

QUESTION 24/1

STRATEGIES AND POLICIES
FOR THE PROPER DISPOSAL
OR REUSE OF TELECOMMUNICATIONS/
ICT WASTE MATERIAL



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ITU-D Study Groups

In support of the knowledge sharing and capacity building agenda of the Telecommunication Development Bureau, ITU-D Study Groups support countries in achieving their development goals. By acting as a catalyst by creating, sharing and applying knowledge in ICTs to poverty reduction and economic and social development, ITU-D Study Groups contribute to stimulating the conditions for Member States to utilize knowledge for better achieving their development goals.

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Study Group 1

For the period 2010-2014, Study Group 1 was entrusted with the study of nine Questions in the areas of enabling environment, cybersecurity, ICT applications and Internet-related issues. The work focused on national telecommunication policies and strategies which best enable countries to benefit from the impetus of telecommunications/ICTs as an engine of sustainable growth, employment creation and economic, social and cultural development, taking into account matters of priority to developing countries. The work included access policies to telecommunications/ICTs, in particular access by persons with disabilities and with special needs, as well as telecommunication/ICT network security. It also focused on tariff policies and tariff models for next-generation networks, convergence issues, universal access to broadband fixed and mobile services, impact analysis and application of cost and accounting principles, taking into account the results of the studies carried out by ITU-T and ITU-R, and the priorities of developing countries.

This report has been prepared by many experts from different administrations and companies. The mention of specific companies or products does not imply any endorsement or recommendation by ITU.

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QUESTION 24/1

Strategies and policies for the proper disposal or reuse of telecommunication/ICT waste material

Summary

This document essentially presents, for the benefit of developing countries, guidelines for the environmentally sound management of waste electrical and electronic equipment (WEEE) resulting from information and communication technologies (ICTs), based on the work carried out by the ITU-D study group responsible for Question 24/1. It is made up of two parts, the first of which contains a report setting forth contributions made by various countries, while the second part presents a number of guidelines by way of an input for the formulation of WEEE policy in developing countries.

The report addresses the following topics: technical classification of ICT wastes; figures for EEE consumption and WEEE generation worldwide (present and future); problems faced by countries seeking to implement a strategy for the proper management of WEEE; experiences in the reuse and proper disposal of this type of waste; country experiences from Latin America, Africa, Asia and the Pacific, and Europe, as well as contributions from international organizations, among others.

The guidelines relate to aspects such as: policy and regulations; import and export of EEE and WEEE; stakeholders; the principle of extended producer responsibility (EPR) and the e-waste management system; information system; social aspects (employment and training); technical aspects (infrastructure, technology and technical guidelines, eco-design or cleaner production); informing and raising the awareness of ICT equipment consumers; economic aspects (business opportunities and economic models for the financing of a WEEE management system); monitoring and control of the system; sanctions.

Lastly, the document presents a number of conclusions resulting from the work done, together with a series of recommendations for possible adoption and/or adaptation by developing countries, in the interests of formulating and implementing a WEEE policy capable of generating positive results in terms of the mitigation and control of the problem currently faced by such countries due to the inadequate management of ICT wastes.

0 Introduction

There can be no denying the fact that ICTs are contributing to the economic and social progress of nations, as can be seen from the data produced by various studies, for example: from 1990 to 1998, ICTs contributed to the 57 per cent growth in GDP enjoyed by a group of developed countries, including Japan, in addition to which, economies characterized by high levels of ICT usage achieve a level of productivity seven times higher than the average in countries with lower usage levels; GDP and productivity growth accelerates with increased ICT use, with each 10 per cent increase in ICT capital resulting in a 1.6 per cent rise in GDP in a low-usage economy, and 3.6 per cent in an economy with high ICT usage; ICTs are responsible for over 50 per cent of the productivity gains in other industries, according to OECD (Vega, J., 2009).

The progress generated by ICTs has prompted governments to take measures aimed at ensuring their widespread accessibility and use, in the interests of reducing the digital divide and social exclusion by fostering everyone's participation in the information and knowledge society. In the social sphere, the efficient use of ICTs enables citizens to have rapid and timely access to more and better information, this having a positive impact on, among other things, education, health and safety/security, while at the same time reducing poverty and fostering a fairer and more democratic society.

The rapid growth in ICTs, coupled with the constant demand for the latest and most innovative technology, is resulting in an ever shorter life cycle for EEE. This, together with developing countries'

desire to reduce the digital divide by allowing the entry into their territories of significant volumes of disused EEE without exercising the necessary controls, has resulted in a situation whereby the high rates of WEEE generation are becoming a problem requiring urgent and priority attention in the interests of monitoring and mitigating the correspondingly negative repercussions for the environment and human health stemming from the inadequate handling of such wastes, which display certain specific properties owing to the presence within their structure of a number of toxic compounds.

In response to this situation, several international organizations have been working on the issue and generating a series of technical guidelines aimed at ensuring the environmentally sound management of ICT wastes. At the same time, the proper handling of WEEE is emerging, in both developing and developed nations, as a business opportunity, particularly where the precious and rare metals to be found in this type of waste are concerned, and as a viable option for providing employment to the poorest and most vulnerable segments of society.

Clearly, then, the establishment of policies conducive to the proper management of WEEE, particularly in developing countries, is an essential first step in the search for solutions, which must include establishment of the requisite infrastructure. To this end, the International Telecommunication Union (ITU), through its ITU-D Study Group 1, has been studying the issue (Question 24/1), by analysing the experiences acquired and lessons learned by those concerned with WEEE, and by developing a number of guidelines of potential use to developing countries as they seek to bring about the environmentally sound management of ICT wastes and corresponding positive impacts for their territories from the environmental, social and economic standpoints.

1 Report on the management of WEEE from ICTs

1.1 Technical classification of ICT wastes

In the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (<http://www.basel.int/text/documents.html>), electronic wastes are classified in Annex VIII under entries A1180, A1190, A1150 and A2010, and in Annex IX under entry B1110.

Under the convention, e-wastes are characterized as hazardous wastes when they are contaminated with mercury, lead, cadmium or polychlorinated biphenyl, or when they contain components such as accumulators and other batteries, PCB capacitors, mercury switches, glass from cathode-ray tubes and other activated glass, to an extent that they exhibit Annex III characteristics. Wastes containing insulation or metal cables coated with plastics contaminated with or containing lead, coal tar, cadmium, PCB, other organohalogen compounds or other Annex I constituents, to an extent that they exhibit Annex III characteristics, are likewise characterized as hazardous wastes. Similarly, precious metal ash from the incineration of printed circuit boards, glass waste from cathode-ray tubes, LCD screens and other activated glasses are classified as hazardous wastes.

Given that the processing of WEEE involves a variety of problems, European Directive PE-CONS 2/12, which is due to enter into force on 15 August 2018, provides for the grouping of all EEE into six categories instead of the current ten (which remain valid from August 2012 until August 2018). Large items of IT and telecommunication equipment (any external dimension more than 50 cm) are included in category 4; small items of such equipment (no external dimension more than 50 cm) are included under category 6; and screens, monitors, and equipment containing screens having a surface greater than 100 cm², come under category 2.

1.2 Figures for EEE consumption and WEEE generation worldwide (present and future)

The ICT industry is currently experiencing accelerated growth. Constant technological enhancement drives consumers to purchase new equipment even when their current EEE still have a considerable portion of their life cycle to run. This situation, coupled with advantageous conditions offered by manufacturers and

service providers, has boosted the demand for services and hence for the manufacture of this type of equipment.

The increasing levels of output are further fuelled by the early obsolescence that stems from an economic model based on the manufacture of equipment with a short life cycle and by the universal production and consumption culture of "buy it, use it, throw it away", resulting in the generation of huge volumes of WEEE.

The ICT data and statistics (IDS) produced by ITU's Telecommunication Development Sector (ITU-D) (<http://www.itu.int/ITU-D/ict/statistics>) bear witness to the exponential growth in Internet users in developing countries, from 501 million in 2006 to over 1.3 billion at end 2011. This means that the volume of equipment used for accessing the Internet, such as portable computers, tablets and smart phones, has also been growing exponentially. Whereas in 2006, 44 per cent of Internet users were in developing countries, that proportion had grown by 2011 to 62 per cent (over half).

According to ITU statistics published in June 2012, "Total mobile-cellular subscriptions reached almost 6 billion by end 2011, corresponding to a global penetration of 86%. Growth was driven by developing countries, which accounted for more than 80% of the 660 million new mobile-cellular subscriptions added in 2011".

Insofar as an estimate of the ICT waste worldwide is concerned, the "Recycling – from e-waste to Resources" report, issued at a meeting of Basel Convention and other world chemical authorities ahead of UNEP's Governing Council meeting in Bali (Indonesia), predicts that in China and South Africa, e-waste from old computers will by 2020 have jumped by 200 to 400 per cent from 2007 levels, and by 500 per cent in India. The report also predicts that, by 2020, e-waste from discarded mobile phones in India will be 18 times higher than in 2007, and seven times higher in China. According to UNEP¹, some 20 to 50 million metric tonnes of e-waste are generated worldwide every year, comprising more than 5 per cent of all municipal solid waste.

Every year, increasing numbers of desktop computers, laptops, tablets and other such items are thrown out long before completing their life cycle, when their owners decide that they need equipment with new and better features. However, we should not fail to take advantage of the opportunity to repair or recondition obsolete equipment to enable its reuse, or to recover materials for use in the manufacture of new equipment or in new production cycles.

1.3 Problems faced by countries seeking to implement an ICT waste strategy

Given the global magnitude of the e-waste issue in both developed and developing countries on account of the huge amounts of WEEE being generated each year, and with the trend being towards exponential growth, developing countries are currently facing a variety of problems that need to be resolved as speedily as possible in order to mitigate the serious environmental impacts, and forestall the health problems, resulting from the inappropriate management of such wastes.

An important contribution was made in Documents RGQ24/1/17 and RGQ24/2/16 (12 April 2012) by ITU, UNEP / Secretariat of the Basel Convention and the United Nations University (UNU), in collaboration with the Solving the E-waste Problem (StEP) Initiative and the Center for Environment and Development for the Arab Region and Europe (CEDARE), which together launched a joint study on WEEE to collect data and put together a general overview of the current situation in that regard, as well as identify challenges for the future.

Among the study's most noteworthy findings are the following: responses to the survey came for the most part from governmental organizations (42.8%), followed by the academic/research sector (15.1%)

¹ Press release, "Basel conference addresses electronic wastes challenge", 27 November 2006, UNEP.

and equipment manufacturers (14.5%); in 66 per cent of the countries surveyed, there is no policy and/or regulatory framework for ICT equipment at end of life (electrical and electronic wastes), while in 60 per cent of those countries there are, on the other hand, policies and/or regulations governing ICT use (ICT equipment to be resold, donated, redistributed, etc.); the highest levels of e-waste generation are seen in CRTs and flat screens (30%); the highest level of WEEE imports are seen in portable computers (notebooks, netbooks) (27%), while for exports it is CRTs that take the lead (22%); in 66 per cent of the countries surveyed, there are no standards or guidelines to be adhered to with respect to used ICT equipment or e-waste.

Listed below are a number of the disadvantages faced by developing countries with respect to WEEE management. In this regard, account was taken of Documents RGQ24/1/12 (UNEP Secretariat of the Basel Convention, 2012) and 1/99 (Tanzania, 2011).

- Absence of a state policy on WEEE management that takes account of all aspects necessary for the successful implementation of such a policy, including the assignment of responsibilities to all those involved in the system and the means of financing that system.
- Total or partial absence of specific regulations governing the management of WEEE from ICTs, with many countries having a large number of standards aimed at protection of the environment, including those relating to solid domestic wastes and hazardous wastes, but not specifically covering WEEE. At the same time, while various developing countries do have regulations, these are inadequate inasmuch as they do not take account of the actual situation on the ground, leaving out certain key factors and not involving stakeholders such as the informal sector. In such circumstances, it is not possible to achieve genuine and steady progress in implementing a system for the management of this type of waste.
- Lack of control over the importation of used ICT equipment that is transported to developing countries to give it a second life cycle and as a contribution to reducing the digital divide. Such controls are necessitated by the fact that, in many cases, the equipment received is beyond repair or refurbishment and ends up as e-waste. Furthermore, the decision to reduce the duties imposed on EEE imports in the interests of reducing the digital divide, coupled with imminent digital migration and the absence of properly functioning systems for WEEE management, is resulting in the problem of e-waste in developing countries becoming more acute by the day.
- Lack of knowledge as to the real situation of the EEE market and management of the wastes it generates. For example: figures relating to the importation and distribution of new and second-hand equipment; ICT sector development forecasts; market participation of manufacturers, importers, assemblers, distributors and traders; sales and consumption figures and trends; equipment life cycle estimates; installed base; volume of equipment earmarked for reuse; volumes of waste generated and managed; existence of waste management facilities; business opportunities involving waste; among others. Such information constitutes an essential point of departure for the construction and development of a management system for ICT wastes.
- In the case of certain countries, a lack of compliance with, or failure to adopt, existing international laws on WEEE (Basel Convention), which facilitates the illegal cross-border movement of such wastes.
- A lack of the technology used in the processing (recycling, treatment and final disposal) of e-wastes in developing countries prevents the local recovery of valuable components and use of safe practices, in accordance with international standards, for handling the hazardous substances found in certain types of ICT waste.
- The handling of certain stages of e-waste preprocessing (collection, disassembly, recycling and recovery) by informal recyclers who lack the necessary technical knowledge or training, resulting in health issues and negative environmental impacts.

- Inadequate labour and occupational health conditions, coupled with a lack of economic alternatives, for persons carrying out WEEE recycling in the informal sector, as well as for families running small EEE repair businesses.
- Non-existent, scarce or inefficient infrastructure for WEEE management in line with the best practices and technologies available in each country and the best, internationally-recognized environmental practices.
- Lack of environmental awareness on the part of society and stakeholders in regard to considerations such as: responsible consumption of EEE; importance of purchasing equipment manufactured with due respect for eco-design criteria; and the importance of reuse, recycling and manufacturer take-back of disused ICT equipment to enable its environmentally sound management.
- Absence of clear policies and guidelines for financing of the e-waste management system in order to ensure its sustainability.
- Absence of linkage and cooperation between the government entities concerned with this issue, coupled with limited participation by certain stakeholders in the process of establishing norms and reasonable targets for the environmentally sound management of ICT wastes in each country or region.

1.4 Experiences in the reuse and proper disposal of ICT wastes

The reuse of EEE has greater environmental benefits (reducing the rates of WEEE/ICT generation) and social benefits (helping to reduce the digital divide in developing countries) than recycling. Reuse is a more sustainable approach for equipment that has been discarded by users before reaching the end of its life cycle. Such equipment will then be of benefit to new users, with or without prior repairs or refurbishment, as the case may be.

Reuse makes for great resource efficiency, especially energy efficiency, since it avoids the extraction of new raw materials and consumption of the energy required for the manufacture of new equipment. The work involved in renovating and repairing equipment such as desktop PCs, portable computers and mobile telephones, in addition to favouring social inclusion of the most disadvantaged segments of society, serves to increase and enhance the knowledge and skills of the technicians and professionals working in the ICT-related disciplines.

In many developing countries, there is currently a high level of demand for computer equipment on the part of large segments of society, for example primary, intermediate and higher educational institutions, public libraries and cultural centres, among others, for which access to the information and knowledge society is hampered by the high costs of new equipment, or in some cases by the problems faced by remote and inaccessible areas. The equipment they require does not generally need to have high processing and storage capacities, since its use will be primarily for office applications and Internet access.

1.4.1 Experience of Latin America

Where experience in the management of WEEE in Latin America is concerned, several countries have established partnerships among the various sectors, such as public, private, academic, civil society and non-governmental organizations, with the aim of addressing solutions for achieving the environmentally sound management of WEEE within the region, including: development of technical studies and diagnoses of the e-waste management situation; drafting and adoption of policies and environmental legislation on WEEE management; awareness-building campaigns; collection campaigns.

Some of these activities have been fostered, coordinated and publicized by the Regional Latin American and Caribbean Platform for WEEE (RELAC) (<http://www.residuoselectronicos.net/>), with the aim of identifying solutions for the prevention, management and final disposal of WEEE from PCs within the region. In March 2011, RELAC published guidelines for WEEE management, based on the outcomes of a regional round table involving the public and private sectors. Those guidelines serve as a reference for the

analysis, development and implementation of national and regional policies designed to ensure the environmentally sound management of WEEE. They were presented during the Colombia-Swiss Side Event accompanying the Tenth Meeting of the Conference of the Parties (COP 10) to the Basel Convention, in October 2011.

The Swiss Federal Laboratories for Materials Science and Technology (EMPA) have contributed to the evaluation of studies on the management of WEEE through the Swiss e-waste Programme in countries such as Chile, Brazil, Peru, Colombia, and Trinidad and Tobago. An offshoot of this programme is the "WEEE recycling in Latin America" project, which fosters capacity-building in Colombia and Peru for the development of local economic activities involving inverse logistics, control and improvement of international trade in used and new equipment, and promotion of the recycling and recovery of WEEE. Along the same lines, the project contributes to knowledge management through access to information on, and lessons learned from, other projects; the fostering of exchanges of experience; and regional learning with respect to the sustainable management of WEEE.

1.4.1.1 Successful experience in the reuse, refurbishment and recycling of disused computer equipment

Computers for Education (CPE) is a social programme that was set up in the year 2000 by Colombia's Ministry of Information and Communication Technologies and Ministry of Education. Its objective is to generate development opportunities for the most needy population segments through reduction of the digital, social and regional divides, and to help in improving the quality of education in schools (basic, primary and intermediate) through the strategic approaches of access to, use and appropriation of ICTs. The 12 years of lessons learned have resulted in the consolidation of an integral and sustainable management model that provides educational, social and environmental benefits. This experience is described in Document 1/RGQ24/1/008 – Colombia, 2011)

The programme's refurbishment centres receive disused computers donated by, among others, individuals, public entities, private companies, organizations and international bodies. These are then subjected to a process of checking, classification, repair, cleaning, software updating, etc., to ensure that they are in an optimum aesthetic and technical condition for reuse within the educational establishments covered by the programme.

During the period of reuse of the equipment, CPE provides a corrective and preventive maintenance service to ensure its normal operation; then, once it has reached the end of its second life cycle, i.e. after four years, the programme collects the equipment and transfers it to the National E-waste Recycling Centre (CENARE), which also receives, from refurbishment centres, excess electronic items not suitable for refurbishment.

Equipment that has been taken back is manually disassembled or demanufactured, involving separation, cleaning and classification of the parts and recovery of some ferrous and non-ferrous metals, as well as plastics and clear glass. These recovered elements are sold by public auction for subsequent industrial use, thereby ensuring that the cycle of such materials is completed in a manner that is environmentally sound and conducive to energy efficiency, reducing the need for mining to extract new materials and hence producing a positive impact in terms of reduction of the carbon footprint. Those elements which contain, among other things, heavy and rare metals are considered potentially hazardous and are entrusted to external entities with an environmental permit, for appropriate treatment. It is worth noting that the demanufacturing strategy has a significant social impact, providing employment to unskilled workers from the most vulnerable segments of Colombia's population.

In addition to its refurbishment and e-waste management strategies, the programme is engaged in a low-cost environmental educational robotics strategy which consists in the recovery of electrical, electronic and mechanical components from the demanufacture of obsolete computers and electronic surpluses, for the subsequent creation of robotics laboratories and kits that enable students to familiarize themselves with various aspects of science and technology, facilitating their assimilation of basic concepts through hands-on experience designed to teach students to resolve day-to-day problems by developing both logical thinking and their own ideas.

The robotics laboratories comprise an educational robotics and automation development station (EDERA), which is one of the main components of the laboratory and includes the interface card (platform brain). Of the microchips contained in this card, 90 per cent come from other interface cards, control cards, motherboards, etc., thus enabling the reuse of high-tech chips and resulting in a significant saving of the energy that would otherwise be required for the manufacture of new electronic components. The EDERA operates with six devices, namely Meteorological Station 1 (EM1), Meteorological Station 2 (EM2), Fotomóvil (a light-powered model vehicle), Hexápodo (a six-legged robot), Electric Door and Basic Kit, all of which are used in conjunction with the EDERA to teach basic elements of science. The robotics laboratories are provided to the educational establishments covered by the programme, and CPE also provides on-site educational guidance on how to use them.

In the period from the year 2000 to 31 December 2012, CPE received 278 292 donated computers and refurbished 181 152 of them, meaning that some 70 per cent of the donated equipment is suitable for refurbishment. From 2005 to 2012, the programme demanufactured 2 371 tons of e-waste, equivalent to 115 659 computers. From 2007 to 2012, a total of 1 765 tons of clean materials (copper, aluminium, plastic, ferrous metals, foam, cardboard, etc.) were recovered; and from 2008 to 2012, a total of 600 environmental robotics laboratories were constructed, comprising the EDERA and six robotics kits.

1.4.1.2 "Computers for connection" project

It is estimated that in 2012, 100 million computers were in use in Brazil, i.e. one computer for every two inhabitants; and by 2014 the most likely scenario is for a doubling of the current number with additional sales of more than 70 million computers.

The Computers for Connection Project (Document RGQ24/1/20 – Federative Republic of Brazil, 2013) was conceived in 2003 and has been operational since 2005 under the coordination of the Department of Logistics and Information Technology of the Ministry of Planning, Budget and Management. The aim is to deploy a national computer refurbishment network comprising repair centres throughout the country. The initiative tackles the digital divide by promoting the reuse of computers and youth training, while at the same time reducing the impact of e-waste by prolonging the life cycle of computers.

The handover of equipment for the connection project is one of the ways in which the federal government is seeking to overcome the digital divide. One of its policy axes is therefore to invest in digital connection, equipment, human resources and training to support the establishment of community telecentres, of which Brazil now has over 7 000 in operation. Telecentres are multifunctional public areas in which people have access to the communication infrastructure, Internet and e-mail, and can also participate in cultural, social, political, economic and community development projects, follow courses and access governmental and banking services. They may also accommodate the basic infrastructure needed for the coordination of government policies in the areas of public safety and security, health, education and social welfare.

Computer refurbishment centres (CRC) are established and maintained by a public-private association with support from the federal Government, through the Computers for Connection project. By making use of the legal structure of their partners, CRCs are assured of the administrative support they need for their installation and operation. Their goals are essentially to: a) refurbish donated computers to a level at which they meet a number of minimum requirements which are regularly updated, for use in connectivity initiatives with appropriate performance standards; b) sort and prepare unserviceable computers for recycling or final disposal; c) provide work opportunities, vocational training and education for young persons involved with the CRCs; and d) receive donations of computer equipment and store it pending its distribution to the selected beneficiaries.

Refurbished computers have a minimum configuration and the basic software package to ensure their proper functioning and, wherever possible, meet the beneficiary's specific requirements. This package comprises a freeware that has been approved by the teams for the connection project. The CRCs produce reconfigured equipment to operate as a network terminal, using server processing and memory resources (thin client). Some components derived from computer demanufacturing can be used as spare parts in

repair and refurbishment processes; however, there are technological limitations where processors and RAM are concerned, these being more costly components which cannot be taken from recovered items.

The refurbished computers are sent, together with the corresponding documentation issued by the CRC in order to formalize the donation, to the beneficiary entity. Transportation to all parts of the country is effected by members or by contractors, according to the requirements of the Computers for Connection project.

The wastes generated by the CRCs are managed in a variety of ways. Casings and ferrous materials are sent to recycling cooperatives; slabs, circuit boards and CRTs are stored with a view to supporting future scientific research on recycling techniques; and other materials are taken away by private partners and dealt with in an environmentally sound manner.

1.4.2 Experience of Africa

The WEEE project in Africa was executed by the Basel Convention Coordination Centre, Nigeria, and the Basel Convention Regional Centre, Senegal, in collaboration with partners such as EMPA, the Institute for Applied Ecology (Oeko-Institut), the European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Partnership for Action on Computing Equipment (PACE). The Secretariat of the Basel Convention was responsible for overall coordination of the project. Financial support for the project was provided by the European Commission, Norway, the United Kingdom and the Dutch Association for the Disposal of Metal and Electrical Products (NVMP).

The study includes determination of the flows of used and end-of-life equipment and e-wastes, especially from Europe, into western Africa, and their subsequent re-exportation within the region. An assessment is made with respect to used equipment, end-of-life equipment and e-waste in Benin, Côte d'Ivoire, Ghana and Nigeria, to identify the environmental management practices followed by the formal and informal sectors. The study describes the requirements for conducting environmentally sound management, as well as the regulatory and legal systems of each country. The assessment shows that, where metal separation is concerned, the hazardous fractions are handled incorrectly, and that open burning is used for copper extraction. There is, however, at least one plant in Ghana which manages e-waste properly, and any fractions which cannot be processed in that country are exported to Europe.

The socio-economic study being conducted in Lagos (Nigeria) shows that used and obsolete EEE collection, refurbishment and recycling activities can generate significant employment opportunities. Collection and recycling can be performed by unskilled workers, whereas refurbishment requires workers with a higher level of expertise. The project proposes a training process for port and customs authorities, government officials and accreditation bodies, focusing on the tracking and control of cross-border movements of used and end-of-life ICTs and e-waste, as well as the prevention of illegal trafficking.

1.4.2.1 Strategies and policies for the proper disposal of e-waste in Rwanda

The Government of Rwanda, having identified ICTs as an enabling sector for a country's development, has developed projects to increase ICT use, eliminated trade barriers to the importation of hardware and software and liberalized the communication sector. All of this has led to greater volumes of EEE entering the country. Rwanda has a policy on WEEE, the regulation of which includes the management and disposal of e-waste in a manner that is safe for the environment and human beings. This is described in Document RGQ24/1/004 – Rwanda, 2011.

The policy provides for equal responsibilities for the various players involved in e-waste management, and seeks to strengthen the role played by Rwanda and the East African Community in regard to WEEE. It is based on the principle of precaution, prevention and the correction of environmental damage, preferably at source, and on the principle whereby "he who pollutes must pay", in addition to which it applies the principles of prevention, recovery and safe disposal of waste. As regards the mechanism for financing the management of disused ICT EEE, the responsibility lies with the manufacturers, importers, retailers and consumers of electronic goods, rather than with the Government or its service providers. The mechanism

includes the "advance recycling fee", visible to the user at the time of purchase and determined according to the quantity and quality of the e-waste involved.

The policy fosters eco-design and promotes the refurbishment of ICT equipment for use in schools and agencies on a not-for-profit basis. It promotes the recovery/recycling of WEEE, identification of potentially hazardous substances, labelling of e-waste with information regarding its hazardous material content, coordination between all concerned parties, and so on.

1.4.2.2 Experience of Tanzania – Regulatory Authority of Tanzania, 2013

Tanzania has developed the Waste Management Plan which includes management of e-waste. The plan has a number of objectives covering issues relating to the revision of policies and regulations on e-waste management, awareness raising, and promotion of recycling and recovery of materials.

As part of its efforts to implement the plan, the Government has initiated activities to develop policies, laws, regulations and guidelines on the management of e-waste. This process of development is a major milestone along the road to solving the country's problems of e-waste management.

1.4.2.3 Rights and obligations of consumers: History and significance – African ICT Consumer Network (AICN)

Document 1/273 (2013) notes that, in the majority of meetings organized by the leading telecommunication and ICT players, the issue of consumer protection has become a constant concern, yet neither regulators nor operators, nor indeed equipment manufacturers, have defined or provided a specific legal basis for the legal consumer protection instruments that need to be implemented in order to guarantee universal access to quality telecommunication services at low cost.

The contribution also outlines the history and significance of consumer protection, a number of legal provisions and national and international initiatives, as well as consumer obligations (one of the most important of which is the obligation to be environmentally responsible and sensitive to the potential environmental effects of consuming a given product) and rights (with regard to safety, information, choice, being heard, education, redress for grievances, a healthy environment, and satisfaction of basic needs).

1.4.3 Experience of Asia and the Pacific

On the subject of WEEE management in Asia and the Pacific, the Secretariat of the Basel Convention, in consultation with selected countries from the region and the Basel Convention Regional Centres in China (BCRC China), Indonesia (BCRC-SEA) and the South Pacific (SPREP), formulated a proposal for a pilot project for the environmentally sound management of e-waste. The Basel Convention programme on the management of such waste for the Asia-Pacific region was officially inaugurated in Tokyo (Japan) in November 2005.

The programme seeks to improve the WEEE management capacity of the Parties in the Asia-Pacific region through the creation of public-private partnerships and prevention of illegal trafficking. In pursuit of these objectives, the programme has adopted a strategy that includes: assessment of the situation; prevention and minimization of the quantity of e-waste produced; implementation of cleaner manufacturing approaches and of eco-design with a view to minimizing or eliminating hazardous substances within e-waste; environmentally sound management of WEEE; and fostering of information exchanges and training activities.

The national action plan in Asia and the Pacific includes: detailed inventories; launching of pilot projects on collection and separation; e-waste take-back plans; refurbishment and recycling; training for customs officials; and evaluation of project efficiency and sustainability. The regional plans cover, among other things: coordination of implementation activities through the Basel Convention regional centres; controlling illicit trafficking in WEEE from the regional perspective; information exchange, enhanced vigilance and information networks within the region; harmonization of regional standardization procedures for better control of WEEE characterized as hazardous waste; creation of public-private

partnerships for project execution; identification of markets for recyclable materials; standards development; guidelines and best practices for the environmentally sound management of WEEE; evaluation of the feasibility study on the establishment of a regional e-waste management scheme.

1.4.3.1 E-waste management in Bhutan

As indicated in Document RGQ24/1/15 (Kingdom of Bhutan, 2012), the Royal Government of Bhutan has issued a body of regulation on e-waste management with the aim of preventing and reducing waste generation, promoting segregation, reuse and recycling, and generally ensuring the environmentally sound management of WEEE. The regulations specify the responsibilities falling to different government agencies and other relevant players. The government, through one of its agencies (the Department of Information Technology & Telecom (DITT)), is responsible for the putting in place of an e-waste management entity, in the form of a private sector body entrusted with the task of waste management. The entity will be selected on a competitive basis and will base itself on government guidelines as well as on relevant international standards and best practices.

If the management activity is not economically attractive, the Government of Bhutan will have to subsidize the operations of the e-waste management entity, consider alternatives for the legal exportation of WEEE, or invest in the handling of e-waste from other countries in an environmentally sound manner. The Department of National Properties is responsible for taking back used and obsolete EEE from all government agencies for subsequent auction to the designated e-waste management entity or any other entity deemed appropriate by DITT. The income derived from such auctions and from fines imposed for non-compliance with the regulations will go towards financing the waste management system. DITT can also levy fees as and when necessary.

The e-waste management system is financed through a fund established and managed by DITT, covering both newly-generated and historic waste. The districts, subdistricts and municipalities are responsible for monitoring implementation of the regulations. For their part, manufacturers and importers are required to contribute, at a percentage rate (WEEE levy) determined by DITT, to a fund that is used for financing the cost of implementing the regulations, in addition to which they must comply with the restrictions in force on the use of hazardous substances and set up adequate collection centres. The government is providing the seed capital for the fund to take care of historic e-waste. Individual consumers and bulk consumers that are not government agencies must deposit their disused equipment with the designated collection centre. Domestic e-waste is collected and taken to a WEEE segregation centre. The e-waste entity then transports the e-waste thus segregated to its facility for further management.

1.4.3.2 Standardization activities to facilitate recycling of rare metals from ICT waste

Given the existence of many elements within WEEE and the availability of the technology capable of recovering them, countries such as the Republic of Korea and Japan are promoting "urban mine development projects" for extracting rare metals from disused equipment, most of which is to be found in urban areas. A rare metal is an uncommon metal found only in certain parts of the world, for example indium, chromium, tungsten, cobalt, manganese, molybdenum and vanadium, in the case of which only five countries account for 90 per cent of world production. Rare metals are widely used in ICT products such as PCs, mobile telephones, monitors, touch screens and LED lighting units. A mobile telephone includes more than 20 rare metals, such as titanium, indium, gallium, barium, tantalum, arsenic, neodymium, zirconium, etc.

In order to facilitate the recycling of rare metals, it is necessary to develop a systemically managed recycling procedure with reference to Recommendation ITU-T L.1100 concerning a method to provide recycling information of rare metals in ICT goods. The Republic of Korea established a recycling management procedure for rare metals in which there are four management points for ICT products during their life cycle: "Producer of ICT goods", "Management body", "Customer" and "Recycler".

The management body gathers and maintains information on rare metals in ICT products that is sent to it by producers in different parts of the world, in order to share it with recyclers or with other management bodies in other countries or regions, at their request. The producer provides the customer with ICT

products for use during a lengthy life cycle, and once that cycle is over the products end up with the recycler. The information on rare metals is transmitted by the producer to the management body, and then on to the recycler. In order for the recycling to be effective, that information has to be accurate and to have been obtained through measurement techniques and the characterization of elements as rare metals. According to the measurement technique used, the possibilities for separating the elements and for quantitative resolution will vary.

Detailed information on these activities is given in Documents 1/INF/30, 2011 and 1/182 – Republic of Korea, 2012.

1.4.4 Experience of Europe

Europe has made significant progress in the environmentally sound management of e-waste, and the European Union has standards which constitute a clear regulatory framework in this sphere. A number of contributions, which are reflected below, report on the manner in which WEEE are managed in certain European countries.

1.4.4.1 Experience of the French Ministry of Ecology, Sustainable Development, Transport and Housing

The African ICT Consumer Network (AICN) (Benin) presented the WEEE collection and management experience accumulated by the French Ministry of Ecology, Sustainable Development, Transport and Housing, founded on the principle of "extended producer responsibility" (EPR), whereby the producers of EEE are required to internalize the cost of disposal of such equipment at end of life. In France, producers have come together in accredited producer responsibility organizations (PROs) (Ecologique, Eco systèmes, ERP or Récylum), which are themselves grouped together within the accredited coordinating agency (OCAD3E) (Document RGQ24/1/2 – African ICT Consumer Network (AICN), Benin, 2011).

The "eco-contribution" charge is displayed on the price tags of new appliances, and retailers take back a household's corresponding old item of EEE free of charge when a new one is purchased, under the so-called "one-for-one" take-back scheme which operates through over 18 600 collection points throughout France. Consumers may also deposit with distributors small items of equipment they no longer require, without any obligation to purchase. It was agreed to vary the eco-contribution charge in order to differentiate between products according to their end-of-life environmental impact; and it was agreed, moreover, that the government should be free to consult the accounting and financial documents of PROs.

The selective collection of household WEEE in municipal waste-disposal centres has been a great success. The rates of collection, reuse/recycling and recovery of household WEEE have increased to the point at which they are now in line with the targets set out in the corresponding European Union directives, with recycling success rates of between 71 and 91 per cent according to the types of equipment in question. At the same time, all players in the household WEEE scheme have a duty to achieve increasingly high selective collection rates, with a goal of 10 kg per inhabitant by 2014.

The reuse of household WEEE will be encouraged through a principle whereby social and solidarity economy structures will be granted access to household WEEE landfills, and PROs will cover the costs of transporting the equipment to reuse facilities as well as taking direct charge of certain hazardous WEEE components in accordance with strict traceability regulations, thereby encouraging eco-design and the creation of environmental awareness among the consumers of ICT equipment.

The principle of extended producer responsibility likewise applies for the management of professional WEEE, although a distinction is made between "historical waste" and "new equipment". In the case of professional EEE that was put on the market prior to 13 August 2005, it is the professional user of the equipment who is responsible for its end-of-life treatment.

1.4.4.2 Electronic waste material: recycling aspects (United Nations, Basel Convention)

- **Case study – France**

The Environment and Energy Management Agency, known by its French acronym ADEME, was established in France in 2006, since when it has been working to foster public awareness of the importance of the WEEE management system by conducting or financing studies and projects aimed at enhancing the recovery of such waste with greater respect for the environment. The studies cover topics such as collection methods and recycling technologies, and nature of the waste. ADEME also, within various groups and commissions, provides technical support to the ministry in charge of ecological affairs, and generates exchanges between stakeholders by organizing technical days or colloquiums relating to collection and recycling schemes. In addition, it has regulatory responsibility for managing the registry of household and professional appliance producers, which themselves register and declare the quantities of equipment that have been placed on the market, collected and treated each year, as stipulated by the order of 30 June 2009.

- **Case study – digital touch-screen tablets**

Launched in early 2010, the digital touch-screen tablet family, by combining the features of the telephone (compact and light) and computer (reasonably sized display), has changed the user's experience of information technology.

From the ecological standpoint, a tablet consumes 30 to 60 times less energy than a desktop computer and the manufacture of a laptop or desktop produces three times and 6 to 12 times the volume of greenhouse gases, respectively. On the other hand, the battery is usually an integrated component, and the tablet's life cycle is therefore the same as that of its battery. To recycle the tablet, the case is burst open and the various components separated and dealt with accordingly: screen, battery, plastic (about 55 g), and electronic board (about 45 g). The glass and aluminium are the easiest materials to recover, unlike the electronic board, which is sent to a "refinery" that extracts copper, precious metals and lead from the soldering. In all, over 80 per cent of the weight of a tablet should be recycled and the rest incinerated or, if less than 1 per cent, thrown away.

Both these case studies are contained in Document RGQ24/1/3 – Thales, France, 2011.

1.4.4.3 Electrical and electronic appliances (Switzerland)

High levels of heavy metals complicate the operation of municipal solid waste incinerators (MSWIs), as well as the treatment and recycling of combustion residues. When EEE are incinerated in MSWIs, reusable metals are largely lost, or can be recovered only at great expense. The separate collection and environmentally sound disposal of end-of-life EEE reduces inputs of heavy metals into unsorted municipal waste. In addition, during the recycling process, reusable metals such as copper and iron are recovered. Problematic components (mercury switches, PCB capacitors, etc.) are dismantled and disposed of separately. Non-recyclable organic chemical wastes (e.g. mixed plastics) can be appropriately incinerated.

Under the terms of the Ordinance on the Return, the Take-back and the Disposal of Electrical and Electronic Appliances (ORDEA), retailers, manufacturers and importers are required to take back appliances at no charge. Consumers, for their part, are obliged to return end-of-life appliances and are not allowed to dispose of them via household waste or bulky item collections. The ordinance covers electrical and electronic appliances in the following categories:

- Consumer electronics
- Office, IT and telecommunication equipment
- Refrigeration and air-conditioning appliances
- Household appliances
- Tools (except large-scale stationary industrial tools)
- Sport and leisure appliances as well as toys

- Luminaires (lighting fixtures)
- Lamps (without incandescent lamps).

Collection and disposal, financed on a private-sector basis, is managed by the Swiss Foundation for Waste Management (SENS) and the Swiss Association for Information, Communications and Organization Technology (SWICO). The purchase price of all appliances covered by the ORDEA includes a prepaid disposal charge based on voluntary sectoral agreements. Equipment can thus be returned free of charge.

Possible measures/scenarios include: monitoring whether the current regime is effective or whether a mandatory financing scheme is required; improving the information given to consumers and local authorities on existing disposal options and second-hand markets; investigation of the scope for improving the recyclability of appliances (by influencing the manufacturing process).

The Swiss experience is described in Documents 1/INF/40 and 2/INF/45 – Swiss Federal Office for the Environment (FOEN), 2011.

1.4.4.4 Eco labels for electronic appliances: EPEAT and IT Eco Declaration – THALES (France) (Document 1/259E, 2013)

This contribution provides information about two Ecolabels for electronic products: EPEAT (Electronic Product Environmental Assessment Tool, United States) and the IT Eco Declaration (ECMA-370, from the EU's European Computer Manufacturers' Association).

The EPEAT label is based on criteria including design, production, energy consumption and recycling, in accordance with the IEEE 1680 Standards Family (Environmental Assessment of Electronic Products). IT equipment (PCs, portable phones, computer screens, and so on) is assessed on 51 criteria – 23 mandatory and 28 optional.

The European Computer Manufacturers' Association (ECMA) was established in 1961 in order to standardize Europe's IT systems. Membership is open to small and large enterprises involved in manufacturing, selling or developing IT or communication systems. In 1994, ECMA changed its name to ECMA International, an international standards body for IT and communication systems. In the course of its activities, ECMA published the fourth edition (June 2009) of the ECMA-370 standard setting out the environmental attributes and measurement methods for ICTs and CE products according to known regulations and currently accepted standards, guidelines and practices. The IT Eco Declaration includes: Annex A – Company environmental profile (CEP), and Annex B – Product environmental attributes (PEA).

1.4.5 International organizations

1.4.5.1 United Nations Environment Programme (UNEP)

In recent years, international transboundary movements have increased significantly and will continue to do so as more and more countries produce EEE. The movements in question involve personal computers and associated hardware, used electronic equipment and used cellular telephones, for the removal of usable parts, refurbishment and reuse, and recovery of raw materials. It is important to exercise greater control over acceptable methods for WEEE disposal, adopt processes to recover valuable constituents and use safe practices to deal with the hazardous constituents in e-wastes (e.g. cadmium, lead, beryllium, CFCs, brominated flame retardants, mercury, nickel and certain organic compounds). The complete text of the UNEP guidelines is contained in Document 1/INF/36, 2011.

1.4.5.2 Background document for Study Group 1 meeting on Question 24/1

Document 1/16 (BDT Focal Point, 2010) refers to the Basel Convention as an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent the transfer of hazardous waste from developed to least developed countries (LDCs). The convention is also intended to minimize the amount and toxicity of wastes generated and ensure their environmentally

sound management as close as possible to the source of generation, and to assist LDCs in the environmentally sound management of the hazardous and other wastes they generate.

Discussions on the environmentally sound management of WEEE recognize "**three Rs**", i.e. **reduce**, **reuse** and **recycle**. The aim should be to **reduce** the generation of e-waste through smart procurement and good maintenance; **reuse** still functioning electronic equipment by donating or selling it to someone who can still use it; and **recycle** those components that cannot be repaired. A country could develop an electronic product management database that shows those organizations which reuse or recycle EEE in an appropriate manner.

The document points to the importance of focusing on national legal and regulatory issues, taking into account international treaties. It also recommends the development of databases on the reuse and recycling of electronic items, specifying those items that are dangerous on account of the lead, mercury and cadmium, among other things, they contain. Carcinogenic substances in e-waste may include polychlorinated biphenyls (PCBs). Capacitors, transformers and wires insulated or coated with polyvinyl chloride (PVC), manufactured before 1977, often contain dangerous amounts of PCBs. The document further notes that studies could be undertaken to investigate global practices with the aim of developing case studies on the three Rs.

Strategies and policies should be put in place to ensure that e-waste disposal does not constitute a risk to workers and communities and that great care is taken to avoid unsafe exposure in recycling operations and leaching of materials such as heavy metals from landfills and incinerator ashes.

1.4.5.3 Umicore – Belgium

The winner in the "best process" category of the European Business Awards for the Environment in 2012 was Umicore of Belgium, for its method for recycling rechargeable NiMH (nickel-metal hydride) and Li-ion (lithium-ion, i.e. with lithium in the ionic state) batteries without taking them apart mechanically, thereby preventing the release of dust and organic compounds into the atmosphere. This method has reduced the adverse environmental and health impacts of batteries when disposed of in landfill sites.

Umicore every year processes around 350 000 tonnes of WEEE, which includes around 60 different substances. The metals recovered in the process, including copper, aluminium, palladium, rhodium and precious metals, are separated out, melted down and refined. Every year about 100 tonnes of fine gold, 2 400 tonnes of silver, 25 tonnes of platinum and 20 000 tonnes of copper are recovered in this way. The cost of the material recovered is competitive compared to extraction from traditional ore. For example, gold ore yields about 5 g of the metal per tonne of ore, compared to 250 g recovered from one tonne of printed circuit waste or 350 g from one tonne of discarded portable phones, while the carbon footprint from WEEE substance recovery is 80 per cent smaller than that of ore processing plants.

Plastics, which are present in abundance in electronic systems, are used as fuel to smelt the metals, and the final waste is used as a component in the production of concrete. This creates a "circular economy" in which nothing is wasted and everything is transformed (ecology): the e-waste and batteries are 100 per cent recycled, thereby obviating the need to transport waste to landfill sites or treatment centres in developing countries.

1.4.5.4 Inputs from ITU-T Study Group 5 to ITU-D Study Group 1 (Question 24/1)

According to Documents 1/156 and RGQ24/1/19, 2012, some of the issues being studied by ITU-T Study Group 5 in the area of e-waste reduction, recycling methods and reuse of recycling management are addressed in the following Recommendations:

- L.1000 "Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices" sets out a common power supply solution for other ICTs with external power supply, in order to reduce the number of adapters and volume of e-waste, and also improve energy consumption by higher efficiency and lower no-load power consumption.

- L.1100 "A method to provide recycling information of rare metals in ICT goods" defines a communication format for providing such information.
- In October 2012, ITU-T Study Group 5 approved draft Recommendation ITU-T L.1001 standardizing the requirements with respect to external universal power adapter solutions for ICT equipment for stationary use and communication technology devices. This Recommendation, which complements Recommendation ITU-T L.1000, describes the basic configurations and general requirements for universal power adapters and their interfaces: cables, connectors, current, voltage, resistibility, energy efficiency, electromagnetic compatibility, ripple, noise, safety and eco-environmental specifications. Through this Recommendation it is possible to cut down on the manufacture of power adapters by widening the range of compatible devices, facilitating adapter reuse and recycling, and increasing build quality and resilience to overvoltages.
- A study carried out in 2012 by the University of Genoa, commissioned by ITU and the Global e-Sustainability Initiative (GeSI), estimates that the widespread adoption of an energy-efficient universal power adapter solution will eliminate an estimated 300 000 tonnes of e-waste annually. In addition, the study shows it could reduce the energy consumption and greenhouse gas emissions of external power supplies by between 25 and 50 per cent.

1.4.5.5 Proposal to develop guidance for the practical implementation of a life-cycle approach for ICT equipment in technical assistance and capacity building projects UNEP

Document 1/286 (2013) puts forward a proposal to develop guidance for the practical implementation of a life-cycle approach for ICT equipment in technical assistance and capacity-building projects in developing countries and countries with economies in transition, based on the toolkit developed in conjunction with ITU.

The contribution notes that sales of personal computers (PCs) significantly increased in all regions between 2000 and 2010. Use of personal computers grew exponentially from about 170 million units sold globally in 2000 to about 370 million units sold in 2010, and this trend will continue until 2014, when it is estimated that sales will reach an estimated 470 million units, a more than twofold increase in the last 10 years.

The document also recommends that facilities that refurbish or repair used computing equipment should take steps to identify and sort used computing equipment that is to be refurbished or repaired from that which should undergo recycling and materials recovery. Refurbishment facilities should use the Basel Convention guidance documents to ensure that they operate in a manner that is protective of the environment and worker health and safety and comply with the requirements of the Basel Convention. The Partnership Programme has to date incorporated two initiatives in its framework: the Mobile Phone Partnership Initiative (MPPI) and the Partnership for Action on Computing Equipment (PACE).

2 Guidelines for the management of WEEE from ICTs

2.1 Preliminary considerations

Any integral e-waste management system for developing countries must take account of the following starting points:

- The need for a situation assessment or diagnosis regarding the e-waste situation, through a study which includes: the existence of policies or regulations relating to WEEE; figures for the importation of new and second-hand ICT equipment; market participation and a projection thereof in the case of manufacturers, importers, assemblers, distributors or traders; figures for ICT equipment sales; EEE sales and consumption trends; familiarity with and monitoring of the life cycles of electronic equipment and e-waste; installed base; ICT equipment earmarked for reuse; quantities of WEEE generated; volume of e-waste generated; existence of infrastructure for WEEE management; business opportunities arising from e-waste management and potential markets.

- The importance of recognizing that e-wastes are a complex mixture of hazardous and non-hazardous substances and materials. This being the case, it is recommended that WEEE be considered a special category of waste to allow for differentiation between hazardous waste and common household waste, in the interests of avoiding risks or difficulties in the early stages of management or pre-processing stages (collection, transportation, storage, classification, repair, refurbishment, manual demanufacture). The foregoing notwithstanding, in the various processing stages (recycling, use, treatment and/or disposal), WEEE can be managed as potentially hazardous wastes in order to ensure protection of the environment and human health. It is essential to be aware that the hazardous nature of WEEE can show itself at any stage if such wastes are not managed in an environmentally sound manner, in line with international standards and best practices.
- The need to define the integral e-waste management system, having regard to such aspects as: the actual situation in each country; size of the market and market conditions; EEE market penetration; life cycle of ICT equipment; infrastructure necessary for WEEE management; possible financing mechanisms; and so on.

The following are the main aspects to be taken into account when drawing up ICT waste management guidelines for developing countries:

2.2 Policy and regulations

Public policy relating to WEEE management in developing countries should be adopted at the national level rather than locally on account of the lack of hierarchy and inadequate resources available at the local level. In addition, EEE reuse should be encouraged, as should the minimization and use of WEEE. The said policy should, as a minimum, cover the following:

2.2.1 Import and export of EEE and WEEE

It is essential for the governments of developing countries that are receivers of used ICT equipment to be sure that the importation of such equipment does not in fact amount to the entry of e-waste. To that end, it is suggested that, before the importation process begins, the EEE are subjected to proof-of-functioning tests, with account being taken of the technical proof-of-functioning guides for the different categories of ICT equipment proposed by international organizations.

Where the importation of EEE is concerned, an assessment has to be made in the case of ICT equipment that is "close to end of life", since while it may still be functioning and usable, it will become waste in a relatively short space of time. Where it is in fact WEEE that is being exported, the exporting countries must ascertain that the receiving countries have the requisite facilities for the environmentally sound management of such wastes.

As is stated in Document 1/INF/36 (UNEP, 2011), in recent years, international transboundary movements have increased significantly and will continue to do so as more and more countries produce EEE. The movements in question involve personal computers and associated hardware, used electronic equipment and used cellular telephones, for the removal of usable parts, refurbishment and reuse, and the recovery of raw materials. It is important to exercise greater control over acceptable methods for WEEE disposal, adopt processes to recover valuable constituents and use safe practices to deal with the hazardous constituents in e-wastes (e.g. cadmium, lead, beryllium, CFCs, brominated flame retardants, mercury, nickel and certain organic compounds).

The EEE and WEE importation and exportation processes must be carried out in accordance with the rules of each country and with international legislation, as well as with due regard for principles of transparency and respect between the parties concerned. It goes without saying that customs officials have to receive the requisite training to enable them to exercise proper inspection and control of EEE and WEE imports and exports, as well as identify electronic wastes with reference to the Harmonized System of the World Customs Organization (WCO).

It should be noted that the WCO has established a standard product classification system, the "Harmonized Commodity Description and Coding System" or simply "Harmonized System". This is a classification system with a progressive tree structure starting from the raw materials (animal, vegetable and mineral) and moving progressively by successive stages of processing and based on the constituent materials, complexity of production, and intended use. The Harmonized System was established with the aim of facilitating international trade, providing a harmonized system of coding products, and ensuring safety for customs officers.

2.2.2 Stakeholders

The government in each country should establish a precise definition of "manufacturer" and assign shared but clearly differentiated responsibilities to the other players involved throughout the supply chain, as follows:

- **Government**

Includes environmental and customs authorities. The main functions of this stakeholder are to:

- adopt, at state level, a policy on WEEE management and regulation which takes account of all the factors involved in the proper functioning of the management system;
- assign clear responsibilities to government entities and to each stakeholder involved in the comprehensive management of e-waste;
- establish, and ensure compliance with, the goals in respect of take-back, reuse, recycling and recovery. The said goals must be discussed and agreed upon between the government and EEE manufacturers before being progressively implemented and periodically adjusted;
- administer the information system relating to WEEE producers;
- foster job creation and training in the area of WEEE management for people in the most vulnerable population segments;
- exercise supervision and control vis-à-vis the various stakeholders to ensure compliance with the regulations, and impose sanctions where necessary;
- organize and direct the e-waste committee. It is important to establish a committee comprising representatives of the stakeholders and of the relevant government entities, for the purpose of discussing, at periodic meetings, technical and organizational aspects of the e-waste management system. The committee should also seek to promote ongoing research into the technical aspects of WEEE management, and study potential sources of financing to that end.

- **Supply chain**

Made up of manufacturers, importers, assemblers, distributors and traders. In those developing countries where no manufacturers are present, it must be clearly established to whom the corresponding responsibilities are to be assigned; for example, manufacturers, importers and assemblers could be grouped together in a category designated "Producers" with the same responsibilities.

These stakeholders would have the following main responsibilities:

- Comply with the regulations governing e-waste.
- Maintain the register of producers, meet the targets and report the results obtained in relation to WEEE management.
- Develop ideas relating to eco-design and cleaner production.
- Provide technical information (e.g. hazardous components in WEEE) and general information (e.g. collection points) to EEE consumers and WEEE managers.
- Comply with the model established for financing of the e-waste management system.
- Allow supervision and control by the government.

- Play an active part in the e-waste committee.
- Carry out information and awareness campaigns encouraging the take-back of disused EEE and their subsequent environmental management.
- In addition to the above responsibilities, traders and distributors should install collection points for disused ICT equipment and provide technical and logistical support to producers.

- **Consumption of ICT equipment**

Relates to donors, donation recipients and purchasers. The key responsibilities are as follows:

- Comply with the regulations governing e-waste.
- Foster a reduction in the rate of WEEE generation.
- Return disused EEE to producers.
- Comply with the model established for the financing of the e-waste management system.
- Allow supervision and control by the government.
- Play an active part in the e-waste committee.

- **Disposal of wastes**

Relates to WEEE managers, reconditioners, recyclers and companies handling disposal. These stakeholders will have the following basic responsibilities:

- Comply with the regulations governing e-waste.
- Carry out environmentally sound management of WEEE in line with international standards, best practices and the rules adopted by each country in that regard.
- Foster a reduction in the rate of WEEE generation.
- Comply with government regulations designed to foster job creation.
- Support the goals established with respect to take-back, reuse, recycling and recovery of e-waste.
- Allow supervision and control by the government.
- Play an active part in the e-waste committee.

2.2.3 Extended producer responsibility (EPR) and the e-waste management system

WEEE regulations adopted by the governments of developing countries should include the principle of extended producer responsibility (EPR), which has been universally accepted, since ICT equipment manufacturers are transnational and operate globally. Under this principle, the manufacturer's responsibility for its ICT equipment extends throughout the various stages of that equipment's life cycle, with manufacturers internalizing the cost of managing the equipment at end of life, through EPR. The EPR principle can be implemented through individual or collective systems, the latter also being known as "producer responsibility organizations" (PRO).

Dealing with individual systems can be difficult because, depending on market share, some stakeholders within the supply chain could have difficulties in achieving the goals set by the government with respect to WEEE management and it would be difficult to ensure the management of historical and orphan equipment, while at the same time the cost of inverse logistics could be higher than normal. With the individual system, and where there is no "door-to-door" collection, users must bring their disused ICT equipment to specific locations, it being no easy matter to guarantee the quantities required for reasons relating to lack of awareness on the part of the consumer, in addition to which separation by brand would be a complicated task (Ott, D., EMPA, 2008). In the case of selective "door-to-door" collection the costs would be significant, and brand-differentiated take-back would be complicated given the lack of certainty as to the existence of given brands in the locations visited for take-back purposes.

Through collective systems it is possible to establish public-private partnerships with a view to implementing a network of collection points in shopping centres, educational facilities, technical service centres and the sales and customer-service points of, among others, television and mobile-telephony operators. A further factor to be borne in mind when implementing collective systems is coverage, be it at the national or regional (involving several countries) level, since the existence of a regional PRO allows for greater control over the cross-border movement of WEEE between the countries of the region in question, in addition to which it is easier for a government to supervise a single PRO than several such entities.

Collective systems present a number of additional advantages, inasmuch as they facilitate negotiations with recycling companies; facilitate the achievement of goals; reduce collection costs through economies of scale; enable the inclusion of historical and orphan wastes; and are able to identify "free riders", i.e. unregistered producers which do not contribute to the financing of the e-waste management system. On the other hand, a single PRO means an absence of competition, resulting in the creation of monopolies and in high costs at the various stages of WEEE management. In order to avoid such disadvantages, the government should foster the creation of various PROs (Ott, D., EMPA, 2008). PROs should be monitored and controlled by the government, which should be authorized to view their financial statements.

"Major challenges in setting up a fully functional EPR system have been found in European countries under EU Directive compliance, and include collection, national registry, logistics and financing". The collective system, which is currently the one preferred, has been "tried out" in various countries. "A majority of developing countries have either planned or developed their regulations under EPR. These countries can benefit from the lessons learnt in implementing the EU Directive". (Nimpuno & Scruggs, 2011).

Finally, companies involved in e-waste management should be controlled by the government and authorized by means of an environmental licensing process to ensure compliance with the technical criteria (international standards and best practices) necessary for the proper management of such waste, in the interests of reducing the negative impacts on the environment and human health.

2.2.4 Information system

It is essential to give consideration to the information that is made available on ICT equipment in the marketplace, as well as on e-waste management. The government should entrust a public entity with responsibility for administering an information system with which the stakeholders in the supply chain must register data that include the following:

- ICT equipment: general information on the companies involved; EEE in the marketplace, by type, brand, weight and quantities.
- Disused EEE management: figures on inverse logistics (take-back and/or return of equipment); quantities of ICT equipment suitable for direct or indirect reuse (repair and/or refurbishment).
- WEEE management: type and quantity of WEE used; type of use; type and quantity of wastes recycled; type and quantity of WEEE treated; type of treatment; type and quantity of wastes finally disposed of and type of final disposal.

All of these stakeholders are responsible for the timely reporting and updating of such relevant information, which will be useful to the government for purposes of planning, amending the regulations as necessary and carrying out monitoring and control activities.

2.2.5 Social aspects (employment and training)

The comprehensive management of e-waste calls for application of the three Rs (reuse, recycle, reduce) and for promoting the direct and indirect reuse of ICT equipment as the first and most important alternative for helping to reduce the rates of e-waste generation, followed by recycling. Both reuse and recycling are conducive to job creation.

In developing countries, informal recyclers, who come from the poorest segments of society, currently carry out part of the recycling and recovery of the materials found in WEEE. However, they do so incorrectly, at enormous cost to the environment and human health. The management of e-waste in developing countries should result in job creation for the most disadvantaged population segments with little or no formal education, and it is thus necessary to develop training activities relating to the direct and indirect refurbishment (repair and/or refurbishment) of EEE and proper management of WEEE.

Such training can be provided by government entities, and the government can in turn promote the creation of jobs in companies dealing with e-waste management, which should be encouraged to adopt manual demanufacturing. The government can, moreover, promote the training of cooperatives (made up of skilled and trained staff) to carry out the environmentally sound management of WEEE, in the interests of improving living conditions and reducing poverty. Given that jobs of this kind generate environmental benefits and help to mitigate pollution and climate change, they are known as "green jobs" and should be promoted by governments in every country.

It is clear that one way of avoiding the improper management of WEEE is to bring the informal sector within the formal sector, rather than competing with or prohibiting it (International Labour Organization, 2012).

2.2.6 Technical aspects

To address this subject, we need to consider the following:

2.2.6.1 Infrastructure, technology and technical guidelines

Developing countries should foster the installation of the requisite infrastructure for proper management of e-waste, with financial support from the government and/or international organizations. Bearing in mind that manual demanufacturing could be an alternative for the creation of jobs for unskilled workers, it is important to include this activity among the preprocessing stages and avoid the use of technology.

Additionally, where the processing stages are concerned, technology has to be used in order to facilitate the recovery, use, treatment and final disposal of WEEE in an environmentally sound manner, in the source country, thereby respecting the proximity principle and enabling the creation and retention of wealth in each nation.

Where the technical aspects are concerned, attention also has to be paid to the flow of information from EEE producers to e-waste managers, in regard to the components and materials used in the manufacture of ICT equipment, location of hazardous substances and preparations, and properties of such substances, among other things. Such an information flow facilitates the proper management of e-waste, enabling reduction and control of any adverse effects on the environment and human health.

The application of environmental standards and technical guidelines is recommended in order to ensure that best practices are followed in the management of ICT wastes, having regard to recognized international standards covering the life cycle of such wastes. The WEELABEX project, in which various stakeholders are involved, establishes European standards for the different stages of WEEE management and conducts audits for the purpose of monitoring the companies responsible for e-waste management.

In addition to the foregoing, it is important to consider the following Partnership Programme initiatives (Document 1/INF/36 – UNEP, 2011):

- **PACE (Partnership for Action on Computing Equipment) guidelines**

These guidelines are intended to increase the environmentally sound management of used and end-of-life computer equipment, having regard to social responsibility, the concept of sustainable development and the promotion of information exchange with respect to the concept of life cycle. The following guidelines and documents have been developed under the programme: Guidance Document on the environmentally sound management of used and end-of-life computing equipment; Guideline on environmentally sound testing, refurbishment and repair of used computing equipment; Guideline on environmentally sound

material recovery and recycling of end-of-life computing equipment; Guidance on transboundary movement of used and end-of-life computing equipment; PACE glossary of terms.

- **MPPI (Mobile Phone Partnership Initiative) guidelines**

The MPPI guidelines provide information relating to the management of used and end-of-life mobile phones. The following guidelines and documents are available: Guidance Document on the environmentally sound management of used and end-of-life mobile telephones; Guideline on the refurbishment of used mobile phones; Guideline on material recovery and recycling of end-of-life mobile phones; Guideline on the awareness raising-design considerations; MPPI glossary of terms.

2.2.6.2 Eco-design or cleaner production

ICT equipment manufacturers should be constantly researching ways and means of extending the life cycle of this type of equipment and working on the replacement of hazardous substances used in their designs with other, more environmentally-friendly substances. Eco-design can have a positive impact in terms of reducing the rate of WEEE generation, facilitating the management of such waste and recovery of materials, and achieving cost reductions. It is important to note that the Basel Convention requires the Parties to reduce the generation of hazardous wastes to a minimum.

In order not to obstruct the importation of equipment needed for the social and digital integration of developing countries, restrictions on the importation of equipment containing contaminating substances should not be any stricter than the recognized international rules.

The MPPI Guidance Document on the environmentally sound management of used and end-of-life mobile telephones² puts forward considerations as to the design of such equipment. It could serve as a reference for proposing a number of factors to be taken into account when designing ICT equipment, such as the following:

- Account must be taken of the six substances – lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ethers – which have been banned by the European Union's RoHS Directive.
- Manufacturers should work in coordination with regulatory bodies, recycling companies, users and others to define the risks, circumstances and priorities in relation to the six hazardous substances.
- Identification of alternatives that are free from brominated fire retardants and lead, without altering characteristics such as the reliability and quality of equipment.
- With the development of new characteristics for the same technology, hardware changes should not be required, i.e. operation on the same platform should be possible.
- Manufacturers of equipment such as mobile phones, cordless phones and portable computers should promote low-energy consumption through the use of renewable energy for battery charging via sources such as solar cells. Low-energy consumption could eliminate or reduce the need for flame retardants, enabling manufacturers to turn to alternatives such as increased use of efficient electronic components.
- Promote the recycling of plastics from ICT equipment, which means that the design stage must be more exacting in terms of materials selection, making it possible to eliminate plastics classification stages during the recycling phase.
- Consider Recommendation ITU-T L.1000 for the design and manufacture of universal current adapters and charger solutions, in the interests of reducing energy consumption and adapting a

² The document was prepared in accordance with the decision formulated by the Mobile Phone Working Group and adopted by the Conference of the Parties to the Basel Convention, seventh meeting, decision VII/4.

wide range of ICT equipment. Such alternative design facilitates substitution and avoids duplication of devices, which in turn reduces the demand for raw materials and generation of waste.

The EPR principle is enabling eco-design to become a priority for manufacturers, which must now assume some or all of the costs associated with WEEE management, according to the mechanisms defined for financing of the system.

2.2.7 Informing and raising the awareness of ICT equipment consumers

EEE manufacturers must comply with labelling requirements by providing data relating to: hazardous material content; potential risks for health and the environment; and availability of collection points for disused ICT equipment. Manufacturers must also communicate to consumers the importance of not treating WEEE as ordinary waste, by displaying the following symbol designed for that purpose:

Figure 1: Symbol for use by manufacturers to inform consumers that their ICT equipment is not to be classified as ordinary waste



The media, with financial support from the government and stakeholders in the EEE supply chain, has a fundamental role to play in the creation of environmental awareness among consumers, in the interests of ensuring that, among other things, disused ICT equipment is taken to collection points and technology is used in a responsible manner. The education sector in each country also has an important role to play in fostering environmental awareness among children and young people, who are no strangers to the magnitude of today's ICT phenomenon.

2.2.8 Economic aspects

In addition to the technical (environmental), social and organizational aspects of the electrical and electronic waste management system, it is also crucial to consider the economic aspects, since the system has to be made financially viable and sustainable.

2.2.8.1 Business opportunities in the comprehensive management of disused EEEs and WEEE

It is clear that the comprehensive management of electrical and electronic devices and of waste ICT equipment constitutes a source of business opportunities which need to be analysed in the light of the conditions specific to each individual country, while not forgetting the importance of achieving a balance between the economic, environmental and social aspects, since striving for economic benefits per se while overlooking the environmental benefits and poverty reduction that should be an offshoot of such management will not produce the desired impact, especially in developing countries.

According to the International Association of Electronics Recyclers (IAER), in 2006 the electrical and electronic devices recycling industry made annual earnings in the vicinity of USD 1.5 billion and employed some 19 000 people in 500 processing plants worldwide (IAER, 2006, quoted by Kahhat et al., 2008), which goes to show that WEEE management can be a profitable and highly beneficial business, particularly in developing countries.

Each of the stages in disused EEE and WEEE management represents expenses and revenue. This being the case, it is a good idea for each country to carry out studies involving the application of simulation models in order to analyse the financial viability and sustainability of different scenarios, taking into account variables such as: requisite infrastructure and percentage utilization thereof (either individually or in partnership with other countries of the region); methods involving the take-back of disused equipment; quantities of equipment taken back and managed; direct and indirect reuse of ICT equipment; manual or mechanical disassembly (the idea being to foster manual demanufacturing in order to generate more jobs, bearing in mind that mechanical disassembly involves higher operational costs); recycling of clean materials; management of materials with hazardous properties (including PCBs, CRTs and batteries).

The biggest expenditure items are liable to be: initial investment in infrastructure (plant); take-back of disused EEE (depending on the method applied); management of CRTs, batteries and capacitors, and separation of precious, rare and heavy metals. The most significant revenues are liable to come from the sale of reused equipment and recovery of ferrous metals, copper and precious and rare metals present in PCBs. In the case of developing countries, a key factor is the infrastructure necessary to enable local recovery of valuable materials (precious and rare metals), bearing in mind that the exportation of PCBs to developing countries should be avoided.

In the interests of fostering reuse as a key process for the generation of benefits that are not only environmental (reduction of WEEE generation rates) and social (reducing the digital divide), but also economic in nature, it is essential that disused equipment be collected in a timely manner so that users do not have to keep such EEEs in their homes or workplaces for lengthy periods of time, thereby ensuring that they re-enter the system with a greater remaining lifetime, this in turn increasing reuse rates and higher selling prices in the reusable equipment market, with the correspondingly greater financial support this will generate for the system (Hoyos, J., 2011).

2.2.8.2 Economic models for financing a WEEE management system

The experience of a number of countries has enabled the identification of various economic models to finance the WEEE management system, as follows:

- **Financing by consumers**

This option involves the payment of an advance recycling fee, which is charged to the consumer at the time of purchase and corresponds to the cost of managing the new equipment when it reaches end of life. The fee may be visible or invisible to the consumer, but the recommendation is that it be visible, appearing as a separate item on both price tag and invoice, since consumers should know how much they are contributing (Astaíza, M., 2010). This helps raise awareness as to the importance of responsible consumption, albeit from an economic angle. With this option, the producer does not bear the financial responsibility, and this constitutes a drawback, since the consumer's contributions may prove insufficient to ensure the economic sustainability of the WEEE management system. Furthermore, this approach runs counter to the EPR principle and inhibits the development of eco-design, leaving the entire responsibility with the consumer.

There is a variation on this model, whereby consumers can return disused equipment to a collection point, in which case they have to pay a sum of money for management of the e-waste or turn in used ICT equipment when they buy new, with the promise of a discount rate (one for one). This financing model is inappropriate, since the first alternative offers no incentive for returning used EEE, with consumers preferring to save money and avoid paying when they return equipment, while the second offers no incentive for the responsible consumption of ICT equipment.

- **Financing by players in the supply chain**

With this model, manufacturers, importers, assemblers, marketers and distributors are responsible for financing the e-waste management system based on their market participation and the environmental impact of their products at end of life, depending on the type of EEE introduced on the market. The funds obtained from use of this model should come from the profits made on the sale of ICT equipment. In this case, producers, marketers and distributors bear full responsibility for the management of historical and

orphan equipment. This approach runs somewhat counter to the "polluter pays" precept, inasmuch as it does not involve the consumer and may not suffice to ensure the system's economic sustainability.

- **Financing by players in the supply chain and consumers**

With this model, the manufacturers, marketers and distributors have to pay a sum of money (which should come from the profits made on the sale of EEE), taking into account their market participation and the environmental impact of the type of ICT equipment marketed when it reaches end of life. The said players bear responsibility for the management of historical and orphan equipment.

In the same way, the consumer contributes to financing the system by paying an advance recycling fee which is visible at the time of any new equipment purchase. The contribution may vary depending on whether it relates to ICT equipment for residential (home or domestic) or professional (corporate or business) use. In the latter case, the amount of the contribution should be greater, having regard to the type and quantity of disused EEE and its environmental impact.

It is suggested that this model be used in the case of developing countries, with adaptation as appropriate to the specific conditions of each country.

One of the main challenges when implementing an e-waste management system is ensuring its sustainability and profitability. Clearly, the investment costs of establishing and operating WEEE pre-treatment and treatment facilities are very high and the volumes of disused equipment liable to be collected relatively small. It is therefore essential to carry out an exhaustive cost analysis to identify the most efficient financing mechanism for covering the costs of inverse logistics and the other stages of e-waste management, and to carry out campaigns to make ICT equipment consumers aware of the importance of handing in their disused equipment rather than hoarding it.

The funds collected by means of the selected financing model should be paid into a special fund or blocked account supervised and controlled by a public or private entity designated for the purpose by the government. The returns generated by this account together with the income derived from fines can be put towards financing the management of historical and orphan equipment.

2.2.9 Supervision and control of the system

The government could make various public entities responsible for supervising and controlling the various players involved in the e-waste management system, with the aim of ensuring compliance with each country's WEEE policy and corresponding regulations. These actions should be carried out regularly, with due regard for transparency, impartiality and efficiency.

2.2.10 Sanctions

The supervision and control procedures could be accompanied by administrative, penal and disciplinary sanctions. Administrative sanctions could include the suspension or withdrawal of environmental and operating licences from WEEE managers and imposition of fines, the proceeds from which could be used to finance the management of historical and orphan ICT equipment. The sanctions imposed must be effective, proportionate and dissuasive.

3 Conclusions and recommendations

- There is no unique or ideal model for e-waste management in developing countries, each of which has its own specific environmental, social, technological, economic and cultural conditions. Some factors are, however, common to all countries and represent key considerations in the formulation of any WEEE policy.
- The developing countries have a very strong need to form part of the information and knowledge society and reduce the digital divide. In many cases, this need results in their receiving used ICT equipment which turns out to be unsuitable for reuse, either direct or indirect, significantly

increasing the volume of WEEE to be managed. Those countries must therefore ensure that their policies include clear criteria for controlling the entry of such equipment.

- It is important for developing-country governments to commit to the environmentally sound management of WEEE, taking the initiative through the adoption of policies and regulations to improve the current situation, despite the conflict of interests that can sometimes arise between the different players and which are resulting in developing countries being flooded with e-waste generated both at home and abroad.
- Based on the experience of various countries in implementing ERP, developing nations should consider the option of incorporating this principle in their WEEE policies, together with solutions related to: the import and export of EEE and WEEE; the responsibilities of stakeholders, and gradualness in establishing the goals to be achieved; information system; social aspects (employment and training); technical aspects (infrastructure, technology and technical guidelines); eco-design or cleaner production; informing and raising the awareness of ICT equipment consumers; economic aspects (business opportunities; economic models for financing a WEEE management system); supervision and control of the system; sanctions.
- A public policy on WEEE management for developing countries should be adopted at State level to encourage the reuse of EEE, with the emphasis on minimizing and recycling WEEE.
- It is recommended that waste-management policies in developing countries accord prevalence to reuse over recycling, as the former is more carbon-efficient and involves less energy consumption, as it does not require the extraction of new raw materials.
- When drawing up their WEEE policy, developing countries could do well to take into account the six EEE classification categories set forth in European Union Directive PE-CONS 2/12, and the fact that each category can be regulated separately, in order to facilitate overall implementation and management of the specific characteristics of each category.
- It is important for the government to promote research and innovation in regard to e-waste, as well as eco-design on the part of manufacturers, as key factors in facilitating the management of such waste and reducing the associated costs.
- Not all countries and regions require the transfer or adoption of technology for the proper management of e-waste, since this will depend on, among other things: their socio-economic situation; the volumes of WEEE to be managed; demand for manpower for stages such as collection, disassembly, separation and manual classification; labour costs; and existing regulations on ICT waste. In the case of the developing countries, which share high rates of poverty and unemployment, the focus should be more on generating job opportunities for unqualified manual workers as part of the WEEE management process.
- It is suggested that, for the environmentally sound management of WEEE, countries should adopt internationally as well as nationally recognized standards and best practices in order to reduce the possible negative impacts on the environment and human health caused by the inappropriate handling of e-waste.
- It is important for countries and regions to make efforts to develop local infrastructure for the recovery of valuable materials (precious and rare metals) and correct management of hazardous waste present in WEEE, by establishing refineries, incineration plants, cement kilns, secure landfills, validated and certified recycling methods, etc., based on stringent technical and security standards, thereby obviating or reducing the cross-border movement of hazardous waste and thus avoiding transference of the problem to nations not equipped with the necessary infrastructure.
- The government should facilitate and promote establishment of the infrastructure needed for carrying out the processes involved in recovering the useful materials (precious and rare metals) present in ICT waste, thereby avoiding the need to send such waste abroad for proper management and ensuring that the wealth it embodies remains in the developing countries.

- When it comes to developing WEEE planning processes, establishing and adjusting goals and exercising oversight and control functions, a key factor is the existence of an information system created and administered by the government of each country and fed into by the other stakeholders.
- It is recommended that a recyclers' organization or entity be created at the regional or country level as a channel to enable producers and recyclers to share information on components, substances and rare metals present in WEEE, with a view to its increasingly proper management at local level. The organization or entity in question will also be in a position to provide technical information relating to WEEE managers operating at the global level and the services they provide.
- It is recommended that the policies and regulations governing the management of WEEE that has been dispatched to developing countries be developed on a holistic basis that facilitates development and interlinking of the economic, social and environmental aspects in a way that makes it possible for anyone entering the WEEE management business to derive benefits, and allows for integration of the informal sector, which in most cases comprises the most underprivileged segments of the population.
- It is essential that entities involved in WEEE management deal not only with waste that generates income (e.g. printed circuit boards), but also with waste that incurs costs on account of the need to process hazardous substances (e.g. CRTs, LCD screens, etc.). In many cases, costs could outweigh income, making it indispensable to have a financing system fed by monetary contributions from both ICT equipment producers and consumers, and to pursue research into safe use of such waste.
- It is important for producers, marketers and distributors, as well as the government, to promote the reuse and responsible consumption of WEEE, employing various means of communication and including the subject in children's and young people's education, as a strategy for reducing the quantities of e-waste generated, where the trend towards (exponential) growth is highly alarming.
- The government should facilitate the creation and implementation of a WEEE management system, without overlooking the role of oversight and control it must play, based on criteria of transparency and impartiality, with the aim of ensuring compliance with the legislation it adopts on the subject.
- Developing countries should employ simulation models to enable them to ascertain those scenarios that are the most advantageous from the economic standpoint and that ensure the financial viability and sustainability of the disused EEE and WEEE management system, without overlooking the balance to be maintained between economic, environmental and social aspects, in order to achieve the desired impact.
- When implementing the WEEE management regulations, prior experience is important, and it is therefore suggested that the implementation of pilot programmes should be promoted in different countries or regions, with the aim of identifying, in practical terms, the drawbacks that may arise in each stage of WEEE management; problems in educating people to hand in their disused equipment; advantages of integrating the informal sector and associated difficulties; implementation of the EPR principle; and so on.

Glossary

Recycling and/or recovery: the process of recovering the residual value or calorific value of the materials comprising hazardous residues or wastes, by means of salvaging, recycling or reclamation (Decree 4741 MADS, Colombia, 2005).

Basel Convention: multilateral environmental treaty dealing with hazardous and other wastes. It has 170 Member States (Parties) and its purpose is to protect the environment and human health from the harmful effects arising from the generation, handling, transboundary movement and disposal of hazardous and other wastes. The Basel Convention was negotiated in the late 1980s, approved in 1989 and entered into force on 5 May 1992 (<http://www.basel.int/Home/tabid/2202/Default.aspx>).

Cannibalization/disassembly/demanufacturing: demanufacturing of computer equipment, components or assemblies in order to separate the materials and/or expand the recycling options and maximize the recovery value.

Final disposal: operations specified in Annex IV A of the Basel Convention for isolating and confining hazardous residues or wastes, especially those that cannot be recycled, in specially selected and duly authorized locations designed to avoid contamination and any damage or risks to human health and the environment (Decree 4741 MADS, Colombia, 2005).

Comprehensive management: an interlinked and interrelated body of policy, regulatory, operational, financial, planning, administrative, social, educational, evaluative, follow-up and monitoring measures ranging from prevention of the generation to final disposal of hazardous residues or wastes, in the interests of securing environmental benefits, economic optimization of the processing operations and social acceptance thereof, with due attention to the needs and circumstances of each locality or region (Decree 4741 MADS, Colombia, 2005).

Comprehensive handling: the adoption of all requisite measures within the context of activities aimed at prevention, production and separation at source, collection, storage, transportation, recycling and/or recovery, processing and/or final disposal, import and export of hazardous residues or wastes, whether individually or appropriately combined, such as to protect human health and the environment against the temporary and/or permanent harmful effects that may stem from such residues or wastes (Decree 4741 MADS, Colombia, 2005).

Incineration: a thermal processing technology for the burning or destruction of wastes, sludges or residues at temperatures ranging from 850° C to over 1 100° C.

Domestic or residential WEEE: household-generated WEEE.

Professional or corporate WEEE: WEEE generated by public or private enterprises.

Historical WEEE: wastes from EEE which were put on the market before the entry into force of legal provisions governing WEEE.

Orphan WEEE: wastes from EEE without any identifiable manufacturer or whose manufacturers have left the market.

Refurbishment: a process for obtaining renovated or refurbished EEE by means of activities such as cleaning, data wiping and software updating. It may include repairs in cases of damaged equipment.

Repair: the process of correcting a specific hardware fault or series of faults in EEE.

Take-back or reverse logistics: a procedure established by the manufacturer to take back and/or collect disused EEE and transport them to refurbishment centres or facilities authorized for the management of WEEE.

Reuse: bring an EEE or one of its functional components back into use for the same or a similar function, thereby giving it a new lease of life, possibly following refurbishment or repair.

Direct reuse: continued use of EEE and components by a second user, without the need for repairs, refurbishment or hardware updating, provided that such use is for the purpose for which the item was originally manufactured.

Indirect reuse: use of EEE and components by a second user following repairs, refurbishment or hardware updating, provided that such use is for the purpose for which the item was originally manufactured.

Recycling: relevant operations set out in Annex IV B of the Basel Convention, consisting in subjecting a used material or product (WEEE) to a physical-chemical or mechanical processing cycle to obtain a raw material or new product.

Hazardous residue or waste: a residue or waste whose corrosive, reactive, explosive, toxic, inflammable, infectious or radioactive properties may represent a risk, or cause harm, to human health and the environment. Packages and packaging that have been in contact with such items is likewise considered a hazardous residue or waste (Decree 4741 MADS, Colombia, 2005).

RoHS: refers to European Parliament Directive 2002/95/CE restricting certain hazardous substances in electrical and electronic equipment, adopted in February 2003 by the European Union (URL: http://ec.europa.eu/environment/waste/weee/index_en.htm).

Processing: any physical, chemical or mechanical activity carried out in a WEEE-processing facility, including disassembly, separation of hazardous components, recovery of materials, recycling or preparation for disposal.

Life cycle: estimated time span during which an object can be expected to perform correctly the function for which it was manufactured.

Abbreviations

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| ADEME | <i>Agence de l'environnement et de la maîtrise de l'énergie</i> Environment and Energy Management Agency (France) |
| AICN | African ICT Consumers Network |
| ARF | Advance recycling fee |
| BCRC | Basel Convention Regional Centre |
| CEDARE | Center for Environment and Development for the Arab Region and Europe |
| CENARE | <i>Centro Nacional de Aprovechamiento de Residuos Electrónicos</i> National e-waste recycling centre |
| CFC | Chlorofluorocarbon |
| CRT | Cathode ray tube |
| DITT | Department of Information Technology & Telecom |
| EDERA | <i>Estación de Desarrollo de Robótica Educativa y Automatización</i> Educational robotics and automation development station |
| EEE | Electrical and Electronic Equipment |
| EMPA | Swiss Federal Laboratories for Materials Science and Technology |
| EPR | Extended producer responsibility |
| IAER | International Association of Electronics Recyclers |
| ICTs | Information and communication technologies |
| IDS | ICT data and statistics |
| IMPEL | European Union Network for the Implementation and Enforcement of Environmental Law |
| ITU | International Telecommunication Union |
| LCD | Liquid crystal display |
| MPPI | Mobile Phone Partnership Initiative |
| NVMP | Dutch Association for the Disposal of Metal and Electrical Products |
| OCAD3E | Household WEEE Authorized Coordinator Agency |
| ORDEA | Ordinance on the Return, the Take-back and the Disposal of EEE |
| PACE | Partnership for Action on Computing Equipment |
| PCB | Polychlorinated biphenyls |
| PCB | Printed circuit board |
| PRO | Producer Responsibility Organization |
| PVC | Polyvinyl chloride |
| RELAC | Regional Latin American and Caribbean Platform for WEEE |
| RoHS | Restriction of hazardous substances |
| SENS | Swiss Foundation for Waste Management |
| SPREP | Secretariat of the Pacific Regional Environment Programme |
| StEP | Solving the e-waste Problem Initiative |

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| SWICO | Swiss Association for Information, Communication and Organizational Technologies |
| UNEP | United Nations Environment Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNU | United Nations University |
| WEEE | Waste Electrical and Electronic Equipment |
| WEELABEX | WEEE LABEL of EXcellence |

Bibliography

Astaíza, María F. Análisis de la gestión de terminales de telefonía móvil en desuso en Latinoamérica [Analysis of the management of disused mobile phone terminals in Latin America]. Plataforma RELAC – SUR/IDRC. March 2010.

Computadores para Educar [Computers for education]. Document 1/RGQ 24/1/008-S, ITU-D, SG 1 Question 24/1. Colombia, September 2012.

European Parliament and Council of the European Union. Directive PE-CONS 2/12. Brussels, May 2012.

MPPi. UNEP/Basel Convention. Guidance document on the environmentally sound management of used and end-of-life mobile phones. September 2008.

Hoyos, Juan C. Desarrollo y Aplicación de un Modelo de Simulación de un Sistema de Gestión de Residuos de Aparatos Eléctricos y Electrónicos Asociados a las TIC en Colombia para Analizar su Viabilidad Económica y Financiera [Development and application of a simulation model for ICT-related waste electrical and electronic equipment in Colombia with a view to analysing its economic and financial viability]. National University of Colombia, 2011.

Karin Lundgren. International Labour Office, Programme on Safety and Health at Work and the Environment (SafeWork), Sectoral Activities Department (SECTOR). – Geneva: ILO, 2012.

United Nations. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 2013. Downloaded 8 March 2013 from <http://archive.basel.int/index.html>.

Federal Office for the Environment (FOEN), Switzerland. Electrical and Electronic Devices, Documents 1/INF/40E and 2/INF/45E, 2011.

Ott, Daniel. Gestión de Residuos Electrónicos en Colombia. Diagnóstico de computadores y teléfonos celulares [Management of e-waste in Colombia. Diagnostics of computers and cell phones]. EMPA/Centro Nacional de Producción más Limpia, March 2008.

Plataforma RELAC. Lineamientos para la Gestión de los Residuos de Aparatos Eléctricos y Electrónicos (RAEE) en Latinoamérica: resultados de una mesa regional de trabajo público-privado [Guidelines for management of waste electrical and electronic equipment (WEEE) in Latin America: Results of a regional public-private symposium]. Proyecto Regional sobre Armonización de la Gestión de Residuos Electrónicos en Latinoamérica. March 2011.

UNEP. Guidance on the Environmentally Sound Management of Used and End-of-life Mobile Phones and Computing Equipment and Experience with E-waste Management in Developing Countries and Countries with Economies in Transition. Document 1/INF/36-E, ITU-D, SG1 Question 24/1. August 2011.

UNEP. Proposal to develop guidance for the practical implementation of a life-cycle approach for ICT equipment in technical assistance and capacity building projects (Document 1/286E, 2013).

UNEP. Document 1/INF/36-E, 2011.

BDT Focal Point for Question 24/1. ITU Activities in the area of electronic waste. Document 1/205-E, ITU-D, SG 1 Question 24/1. September 2012.

BDT Focal Point for Question 24/1. ITU Activities in the area of electronic waste. Document 1/108-E, ITU-D, SG 1 Question 24/1. August 2011.

BDT Focal Point for Question 24/1. Lessons learned on e-waste. Document RGQ24/1/005-E, ITU-D, SG 1 Question 24/1. April 2011.

African ICT Consumer Network (AICN). Droits et responsabilités des consommateurs : Historique et signification. Document 1/273-F, 2013.

Kingdom of Bhutan. E-waste management in Bhutan. Document RGQ24/1/15-E, ITU-D, SG 1 Question 24/1. March 2012.

Republic of Benin. A useful example for the work of the Rapporteur Group. Document RGQ24/1/2-E, 2011.

Republic of Colombia Ministry of ICT. Survey on telecommunication/ICT waste material. Document 1/95-E, ITU-D, SG 1 Question 24/1. August 2011.

Republic of Colombia Ministry of ICT. ITU Activities in the Area of e-Waste. Document RGQ24/1/014-E, ITU-D, SG 1 Question 24/1. April 2011.

Republic of Korea. Standardization activities to facilitate recycling of rare metals from ICT waste. Document 1/182-E, ITU-D, SG 1 Question 24/1. August 2012.

Republic of Korea. Methodology to facilitate recycling of rare metals from ICT waste. Document 1/INF/30-E, ITU-D, SG 1 Question 24/1. August 2011.

Republic of Rwanda. Update on Rwanda activities on E-Waste Management. Document RGQ24/1/21-E, ITU-D, SG 1 Question 24/1. February 2012.

Republic of Rwanda. Strategies and policies for the proper disposal of e-waste in Rwanda. Document RGQ24/1/004-E, ITU-D, SG 1 Question 24/1. March 2012.

Federative Republic of Brazil. Computers for Connection. Document RGQ24/1/20-E, ITU-D, SG 1 Question 24/1. February 2013.

Federative Republic of Brazil. Electronic waste – mobile phones. Document RGQ24/1/16-E, ITU-D, SG 1 Question 24/1. April 2012.

UNEP Secretariat of the Basel Convention. Contribution to the report with recommendations and actions to be taken by developing countries to implement a comprehensive system of management of telecommunications/ICT waste. Document RGQ24/1/12-E, ITU-D, SG 1 Question 24/1. February 2012.

StEP Solving the e-waste problem. Sustainable innovation and technology transfer. Industrial Sector Studies. Recycling – from e-waste to resources. (2009). Downloaded 22 May 2013 from http://www.unep.org/pdf/pressreleases/E-waste_publication_screen_finalversion-sml.pdf.

Switzerland. Electrical and Electronic Devices. Document 1/INF/40-E, ITU-D, SG 1 Question 24/1. August 2011.

Tanzania. Strategies and policies for the proper disposal or reuse of telecommunication/ICT waste material. Document 1/99-E, ITU-D, SG 1 Question 24/1. 22 August 2011.

THALES Communications (France). European Directive of 2012 on waste electrical and electronic equipment (WEEE). Document 1/145-E, ITU-D, SG 1 Question 24/1. July 2012.

THALES Communications (France). European Business Awards for the Environment 2012. Document 1/141-E, ITU-D, SG 1 Question 24/1. June 2012.

Thales Communications (France). Electronic waste material: recycling aspects (United Nations, Basel Convention). Document RGQ24/1/3-E, ITU-D, SG 1 Question 24/1. March 2011.

THALES Communications (France). Recommendation ITU-T L.1001. Document RGQ24/1/19-E, ITU-D, SG 1 Question 24/1. November 2012.

THALES Communications (France). Ecolabels for electronic products: EPEAT and IT Eco Declaration: EPEAT and IT “Eco Declaration”. Document 1/259-E, 2013.

ITU-D. ICT Statistics. (2013). Downloaded 15 May 2013, from <http://www.itu.int/ITU-D/ict/statistics>

ITU-T Study Group 5. Liaison Statement concerning on ICT and Climate Change Mitigation. Document 1/156-E. April 2012.

Vega, Jorge J. Las TIC como Motor de Desarrollo Económico con Oportunidad Social [ICTs as a motor of economic development with social opportunities]. Argentina, June 2009.

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