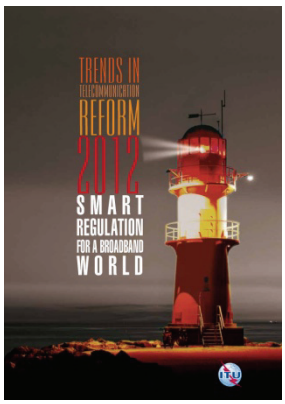
International Telecommunication Union

GSR 2011 Discussion Paper

E-WASTE AND RECYCLING: WHOSE RESPONSIBILITY IS IT?



Work in progress, for discussion purposes

Comments are welcome!

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LIST OF ACRONYMS

BAN	Basel Action Network
BFR	Brominated flame retardants
BPO	Business process outsourcing
CFSK	Computers for Schools Kenya
CD	Compact disc
CEC	Commission for Environmental Cooperation
CRT	Cathode ray tube
DfE	Design for environment
DNA	Deoxyrebonucleic acid
DVD	Digital versatile disc
ECDM	Environmentally conscious design and manufacturing
EPA	Environment Protection Agency
EPR	Extended Producer Responsibility
EU	European Union
GPS	Global positioning system
ICT	Information and communication technologies
IT	Information technology
ITU	International Telecommunications Union
LCA	Life cycle analysis
LCD	Liquid crystal display
MEA	Multilateral environmental agreements
NAAEC	North American Agreement on Environmental Cooperation
NAFTA	North American Free Trade Agreement
OECD	Organization for Economic Co-operation and Development
PAHs	Polyclic aromatic hydrocarbons
PC	Personal computer
PCB	Ploychlorinated biphenyls
PBDEs	Polybrominated diphenyl ethers
PRO	Producer responsibility organization
PVC	Polyvinyl chloride
RoHS	Restriction of the use of certain hazardous substances
UK	United Kingdom
UNEP	United Nations Environmental Programme
TFT	Thin film technology
RSP	Respiratory suspended articles
SME	Small and medium enterprises
STB	Set top boxes
TV	Television
VAT	Value added tax
VCR	Video camera recorder

WEEE	Directives on Waste Electrical and Electronic Equipment
WSIS	World Summit on the Information Society
WTO	World Trade Organisation
WTPF	World Telecommunication Policy Forum

EXECUTIVE SUMMARY

This paper commissioned by the International Telecommunications Union (ITU), investigates the rising concern about e-waste globally. It seeks to explore some of the factors that are contributing to a rapidly increasing quantity of e-waste. It also brings out some of the adverse consequences brought about by e-waste to human health and the environment and makes a case for an urgent need for comprehensive response to the e-waste problem. While some countries have in place elaborate mechanisms for handling electronic equipment after its useful life is over, others have no plan in place.

In discussing the relationship between e-waste and the ICT sector, this paper seeks to identify whether the nature of the relationship places a special role on national regulators for the ICT industry. As ICT devices and networks become ubiquitous and applications and services based on ICTs continue to grow, this paper suggests the necessity of making e-waste management a consideration at the center of the design of ICT policy. This is a significant departure from the current situation where aspects of waste (including e-waste) tend to fall in purview of environmental law or as the responsibility of local and municipal authorities. Except in a few limited cases such as China and Thailand, there is little evidence of comprehensive e-waste regulatory frameworks in developing/transition countries.

The paper explores various approaches that have been adopted in handling e-waste. It seeks to identify and discuss best practices that can be adopted at policy and regulatory levels either through assumption of voluntary obligations or mandatory requirements in the law. It seeks to identify incentives and obligations that regulators can adopt in an effort to reward comprehensive integration of e-waste into business strategy and at the same time exact a penalty for non-compliance.

This paper introduces two policy principles in detail – recycling and extended producer responsibility (EPR) - into the ICT policy arena. The first principle seeks to promote the high utilization of product and material quality through effective collection, treatment and re-use or recycling in an environmentally friendly and socially desirable manner. The second principle tries to encourage producers to assume responsibility for the products they generate through their entire life cycle. This is done through a matrix of incentives that systematically encourage the producer to design improvements of products and product systems that have an optimal environmental performance even at their end of life. This is known as design for environment (DfE). This paper explains what each of the two policy principles involve in detail, and touches on likely barriers in the path of implementation.

At the heart of this discussion, the objective is not to prescribe solutions for adoption. Indeed the paper dialogue recognizes that any effective e-waste management ecosystem must address the local context at the core of its design. This means that a highly mechanized recycling system, for example, is likely to fail in an economy that needs to create jobs for its population. The financing mechanism of e-waste is not clear particularly for developing countries where ICT goods are imported through third parties, making it difficult to implement EPR. Due to this unstructured method of supply, this paper seeks to provoke a discussion on possible funding mechanisms that are sustainable. It proposes a careful consideration of the need to balance the push for access to ICTs with the practicality of harnessing the resultant e-waste which is the dark side of these innovations, in a manner that is sustainable for the long term.

While most data and information was available from Europe and North America, a deliberate effort has been made to draw information from other regions in the world in order to sustain balance in the research content and in the buildup of thematic areas under consideration.

In order to facilitate formulation of e-waste management ecosystems that are sensitive to individual country situations, this paper aims to create awareness and generate constructive debate. Subsequently, the exchange of ideas and information will create a collaborative platform that will be a valuable aid in decision making at the strategic policy and regulatory level going forward.

As a buildup **of analysis**, this paper proposes a checklist of critical aspects to be considered in the establishment of a roadmap for the management of e-waste. These factors can be considered as a guide in engagement of various stakeholders in the formulation of e-waste ecosystems. The checklist is designed to enable ICT regulators identify and leverage on critical regulatory aspects within the scope of governance of e-waste at the local, regional and international level.

In making policy and regulatory recommendations, this paper advocates for the need to identify players in the e-waste space in order to ensure optimal inclusion (given the fluid nature of the ICT ecosystem) in engagement for policy architecture and subsequently in allocation of roles and responsibilities. It makes some recommendations towards adoption of unique approaches such as regional harmonization initiatives that would be particularly beneficial for jump starting developing countries on the path of e-waste management. In concluding, this paper will be a success if it is able to:-

a) Raise awareness on the dangers of e-waste;

b) Encourage the consideration of e-waste management in the design of ICT policy;

c) Create an urgency for the adoption of strategic policy and regulatory approaches that are sensitive to local context; and

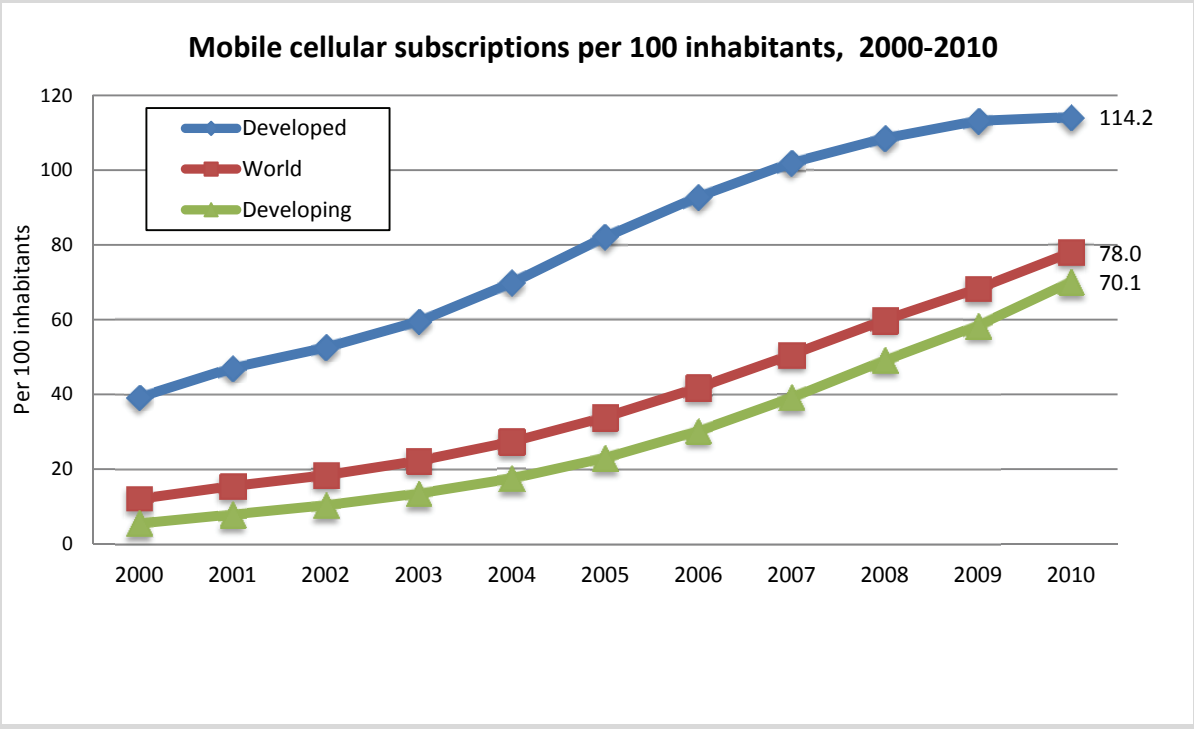
d) Encourage a move to more concerted cooperation in handling e-waste at the regional and international level.

1 E-WASTE AND RECYCLING: WHOSE RESPONSIBILITY IS TI?

Author: Mercy Wanjau, Principal Legal Officer, Communications Commission of Kenya

1.1 Introduction

The information and communication technologies (ICT) sector has experienced unprecedented growth in the last decade. This trend has been boosted by market liberalization and augmented by convergence, new technologies and resultant innovations such as mobile phones which continues to be the most rapidly adopted technology in history. While sector growth has been experienced worldwide, the impact has been exponential in developing countries. Today the mobile phone is the most popular and widespread personal communication technology on the planet, with an average subscription world rate of 78 per 100 inhabitants in 2010. The subscription for the developing world stands at 70.1 in the same period, a very close match, given the wide disparities that existed for fixed lines in yester years, and the differences in terms of social and economic development[1].

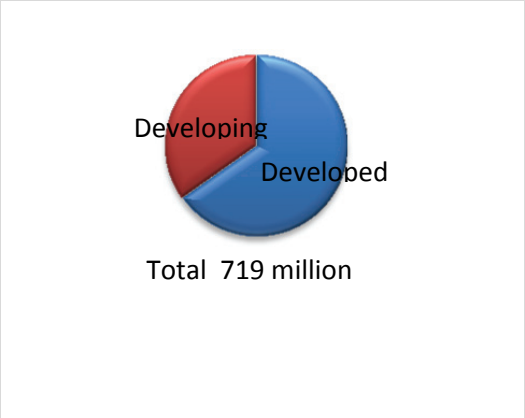


Source: ITU World Telecommunication/ ICT indicators database.

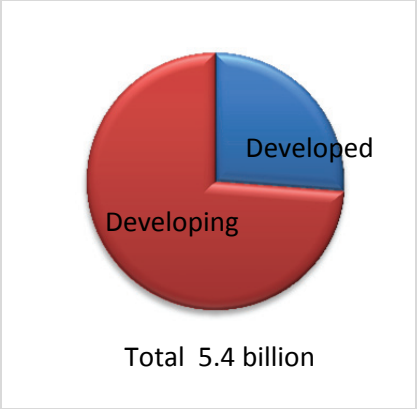
It is estimated that there are approximately 5.4 billion mobile subscriptions globally, an increase from 719 million, in year 2000. The 751% increase viewed alone, speaks of amazing achievements in terms of ICT access and bridging the digital divide. This interpretation however would be very narrow as the factors leading to ICT access are bound to interact with the environments in which they operate. In this case, a critical analysis of mobile subscriptions by level of development, should trigger alarm bells as the sharp increase in ICT access is inordinately skewed towards developing countries as illustrated in the pie chart below. Why the concern?

Mobile subscriptions by level of development

Year 2000



Year 2010



Source: ITU World Telecommunication/ICT Indicators database

While increase in access makes innovation and digital opportunity available, it also spews poison in the form of electronic waste, or e-waste. This is because the sharp increase of e-waste has not been matched with policy and regulatory mechanisms designed to cope with the influx of e-waste in developing countries generated from usage within and from illegal trade related dumping. Huge populations and the environment are now unduly exposed to the devastating effects of unmitigated handling of e-waste. This dismal situation spins a tragic story for many in the developing world who unknowingly make a choice between poverty and poison[2]. Unfortunately, many people who have to pay the price never get to have a say in the matter.

The situation is bound to get worse.

Indeed, ICTs have become so integrated with our way of life to the extent that they are identified as a primary tool of getting certain things done. Governments all over the world have identified ICTs as a key element in the delivery of services to their citizens and in the expansion of business as they seek more prosperity for their citizens[3]. The uptake of broadband networks (which provide high speed access to the Internet) is pushing for the replacement of massive copper infrastructure. It is also leading to adoption of a multiplicity of electronic devices, prompting consumers to buy a new phone, a new computer, a new program which will become obsolete by the time we can figure out how to install it. A newer, better, and more expensive version will be already on the market, lessening the value and the appeal of versions released just prior[4]. The statistics on mobile broadband penetration in 2010 demonstrate a growth in uptake globally[5]. The same upward trend in Internet penetration in households by level of development attests to the steady adoption of these new technologies by both the developed and developing countries in 2010.

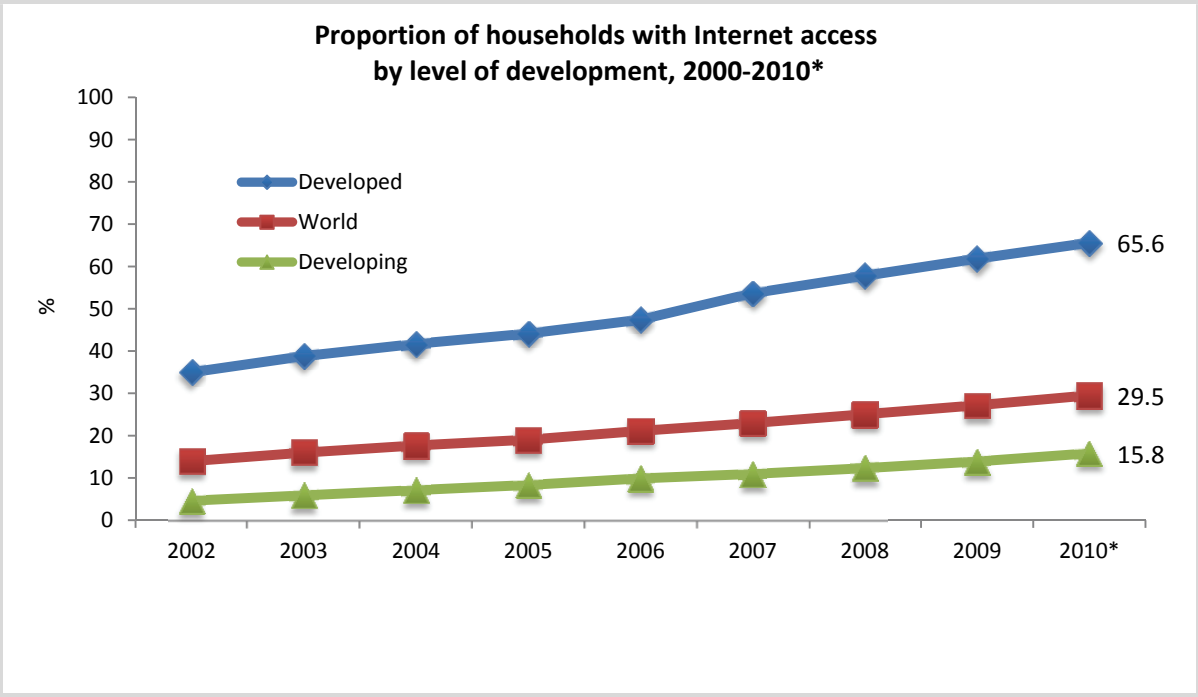
Box 1: Defining e-waste

E-waste is a generic term encompassing various forms of electrical and electronic equipment (EEE) that are old, end-of-life electronic appliances and have ceased to be of any value to their owners. A practical definition of e-waste is 'any electrically powered appliance that fails to satisfy the current owner for its originally intended purpose'.

Source: UNEP, www.unep.fr/scp/waste/ewm/faq.htm#1

Chinese child sits amongst e-waste

Source: www.reallynatural.com



* Estimates

Source: ITU World Telecommunication/ICT Indicators database.

E-waste is one of the fastest growing waste streams today and it is growing at three times the rate of municipal waste globally[6]. Only 13% of e-waste is reported to be recycled with or without safety procedures[7].In February, 2010, UNEP released a report titled, *"Recycling – from E-Waste to Resources,"* in

which it called for the urgent need to prepare developing countries for the surge in e-waste[8]. It used data from 11 representative developing countries to estimate current and future e-waste generation – which includes old and dilapidated desk and laptop computers, printers, mobile phones, pagers, digital photo and music devices, refrigerators, toys and televisions. For PCs, TVs and refrigerators, on average, a linear increase was found. Mobile phone waste however demonstrated an exponential growth.

The report highlighted that by 2020 China's e-waste from old computers will have jumped by 200 to 400 percent from 2007 levels and by 500% in India. The report further indicated that by 2020, e-waste from discarded mobile phones in China will be about 7 times higher than 2007 levels and, in India, 18 times higher[9].

The issue of e-waste as an emerging telecommunications policy and regulatory issue has received recognition at the highest level of governance in ITU. The ITU Plenipotentiary Conference, 2010 held in Guadalajara, Mexico, resolved that ITU would continue to demonstrate its leadership in conjunction with other agencies on the role of ICTs in climate change and protection of the environment [10] . Resolution 182 recognized the role of ITU *'to promote awareness of the environmental issues associated with telecommunication/ICT equipment design and encourage energy efficiency and the use of materials in the design and fabrication of telecommunication/ICT equipment in order to promote a clean and safe environment'*[11]. The resolution also invited Member States, Sector Members and Associates to promote recycling and reuse of telecommunication/ICT equipment[12];

Item C7 of the Plan of Action of the World Summit on the Information Society (WSIS) under C7 (20) continues to encourage *'government, civil society and the private sector to initiate actions and implement projects and programmes for sustainable production and consumption and the environmentally safe disposal and recycling of discarded hardware and components used in ICTs'*[13].

Previously, at the World Telecommunication Policy Forum (WTPF) 2009 held in Lisbon, Portugal, ITU Secretary General Dr. Hamadoun Touré noted the rising concern over e-waste among the growing challenges that are reshaping the telecommunication industry, and emphasized that the Forum had come at a pivotal time, to define opinion on the future direction of the industry[14]. The Forum called on ITU *'to continue to study methods for environmentally safe disposal and recycling of discarded ICT equipment and facilities'*.[15]

Source: ecosystemdiscovery.com

Finally, the issue of e-waste has also been widely treated on the series of ITU symposia on ICTs, the environment and climate change[16], as well as in the 2011 and 2010 editions of the WSIS Forum[17]. These fora have already highlighted the challenges that the accelerated adoption of ICTs will present for human health and the environment if the environmentally sound management of ICT equipment is not applied. Another angle highlighted by the participants of these events have been the need to strengthen the link between the ICT and environment sectors at the national level needs, and the need to engage the private sector to addressing e-waste.The assumption into the ICT sector in many countries, however, needs to be examined a bit more critically. This concern has arisen particularly in developing countries that continue to experience such rapid growth in the sector such that they do not have the opportunity of time to sequence complimentary mechanisms to handle the resultant e-waste.

1.2 What is e-waste?

e-Waste for short – or Waste Electrical and Electronic Equipment (WEEE) – is a generic term embracing all types of waste from old, end-of-life or discarded appliances containing electrically powered components. It includes computers, laptops, TVs, DVDs and other consumer electronics, fridges, freezers etc which have been disposed of by their original users[18]. WEEE is regarded as hazardous based on the characterization of the inherent constituent components including heavy metals such as lead, mercury, silver, cadmium and other hexavalent chromium elements.

Public perception of e-waste is often restricted to a narrower sense, comprising mainly of end-of-life ICT equipment and consumer electronics. Technically, however, electronic waste is only a subset of WEEE. The composition of the various subsets is not standard globally, and may differ between countries and regions.

According to the OECD, any appliance using an electric power supply that has reached its end-of-life comes under WEEE[19]. The classification under EU legislation is as illustrated in the table below.

In this paper, reference to "e-waste" is in relation to electronic waste generated from ICT Equipment and the infrastructure associated with it.

Classification under the EU WEEE Directive

Large Household Appliances
Washing machines, Dryers, Refrigerators, Air-conditioners, etc.

Office, Information & Communication Equipment
PCs, Laptops, Mobiles, Telephones, Fax Machines, Copiers, Printers etc.

Entertainment & Consumer Electronics
Televisions, VCR/DVD/CD players, Hi-Fi sets, Radios, etc

Lighting Equipment
Fluorescent tubes, sodium lamps etc. (Except: Bulbs, Halogen Bulbs)

Electric and Electronic Tools
Drills, Electric saws, Sewing Machines, Lawn Mowers etc. (Except: large stationary tools/machines)

Toys, Leisure, Sports and Recreational Equipment
Electric train sets, coin slot machines, treadmills etc.

Medical Instruments and Equipment

Surveillance and Control Equipment

Automatic Issuing Machines

Source: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:037:0024:0038:en:PDF

Computers pile up and pollute the earth, rotting slowly and dissolving into the soil

Source: http://stamen-tonchev.blogspot.com/

1.2.1 Statement of the problem

> *The information technology revolution Has made us smarter, faster, and more globally savvy. It has also seeped poison.*
>
> *Newsweek*[20]

Electronic waste can cause widespread environmental damage due to the use of toxic materials in the manufacture of electronic goods. Once the electronic item is no longer needed by the user, it is disposed off. In developed countries, a mechanism for the return or collection and recycling of this electronic waste is often in place, ensuring that such items are handled appropriately, hence safeguarding the environment and human health from adverse effects. But this is hardly the reality in most developing countries.

In developing countries, disposal in landfills releases hazardous materials into the waste stream with no special precautions in handling and recycling methods to avoid the known adverse effects on the environment and human health. Informal recyclers handle the disposed goods manually, sustaining cuts and bruises in the process, as they lack protective clothing and appropriate equipment. Often children and women are involved in these processes alongside the men in a bid to eke out a livelihood[21,22].

The crude processes are carried out in back yards, in the open air or in poorly ventilated enclosed areas. What is not immediately apparent is the undue exposure to pollutants; heavy metals, toxic gases, biologically active materials (mimicking human/animal hormonal activity), slow poisoning chemicals, acids and plastic additives. These have both chronic and acute effects on the human system when exposed at variant levels in the human environment.

Below is an illustrative table of the health effects resulting from toxic constituents of e-waste.

Woman working in e-waste yard in Asia

Source: www. loe.org

E-waste and its effect on health

Source of E-Waste	Constituent	Health Effects
Solder in printed Circuit boards, glass panels and gaskets in Computer monitors	Lead (PB)	Damage to central and peripheral nervous systems, circulatory System and renal system. Affects brain/cognitive development of the young.
Chip resistors and semiconductors	Cadmium (CD)	Irreversible damage to human health. Accumulates in kidney and liver. Neural damage. Have teratogenic effects – foetal deformities and spontaneous miscarriages.
Relays and switches, printed circuit boards	Mercury (Hg)	Damage to the brain. Respiratory and skin disorders due to accumulation in food species.
Corrosion protection of untreated and galvanized steel plates, decorator or hardener for Steel housings	Hexavalent chromium (Cr) VI	Asthmatic bronchitis. DNA damage.
Cabling and computer housing	Plastics Including PVC	Burning produces dioxin. It Causes: reproductive and developmental problems; immune system damage; interference with regulator hormones
Plastic housing of electronic equipments and circuit boards.	Brominated flame retardants (BFR)	Disrupts endocrine system functions
Front panel of CRTs	Barium (Ba)	Short term exposure causes: muscle weakness; damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	Carcinogenic (lung cancer) Inhalation of fumes and dust causes chronic beryllium Disease or beryllicosis. Skin diseases such as warts.

Source: Report on Workshop titled 'E-waste: Impacts, challenges and the role of government, service providers and the consumers in Kenya'.

These hazardous substances also result in environmental impacts such as air pollution by various toxic gases including those generated from incineration, soil pollution by solid waste materials, ground-water pollution from leaching toxins in landfills and garbage dumps. Lead that accumulates in the environment has highly acute and chronic toxic effects on flora and fauna. Indeed, the physical existence of ICTs through manufacturing, assembly, installation and disposal has been cited in academic research as a contributor to climate change of the first order[23].

Poor conventional methods of disposing e-waste, which are mainly open dumping and open burning results into oxidation of plastics made of Brominated Flame Retardants (BFR). This releases dioxins, furans and toxic Respiratory Suspended Particles (RSP) that cause risks to human health on exposure, and alter environmental systems.

Several studies have documented the hazards of informal backyard recycling. The table below is illustrative of the adverse outcome of investigations carried out between 2003 and 2007 in the town of Guiyu, Guangdong, China which is often referred to as "the e-waste capital of the world."[24].

Modern electronics can contain up to 60 different elements; many are valuable, some are hazardous and some are both. Electronic goods generate e-waste which contains valuable materials such as gold and copper. In its entity, electrical and electronic equipment is a consumer of many precious metals and therefore an important contributor to the world's demand for metals. Despite all legislative efforts in the developed countries and the EU to 'mine' these valuable resources from e-waste, the majority of these resources are lost[25]. One of the main obstacles to efficiently recovering these resources is the almost non-existent infrastructure for collection and recycling as well as the missing assignment of clear responsibilities[26]. Uninformed disposal leads to a waste of resources when such economically valuable materials are dumped or unhealthy conditions are developed during informal recycling. There is a growing concern about the adverse effects of e-waste as the electronic industry is one of the world's largest and fastest growing industries in the world.

Effective recycling to obtain these metals and other re-usable materials is crucial in order to make them available for the manufacture of new products. It will also ensure that primary metals are conserved for future generations.

The table below illustrates a schedule of hazardous materials that are found in e-waste components.

Outcome of investigations in Guiyu, China

- Elevated concentrations of PBDEs in soil and sediment samples, with substance profiles similar to various technical formulations of flame retardant products;
- Concentration of soils with carcinogenic, mutagenic, teratogenic and bioaccumulating PAHs especially from soils used for open burning of waste;
- High concentration of heavy metals in sediment samples from the Lianjiang river, consistently above the Interim Sediment Quality Guidelines set for Canadian standards;
- Concentration of some heavy metals associated with fine particulates in air samples ranging from 4 to 33 times higher than those recorded in other Asian cities;
- High concentrations of PBDEs in the blood samples of residents of Guiyu, including the highest concentration of of the commonly used brominated flame retardant BDE-209 so far reported in humans;
- High levels of lead in the blood of children from Guiyu and the potential damage to their IQ and developing central nervous systems as a result.

Source:http://gvisionaries.wordpress.com/2011/05/02/digital-dumping-an-inside-look-at-e-waste/

Hazardous Materials	
Components	**Constituents**
Circuit boards	Lead,Cadmium, Brominated flame retardants and antimony oxide
Monitor cathode ray tubes (CRTs)	Lead oxide and Cadmium
Switches and Flat screen monitors	Mercury
Computer batteries	Cadmium
Old capacitators and transformers	Polychlorinated biphenyls (PCBs)
Plastic casings, cables and polyvinyl chloride (PVC) cable insulation	Brominated flame retardants
Source: Report on Workshop titled 'E-waste: Impacts, challenges and the role of government, service providers and the consumers in Kenya.	

1.3 Factors causing an increase of e-waste

Technological advances are driving innovations leading to a constant launch of new product ranges that lay a claim to being 'faster', 'smarter', 'lighter' and therefore offering more value to the user than the 'old and out of date' gadgets already in the market. This proliferation of gadgetry is pushed by the consumer oriented nature of the society today at an astonishing rate. The extract below describes the consumer reality in the United States in 2007[27].

Electronic equipment has become a mainstay of our American way of life.
In one way or another, it is an integral part of everything we do and own:
TVs in our homes, GPs's in our cars, cell phones and MP3 players in our ears, blackberries and videogames in our hands, and computers in our laps and on our desks. The electronic industry generates nearly $2 billion a year, and it's no small wonder. Americans own nearly 3 billion electronic products.
For each new product that comes along, one or more becomes outdated or obsolete.

While the degree of gadget proliferation differs, the extract above is very reflective of the emerging scenario of many countries today.

The Environmental Protection Agency[28] statistics speak to the levels of e-waste in the US in the same year, as below.

E-Waste in 2007 – Was it Trashed or Recycled

Products	Total disposed** (million of units)	Trashed (million of units)	Recycled (million of units)	Recycling Rate (by weight)
Televisions	26.9	20.6	6.3	18%
Computer Products*	205.5	157.3	48.2	18%
Cell Phones	140.3	126.3	14	10%

*Computer products include CPUs, monitors, notebooks, keyboards, mice, and "hard copy peripherals", which are printers, copiers, multi's and faxes.
**These totals don't include products that are no longer used, but stored.

Source: EPA [1]

One of the technological advances that is currently causing rapid product obsolescence is the digital switch over in the broadcasting sector[29].

The switch to digital broadcasting has led to the ongoing transition from analogue to digital transmission of radio and TV signals by 2015 and in some regions, such as the EU, by the end of 2012. The conversion has led to procurement of Set Top Boxes (STB) to allow owners of analogue sets to receive digitally transmitted signals and acquisition of latest energy efficient broadcast equipment While the transition does not mean a systematic abandonment of analogue TV sets, many consumers are using this switch to overhaul their electronic devices and appliances in developed countries which are implementing the switch. As a result, there is flooding of analogue TV sets from developed nations implementing the switch into those countries that are yet to implement the digital switch over.

With regards to mobile services, the technological migration from second mobile communication networks (2G), which enable voice and limited data communications, to third generation networks (3G), which enable full data communications, and onwards also spurs the acquisition of smartphones and mobile Internet devices that place heavier demands on batteries than previous technologies[30]. This leads to faster disposal of gadgets in the pursuit of new product releases that are able to harness the emerging functionalities. To enable these trends, it is often necessary to abandon legacy infrastructure and upgrade to accommodate broadband. This is yet another increasing stream of e-waste.

In the computing and information sub sector, there is demand for equipment with faster processing speed, larger memory and Liquid Crystal Display / Thin Film Technology (LCD/TFT) display units which are lighter and occupy less space. There has been a drastic reduction of memory devices like CDs, DVDs, Flash disks, memory cards and hard disks leading to a high turnover of obsolete accessories. All these have resulted in generation of e-waste.

Privatization and liberalization of the sector in many regions of the world has opened up a new platform for delivery of services to citizens. This has been particularly evidenced in developing countries where innovation around the mobile phone, for example has enabled delivery of education, agricultural and even financial services on this non-conventional medium. Governments have responded by enabling further adoption through public policy moves such as tailoring fiscal measures that would enable increased use of ICT equipment.

The Government of Kenya in the budget of 2009/2010 reduced cost of mobile phones and other ICT equipment and related components through elimination of VAT (sales tax) and import duty making ICT gadgets cheaper and enhancing affordability[31]. In the same year, the Government of Mauritius outlined a variety of generous financial incentives to encourage foreign IT/BPO companies into the country. These included corporate tax exemption (either 0% in the first year and 15% thereafter, or 5% in perpetuity); zero customs duty on ICT equipment; 50% tax relief on personal income tax for foreign IT specialists; and refunds of up to 75 % of training costs[32]. ICT companies continue to seek tax incentives in Singapore indicating that this would foster an environment conducive to internationalization through establishment of overseas markets [33] . Without a doubt, these well meant scenarios geared towards growth and expansion of markets eventually lead to increased e-waste downstream. Consideration of fiscal incentives that would promote recycling would help achieve a more balanced outcome in the long run.

At the international level, laxity in enforcement of regulatory requirements on movement of e-waste leads to the export of e-waste from one jurisdiction to another. The exporting jurisdiction does this in order to benefit from cheaper labour and lax standards in the recipient jurisdiction. Often times, the export is a dumping strategy. Whatever the intention of exporting, it leads to an increase of e-waste in the recipient jurisdiction which is often ill prepared to handle it. It therefore gets saddled with dealing with e-waste as a secondary problem.

The United States is one of the largest producers of e-waste in the world. An examination of US data is illustrative of the magnitude of exported e-waste. It indicated that in 2005, approximately 61%, or 107,500 tons of CRT monitors and TVs collected for recycling were exported for remanufacture and refurbishment. The next largest portion (about 14% or 24,000 tons) was CRT glass sold to markets abroad for glass-to-glass processing[34]. Currently, there is a lack of basic data on shipments of electronics from the U.S. to other countries. Information about where the waste is going, to whom does it go, and in what quantities will help in a better understanding of the extent of the problem, along with ensuring that solutions are targeted appropriately[35].

E-waste is the dark side of ICT innovation. While countries are encouraged to optimize on the ICT platform to meet socio-economic goals, this is the right time to recognize the need to balance the push for access to ICTs with the practicality of harnessing the resultant e-waste in a manner that is sustainable for the long term.

1.4 The e-waste ecosystem

From the foregoing discussion, it is clear that while e-waste presents a significant problem, it also presents opportunities alongside. In most developing countries, the problem of e-waste has continued to fester due to the almost non-existent infrastructure for collection and recycling. Developed countries have been able to harness this situation through formal structures that assign clear responsibilities to the various actors in the e-waste ecosystem.

1.4.1 Features of an effective e-waste ecosystem

At the heart of the design of an effective e-waste recycling ecosystem, the following fundamental objectives should be met:

- Handling hazardous and toxic substances in e-waste in an environmentally sound manner;
- Optimizing the recovery of valuable materials; and
- Creating sustainable businesses through models that address the local context (such as job creation, level of awareness of applicable technologies, etc.)

Typically, in most developing countries and economies in transition[36], the recycling of e-waste involves small enterprises that are numerous, widespread and difficult to regulate. They take advantage of low labour costs due to high unemployment rates, internal migration of poor peasants, and the lack of protest or political mobilization by affected villagers who believe that e-wastes provide the only viable source of income and entry into modern development pathways. An effective e-waste ecosystem must stand the scrutiny of environment, health and safety standards. This would involve detection and measurement of emissions into air, water and soil as well as safety and protection for workers involved in this industry.

The recovery of useful materials would entail deployment of energy efficient technologies with a good yield of recovered material with respect to economic and environmental value.

The use of business models that address the local context is of utmost importance in determining the success of e-waste recycling. In many cases, the ability to provide jobs that accommodate the existing informal infrastructure in the industry would be key considerations for a developing country context. An assessment of the magnitude of e-waste in a country would provide vital preliminary data that would drive dialogue on how best to position interventions that are appropriate and relevant to the local context, yet cognizant of the need to build up an e-waste recycling ecosystem that complies with best practices.

1.4.2 Elements of the recycling chain

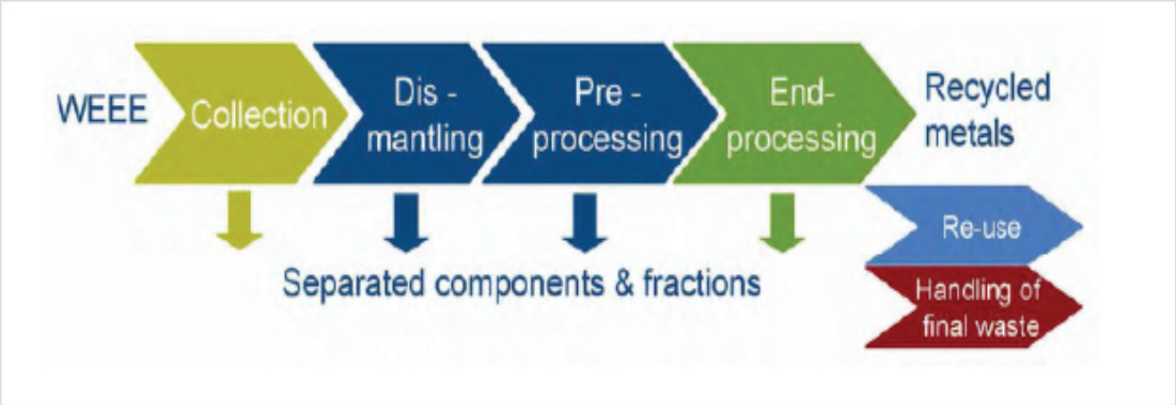
The recycling chain of e-waste consists of three main steps:

- Collection;
- Sorting/dismantling and pre-processing; and
- End-processing which includes refining and disposal.

The effectiveness of the recycling chain is only as strong as its weakest link as the linkages are heavily interdependent. The efficiency of the entire recycling chain depends on the efficiency of each step and on how well the interfaces between these interdependent steps are managed.

The recycling chain is also linked to other steps in the product life cycle such as product design, manufacturing and product use as what is done in dismantling and pre-processing affects the subsequent steps of material recovery. In addition, technological advances in final materials/metals recovery might imply new requirements for the output fractions of preceding steps. New material compositions, combinations or connections in electrical and electronic equipment, like LCD or plasma monitors, can imply adjustments to the set-up of the recycling chain.

E-waste recycling value chain



Source: Recycling – From E-waste to Resources: Sustainable Innovation and Technology Transfer Industrial Sector Studies, UNEP, 2009

1.4.2.1 Collection

This is the backbone upon which the e-waste recycling ecosystem rests. It determines the amount and type of material available for recycling. It requires an accessible, consistent and co-ordinated collection mechanism to enhance the chances of collection success. The lack of a collection system is a significant factor leading to e-waste being stock-piled in homes, offices and repair shops[37,38.]

Outcomes of consumer surveys have also indicated that social and societal factors also play a role in determining the rate of collection success. Anecdotal evidence regarding mobile handsets has pointed to the reality that operator take back schemes often fail because of consumer behavior of not returning phones or expecting something in return[39].A global consumer survey by Nokia in 2008 revealed that majority of old mobile phones are lying in drawers at home and not being recycled as only 3% of people participate in recycling[40]. his points to the need to create awareness and develop incentive mechanisms to make consumers more responsive because a recycling chain cannot be established without the collected items to feed it.

Mobile phone manufacturers could play a critical role in setting up a collection infrastructure to take back their old handsets. For example, Nokia is involved in take back schemes in the European Union, Australia, parts of South America and Asia. In 2006 around 500 Nokia Care points in China started to collect used phones, with China Mobile offering prepaid cards as an incentive to recycle. The scheme collected over 80 tonnes of electrical materials and has now been extended to cover 11 Nokia suppliers in China[41]. Samsung Electronics has developed voluntary take back programs for its products at the end of their working lives in North America, Europe and Asia[42]. This responsibility includes ensuring that all collected products are recycled in the most efficient way to minimize the volume of unrecoverable materials and maximize the usable materials. It would seem that no efficient take back scheme exists as yet in Africa[43].

1.4.2.2 Dismantling and pre-processing

The purpose of dismantling and pre-processing is to liberate the materials and direct them to the appropriate final treatment processes. Hazardous substances have to be removed and stored or treated safely, while valuable components need to be taken out for re-use or to be directed to efficient recovery processes. This stage also includes removal of batteries which are sent to specialized plants for further processing.

Circuit boards present in ICT equipment contain most of the precious and special metals. Extraction of metals (such as from circuit boards) sometimes requires state of the art gas treatment equipment to prevent the release of dioxins to the environment. In hydrometallurgical plants, the special handling and disposal requirements necessary for the strongly acidic leaching effluents (such as cyanide, nitric acid, aqua regia) have to be diligently followed to ensure environmentally sound operations and to prevent tertiary emissions of hazardous substances. In implementing this stage, the challenge is to define the right priorities and find a balance in metals recovery that considers economic and environmental impacts instead of maximization of metal recovery rates in isolation. The current global approach is discussed in greater detail in the next sub-section.

Preprocessing of e-waste is not always necessary. Small, highly complex electronic devices such as mobiles and MP3 players can (after the removal of the battery) be treated directly by an end processor to recover the metals. After the removal of both the hazardous as well as the special components, the remainder of the device is further separated in the material output streams by manual dismantling or mechanical shredding and sorting techniques.

1.4.2.3 Mechanical pre-processing

Whereas investments and technology are less challenging in collection and dismantling, mechanical pre-processing and especially metallurgical metal recovery requires considerable investments in advanced technologies to handle the heterogeneous and complex materials. Division of labour at the international level has developed over time in response to this situation[44]. It works with collection, dismantling and partly mechanical processing taking place at a national or regional level, as well as metals recovery from less complex materials such as ferrous, copper and aluminum.

Treatment of complex materials such as circuit boards, batteries, cell phones in integrated metal smelters or specialized battery recycling plants takes place in a global context. For such plants to run, they require a heavy financial investment and employ a highly skilled work force. Currently, integrated metal smelters equipped with appropriate installations for off- gas and effluent treatment are located in Belgium, Canada, Germany, Japan and Sweden. They source their feed materials from all over the world. Their feed mix comprises in addition to circuit boards and copper/precious metals containing e-waste fractions consists mining concentrates, smelter residues and catalysts[45].

The aspect of considering a regional approach in treatment of complex e-waste material would be a value proposition worth consideration in regions that are yet to formulate an e-waste strategy.

1.4.2.4 Refurbishment

During the classification of the e-waste collected, there are electronic items that can be sorted and identified as fit for re-use. Such items such as computers can be refurbished and eventually find their way back to the market. Refurbished or recertified computers are those which are checked for any faults, and if any, they are corrected and sold with a warranty. Used computers in the second-hand market, will however not carry a warranty upon re-sale, or will include a limited warranty over a shorter period of time. Through refurbishment, electronic equipment such as laptops, computers, servers and printers get a new lease of life, usually to a new community of persons who would not otherwise have afforded a brand new item.

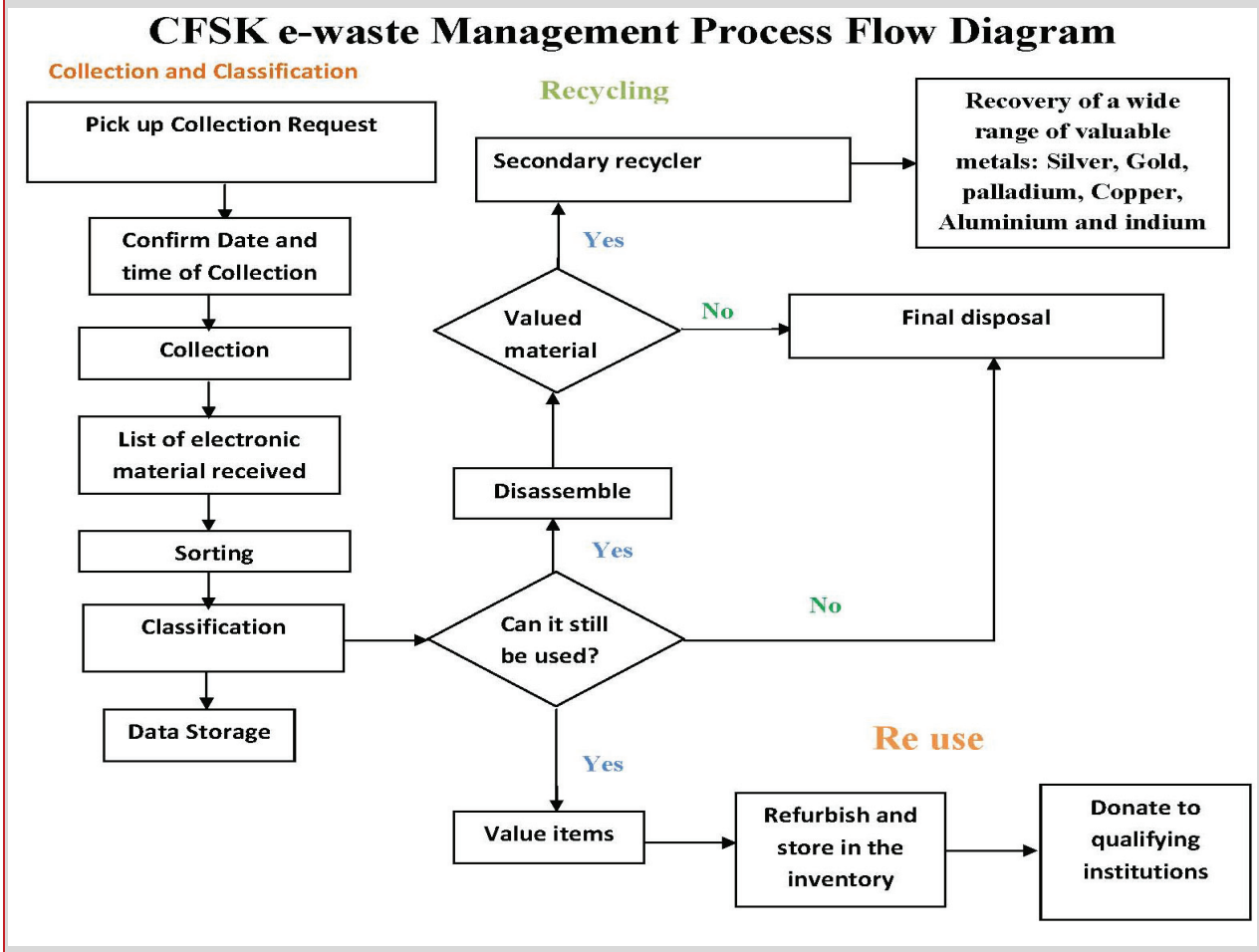
The interdependence of the e-waste recycling ecosystem indicates the need to clearly identify the key actors/stakeholders in the value chain and develop a healthy dialogue upon which to nurture their mutual relationships. A healthy engagement and adequate communication would enable the achievement of efficiencies and development of proactive strategies for the e-waste recycling ecosystem.

A sample of an e-waste management process flow diagram by Computer for Schools Kenya (CFSK) is illustrated below.

1.4.2.5 Towards a greater awareness

There do exist several initiatives in support for a greater awareness about e-waste in order to inform our response towards its reduction and this section aims to highlight a few of these.

An environmental awareness initiative worth noting is the RSA WEE Man that was launched in 2006 following the enactment of the WEEE Directive[46]. The RSA WEEE Man, is an imposing seven metre high, human figure composed of three tonnes of WEEE. This represents the total amount of electronic waste that an average person in the UK is likely to consume in their lifetime and it was meant to highlight the growing problem of Waste Electrical and Electronic Equipment (WEEE) in the UK and across Europe.



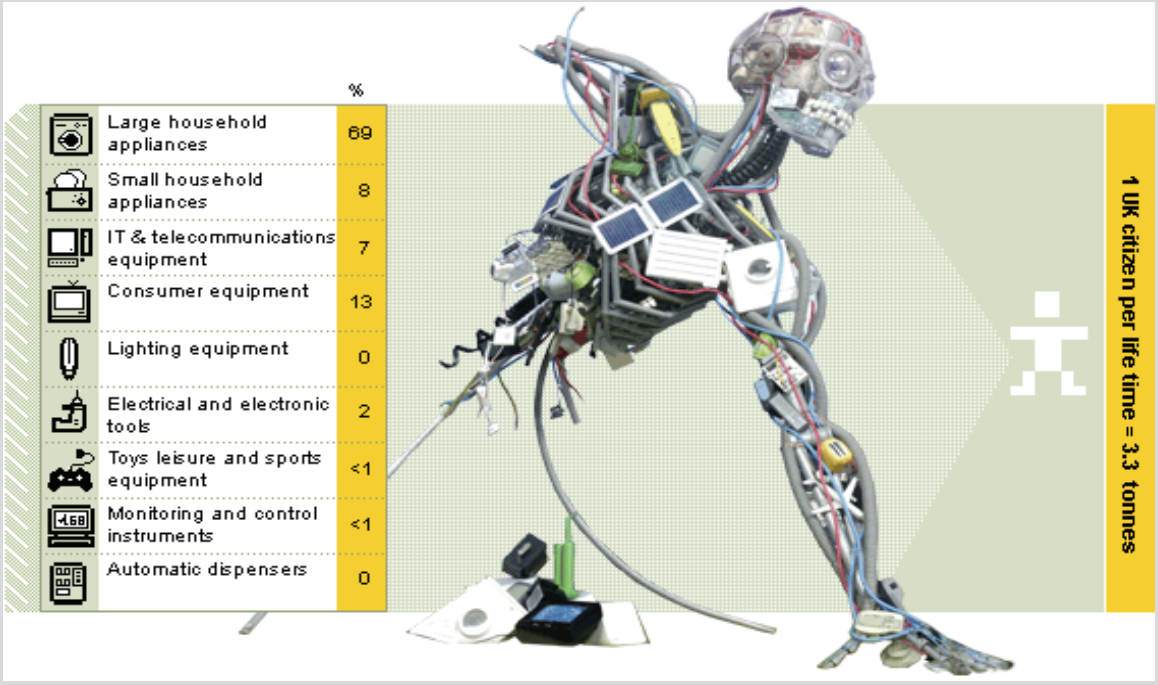
Source: www.cfsk.org

International civil society organizations have also stepped up the e-waste cause through various campaigns. Greenpeace[47], has developed a Guide to Greener Electronics with the goal of seeking creative solutions to the environmental problem of e-waste. The guide ranks the 18 top manufacturers for PCs, computers, mobile phones, TVs and game consoles according to their policies on toxic chemicals, recycling and climate change. The three goals of the guide are to get the companies to:–

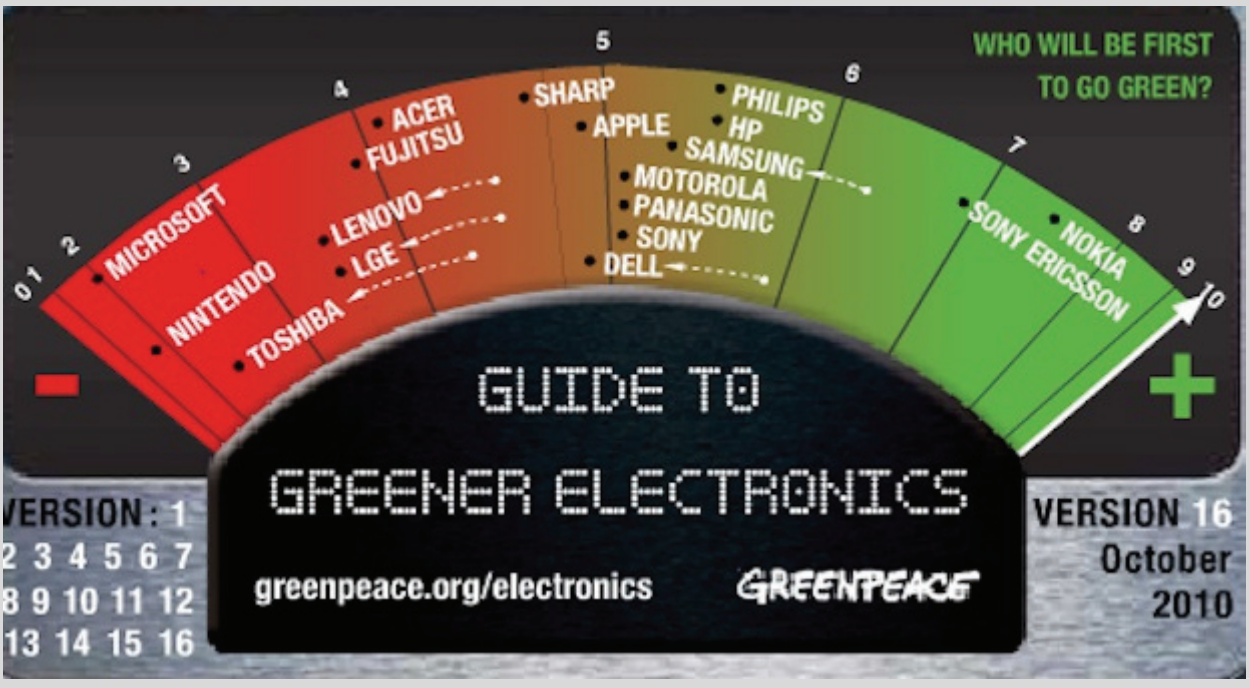
- Clean up their products,
- Take back and recycle their products once they become obsolete, and
- Reduce the climate impacts on their operations and products.

The most recent guide (version 16) was released in October 2010 and is displayed below. A new release is expected in November 2011.

The WEEE Man

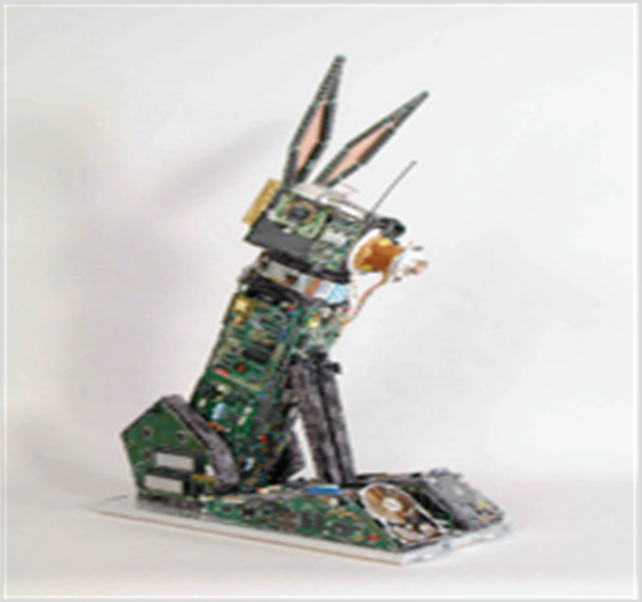


Source: www. weeeman.org/



Source: www.greenpeace.org/electronics.

The entry of e-waste artists is an interesting emerging trend where artists turn e-waste into art. Using discarded hard drives, discs, circuit boards and other components, sculptors are able to create works of art, some of which are quite expensive[48]. Below is 'Jack', an art piece by Brenda Guyton that was on sale for USD 995.



Source: www.treehugger.com

Solid waste management is already a big challenge in many developing countries, and is likely to become worse with the invasion of e-waste, particularly computer waste. Creative forms of utilization of the e-waste would help to raise awareness while creating employment at the same time[49]. An e-waste treatment facility established by Hewlett Packard in Cape Town, South Africa processed approximately 60 tons of electronic equipment, generated about $14,000, and employed 19 people in 2008. Workers refurbished and resold some products and dismantled others to sell the raw materials to businesses that recycle metals and plastics. They also made jewelry out of some of the processors and boards[50].

1.5 Barriers to safe E-Waste Management

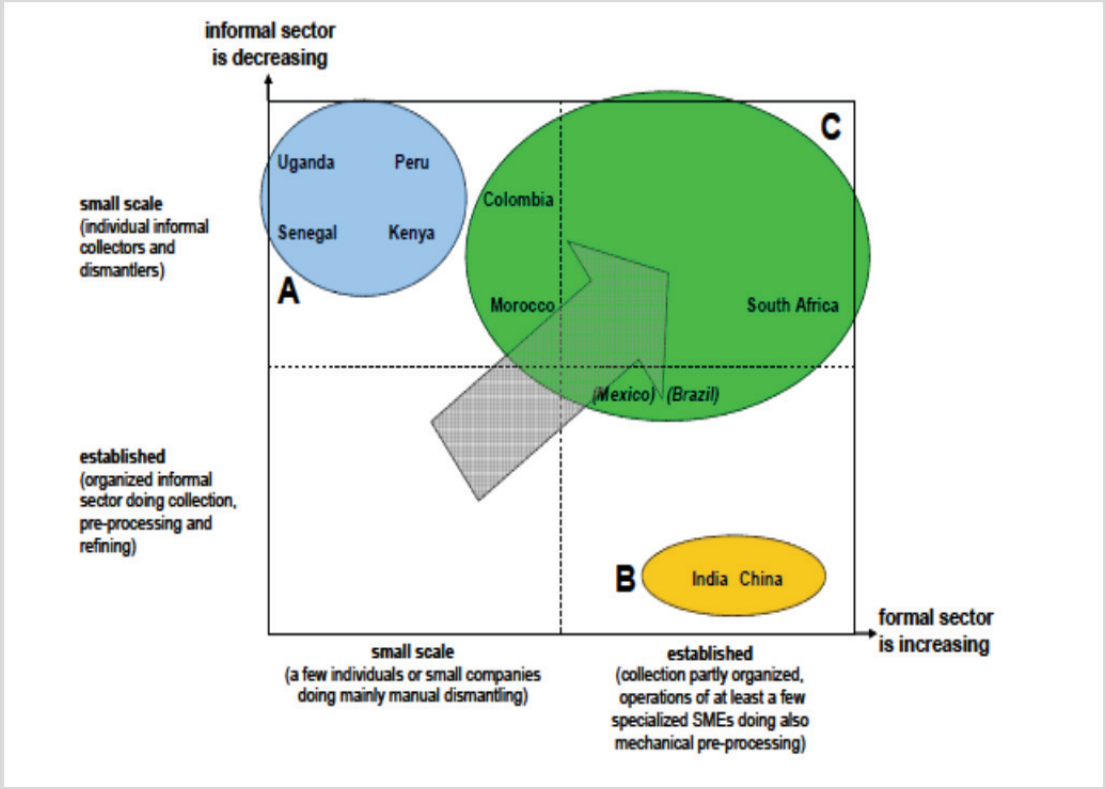
Despite the growing concern on e-waste management, the problem does not seem to be matched by development of mitigation strategies to handle the situation. One of the immediate strategies would be the development of collection systems, often referred to as the back bone of any successful e-waste management system.

UNEP conducted an assessment to establish the informal and formal processes in the e-waste recycling chain in selected developing countries and it emerged that the use of informal recycling should not presuppose lack of sustainability. In fact, informal collection systems were found to be rather efficient in countries like India and China because the daily informal collectors were able to penetrate each community and collect e-waste from house to house. The collectors were also able to get a reasonable pay and this in turn promoted a high collection rate, hence a model that was responsive to local needs for job creation[51].

While this model would be preferable for developing countries where labour cost is low and there is an available work force, a further analysis revealed that most sustainable recycling systems tended to be found where recycling schemes were formal[52]. It should therefore be noted that depending on the socio-economic context of a country, a sustainable recycling system could include a blend in an organized informal collection system.

The graphical depiction of the analysis was as below:

Comparative analysis of selected developing countries regarding the dimension of the formal and informal e-waste recycling sector.



Source: Recycling – From E-waste to Resources: Sustainable Innovation and Technology Transfer Industrial Sector Studies, UNEP, 2009

As shown in the illustration above, all developing countries selected featured a formal and informal e-waste recycling sector. The graph is divided into four quadrants representing different shares of the recycling market between the informal and formal sector. It emerged that a sustainable recycling system should grow towards the upper right hand corner of the graph, where most of the established recycling schemes in Europe and North America are currently located.

The report noted that with strong support in capacity building, technology and knowledge exchange, these countries would be able to strengthen their informal sector and move towards establishment of a formal sector with some capability of end-processing technology. Trade related issues also constitute a significant barrier to effective e-waste management.

E-waste from developed countries finds its way into developing countries in the name of free trade and further complicates problems associated with waste management[53]. It is difficult to estimate the quantum of transboundary e-waste streams, as this trade in e-waste is camouflaged and conducted under the pretext of obtaining 'reusable' equipment or 'donations' from developed nations. Often government trade data does not distinguish between imports of new and old computers and peripheral parts and so it is difficult to track what share of imports are used electronic goods. Some exporters may deliberately leave difficult-to-spot obsolete or non-working equipment mixed within loads of working equipment (through ignorance, or to avoid more costly treatment processes).

The trade related implications of e-waste have led to great co-operation on the international and regional fronts in an attempt to curb rising pollution, the waste of natural resources, and health problems associated with dumped electronics.

Unmarked shipments containing electronic waste make their way to Asia, Africa (Particularly West Africa) and other parts of the world that have little capacity to interdict illegal imports or safely recycle electronics at the end of the useful life[54]. These digital dumping grounds are located primarily in Ghana, Nigeria, Pakistan, India, and China[55]. In Lagos, while there is a legitimate robust market and ability to repair and refurbish old electronic equipment including computers, monitors, TVs and cell phones, local experts complain that of the estimated 500 40-foot containers shipped to Lagos each month, as much as 75% of the imports are "junk" and are not economically repairable or marketable. Consequently, this e-waste, which is a hazardous is being discarded and routinely burned in

what the environmentalists call "a cyber-age nightmare now landing on the shores of developing countries[56]."

It is for these reasons that the development of an effective e-waste management response cannot be complete without appreciating the policy and regulatory governance frameworks that exist at the global, regional and local levels to complement each other in various respects of enforcement and compliance.

The case of Agbogbloshie, a slum that lies on the outskirts of Ghana is illustrative of the trade related implications of e-waste. It is one of Ghana's largest e-waste dumps, with mountains of abandoned motherboards, computer monitors, and hard drives littering the landscape. Living conditions, amid black smoke and the stench of burning plastic are so harsh that locals have nicknamed it 'Sodom and Gomorrah'.

Agbogbloshie is a sad story about best of intentions gone awry. Functional second hand computers began arriving from the West to help 'bridge the digital divide'. Ghanaians welcomed these donations, because these computers cost 1/10th of a new one[57]. As the turnover rate of electronics increased, the once benevolent act of donating used computers became corrupted. Unsalvageable (outdated, broken, unusable) electronics started to be exported to Ghana in mass quantities. What had been an ad hoc development project quickly devolved into a scheme for companies in the West to send unregulated shipping containers, marked 'donations', as a means to get around national regulations and cheaply dump dangerous garbage into ill-equipped and extraordinarily poor rural villages[58, 59].

For Western industries which have strict laws controlling the disposal of e-waste, it is cheaper to ship outdated and damaged computers to developing countries under the 'donation' label than to properly recycle the electronics. As a result, Agbogbloshie's soil and water, have high concentrations of lead, mercury, thallium, hydrogen cyanide, and PVC.

Barriers to safe e-waste management

- Lack of public awareness on the need for an e-waste management system and consumer responsible behavior.
- Inadequate legislation
- Difficulty in inventorization
- Funding/sustainability
- Unhealthy conditions of informal recycling
- No data on quantity of e-waste generated and disposed off each year and the resultant extent of environmental risk
- Reluctance on the part of corporates to address critical issues
- Limited capacity of important government agencies to deal with e-waste
- Lack of co-ordinated approach across service providers and ministries to deal with e-waste.
- Limited support for local initiatives

Children scavenging at Agbogbloshie

Source: http://gvisionaries.wordpress.com/2011/05/02/digital-dumping-an-inside-look-at-e-waste/

1.6 Governance of e-waste management

One of the factors that play a significant part in determining the state of the e-waste management sector in a country is the existence of policy and legislative regime articulating the expectation and aspirations pertinent to e-waste management.

The lack of policy and regulatory frameworks, or the existence of disjointed and contradictory frameworks encourages illegal dumping of toxic e-waste and the handling of hazardous waste without safety and protection standards. The use of crude extraction methods exposes the handlers and the environment to unnecessary harms. This is typically the situation in developing countries where the e-waste recycling sector is informal and has no benefit of standards and structures that a regulatory framework would provide.

A governance regime provides the building blocks on which the transfer of skills and technology can be made. It will also determine the involvement of other players such as the private sector who are critical in provision of business and finance in setting up the necessary infrastructure. The role for the ICT regulator is, inevitably drawn to the spotlight as its recognition of e-waste management as a priority determines the commitment in developing a policy and regulatory framework going forward.

The regulatory authority is a custodian to ensure that there is compliance with standards. It is recognized that in different countries, one or more agencies could be called upon to act on the issue of e-waste depending on the structure in place. For example, South Africa, Botswana, Zambia, Zimbabwe among many other African countries have distinct ministries/government departments for ICT and environment, However, the regulator in charge of promotion of use of ICTs would be a critical actor in articulating policies and strategies for dealing with concerns arising after the end of life period of ICT gadgets and devises. It is recognized that there would need to be a good collaboration with related agencies to ensure visibility and scrutiny of all actors towards compliance with e-waste governance requirements.

While the momentum on how to handle e-waste is fairly established in developed countries in Europe, North America and Asia, it remains comparatively unexplored in developing countries. The initiation of this discussion at ITU is an indication that the e-waste dilemma is sitting at the door of the ICT regulator. This is evidence of the law of unintended consequences – markets are regulated to drive competition, giving users access to advanced ICTs; however the resulting proliferation of users and devices has negative effects on us and the environment.

It is timely to have this discussion so that it can prompt a responsible reaction on the role of regulators in enabling and promoting measures that would effectively handle the management of e-waste. Being a new area, this would call for support from ITU in collaboration with other international agencies such as UNEP or the Basel convention, in building capacity necessary to implement an e-waste regulatory framework at all levels – locally, regionally and internationally.

1.6.1 International level

Sector governance through a comprehensive policy and legislative framework lies at the heart of a sustainable e-waste recycling management strategy. This would aid the process of identification of the roles and responsibilities of various players in the sector at the local, regional and international level. The ultimate reflection of commitments made at the supra level would be through development of comprehensive legislation at the domestic level.

1.6.1.1 Basel Convention

The tightening of environmental regulations in industrialized countries sparked the genesis of multilateral environmental agreements (MEAs) as this situation led to a dramatic rise in the cost of hazardous waste disposal. Searching for cheaper ways to get rid of the wastes, "toxic traders" began shipping hazardous waste to developing countries and to Eastern Europe. When this activity was revealed, international outrage led to the drafting and adoption of the Basel Convention. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental agreement on hazardous and other wastes[60]. The Convention had 175 Parties as at April, 2011 and aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes. The Basel Convention came into force in 1992[61].

During its first Decade (1989-1999), the Convention was principally devoted to setting up a framework for controlling the "transboundary" movements of hazardous wastes [62], that is, the movement of hazardous wastes across international frontiers. It also developed the criteria for "environmentally sound management". A Control System, based on prior written notification, was also put into place.

New roles .... New questions

- Should the ICT Regulator play a role in encouraging its licensees to integrate e-waste concerns in their business strategies?
- What role should the ICT regulator assume in relation to e-waste management: facilitator, enabler, promoter, awareness raiser, enforcer?
- How should e-waste policies be designed so that they do not present a bottle neck to innovation, competition and universal access in the ICT sector?
- Which mode of regulation would be ideal to ensure achievement of the desired objectives?
- What should be the scope and extent of regulatory interventions that are designed towards effective e-waste management?
- How will the ICT regulator ensure that there is effective co-ordination with other agencies, such as the environmental agency, in relation to any interventions directed at compliance and enforcement of e-waste obligations?
- What role can ITU play in supporting and ensuring acquisition of relevant skills for implementation of an e-waste regulatory framework?

During The Second Decade (2000-2010), the Convention built on this framework by emphasizing full implementation and enforcement of treaty commitments. The other area of focus was the minimization of hazardous waste generation – both in terms of quantity and hazardousness.

The Basel Convention contains specific provisions for the monitoring of implementation and compliance. A number of articles in the Convention oblige Parties (national governments which have acceded to the Convention) to take appropriate measures to implement and enforce its provisions, including measures to prevent and punish conduct in contravention of the Convention. Each party to the Convention is required to report information on the generation and movement of hazardous wastes.

The 2002 Strategic Plan for the Implementation of the Basel Convention has been recognized as a key pillar in giving effect to environmentally sound management of hazardous and other wastes until 2010.There is still much to be done in realizing the full effect of the Basel Convention, particularly for developing countries and economies that are in transition. These challenges stem from the difficulties experienced by developing countries in regulating the import of e-waste among a wide spectrum of actors – both domestically and abroad – coupled with high costs of creating an infrastructure capable of enforcing the proper disposal of e-waste[63]. As a starting point, countries that have not ratified or become signatories to the Convention could examine the possibility of becoming parties to it.

The listing of Parties and Signatories is available at www.basel.int/ratif/ratif.html.

The continued growth of the ICT sector is influencing the movement of issues pertaining to e-waste from the periphery to the center of policies related to ICT and sustainable development. This movement is a reflection of a new awareness particularly in developed countries that have over the years worked on mechanisms to harness the situation. The lack of preparedness for developing countries highlights the plight they are in because e-waste is growing and encroaching uncontrollably every day.

In recognition of this, the Nairobi Ministerial Declaration on the environmentally sound management of electronic and electrical waste was passed during the 8th Meeting of the Conference of the Parties to the Basel Convention held in Nairobi, Kenya from 27 November-1 December, 2006. The declaration, recognizing the lag of enforcement by developing countries sought to re-emphasize the need to co-operate and provide creative innovative solutions to bridge the developmental gap. This subsequently led to the adoption by the 9th Conference of the Parties to the Basel Convention of the Work Plan for the Environmentally Sound Management of E-waste, focusing on the needs of developing countries and countries with economies in transition.

An extract of the Declaration is provided below.

Focus areas of the Basel Convention

- Prevention, minimization, recycling, recovery and disposal of hazardous and other wastes, taking into account social, technological and economic concerns;
- Active promotion and use of cleaner technologies and production methods;
- Further reduction of movement of hazardous and other wastes;
- Prevention and monitoring of illegal traffic;
- Improvement of institutional and technical capabilities -through technology when appropriate – especially for developing countries and countries with economies in transition;
- Further development of regional centres for training and technology transfer;
- Enhancement of information exchange, education and awareness-raising in all sectors of society;
- Cooperation and partnership with public authorities, international organizations, industry, non-governmental organizations and academic institutions;
- Development of mechanisms for compliance with and for the monitoring and effective implementation of the Convention and its amendments.

Nairobi Declaration[64]

Concerned about the risk to the environment and human health arising from international traffic in e-waste to countries, in particular to developing countries that do not possess the capacity for the environmentally sound management for such e-wastes,

1. *Declare:*
   a) That we shall promote awareness at all levels on the issue of e-waste, challenges and solutions;
   b) That we shall encourage and promote exchange of information and transfer of best available technologies for the environmentally sound management of e-waste from developed countries to developed countries and countries with economies in transition;
   c) That we shall encourage national, regional and global comprehensive actions for the environmentally sound management of e-waste, and end-of-life equipment, through shared responsibilities and commitments from all concerned stakeholders;
   d) That we shall improve waste management controls through the establishment of robust national policies, legislation and diligent enforcement, including producers' and traders' responsibilities as well as take-back and recycling schemes and their targets;
   e) That we shall prevent and combat illegal traffic of e-waste, taking into account the benefits accrued through harmonization of national laws at the regional level;
   f) That we shall develop and consolidate national, regional and international cooperation and programmes or initiatives to support the implementation of activities aimed at the environmentally sound management of e-waste utilizing, as appropriate, the Basel Convention region centers;

1.6.2 Regional level

With the creation of political federations, economic trade areas and common markets, the need to articulate regional issues on a common platform has gained currency over the years. The European Union (EU) is probably the most distinguished in this regard, requiring member stated to pass on regional directives into their national laws for compliance and enforcement.

1.6.2.1 Directives on Waste Electrical and Electronic Equipment (WEEE)

While most MEAs focus on the proper disposal and transportation of e-waste, WEEE and Restrictions of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations (RoHS) are partner Directives focusing on minimizing the source and creation of e-waste by banning certain hazardous chemicals and shifting the costs and responsibility of e-waste disposal to industry through the concept of Extended Producer Responsibility (EPR)[65].

Through EPR, industry is expected to establish an infrastructure for collecting WEEE, in such a way that "Users of electrical and electronic equipment from private households should have the possibility of returning WEEE at least free of charge". Also, industry is compelled to use the collected waste in an ecologically-friendly manner, either by ecological disposal or by reuse/refurbishment of the collected WEEE.

RoHS restricts the use of mercury, lead, hexavalent chromium, cadmium and a range of flame retardants notably polybrominated biphenyls and ploybrominated diphenyl ethers in electrical and electronic equipment. The only exemptions for use of these hazardous substances are where alternatives do not presently exist. There are also permissible maximum concentration values which allow for any trace presence. Given the scope of RoHS, it assigns responsibility to manufacturers, assemblers and importers of electrical and electronic equipment[66].

These Directives apply to products placed on the European market and each member state was required to transpose their provisions into national law by 13th August, 2004.

1.6.2.2 The North American Agreement on Environmental Cooperation

The Commission for Environmental Cooperation (CEC), is an international organization established by the United States, Canada, and Mexico under the North American Agreement on Environmental Cooperation (NAAEC) to complement the North American Free Trade Agreement (NAFTA).

Since its creation in 1994, the CEC has advanced dialogue and understanding of trade-environment linkages; increased government accountability regarding enforcement; achieved substantial results on key North American issues such as chemicals management and the conservation of North American biodiversity; and built substantial environmental capacities. The North American cooperation addresses issues of illegal movement of e-waste and also contributes to more effective enforcement at the domestic level in the region.

Currently, projects specific to e-waste relate to: Recycling metals and plastics within Small and Medium Enterprises (SMEs), E-Waste Intelligence Sharing to enhance enforcement and Studying trade flows of Used Electronics in the region. The latter project goal is to improve the understanding of the trends of e-waste and used electronics coming into North America and those being exported to the rest of the world. Thereafter an electronic system for exchanging information on the transport of hazardous wastes and hazardous recyclable materials in North America will be completed[67].

Worth noting in this example is the pooling of synergies at a regional level to tackle issues of commonality. This would be a critical learning item for regions yet to implement e-waste management mechanisms as some aspects of e-waste management are easier to achieve through regional cooperation due to huge financing requirements, extensive compliance and enforcement requirements etc.

1.6.2.3 Durban Declaration on e-waste management in Africa

The Durban Declaration was the outcome of an e-waste workshop held during WasteCon 2008 in Durban South Africa. Based on the sharing of experiences from Kenya, Morocco, Senegal, South Africa and Uganda, it recognized the need to escalate awareness among stakeholders about environmental and health issues related to recycling and disposal practices of e-waste[68]. It also recognized the need for every country in Africa to initiate its own internal process that would define a road map related to specific e-waste management objectives. While this Declaration does not qualify as a multilateral agreement, it does demonstrate the beginning of a 'meeting of minds' on an issue which is a great catalyst to drive a regional dialogue towards implementation of e-waste management best practices.

1.6.3 Domestic level

As a carry forward of commitments made at the international and regional level, there is need for an e-waste policy and regulatory environment at the domestic level that encourages investment right through the ICT value chain to ensure minimization of the waste and environmentally safe disposal.

Many jurisdictions do not have any dedicated legislation dealing with e-waste such as India, Brazil, Mexico, Colombia, Kenya and South Africa. At best, the issue of e-waste management is covered in disparate legislation on issues of environment, water, air, health and safety, municipal waste and hazardous waste[69]. The lack of a focal custodian means that there is no one agency dedicated to this issue, resulting in inertia, inordinate delays in formulation of the much required regulatory frameworks and lack of uniformity in enforcement. Government, however, is ultimately responsible for enforcement through mandatory regulations that serve the purpose of controlling and monitoring, setting of goals, and establishing enforcement rules[70].

Earlier studies have indicated a significant correlation between legislative activity and constraints in landfill capacity, such as in Western Europe[71] and Asia[72] and in Australia[73]. Japan and Taiwan, China face similar problems with Japan's landfill capacity having been estimated to be zero by 2008[74,75,76]. Could the existence of open spaces in many developing countries be the source of comfort?

Source: www.flickr.com

The limited capacity in government agencies coupled with lack of a coordinated approach means that visibility of the actors to the legal requirements is low, and at worst lost. The issue of e-waste management continues to be absent from the political agenda in many countries due to this dispersion of effort, at a time when it should be in the fore front. The knowledge and expertise resident with ICT regulators would play a key role in shaping and driving the dialogue on e-waste. The regulator would also be able to ensure a responsible balance between the push for ICT access and disposal of ICT components and gadgets.

1.7 Role of legal reform

In the last two decades, significant technological developments and correspondingly rapid social and economic changes have been experienced in the ICT sector. Largely, the changes have been positive and are to be celebrated. There are however new challenges that have come with this new prosperity that have exacerbated tensions in government institutions ill prepared to cope and put increased pressure on the regulatory frameworks that did not quite anticipate the emerging challenges. This unfolding scenario presents the ICT Regulator with a frontier for legal reform in the area of e-waste management in order to ensure that its regulatory framework remains responsive to emerging needs in society.

All regulation is ultimately about encouraging and reinforcing good behavior or penalizing and deterring bad behavior. This can be achieved through various means, formal and informal with varying degrees of informality and enforceability. Interventions can be supported with a range of incentives, penalties and sanctions designed to steer behavior towards the desired direction.

1.7.1 Formal and informal regulation

In the absence of strong legislative practices, voluntary actions appear to guide waste management – both at global and national levels[77]. Statutory law is very formal and mandatory in nature. It is normally enacted by a legislature or other governing body before it becomes operational. The mandatory nature allows for achievement of certain defined public policy goals and backs up non-compliance with penalties[78]. It is often the means used where informal voluntary efforts are not enough in achieving the desired regulatory goals. Informal measures come in many forms and can be supported with varying levels of formal interventions.

Formal regulation Statutory law	
Advantages • Mandatory, non-negotiable • Has access to immediate adverse consequences in the event of non-compliance • Allows a government to communicate a clear and consistent signal to its target	*Disadvantages* • Could stifle innovation if construed too strictly • Vulnerable to being overtaken by events as sometimes law reform can take a long time.

Informal regulation Code of practice, code of conduct Key performance indicators Targets Voluntary agreements Guidelines Industry labels Best practice information Public consultation, publication, information and education	
Advantages • Less formal, can be changed from time to time to accommodate changing circumstances • Can influence introduction of corporate social responsibility programmes to deal with e-waste	*Disadvantages* • If the parameters keep changing, it can lead to confusion in the targeted audience • Due to informality, it relies on good will or peer pressure to achieve desired outcomes. It is therefore prone to free riders who can seriously hamper the achievement of the desired objectives • Because of the impact on human health and the environment, e-waste cannot be left to voluntarism. It is a national priority and should be regarded as a key consumer awareness issue. • Sometimes can be implemented to pre-empt legislation or avert a regulatory threat without the intention to really achieve goals • Voluntary business practices tend to be the exception rather than the rule • The success of informal regulation is very dependent on the existence of industry associations, commitment by members, ability to generate industry solutions which factors may not be present or consistent • Self regulation on its own hardly provides sufficient credibility to the system

From the tables above, the scales seem to tip in favour of formal regulation. The existence of e-waste is a symptom of deviant behaviour in a market economy – whether it be illegal importing, polluting recycling or poor product design and it needs to be corrected at any rate.

A study on dissemination of DfE in Europe shows that "regulations are the main driver for eco-design activities" [79]. Further research indicated that the conclusion and implementation of the most successful covenants, a flagship of the voluntary approach, would not be possible without a so-called 'regulatory threat' and observes that the anticipation of upcoming legislation can be just as powerful as actual mandatory requirements in stimulating improvements.'[80].

While each form of regulation can be supportive of the other, the growing concern on e-waste and the need to allocate obligation on users and manufacturers, would call for statutory interventions for enforcement to be successful. Statutory intervention is able to leverage itself in achievement of strategic transformation by enabling the ICT regulator steer growth and innovation in the sector in a sustainable direction. Unless there is statutory direction on e-waste management, there is a high likelihood that the ICT sector will adopt a 'wait-and-see' strategy, hence compounding the problem.

It is however worth noting that even in countries where legislation had been developed, the success has been mixed. For instance, despite all legislative efforts to establish sustainable e-waste recycling in many developed countries such as the UK and the US, there is evidence of weaknesses in implementation. That explains why investigative reports by UK media houses tracked electronic devices belonging to the UK's leading public institutions including local councils, the police department and health services in dumping sites in Ghana and Nigeria[81]. In August 2008, a scathing report was issued against the EPA, indicating that large amounts of e-waste collected in the United States were still ending up in China and India[82]. A study by UNEP analyzing policy and legislation mechanisms to assess barriers for sustainable e-waste management in eleven countries (South Africa, Kenya , Uganda, Morocco, Senegal, Peru, Columbia, Mexico, Brazil, India and China)

showed that no country – with the exception of China, which has a low record of implementation – has dedicated policy and legislative mechanisms to deal with e-waste[83].

In addition, it is also noted that most developing countries do not have strong industry associations that are capable of implementing informal regulation with the commitment and adherence of all their members. It therefore demonstrates that informal activity will be ridden with loopholes and therefore be incapable of credibly administering an e-waste management strategy. It is with this in mind that the next section will discuss the concept of extended producer responsibility and propose that countries consider its adoption into their e-waste regulatory frameworks.

1.7.2 Extended Product Responsibility (EPR)

Increased environmental awareness is contributing to new government regulatory measures that address disposal of electronic waste. EPR is a concept that is increasingly being adopted into legislation. It is a strategy designed to promote the integration of environmental costs associated with goods throughout their life cycle into the market price of the products[84]. EPR may take the form of a reuse, buy-back (take-back), recycling or disposal program, or in energy production from waste materials.

Also known as product stewardship, EPR uses financial incentives to encourage manufacturers to design environmentally-friendly products by holding producers liable for the cost of managing their products at end of life. This strategy attempts to relieve local governments of the costs of managing certain products by forcing manufacturers to internalize the cost of recycling within the product price. EPR promotes that producers (usually brand owners) have the greatest control over product design and marketing and therefore have the greatest ability and responsibility to reduce toxicity and waste [85] One of EPR's main objectives is not only to mitigate harmful environmental impacts at the end-of-life of a product, but to do so by influencing the product design process. In response to legislated producer responsibility, methodologies have been developed which incorporate a form of environmental consciousness at product design stage[86,87,88].

The most direct form of EPR implementation is take-back legislation, where the producer may be required financially and sometimes physically to reduce the environmental impact (i.e. handling and disposal of waste)[89]. The producer may also choose to delegate this responsibility to a third party called a producer responsibility organization (PRO), which is paid by the producer, for spent-product management. In this way, EPR shifts responsibility for waste from government to private industry, obliging producers, importers and/or sellers to internalize waste management costs in their product prices and ensuring the sustainable and safe handling of the remains of their products[90,91]. The producer responsibility arrangement can vary from fully private models to publicly funded ones, sharing operational and controlling aspects at different levels[92].

Mobile Cashmate, UK is registered as an Approved Authorised Treatment Facility (AATF) to facilitate re-use or recycle of electronic equipment in compliance with the EU Directive

Source: news.mobilecashmate.co.uk/

The goals of take-back laws are to:

1. encourage companies to design products for reuse, recyclability, and materials reduction;
2. correct market signals to the consumer by incorporating waste management costs into the product's price;
3. promote innovation in recycling technology[93].

The greatest take-back activity has been in Europe, where government-sponsored take-back initiatives arose from concerns about scarce landfill space and potentially hazardous substances in component parts. Although the United States does not currently have a national law or policy requiring producer responsibility, 25 states have already passed laws requiring producer responsibility and many others are currently working towards passing producer responsibility laws[94].

Advantages of EPR

When producers are held directly accountable for their products end of life impact or recycling under EPR through a financial or physical burden, they become more responsive to design more sustainable, less toxic, and easily recyclable electronics[95,96,97,98]. They tend to use fewer materials and design their product to last longer in order to cut costs[99,100]. EPR has the potential to alter the industry standard of planned obsolescence by encouraging a longer life to reduce overall cost of production and recycling[101]. EPR's can also extend from product design to research and development for better ways to recycle and reuse[102,103]. An immediate direct benefit of enactment of take-back legislation would be reduction of waste in landfills[104].

Disadvantages of EPR

Due to the complexity of electronics, the problems of disassembly of parts to be re-used and their quality and durability for re-use are a concern[105]. The need to develop an elaborate collection mechanism, particularly for large items such as computers, coupled with more sophisticated methods of recycling due to heavy metals used, could increase the cost of electronics for consumers because producers would be adding recycling costs into the initial price tag of items. It has also been argued that the obligations imposed by EPR would slow technical innovation and impede technological process. In countries where take-back is ran on a voluntary platform, it can encourage free riders, which places companies that act most responsibly at a disadvantage[106].

The greatest challenge of implementing EPR is the requirement for sustainable financing for a collection mechanism. Where responsibility of a product is shared between many producers, the assignment of EPR along the value chain gets complicated[107]. In developing countries, the EPR requirement would extend to importers since most of the electronic goods sold are imported. International companies would therefore have to factor the implications of EPR within their distribution channels.

1.7.3 Financing

Significant resources would be required to implement an e-waste regulatory framework due to the extensive compliance and enforcement requirements to be met. The need to establish formal collection systems locally and facilities for treatment of complex e-waste material within regions would demand considerable investments in advanced technologies and the requirement for a highly skilled work force.

Challenges to implementation of EPR

- Trade problems
- Producer definition
- Collection logistics
- Assignment of financial responsibilities
- Free riders
- Identification of responsible producer for some items
- Retroactive legislation

The financing mechanism of e-waste is not clear particularly for developing countries where ICT goods are imported through third parties, making it difficult to implement EPR. Due to this unstructured method of supply, how best should a sustainable funding mechanism be designed?

The lack of e-waste policies in developing countries could be an early indication on the lack of clarity as regards who should bear the cost of responsibility in e-waste management – is it the consumer, producer, service provider, municipal authority or the government?

There is however a need to balance the push for access to ICTs with the practicality of harnessing the resultant e-waste which is the dark side of this innovation, in a manner that is sustainable. Yet the implementation mechanism must be robust enough to support formalization of collection systems, establishment of treatment facilities and enable co-operation at regional and international level where transboundary enforcement issues are handled.

From a general perspective, three main stakeholders have been identified as potential bearers of responsibilities for managing e-waste and could be used to inform the financing model going forward[108]. These are producers, consumers and the government.

A 'front-end' mechanism as a basis for a financing model would be informed by the producer responsibility principle. This would entail increasing sales prices and reducing sales margins in order to absorb the cost of managing e-waste. It must however be recognized that the current producer responsibility principle across Europe has not always been an incentive to collect more, simply because stakeholders responsible for financing have no economic benefits.

The 'polluter pays' principle can be extended to consumers with the justification that they are the cause of e-waste through consumption and should therefore pay for its management. This mechanism is workable through the designing-in of additional funding through advance recycling fees on all ICT products. This 'back-end' financial mechanism has been found to be a prudent source of finance from actors at the point of retail sale for final consumption where there is both the ability and the willingness to pay[109].

However, while this would generate a proportionate revenue stream dedicated to recycling, it would raise the cost of products (whose price has probably already been subsidized through tax waivers and rebates in developing countries) thus making them inaccessible. This in turn could fuel a grey or black market for used EEE from elsewhere. In addition, the enforcement requirement in markets with unstructured importation might be difficult to achieve due to non-documentation of points of sale which renders them 'invisible' as a back-end fund collection mechanism, leading to weak fund collection potential.

Both these 'front' and 'back-end' models are constrained in terms of bearing the cost of handling historical cases consisting of existing e-waste and electronic products in the market with no recycling obligations attached. As long as illegal imported e-waste continues to arrive into developing/transition countries, allocation of financial responsibility would be a complicated issue and may force government to step into the gap. The problem of historical and orphan products cannot be resolved in an ex ante fashion as the products had already been placed on the market and their producers have subsequently disappeared before the establishment of any financial mechanisms[110]. Where it is not possible to identify producers for free rider products, should the identifiable producers bear the cost of the free riders proportionately, based on the present market share? It would therefore appear that, these mechanisms utilized in isolation, would fall short in addressing the e-waste realities on the ground.

As e-waste is a societal problem and it has long-term environmental impact, its management could be effectively regulated by public policy mechanisms. Government would therefore come in as a veritable stakeholder to oversee e-waste management financed by tax. This funding model would be a complementary mechanism to either one of the two models discussed earlier. It would also bear the costs of free- riders such as e-waste from no-name products, historical and orphan products, illegally dumped e-waste and branded products that "escaped" at the point of sale. As no-name products tend to be cheaper, they might easily comprise a significant market niche and hence a considerable proportion of e-waste in developing countries.

Certain questions become pertinent in addressing the issue of financing in a developing country context:

Questions in relation to e-waste financing mechanisms

- What is the proportion of products in the market whose producer is identifiable/not identifiable?
- Is the market being supplied with branded products, no-name products or refurbished products from elsewhere?
- Are the supplies being put on the market by their manufacturers or by third parties?
- Is it possible to identify the front-end point of sale eg. Sales over the internet and harness it for enforcement purposes?
- Is illegal WEEE imported into the country?
- Which design of e-waste management best suits the local situation: producer led or centralized, with the ICT regulator?

In general, most studies find that a combination of a front-end tax and a subsidy for recycling is an effective way to provide economic incentives for design improvements while guaranteeing high utilization of product and material quality which are cornerstones of effective e-waste management.[111].

With e-waste considerations moving to the center of design of ICT policy, it will ensure that there is an attempt to balance ICT access with interventions to handle e-waste in a sustainable manner. This shift will lead to the ICT regulators, particularly in developing countries, acting on the issues of e-waste to meet boarder public policy goals. In this regard, could universal service funds that are dedicated towards development of the ICT sector also be used to provide complimentary financing to implement e-waste management strategies?

1.8 Critical aspects in the development of a roadmap for management of e-waste

The adoption of a carefully thought through roadmap as a guide in the achievement of the various policy objectives, can be a resourceful reference point in terms of progression in the short, medium and long term.

1.8.1 Identification of Stakeholders

In executing its mandate through implementation of its regulatory framework, the ICT regulator ought to know its stakeholders. This would enable identification and create visibility for all actors on the e-waste value chain to state scrutiny for regulation of standards and monitoring for quality assurance of processes.

The ICT sector however presents a stakeholder profile that is not clear cut, calling for a careful analysis. The sector has been described as *"a fluid and ever changing ecosystem, (which includes) individuals, fixed and mobile network operators, internet service providers, chipset design firms, device manufacturers, application developers, content owners and infrastructure providers."*[112] To this category, it would be justified to add broadcasters and satellite providers. In addition, importers of ICT equipment running SMEs, recipients of donations of ICT products, government agencies, informal recyclers, service providers, scrap metal dealers and customers using ICT products and services would rightly find their place in this category.

This fluid mix of stakeholders creates a dynamic challenge for the ICT regulator. For example, SMEs import a lot of computer hardware and software into developing countries. Many lack distributor linkages with the manufacturers of the ICT products, making it difficult to allocate responsibilities like EPR. Such SMEs are subject to general corporate laws such as company and tax law. How would the ICT specific obligations be extended to such an SME and be monitored for compliance as they are also part of the e-waste value chain?

A close interaction and communication among stakeholders will foster partnership which is necessary to achieve overall efficiency. In this respect, it is envisaged that the regulator would be identifying stakeholders at three levels:

a) Those directly involved in the e-waste value chain and come under the scrutiny of the ICT regulatory framework. These are mostly licensees.

b) Those who are directly involved in the e-waste value chain but fall outside the regulatory scrutiny of the ICT regulatory framework. These include actors like importers and recipients of donated ICT goods.

c) Those who while not directly in the value chain, have ability to significantly influence the e-waste agenda such as government agencies (handling environment, air, health and safety, importation, taxation, education), informal recyclers and scrap metal dealers.

A deliberate attempt by the regulator to carry along its stakeholders through information, engagement and feedback allows for dialogue that is proactive and supportive of each other, a desirable situation when tackling an issue that calls for multiple solutions by multiple players such as this one. This also allows for a sharing of experiences and models that have worked elsewhere, as the ICT sector enjoys a fair share of stakeholders with international operations.

A typical selection of actors would include state actors (government agencies handling policy, regulation, standard setting, municipal authorities), Private sector (manufacturers, suppliers and importers), civil society such as donation recipients and consumers.

1.8.2 Compliance

The ICT regulator is mandated to guard adherence to standards and responsibilities in order to uphold the governance standards set out. This can be particularly challenging where different compliance parameters are monitored or measured by different agencies. While partnership and collaboration is encouraged at all times, the reality on the ground can sometimes point to agencies having varied levels of technical resource capacities, activity schedules and outright territorial rivalry which make it difficult to conduct joint or coordinated exercises. With the continued growth of the ICT sector, e-waste recycling will have to take center stage for sustainability to be achieved. Can this be achieved in the present circumstances?

In implementing compliance standards, it may be necessary to phase the approach into three categories:

1. e-waste that is already in-country;
2. e-waste that is anticipated in form of legal expected imports of ICT equipment and
3. e-waste arising from illegal dumping.

Each category, while complementing the other calls for engagement of different strategies, actors and resources. Should developing countries adopt a piece meal approach opting for one strategy at a time or should they adopt a gradually progressive approach tackling all categories at the same time?. The ICT regulator could effectively re-define the e-waste landscape in a country that adopts the broad scope of office, information and communication equipment set out in the EU Directive. By requiring that equipment in this category be submitted for type approval, this move alone would signal to manufacturers and importers on raised standards on a much wider array of EEE, rather than the handsets and mobile phones that have been traditionally presented for type approval.

One emerging issue is that a pool of skills on handling and inspection of EEE is urgently required within the ICT regulator in order to boost compliance and enforcement and facilitate collaboration with other agencies e.g. Customs, where required. Facilitation of such skills at regional level by lead agencies such as ITU would enable adoption and effective implementation of e-waste management strategies.

The emerging situation prompts the need for conducting an urgent situational analysis of ICT regulators in developing countries with a view to assessing their capacity to handle e-waste. The outcome would generate different solutions for different countries, with some strengthening skills within the regulator and others pursuing collaboration with other agencies in a more concerted manner. There is no one size solution for all and countries would be encouraged to conduct individualized case by case assessments.

Compliance success can happen if stakeholders are made aware of the critical issues and encouraged towards self-assessment. For example, agencies concerned and manufacturers would need certainty about the actual performance of recycling operations in achieving resource efficiency and environmental compliance, so that producer responsibility obligations are fulfilled by respective parties. It would however be the role of the ICT regulator to exercise leadership in ensuring that information awareness and sensitization on pertinent issues is maintained at all times.

1.8.3 Enforcement

The efforts to improve any situation through regulations, though an important step, are usually only modestly effective if there is lack of enforcement. Provisions for fines and penalties are only half the story as they only specify the penalty for non-compliance but not the probability of being caught. In the event of non-

compliance with the legal requirements, it is the role of the regulator to take firm action in ensuring that necessary mechanisms are put in place to oblige compliance or remove the discordant actor from the sector. Enforcement can present a challenge if the regulator lacks specialized measuring and investigative (monitoring) tools. Reporting obligations should also be in place to reinforce enforcement.

Inadequate staffing capacity or unethical practices and corruption can also hamper successful enforcement. Due to the long delay in amending laws, the penalties provided for breaches can sometimes be so low that they do not act as a deterrent to the commission of the offence. It is therefore the role of the regulator to ensure that it pursues legal reform continually and upholds legal requirements in order to avoid being labeled a 'toothless bulldog'.

Given the significant harms that inappropriate handling of e-waste can pose, there should be political recognition and support at the country level of the need to equip the regulator with all resources that are required (financial, technical, capacity) to enable it respond to the emerging issue of e-waste.

The prominence of the role that trade related issues play in barring effective e-waste management needs to be emphasized as an enforcement concern. Countries that allow the import of e-waste for recycling should close their borders to this trade as e-waste should be treated as close as possible to the place where it is generated. Enforcement success would require that countries that export collected e-waste halt this practice too. The ICT regulator would need to partner with customs to halt this illegal traffic by having clear guidelines which distinguish the various categories of EEE. A more severe measure would be to ban all imports of used EEE into the country, irrespective of use.

1.8.4 Awareness and capacity building

The discussion so far recognizes that the e-waste management issue calls for multiple solutions by multiple players. Activities aimed at sensitization and awareness creation therefore take center stage in not only providing information, but also providing opportunities to transfer knowledge. They provide opportunities to exchange information on best practices and lessons learnt with a view to enabling articulation of practical solutions to the problems caused by e-waste in a particular local context. Incorporation of information from different actors would help with development of an integrated vision and enable implementation of a sustainable e-waste management strategy that takes all major interests into account.

Consumers of electronic products are the dynamo that drives ICT markets and innovation. At an individual level, they have a responsibility to buy smart, use right, and at the end of the equipment's useful life, to dispose well. Collectively, they have a responsibility for critical awareness, action, solidarity, empathy and maintaining a healthy and sustainable environment. Awareness on their part would be critical in driving the development of responsive policy and regulatory frameworks at the domestic level. Concerted consumer action would ensure implementation and follow-up, which often lack, leading to good laws but no actual results.

With awareness and appropriately directed capacity building initiatives to the spectrum of actors at state level, private sector and civil society, the necessary critical mass will have been developed to drive the e-waste management roadmap forward.

1.9 Policy and regulatory recommendations

"If we develop and apply ICT badly, it could add to the world's problems. It could devour energy and accelerate climate change, worsen inequality for those who do not have access and increase pollution and resource use by encouraging ever more frenetic consumerism. If we apply ICT well, the rewards could be enormous. It could help to enhance creativity and innovation to solve our problems, build communities, give more people access to goods and services and use precious resources much more efficiently. We have the capacity – through our decisions on how we produce, buy, use and apply ICT – to secure enormous social and economic benefits."

Forum for the Future[113]

Despite being parties in MEAs like the Basel Convention, many developing countries have not been very successful in translating these commitments made at the international level into their domestic legislative frameworks. Because of these regulatory gaps, they continue to experience challenges in regulating the import of e-waste from a wide spectrum of actors – both domestically and abroad. They are also faced with high costs of creating an infrastructure capable of enforcing the proper collection and disposal of e-waste.

Checklist for development of a roadmap for management of e-waste

1. Are you a signatory to the Basel Convention?
2. Has an assessment of the e-waste generated in your country been undertaken?
3. Have stakeholders been identified?
4. Has a strategy/roadmap for e-waste management been formulated?
5. Do you have an e-waste policy?
6. Do you have a domestic regulatory framework on sound management of electronic waste?
7. Has a vulnerability assessment of the e-waste regulatory framework been undertaken?
8. Is there a specific agency mandated to handle the management of e-waste? OR
   If there are a number of regulatory agencies with responsibility of various aspects of e-waste, is there a defined framework for co-operation?
9. Have you identified some aspects of e-waste management in-country which can be handled through co-operation with other countries at a regional level?

An effective proposal on response to the e-waste problem calls for a clear allocation of roles and responsibilities between several actors as well as identification and implementation of a policy mix of interventions, which must be adapted to the local context as much as possible. Unless a policy is tuned to match the social, technological, economic and political contexts, it is likely to result in inappropriate implementation with synergies being lost and counterproductive outcomes being observed. As such, the exact allocation of roles and responsibilities and policy choices are very dependent on particular local circumstances.

1.9.1 Harmonization

Even where attempts have been made to benchmark with exemplary regional best practice, the level of adoption and implementation varies. For example, the manner in which EPR for WEEE is transposed into legislation and its subsequent implementation differ from country to country, particularly in its scope (the entire WEEE categorization or part thereof), range and type (collective *vs* individual responsibility) and funding mechanisms (financial responsibility and its point of imposition)[114]. This scenario will present some operationalization anomalies within regions when for example, broader cooperative efforts towards enforcement of import of hazardous substances would net the wrong type of equipment due to differing classification, or worst still be hampered in regions that have no provision for financing mechanisms.

This section proposes that there are aspects of e-waste management that can be handled at the regional level, particularly in regions that have nascent or non-existent governance frameworks for e-waste. Evidence has already been provided of regional efforts in Europe and North America that have realized significant gains. The following aspects are proposed for consideration and implementation on a regional level.

1) Establishment of regional e-waste cooperation mechanisms

The success that has been realized through cooperation in regions that have established e-waste management systems has been recognized. Borrowing a leaf from the examples given of the EU and North American cooperation, the establishment of a dedicated regional e-waste cooperation mechanism would enable the advancement of dialogue and understanding on e-waste concerns per region.

Regional co-operation mechanisms would provide a focused platform to deal with issues such as illegal movement of e-waste and trade-environment linkages. It would also contribute to more effective enforcement at the domestic level in the region. Introducing a system of type approval and type acceptance of ICT EEE within a region would ease the individual burden of approval per country and also hasten the scrutiny of equipment in this category for compliance with agreed guidelines. This would be a critical stepping stone for regions yet to implement e-waste management mechanisms as these might be easier to achieve through regional cooperation due to availability of

technical support, huge financing requirements, extensive compliance and enforcement requirements etc.

The need for co-ordination by ICT regulators over the management of e-waste at the regional level would add to the urgent and growing list of issues to be handled through regional regulatory associations.

2) Harmonization of policies and legal frameworks within regions

Harmonization would allow for an approximation of principles and still afford the ability to address local situations in domestic laws for implementation. Development of regional guidelines led by ICT regional regulatory associations would greatly assist in overcoming technical capacity challenges at country level and in this way hasten the emergence of regulatory frameworks at the domestic level.

Countries within the same region will tend to have similar experiences which will allow for a platform on which to develop an approximation of guidelines addressing solutions to the challenge of e-waste. At this level, it will be possible to provide indicative direction on establishment of a collection infrastructure, ownership models and financing mechanisms.

Approximation will allow a country when establishing its collection infrastructure, for example, to address issues of employment in determining how to integrate the informal collection mechanisms at various levels. It also allows the country to structure the ownership of collection facilities at various levels, ranging from public ownership, such as in Taiwan, China where the government owns and operates collection facilities, to models where government only provides subsidies such as in California, USA or loans to induce the establishment of private facilities such as in China[115].On the other hand, the country could opt for the design of a legal framework and leave it to producers to develop the necessary facilities. This is the model used in the EU, Japan and the Republic of Korea.

The beauty of harmonization at regional level is recognized due its capacity to fast track development of regulatory frameworks and implementation mechanisms. It also brings the expert role of the ICT regulator and ITU to the fore in interpretation of local subtleties against best practices – necessary considerations – as countries tailor their policy mix to address their local contexts.

3) Consideration for establishment of mechanical pre-processing within regions

A regional approach in treatment of complex e-waste material would be a worthwhile value proposition due to the considerable investments in financing, advanced technologies and the requirement for a highly skilled work force.

Regional efforts would contribute significantly in helping design a regulatory framework that is holistic in dealing with e-waste management. This would entail multi-pronged strategies that seek to handle both proper disposal and transportation of e-waste and the reduction of creation of e-waste by banning certain hazardous chemicals. The challenge can be met considering that in developing countries, the share of historical products is still low and the share of non-branded products is often overestimated[116]. Formalization of part of the informal sector is a must; however low-risk operations like collection can be left in part to the informal sector[117].

1.9.2 Standards and certification

International agreed standards can provide a unique framework to control, limit and ultimately reduce e-waste at the global level. At the supply side, the inclusion of the e-waste problem in the process for the elaboration of new standards can limit the volume of e-waste generated annually. The recently adopted ITU-T Recommendation L.1000[118], which defines a global standard for a universal power adapter and charger solution for mobile terminals, can reduce significantly the volume of e-waste by limiting the amount of chargers produced annually for mobile devices. This same approach can be taken by introducing similar standards in other ICT equipment and devices. On the regulatory side, ICT regulators can introduce new measures to encourage manufactures and service provides to comply with such standards, either on a voluntary basis or through new regulation.

On the recycling part, and going forward, e-waste management requires to be anchored in a comprehensive regulatory framework with shared responsibility for collection and recycling amongst manufacturers/assemblers, importers, recyclers, scrap metal dealers, regulatory bodies, consumers and other key actors. This engagement of actors would provide a platform on which to develop efficient take-back schemes and other formal recycling infrastructure that would be supported by informal collection mechanisms.

Stringent regulations on standards and procedures to be followed in handling and disposal would need to be in place as well as strict requirements for operator training and certification. Due to the dearth of laws that regulate the electronics recycling industry, high-bar voluntary standards for the recyclers can be established as a bridging mechanism. These can be backed up by a certification program, where accredited third-party auditors certify that recyclers are meeting the standards. A certification standard, such as E-stewards[119], would be necessary in introducing formal structures and best practices into the e-waste management arena.

1.9.3 Matrix of obligations and incentives

Compliance with the various roles and responsibilities assigned to the actors can be achieved by regulatory scrutiny through an effective enforcement mechanism. It has been recognized that e-waste management is an emerging problem which is turning out to be a business opportunity, given the volumes of waste being generated.

This reality should be buttressed by a regulatory framework that contains an adequate matrix of incentives and obligations.

With the expansion and upgrading of ICT services over huge expanses geographically, it is expected that the infrastructure will produce considerable amounts of e-waste in time. Encouragement for operators to share infrastructure, where possible, will contribute to minimization of e-waste and its adverse impacts on the environment[120].

The success of some of the proposed obligations e.g. Take back schemes, would only be possible where informal and haphazard recycling is prohibited. This would ensure availability of adequate amounts of EEE required to sustain safer methods of e-waste disposal such as recycling. Introduction of standards for scrap metal dealing would ensure a minimum threshold for protection of workers and handling of EEE.

e-Stewards Initiative

The e-Stewards Initiative is a project of the Basel Action Network (BAN), which is a 501(c)3 non-profit, charitable organization of the United States, based in Seattle, Washington. It is against the backdrop of the growing e-waste crisis that the e-Stewards Initiative was born.

Without appropriate national and international legislation or enforcement in place in many regions, it is unfortunately left up to individual citizens, corporations, universities, cities – all of us – to figure out how to prevent the toxic materials in electronics from continuing to cause long term harm to human health and the environment, particularly in countries with developing economies.

e-Stewards Certification is rapidly emerging as the leading global program designed to enable individuals and organizations who dispose of their old electronic equipment to easily identifiable recyclers that adhere to the highest standard of environmental responsibility and worker protection.

e-Stewards Certification is open to electronics recyclers, refurbishers and processors in all developed countries

Proposed matrix	
Examples of License Obligation Implement a take back scheme Implement a trade-in scheme eco-labeling recycling Develop environmentally superior products	
Incentive Discount on fees Tax benefit Expenditure grant Recognition Reward scheme	*Penalty* Fine Enforcement action Social pressure

1.9.4 Extended Producer Responsibility (EPR).

Recognition of EPR by developing countries in domestic policies would ensure that manufacturers have the responsibility to collect and recycle their old products after consumers are done with them. It would also ensure that emerging manufacturers and assemblers are motivated to take the lessons learnt in disassembly and recycling of their products and feeding them back into design. This would also induce importing producers into compliance at the risk of being shut out from these markets. These policies would also impact the rest of the electronics supply chain including small-parts producers, end-use manufacturers and distributors[121].

1.9.5 Partnerships

No one stakeholder in the e-waste space holds a turn-key solution for effective e-waste management. Any measure of success can only be achieved through partnerships at all levels – internationally and regionally to address aspects that cross boundaries such as illegal dumping. At the local level, robust partnerships between state actors (regulatory agencies for ICT, environment, water, land, solid waste management, customs, trade etc), the private sector, civil society and consumers would need to work together in identifying practical solutions that are responsive to their local contexts.

1.10 Conclusion

That the volumes of e-waste will continue to increase due to emerging technologies and consumer sophistication is not in doubt. The absence of e-waste management frameworks or a relaxed approach in enforcement will lead to unwarranted threat to the environment and human health. This is a good time for countries to reflect on where they are in the path of implementation to enable a decision on whether there is need to realign the e-waste agenda towards more comprehensive implementation.

A default approach would be irresponsible and would amount to endorsing environmental devastation and danger to human health arising out of the 'developments' we have created for ourselves. But then, the choice is ours to make.

There is an urgent need to recognize the challenge of e-waste as a priority in the political agenda of countries that have not yet done so. This will enable allocation of resources to strengthen the supervision of regulatory standards for e-waste management. With required support in capacity building, technology and knowledge exchange, countries that have no e-waste governance policy in place will be able to streamline their informal sector and move towards establishment of a formal sector with some capability of end-processing technology.

In many developing countries, recognition of informal activities that turn e-wastes into resources would strengthen them and enable them to enjoy tax and other business incentives. This would enable the e-waste management sector to exercise its potential in job creation and poverty alleviation. Awareness creation on the adverse implications of e-waste will raise the environmental consciousness that is critical to drive forward a policy framework advocating for application of the 3Rs-Reduction, Re-use, Recycle of e-waste.

By acting now, we can turn an e-challenge into an e-opportunity.

Source: www.ecycle.co.za

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