of information (27).
- The Ministry of Environment and Natural Resources (MENR) in Sri Lanka and SBC has signed an MOU to implement a project for management of e-Waste in Sri Lanka. The project objectives are establishment of National Implementation Plan for e-Waste which also forms one of the components of Asia Pacific Pilot project, strengthen the national capacity for e-Waste management, develop national and local multi stakeholder partnerships and assigning roles to stakeholders, greening supply chain and developing mechanism to register informal sector repair shops.
- In Thailand, the pilot project for mobile phone battery take back system and fluorescent lamp take back system & recycling is also being implemented (28).
- In Philippines the Department of Environment and Natural Resources (DENR) and National Solid Waste Management Commission (NSWMC) initiated study on recycling industry development in partnership with Department of Trade and Industry- Board of Investment (DTI-BOI) with technical assistance from Japan International Cooperation Agency (JICA). The study is included under the pilot project entitled Cell Phone Waste Collection and Recycling launched in September, 2007. The project aims to designate drop-off points for collection of discarded cell phones and components located in shopping malls and other public places by installation of 20 collection bins in three designated areas in Metro Manila. The MOU was signed between the project partners

composed of DENR DTI, cell phone manufacturers (Alcatel, LG Electronics, Nokia, Samsung, Sony Ericsson), network service providers (Globe Tech Communication and Sun Cellular), selected mall owners, transport and storage facilities (HMR Envirocycle Philippines) and JICA. A technical working group (TEG) of partners was created to provide technical inputs for project implementation (29, 30).

- *Industry Initiatives* The Center for Information and Communication Technology in La Paz, Bolivia (31) designed a one year initiative to develop and disseminate e-Waste tool kit for users of computers through media, primary and secondary schools, libraries, Rotary Clubs etc. for awareness on key issues.
- The DOWA project for end of life mobile phone management was initiated in 2006 between the Secretariat of Basel Convention, Basel Convention Regional Centre of South East Asia and DOWA ECO-SYSTEM Co., Ltd. The project is supported by Ministry of Environment in Japan and is fully funded by DOWA. The project is performed in cooperation with PCD in Thailand, DOE in Malaysia and NEA in Singapore as well. The study concluded that the used phones are in second hand market and in some cases it is traded internationally. The administrative authorities do not supervise the second hand market so the detailed information on flow of goods is not available. Major manufacturers like Nokia and Motorola are collecting used phones as a part of EPR although in very small quantities (32).
- The Information Technology Association of South Africa (ITA) is working closely with Swiss State Secretariat for Economic Affairs (SECO) and Swiss Federal Laboratories for Materials Testing & Research (EMPA) Knowledge Partnership and Capacity Building Project which supports the establishment of Green e-Waste Channel for efficient reuse and recycling system. The project also supported the formulation of a working group now evolved as e-Waste Association of South Africa (eWASA) (33).
- Footprints Environmental Center (FEC) is a registered, community based Non Profit Organization based in Wynberg (CapeTown, South Africa) which plays an important role in South African electronic waste (e-Waste) programme supported by SECO/EMPA and is part of Cape Town e-Waste Channel. The FEC e-Waste programme offers opportunities for public to dispose of end of life electronic equipment by practicing the 4R concept for e-Waste disposal. The 4R symbolizes Reduce, Reuse, Repair and Recycle which offers job opportunities from the testing facilities, repairing/refurbishing centers, stripping down of non-working components and production of value added products (14).
- In Sri Lanka an initiative was undertaken by top celco Dialog Telekom for collection of old cell phones, batteries and accessories. The initiative was launched for prevention of release of toxic metals in the domestic waste stream by launching 14 collection centers at proper locations (34).
- Nokia launched recycling initiative for East African region for disposing off the old mobile phones in a structured manner as the consumers can drop off their old mobile phones of any manufacturer in designated Nokia Collection centers. The obsolete mobiles and accessories will be sent to Europe for recycling and no money will be paid to the

consumers. The initiative covers East African countries like Kenya, Rwanda, Uganda, Somalia and Tanzania and is backed by key mobile phone vendors like LG, Motorola, Philips, Siemens, Matsushita-Panasonic and Philips (35).

- *Voluntary Initiatives* Computers for Community (CFC) initiative is designed to promote computer refurbishing programs as a tool for e-literacy and social inclusion in 34 countries throughout the LAC region. For example in Colombia the national website where refurbishing centers are implemented serves as a platform for exchange of best practices and experiences from the experts of all countries for setting up refurbishing centers as per their requirements, job creation and ICT penetration (36).
- South Cooperation for Social Studies and Education (Santiago, Chile) in cooperation with International Center for Development Research (IDRC) and Institute of Connectivity in America (ICA) initiated an Applied Research project for the year 2004-2007 at exploring the opportunities and challenges from excess computers entering from industrialized nations (37). The other project being implemented by SUR Corporation of Social & Environmental Studies and IDRC in LAC region for the year 2007-2010 is to implement regional platform through applied research, promoting communication and technology and disseminating initiatives for sound management of electronic wastes.

4.3 International Measures

- **Basel Convention and e-Wastes**

The e-Wastes are classified in the Basel Convention as Annex VIII entries A 1180, A 1150 and A 2010 as well as under Annex IX as B1110. The Basel Convention & e-Wastes has many cross linked issues like controlling transboundary movement of hazardous wastes and other wastes, provide standards through adapting technologies and guidelines for environmentally sustainable management of hazardous wastes, capacity building for enforcement and awareness raising, cooperation with World Custom Organization and cooperation with UNEP and other IGOs and other government initiatives (e.g. G8- 3Rs initiative). The e-Waste is also identified as priority waste stream identified in the Basel Convention Strategic Plan (2002-2010) adopted at the sixth meeting of Conference of Parties to the Basel Convention (38). The Nairobi Declaration on environmentally sound management of electrical and electronic wastes Decision VIII/5 on partnerships and VIII/6 on Mobile Phone Partnership Initiative (MPPI) was adopted in the eighth Conference of Parties to the Basel Convention (39).

- Partnership on computing equipment- Partnership was launched in October, 2004 in seventh meeting of Conference of Parties to Basel convention. The future steps are to draft a work program, terms of reference and to identify budget. The need is felt to involve more manufacturing companies from Asia and Europe as well as officials from developing countries.
- Mobile Phone Partnership Initiative (MPPI)- The Mobile Phone Partnership Initiative (MPPI) of the Basel Convention targets for environmentally sound management of used and end-of-life mobile phones (including processes like

repair/refurbishment for extending their life, recycling, collection, transboundary movement and awareness on design considerations). The MPPI includes manufacturers like Alcatel, LG, Matsushita (Panasonic), Mitsubishi, Motorola, NEC, Nokia, Philips, Samsung, Sharp Telecommunications Europe, Siemens and Sony Ericsson, telecom operators like Vodafone, Bell Canada and France Telecom/ Orange and other stakeholders i.e. Parties, Signatories, BCRCs, refurbishers, recyclers, associations and NGOs. During the Working Program of 2003-2006 five guidelines were developed and adopted by MPPI working group. The five guidelines were provisionally adopted at COP8 of Basel Convention in 2006. The Work Program of 2007-2008 includes testing of all the five individual guidelines and data related to transboundary movement of used and end-of-life mobile phones will be collected, as there is insufficient information related to this (40).

- **StEP Initiative**

It is voluntary initiative of United Nations University (UNU) with MOU between participating members. The Secretariat acts as the operation, coordination and communication hub, assists in stakeholder dialogues, networking, liaising and fundraising. The members of the initiative are government (GTZ, SECO and USEPA), private members, and research organizations, NGOs, UNU, UNCTAD and UNEP. The objectives are to initiate research studies, increase public awareness, scientific and business knowledge on optimization of life cycle of EEE, improving supply chain, closing material loops, reducing contamination and increasing utilization of resources. The research studies undertaken are global supply chain targeting environmental, economic and social constraints, mapping global flow of selected elements contained in electronics, sustainable material flow for secondary materials from end of life electronics in developed and developing nations, global e-waste programme to improve local recycling processes in informal sector and study on future options for management of CRT glass (41).

- **UNEP DTIE**

The 5th Special Session of Governing Council identified priorities such as environmental monitoring, development of environmental policy instruments and transfer of environmentally sound technologies. It is responsible for advancing Global Compact Principles and supports Global e-Sustainability Initiative (GeSI). The initiatives are supported by Branches like Production and Consumption (Cleaner Production), Business and Partnership and International Environmental Technology Center (Environmentally Sound Technologies). The members of the initiative are industry and international organizations interested in EST and GeSI. The GeSI initiative includes ICT service providers and suppliers, supported by UNEP and International Technical Union (ITU). The objectives of the UNEP DTIE initiative are to support sustainable consumption and production, initiate voluntary actions to improve member's sustainability performance, implement integrated waste management programs and build capacities in developing countries and implement strategies that influence informed decision making through partnerships with other international organizations, NGOs,

government authorities, business and industry (e-Waste and role of selected international organizations (41).

- BCRC Egypt plans a pilot project to develop a regional strategy to improve management of e-waste in the region and to ascertain the feasibility of regional e-waste recycling facility. The project is included under the business plans of BCRC for the year 2007-2008.
- The project entitled Assistance to Developing countries in implementing the Basel Convention and in preparing Hazardous Waste Management Plans reported by SBC, Geneva (1998) made a list of recommendations and action programme endorsed by member states comprising of Bahamas, Trinidad, Guyana, Suriname and Belize. The recommendation of the project suggested establishment of Sub-Regional Centre for the Caribbean region and the action culminated in the establishment of Basel Convention Regional Centre (BCRC) for Training & Technology Transfer for the Caribbean region (2004) with the core functions of the Centre namely; training, technology transfer, information, consulting and raising awareness for environmentally sound technologies and minimization of hazardous wastes including e-Wastes.

4.4 Management of End of Life Electronics

- **Collection and Segregation**

In Malaysia for e-Waste management the mobile phone batteries recycling programme was initiated. The bins for collection of mobile phone batteries are placed at strategic positions. The end-of-life mobile phone awareness campaign was organized by government administrative centre for Putrajaya. Nearly 350 bins were placed in government offices, shopping complexes and telecommunications companies to collect batteries, end-of-life mobile phones and their accessories (16).

- In Slovenia two collective WEEE management plans namely ZEOS, INTERSEROH are approved and one plan is under assessment. The quantity of EEE is 28kT of EEE/ year which is equivalent to 14kg/capita. The amount of WEEE collected in the year 2005 is 2kg/capita (17).
- The cell phone sector in Colombia has signed an agreement with the government entitled Coordination Agreement for Environmentally Sound Management of Wastes from the Mobile Telephone and Trunking Services Subsector within the Framework of Product Life-Cycle for take-back of discarded cell phone batteries in 2007 (42).

- **Product Reuse**

This is non-destructive form of reutilization of product without changing the components and retaining the product in its original form. The reuse forms a major component in waste management in developing countries as it helps in extending the product useful life. Reuse can be of two types –

- *Direct Reuse* This involves reuse of products without any or minimal repair to make the product useful for the new user. The households first use computers, televisions, mobiles etc can be given to impoverished societies for increasing the ICT penetration and utilization of resources. The wastes generated from offices and enterprises need to be cleaned for the information stored which can be an obstacle.
- *Indirect Reuse* Indirect reuse involves partial or complete disassembly of the components to achieve reuse of components/ parts for reuse and refurbishment. In developing countries the disassembling is usually performed manually and the components that are usable are used for refurbishing purposes while the non-usable components are either salvage or sold to scrap dealers for recovery of metals. Initiatives to refurbish electronic equipments are undertaken. The lower labour rates, lower penetration and accessibility, lower cost working conditions for UEEE results in increased markets for commercial reselling of components and refurbished goods.

- **Disposal**

- RECYCLA in Chile is the first recycling facility set up in the year 2003 with B2B model and partnerships with government, NGOs, Chambers of Commerce, sector associations and other companies like Kepler Data Recovery with 2% recycling rate (43).
- In South Africa there are three large recyclers who process e-waste namely Universal Recycling Company, DESCO Electronic Recyclers and African Sky Electronic Recycling. The Rand Refinery, Gauteng processes tons of recovered material per annum from e-waste recyclers. This refinery also receives pre-processed material exported from Far East and USA containing mainly precious dust (14).
- Currently in Malaysia there are 75 recycling facilities licensed by Department of Environment out of which only two are full recovery facilities. The licensed contractors are located in Johor, Kedah, Melaka, Negeri Sembilan, Perak, P. Pinang, Sarawak, Selangor and F.T. Kuala Lumpur (44).

- **Legislation/ Policies**

Legal framework will provide an implementation and management model for the waste handling and minimization, disposal, setting up goals and standards, allocation of responsibilities and identify penalties.

- The Ministry of Health of Costa Rica proposed nationwide e-Waste Take Back Regulation (entitled Regulation Creating the National System for the Management of Electronic Wastes) covering large number of electronic products (42).

- In Vietnam there is no direct law for e-Waste but several regulations mention and categorize e-Waste the Government details the implementation of Trade law regulations which bans the import of second-hand commodities including the electronics, cooling appliances, home appliances and information technology products and the Decision of Ministry of Natural Resources and Environment on issuance of List of Hazardous Waste includes electric and electronic wastes. Also the Circular of Ministry of Natural Resources and Environment on guiding the capacity and conditions for management of hazardous wastes proclaims the registration of HW generators and professional permits for transporter & disposer of HW (including e-Wastes) (45).
- In Malaysia, e-Waste is categorized as scheduled wastes under the code SW 110, First Schedule, Environmental Quality (Scheduled Wastes) Regulations 2005. The SW 110 wastes are defined as wastes from electronic and electrical assemblies, glass from CRTs, polychlorinated biphenyl capacitors or contaminated with Cd, Hg, Pb, ni, Cr, Cu, Li, Mn or PCBs etc. As Malaysia is also a party to Basel Convention thus importation/exportation of wastes requires written approval from Department of Environment as mandated under the Environmental Quality Act, 1974. The scope of the guidelines is to assist all parties (waste generators, transporters, importers/ exporters and relevant authorities in waste management) in identifying and classifying a used EEE or component as e-Waste and determines criteria whether the UEEE or component proposed for import or export is categorized as e-Waste (46).
- In Thailand the Regulations on the import/ export of new electronic products should meet with environmental standards which restrict usage of hazardous substances, used electronic products should comply with domestic permit system and e-Wastes should comply with PIC procedure and domestic permit system. The certain set of criteria's are formulated for import control of used electronic products like determination criteria (limited age, certified quality etc.) for reuse, criteria for repair/ refurbish, disassembly & recycle/ recovery (47). The Thai government was worried about the increasing e-Waste in the country after China imposed a ban on importation of crushed electronics in 2002. In response the Thai Ministry of Industry issued restrictions on imports of used electrical goods, PCs and other items in 2003. The used copiers can be imported only if it is manufactured less than five years previously while the other electronics (28 items) should be less than three years old (48). In Thailand the Draft law for Hazardous waste (E-waste) management based on Take-back policy is drafted by assigning responsibilities to producer, consumer, municipalities through take back network and separate committee for monitoring the fund (47).
- In Slovakia and Bulgaria there are special regulations for management of fluorescent tubes (49).
- Chinese RoHS enacted in the year 2007 covers all electronic products in Chinese market including imported products. The production and designing of electronic information products will involve eco friendly techniques, products will be labeled for toxic and hazardous components as well as reuse/recycle information and usage of six hazardous materials shall be prohibited for products listed in Pollution Control List of Key Electronic Information Products. The draft e-Waste law would include measures like

EPR, consumer responsibility, emergency response, fund for retrieval and reuse/recycle, e-Waste collection, dismantling, disposal standard and certification, e-Waste import and export management and compulsory e-Waste recovery.

- Hungary has adopted implementation legislation for the transposition of the European Union's WEEE Directive through the Government Decree on the take back of WEEE and the Ministerial Decree transposing the treatment provisions of the WEEE Directive and the amendment to the Product Fee Act. The requirements under the Hungarian WEEE laws are in force. Hungary has a derogation period (extended deadline is 31 December 2008) for meeting the collection, recycling and reuse targets under the WEEE Directive (42). In Hungary presently there are 6 PROs. The B2B and B2C products are differentiated by preparing an exhausting list of B2C products on CN code basis. The producers are allocated the responsibility for collection of B2C products on the basis of previous year products put on the market (50).
- EIATRACK reported that Latvia has implemented the WEEE Directive through several legal instruments, including the Law on Waste Management, Regulations on Categories of EEE, Regulations on Requirements for the Labeling of EEE, Regulations on the Management of WEEE and Regulations on the Registration of Producers of EEE. As part of the WEEE Directive's implementation, Latvia has adopted a tax (42).
- EIATRACK reports that Estonia has implemented the WEEE Directive in 2005 through several legal instruments. Estonia has been granted a derogation period of two years for meeting the collection, recovery and reuse/recycling targets till 31 December 2008. Producers are responsible to take back WEEE and are required to register with the Environment Information Centre of Ministry (EEIC) and are responsible for organizing separate collection and treatment systems for their WEEE. Membership of a producer in a compliance organization will serve as a guarantee to ensure the financing of the proper disposal of electrical and electronic equipment (EEE). Two collective schemes have been established: EES-Ringlus MTU and Elektroonikaromu MTU (42).
- The WEEE Act (2005) in Poland altered several provisions of other laws for example Act on Environmental Protection, Waste Act, Cleanliness Act, as well as some tax and public finance Acts along with three further orders been enacted under the Polish WEEE Act for Ministry of Environment and Ministry of Economy. First, an Order of the Ministry of the Environment (2006) provides a standard form on which the individuals putting EEE on the market, or collective schemes, must report annually on the product fees paid the previous year. Second, an Order of the Ministry of Economy (2006) imposes a requirement on entities that put EEE on the market to take out third party liability insurance to protect against any failure to fulfill collection, processing, recovery and recycling duties for WEEE. Third, an Order of the Ministry of the Environment (2006) provides a standard form for reporting on the amounts of WEEE processed. The responsibility for implementation of the WEEE Act is of Ministry of Environment. Poland

has been granted a derogation of two years for meeting the collection, recovery and recycling targets and the deadline for these obligations is 31 December 2008 (42).

- In Romania the implementing legislation is adopted for the transposition of the WEEE Directive into national law. The Governmental Decision on WEEE is supplemented by three Ministerial Orders, including Order on the approval of specific measures for the collection of WEEE to prevent risk to the safety and health of collection point personnel, Ministerial Order concerning the collection of WEEE and Order on the registration, recording and reporting procedures regarding EEE and WEEE. EIA TRACK reports The Directive 2002/95/EC on the Restriction of certain Hazardous Substances Directive (RoHS) and Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) are in force in Romania (42).
- The implementation of the WEEE Directive in Slovakia was achieved by amending the Waste Act (2001) on Waste Disposal, supplementing certain other Acts and further implementing regulations and Ministerial Orders. The amended Waste Act defines producer responsibility for WEEE, regulates rights and duties of legal entities and individuals with regard to prevention of waste generation and disposal, right of state administrative authorities and municipalities, the import/export and transit of waste, violation of duties, establishment of the Recycling Fund as part of the Slovak take-back system and implementation of RoHS Directive. Slovakia has passed further legislation regarding WEEE management (2005) providing details about registration, guarantee, marking, reporting and RoHS exemptions. In addition the Government Order (2005) on Collection and Recovery Targets sets targets regarding the amount of WEEE each producer has to collect and recover in each category and another Ministerial Order (2005) on Contributions to the Recycling Fund introduced a new fee structure. Slovakia has been granted a grace period until 31 December 2008, to meet the targets i.e. 4 kg WEEE collection per capita and imposing recovery and recycling targets of the WEEE Directive (42).
- The implementation of the WEEE Directive in Slovenia was achieved by enacting Decree on WEEE Rules for management of WEEE (2004) and further amended in 2005. The rules have been complemented by the WEEE Treatment Decree (2006) through further implementing regulations on the Manner and Conditions for Performing the WEEE Public Utility Service (2004) and Eco-Fee Decree (2006). The Slovenian WEEE legislation incorporates a two-step producer registration regime, reporting duties, producers financing for WEEE treatment, collection, recovery and recycling of EEE, EEE marking requirements, free provision by retailers and distributors of in-store take-back of WEEE or alternative arrangements through a compliance scheme, obligation by retailers and distributors to ensure that private householders are informed of WEEE take-back

points available to them and encouraged to participate in the WEEE separate collection system (42).

- The Central Pollution Control Board, India released the Draft e-Waste regulations in 2007 for sound management of e-Waste. The Taskforce was constituted for discussing the feasibility, allocation of responsibilities, inclusion under Hazardous Waste Management (2003) Rules, implementation methodology, disposal standards and other implications (Table 1).

- **Research & Development and Awareness & Education**

The regional workshop on WEEE for Central and Eastern Europe was conducted in June, 2007 to inform the participants on the environmentally sound management of used and end-of-life mobile phones according to Basel Convention Guidelines (refurbishment, material recovery, recycling, collection, awareness raising designs and transboundary movement) and EU Directives related to e-Wastes. The major recommendations made were improved collection systems, or setup collection system wherever it does not exist, awareness among all stakeholders, organize workshops and information documents at local and regional levels, adopt guidelines, establish networks, assigning responsibilities to retailers and industry, improved coordination between different stakeholders, establish appropriate financing system and evolving collection targets (40).

- South Africa also has an Environmental Enforcement Unit (or Green Scorpions) which is engaged in monitoring and regulating waste sites as well as capacity building of magistrates on environmental issues and management (51).
- South Asia Co-operative Environment Programme (SACEP) in collaboration with Development Alternatives organized e-Waste management workshop in 2007, South Asia with participation of member countries; Sri Lanka, Nepal and India. The workshop concluded with the recommendations like formation of a task force to exchange best practices, coordination for technology transfer & information exchange and developing legal framework for transboundary movement of e-Waste within the region for recycling purposes.
- The 6th ITU Annual Private Sector Cooperation Meeting (2007) for the Arab States Region was held in Giza-Egypt. One of the technical sessions of the meeting focused on the role of private sector for environmental management, e-Waste management and recycling headed by Center for Environment and Development for Arab region and Europe (CEDARE) and included panelists from Mobinil-Egypt, GSMA and Nokia Siemens Networks. Siemens highlighted its effort in reducing e-Waste from their production units and minimization of energy usage in its products (52).
- Regional program in Asia & Pacific and project development in Africa, Central & Eastern Europe and Latin America- the Asia Pacific Initiative Inception workshop was hosted by

Government of Japan (November 2005 in Tokyo). The objective of the workshop was to develop national and regional program on e-waste for Asia Pacific region for assessment of situation (database, inventories) prevention and minimization, management practices, awareness raising and recommended actions at regional and national level.

- Opportunities for Design for Toxics Reduction – To achieve the global marketplace for electronic products the companies may be driven for improving the product design as a result of regulatory pressure in specific regions of the world. The opportunities for design improvements involve the replacement of materials with negative environmental impact, reduce the amount of toxicity of materials and avoid heavy metal coatings. For example lead free solders has been developed and commonly used by Asian manufacturers (53).

5. CHALLENGES

5.1 Policy mechanism

The electronic waste is not a priority waste in municipal policy in many non-OECD countries for example in Latin America, South Asian countries, East Asia and Pacific regions. The developing nations usually lack the policy mechanism and would have weak impact for example in Latin America, EPR would have less applicability as only some of the computers have a brand producer. This would force agencies to include the importers or other producers (Companies that make television or appliances) in EPR systems excluding the producers who make less than 1,000 machines in Latin America and clone assemblers out of the EPR system (54). The major challenges with implementation of WEEE management are lack of awareness in end users, improper collection of WEEE, collection within bulky wastes, no disposal facilities available, disposal at household waste landfill, no organized market and insufficient data/statistics on the amount of electronics and electrical appliance put on the market for example in Slovenia, India, Sub-Saharan Africa and East Asian countries.

5.2 Markets and Material

Several initiatives are now undertaken in LAC region to increase the computer and internet penetration like by Computer Aid International, World Computer Exchange and Computers for Schools (CFS) for increasing the supply of used computers which have shorter life span. There is urgent need to educate the public and create awareness on environmental and health impacts of second hand goods imported in LAC regions from their northern counterparts. These products bear no responsibility at the end of its useful life. In Vietnam the trade in used goods is currently unrestricted. Some of the streets in Ho Chi Minh City are lined with businesses selling imported used PCs and Japanese radios and audio equipments are on sale in Hanoi (48). Thus there is urgent need for increasing the awareness among the consumers about the hazards posed by the end of life equipments, collection systems and proper disposal mechanism.

5.3 Infrastructure

- **Collection and Logistics:** In Bulgaria, effectively functioning separate collection systems for WEEE and batteries/accumulators have not been established yet. At the present moment only one collective system (recovery organization) for separate collection of WEEE, organized and financed by producers and importers of EEE, got an approval from the Ministry. There is no authorized collective system (recovery organization) for batteries/ accumulators. Very few individual performers for WEEE and only one for lead acid batteries have been approved (operated by a Lead accumulators recycling plant “MONBAT”).
- **Lack of Awareness:** In Latvia the consumer response is less and the collection targets for WEEE are not achieved because of lack of awareness among consumers about collection points. In order to raise consumer awareness several collection campaigns, lotteries and information campaigns are carried out. The State Environment Service carried out inspections of collection facilities and treatment facilities and assessed the challenges as no proper record keeping of the quantity of wastes treated and no water proof, pollutant proof anti-filtration covering of storage and treatment areas (55).
- **Reprocessing technologies –** In Thailand the major challenge is exporting to other countries in terms of quantity and number due to lack of domestic facilities (56).
- **Financial considerations –** In LAC regions the recycling operations are self sufficient as cost of labor is low, great opportunities for resale and marketing of refurbished goods exists. The only part of computer that has negative cost is the cathode ray tube as it creates greater liabilities on municipalities for separate collection, logistics, sorting and cost of removal.
- **In Indonesia** most of the valuable e-Wastes categorized as hazardous wastes (PC Boards, solder residues etc.) needed extra cost for sending to legal facilities and mostly was given to scrap companies either free of charge or paid. The open dumping of PCBs was also found in Sei Lekong Tanjung Uncang (57).

5.4 Imports

The Nigerian computer dealers’ business association (CAPDAN) state that 75% of the imported used computer equipment not economically repairable and resalable. The local traders at Lagos, claim that every month about 500 containers of used computer scrap enter the country from developed nations and each container contains about 800 computers or monitors. This is the reason for flourishing used electronics trade in Lagos with a robust legitimate market for repair, reuse and recycling of old computers, televisions, monitors and cell phones (58).

Table 1: Regulations on e-Waste Management in Developing Countries

S.No.	Country	Regulation	Products covered/ Scope	Responsibility	Implementation
1	Costa Rica	Creating National System for Management of e-Wastes	Large number of electronic products	-	Ministry of Health proposed nationwide e-Waste Take-Back Regulation
2	Vietnam	<ul style="list-style-type: none"> Implementation of Trade Law Issuance of List of Hazardous Substances Circular on guiding capacity and management of hazardous wastes 	<p>Electronics, cooling appliances, home appliances and IT products</p> <p>Electric and electronic wastes</p> <p>HW including e-Wastes</p>	<p>-</p> <p>-</p> <p>Registration of HW generators and professional permits for transporter and disposer of HW</p>	<p>Government bans import of second hand commodities</p> <p>Ministry of Natural Resource and Environment</p> <p>Ministry of Natural Resource and Environment</p>
3	Malaysia	Guidelines for Classification of UEEE as Scheduled Wastes	<p>Electrical and electronic assemblies containing components like accumulators, mercury switches, CRT glass, PCB capacitors or contaminated with heavy metals or PCBs</p> <p>Assist Parties in identifying and classifying e-Waste and determines criteria for import/export</p>	Waste generators, waste transporters, importer/exporter of wastes, relevant authorities in waste management	-
4	Thailand	<ul style="list-style-type: none"> Regulations on Import/ Export of new products 	Restrict usage of hazardous substances	Comply with domestic permit system (UEEE)	Pollution Control Department

		<ul style="list-style-type: none"> Draft Law on HW based on Take-Back 		<p>Comply with PIC procedure and domestic permit system (e-Wastes) Set of Criteria formulated for import control of UEEE Criteria for repair/ reuse, disassembly & Recycle</p> <p>Assigning responsibilities to producer, consumer, municipalities through Take Back network and separate committee for monitoring fund</p>	
5	Slovakia & Bulgaria	Regulations for Management of e-wastes	Fluorescent Tubes	-	-
6	China	<ul style="list-style-type: none"> Chinese RoHS Draft e-Waste Law 	<p>All electronic products including imported products</p> <p>Fund for reuse, collection, dismantling, disposal standard, import/export management and compulsory recovery</p>	<p>Labeling of products, Eco Design, ban on usage of 6 hazardous materials</p> <p>EPR, Consumer responsibility,</p>	-
7	Hungary	Implementation of WEEE Directive	B2B & B2C products are differentiated by list of B2C products on CN code basis	6 PROs Producers responsibility for collection of B2C products	Government Decree on Take Back Ministerial Decree transposing treatment provisions Amendment to Product Fee Act

8	Latvia	Implementation of WEEE Directive	-	Latvia adopted a Tax as part of WEEE Directive Implementation	Law of Waste Management, Regulations on Categories of EEE, Labeling requirements of EEE, Regulations on Management of WEEE, Regulations on Producers Registration
9	Estonia	Implementation of WEEE Directive (2005) with two collective schemes	-	Producers take back WEEE Producers required to register with Environment Information Center Producers are responsible for separate collection and treatment of WEEE	Membership of producer in compliance organization will serve as guarantee to financing proper disposal
10	Poland	Polish WEEE Act	-	Individuals putting EEE in the market or collective schemes must report annually on product fees paid Entity that put EEE on market requires third party insurance to protect against failures Standard form for reporting the amount of WEEE processed	Ministry of Environment, Ministry of Economy
11	Romania	WEEE Directive and RoHS are in force in Romania	-	Order on specific measures for collection preventing risks, Order on	Governmental Decision on WEEE is supplemented by 3 Ministerial Orders

				collection and Order on Registration, Recording and Reporting	
12	Slovakia	WEEE Management in Slovakia (2005)	-	Producer responsibility Rights and duties of Legal entities and individuals Right of State administrative authorities	Recycling Fund on Slovak Take-back system Implementation of RoHS Government Order on Collection and Recovery Targets and Order on Contributions to Recycling Fund
13	Slovenia	WEEE Management in Slovenia	-	Two-step producer registration regime, reporting, producers financing WEEE management, EEE marking requirements, Free provision by retailers and distributors Obligation by retailers and distributors for informing households on take-back points	Implementing Regulations on Manner and Conditions for Performing WEEE Public Utility Service (2004) and Eco-Fee Decree (2006)

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