EWAM Tool-kit:

Proceedings from the 2012 GeSI & StEP E-waste Academy – Managers Edition (EWAM)

A Closer Look into E-waste Management and System Design

Preface

United Nations University was established by the UN General Assembly in 1973 as “an international community of scholars, engaged in research, postgraduate training and dissemination of knowledge in furtherance of the purposes and principles of the Charter of the United Nations”. Todayin essence, UNU is a leading think tank and operates through a worldwide nexus of institutes and programmes that are coordinated by the UNU Centre in Tokyo.

The UNU Institute for Sustainability and Peace (UNU-ISP) seeks to achieve and promote a better understanding of the issues of global change, peace and security, and development. UNU-ISP takes an innovative approach to sustainability, bridging these cross-cutting themes through research, educational and collaborative initiatives with the aim of solving current problems and anticipating future challenges. UNU-ISP Operating Unit SCYCLE, the first Operating Unit of UNU-ISP, aims to enable societies to reduce the environmental load of the production, use and disposal of ubiquitous goods such as electrical and electronic equipment to sustainable levels through the development and promotion of independent, comprehensive and practical research and capacity building activities as a sound basis for policy development and decision making

Over the last decades the electrical and electronic products have revolutionized the world: mobile phones for maintaining social networks and now accessing the internet; the computer for word processing and increased productivity while also staying connected to news and events in real-time; the refrigerator to keep perishable products from decomposing and potentially having disastrous impacts on human health; light bulbs, which revolutionized the way we literally see the world; and the list goes on and on. Without these products, modern life would not be possible in (post-) industrialized, industrializing and developing countries as well.

Unfortunately, very often these products are being discarded inappropriately at end-of-life becoming what is usually called e-waste. E-waste is usually regarded as a waste problem, which can cause environmental damage to our planet as well as having adverse impacts on human health if not dealt with in an appropriate way. Moreover it can be a waste of valuable and scarce resources, also essential for maintaining existing production chains.

In last ten years a growing number of countries began addressing the e-waste problem and in recent years, a lot of African governments are discussing or are in the process of developing national legislation and policy bills.

Considering that e-waste poses most diverse challenges, including environmental, economic and social aspects, where all stakeholders need to participate in the development and even more the implementation of solutions, UNU-ISP SCYCLE decided to address both policymakers and government officials as well as representatives of small and medium sized companies with an intended focus on developing and transition countries. UNU therefore developed the concept for the first E-waste Academy ever, a pioneering concept in research and capacity building that fosters multi-stakeholder partnerships and collaboration on e-waste policy and management, looking at the e-waste issue in its entirety, rather than through the lens of a specific discipline.

The E-waste Academy – Managers Edition (EWAM) will offer a diverse curriculum in an innovative collaborative framework supported by various methodologies including expert lectures, group work, workshops, participant presentations and site visits with an international interdisciplinary faculty and experienced facilitators.

It is important to remember that e-waste is not inherently a problem as it is a readily available source of valuable raw materials and resources. Once humans and systems become involved in the equation, only then can it pose a serious threat. Against this, one solution to this is to have holistic system approaches laying the ground for sound policy instruments and vice-versa in place to foster the safe and proper recovery of these valuable materials thereby reincorporating them back into the supply chain.

There are numerous, extensive manuals and guidelines existing on e-waste management – developed by Agencies of the UN, national governments, research institutes, consulting companies et al – most of them characterized by the same lengthy, text-driven structure. With this EWAM Tool-Kit, users will have access to the proceedings of the entire 2012 E-waste Academy – Managers Edition, which can offer an easy-to-navigate compendium of the fundamental e-waste elements to consider when looking into the complexity of e-waste and how a life cycle perspective and systems thinking contribute to effective e-waste solutions.

Ruediger Kuehr

1 Background

1.1 What is the EWAM Tool-Kit and how to use it

There are numerous, extensive manuals and guidelines existing on e-waste management – developed by Agencies of the UN, national governments, research institutes, consulting companies et al – most of them characterized by the same lengthy, text-driven structure. With this EWAM Tool-Kit, users will have access to the proceedings of the entire 2012 E-waste Academy – Managers Edition, which can offer an easy-to-navigate compendium of the fundamental e-waste elements to consider when looking into the complexity of e-waste and how a life cycle perspective and systems thinking contribute to effective e-waste solutions.

When going through the different sections of the the EWAM Tool-Kit, it is important to keep in mind this set of proceedings builds off of the actual programme structure, interdisciplinary content and interactive discussions of the first E-waste Academy – Managers Edition which took place in June 2012 in Ghana. It provides e-waste system insights based on the entire WEEE value chain – from policy and enforcement to design, (re)use, collection, recycling using practical examples and existing scenarios from our international EWAM expert faculty members.

One of the most unique aspects of the EWAM Tool-Kit is that users will be able to watch the actual video recordings of all expert faculty members as the 5-day EWAM programme was video recorded in real-time. In this sense you will be able to watch the expert lectures generating the feeling as if you were sitting in the room listening to the presentation. Additionally, for e-waste system areas of particular interest to you, we provide recommended reading with short summaries of the documents or publications.

1.2 What is the E-waste Academy – Managers Edition (EWAM)

The E-waste Academy – Managers Edition (EWAM) is a pioneering concept in research and will foster multi-stakeholder partnerships and collaboration on e-waste policy and management, looking at the e-waste issue in its entirety, rather than through the lens of a specific discipline.

Considering that e-waste poses most diverse challenges, including environmental, economic and social aspects, where all stakeholders need to participate in the development and even more in the implementation of solutions, EWAM addresses both policymakers and government officials as well as small and medium sized companies (mostly recyclers, collectors and refurbishers) with an intended focus on developing/transition countries. The vision for the EWAM is to be the foremost forum available for stakeholders involved in e-waste system design as well as implementing solutions to share their knowledge, interact with experts and develop collaborative partnerships fostering high long-term, sustainable solutions and approaches on all policy-related areas related in e-waste - from policy to technology to economics to social aspects.

The EWAM offers participants a diverse curriculum in an innovative, collaborative framework supported by various methodologies including expert lectures, workshops, interactive group work and site visit(s) with an international interdisciplinary faculty and experienced facilitators.

Objectives are to:

- Establish a platform for exchange of best practices.
- Snapshot into the current status of e-waste policy in the respective countries.
- Foster an interactive atmosphere of knowledge sharing and practical first-hand experiences, supporting better-informed decision-making.
- Get feedback and advice from e-waste experts and fellow policymakers.
- Establish a sustaining network for continued interaction after the EWAM.
- Integrate E-waste Academy alumni into the StEP and sponsors' networks in order to ensure a continued, mutual information flow among participants and sponsors as well as maintaining positive momentum even after the EWAM has come to a close .

For those reasons the curriculum comprises a mix of expert faculty lectures, site visit(s), interactive workshops and presentation of final EWAM outputs. One envisaged sustaining output is the establishment of National/Regional Permanent Working Group (PWG) that would provide regular snapshots into latest policy developments in the participants' countries. Such a platform could be maintained via regularly scheduled conference calls between PWG members, rotating physical meetings and the introduction and use of online tools that allows sharing of documents in a controlled, secure setting as well as access to updates and news on existing policy documents with commentary by experts, science and academia.

1.3 United Nations University Institute for Sustainability and Peace, Operating Unit SCYCLE

UNU-ISP SCYCLE, located in Germany, is UNU-ISP's first Operating Unit and became operational on 1 January 2010. It integrates the activities of the former UNU/ZEF European Focal Point into its framework. The intent of SCYCLE is to contribute to UNU-ISP objectives, primarily by:

> *Enabling societies to reduce the environmental load of the production, use and disposal of especially but not exclusively, electrical and electronic equipment to sustainable levels through the development and promotion of independent, comprehensive and practical research as a sound basis for policy development and decision making.*

Hence, SCYCLE stands for Sustainable Cycles, which are the key objectives of its work. Within this context SCYCLE will:

- Conduct research on eco-structuring towards sustainable societies
- Develop interdisciplinary and multi-stakeholder public-private partnerships
- Undertake education, training and capacity development
- Facilitate and disseminate practical, science-based recommendations to the United Nations and its agencies, governments, scholars, industry and the public

SCYCLE also hosts the Secretariat of the StEP (Solving the E-waste Problem) Initiative. StEP was launched in March 2007 and now consists of more than fifty stakeholders from industry, academia, government, international organizations and civil society committed to the development of applicable, holistic, science-based recommendations concerning the increasing e-waste problem. It also intends to expand the work of the Electronics Recycling Group (ERG) by extending its world-wide university network for post-graduate training and among others through the continuation of the StEP E-waste Summer School Series. It supports the realization of a more sustainable industrial-societal system (in which, for example, the waste products of one industry or sector become value-added inputs for another).

While there are many research centres focusing on production and consumption, SCYCLE is unique as its concept embraces a holistic approach, while its operations converge on the nexus of policy, design, re-use, recycling and capacity building, an approach that provides additional entry-points for essential multi-stakeholder collaborations

Structure:

1.4 Solving the E-waste Problem (StEP) Initiative

Each day a vast number of electrical and electronic devices end up as waste; some of them ready for disposal, others just obsolete. Because the increasing amount of electronics entering the waste stream is gradually mounting up to a serious environmental problem, StEP identified the need for scientific analysis and goal-oriented dialogue from a neutral, scientific-based standpoint in order to find solutions that reduce environmental risks and enhance development. Based on this, the StEP Initiative was developed in late 2004 and has since grown to a 55+ member initiative as of today. As its name already says, StEP is an initiative, i.e. a network of actors who have joined to exchange ideas and experiences and work with each other toward the realization of common aims.

StEP's activities are carried out through its five Task Forces, each addressing one component of the complex e-waste value chain. In each Task Force StEP uses an interdisciplinary lens and undertakes a cross-cutting, life cycle approach to the complexities of the e-waste problem. Because political and legislative guidelines and frameworks influence design, re-use and recycling activities, Task Force 1 "Policy and Legislation" acts as a cross-cutting Task Force as its results and pilot-projects directly and indirectly impact Task Forces 2-4, "ReDesign", "ReUse" and "ReCycle" respectively. Task Force 5 "Capacity Building" also takes on a cross-cutting role by disseminating the results and achievements of the other Task Forces but also by providing a platform to gain from the insights gathered and experiences made by the other Task Forces. In this sense StEP's inter-Task Force approach and organizational structure aims toward providing holistic, systems-oriented solutions to the intricacies along the e-waste spectrum.

StEP's prime objectives are:

- Optimize the life cycle of electrical and electronic equipment
- Improve supply chains and close material loop
- Reduce contamination
- Increase utilization of resources and promote re-use of equipment
- Exercise concern about disparities such as the digital divide between the industrializing and industrialized countries
- Increase public, scientific and business knowledge

1.5 Global e-Sustainability Initiative (GeSI)

The Global e-Sustainability Initiative (GeSI) is a strategic partnership of the Information and Communication Technology (ICT) sector and organisations committed to creating and promoting technologies and practices that foster economic, environmental and social sustainability.

Formed in 2001, GeSI's vision is a sustainable world through responsible, ICT-enabled transformation. GeSI fosters global and open cooperation, informs the public of its members' voluntary actions to improve their sustainability performance, and promotes technologies that foster sustainable development.

GeSI has 31 members representing leading companies and associations from the ICT sector. GeSI also partners with two UN organizations - the United Nations Environment Programme (UNEP) and the International Telecommunications Union (ITU) - as well as a range of international stakeholders committed to ICT sustainability objectives. These partnerships help shape GeSI's global vision regarding the evolution of the ICT sector, and how it can best meet the challenges of sustainable development.

1.6 Sponsors

1.6.1 GeSI

The Global e-Sustainability Initiative (GeSI) is a strategic partnership of the Information and Communication Technology (ICT) sector and organisations committed to creating and promoting technologies and practices that foster economic, environmental and social sustainability.

Formed in 2001, GeSI's vision is a sustainable world through responsible, ICT-enabled transformation. GeSI fosters global and open cooperation, informs the public of its members' voluntary actions to improve their sustainability performance, and promotes technologies that foster sustainable development. GeSI has 31 members representing leading companies and associations from the ICT sector.

GeSI also partners with two UN organizations - the United Nations Environment Programme (UNEP) and the International Telecommunications Union (ITU) - as well as a range of international stakeholders committed to ICT sustainability objectives.

These partnerships help shape GeSI's global vision regarding the evolution of the ICT sector, and how it can best meet the challenges of sustainable development.

1.6.2 UNEP – IETC

The International Environmental Technology Centre (IETC) is a branch of the United Nations Environment Programme (UNEP) / Division of Technology, Industry and Economics (DTIE). Its main function is to promote the application of environmentally sound technologies (ESTs) in developing countries and countries in transition. Currently IETC focuses on waste management issues. As a part of the United Nations Environment Programme (UNEP), IETC contributes to implementation of its goals and vision.

The work of UNEP is underpinned by the fundamental values identified in the Millennium Declaration of freedom, equality, solidarity, tolerance, respect for nature and shared responsibility and recognizing, among other things, the principle of common but differentiated responsibilities as contained in the Rio Declaration on Environment and Development. The work of UNEP contributes to the achievement of the relevant Millennium Development Goals and enhancing the understanding of agreed international environmental goals and targets.

1.6.3 NVMP ASSOCIATION

The NVMP Association is the collective advocate of six foundations that are directly involved in the regulation and legislation in the field of Waste Electrical and Electronic Equipment (the so-called WEEE-Directive). The manufacturers and importers of electrical and electronic equipment have been united in these six foundations. NVMP aims to collect and recycle equipment marketed by our participants as good as possible, after it has been dismissed. In most cases, we go way beyond what the government prescribes. For collecting and recycling is not just a matter of producer responsibility, but mainly of socially responsible entrepreneurship. With that in mind, the mission of NVMP is very clear: the volume of dismissed equipment collected, needs to increase. That is the challenge we address.

1.6.4 UNIDO

The United Nations Industrial Development Organization (UNIDO) is the specialized agency of the United Nations mandated to promote industrial development and global industrial cooperation. Competitive and environmentally sustainable industry has a crucial role to play in accelerating economic growth, reducing poverty and achieving the Millennium Development Goals (MDGs).

UNIDO works toward improving the quality of life of the world's poor by drawing on its combined global resources and expertise. It provides comprehensive and integrated packages of services which combine its operational activities with its analytical, normative and convening roles, both globally and locally.

UNIDO was established in 1966 and became a specialized agency of the United Nations in 1985. It has 173 Member States and is headquartered in Vienna, Austria, but operates worldwide.

2 Sustainability for Electrical and Electronic Equipment (EEE): Holistic Approach to System Design

2.1 Introduction: How policy can enable solutions to the (W)EEE challenge?

Over the last decades the electronics industry has revolutionized the world: electrical and electronic products have become ubiquitous of today's life around the planet. Without these products, modern life would not be possible in (post-)industrialized, industrializing countries and developing countries as well. These products serve in such areas as medicine, mobility, education, health, food-supply, communication, security, environmental protection and culture. Such appliances include many domestic devices like refrigerators, washing machines, mobile phones, personal computers, printers, toys and TVs.

They are discarded at end-of-life becoming what is usually called e-waste. E-waste is usually regarded as a waste problem, which can cause environmental damage for our planet as well as impacts on human health if not dealt with in an appropriate way. Treatment processes of e-waste aim at either removing the hazardous components or as much of the main recyclable materials (e.g. metals, glass and plastics) as possible at separation; achieving both objectives would be most desired. However, the enormous resource impact of electrical and electronic equipment (EEE) is widely overlooked, especially for some of the materials used during the production phase.

It has been more than ten years since policies have been developed in different parts of the world (European Union, Japan, few US States and even countries in Latin America). Since the start of the implementation process, all stakeholders involved in the electronics recycling chain have gained experience on the impact or potential impact and challenges associated with developing sound policy bills.

In particular difficulties with implementation arose as a result of the complexity of actively involving all relevant stakeholders and agreeing on respective responsibilities. These difficulties have contributed to substantial delays and un-effectiveness sometimes of policies.

End-of-life (EoL) electronics have garnered significant interest among policymakers because they are a waste stream with a unique combination of characteristics. First, levels of EoL electronics, or “e-waste”, have been increasing and are expected to continue on this path. Second, e-waste contains materials that are considered toxic, such as lead, mercury and cadmium, which have led to increased environmental concern about improper disposal of these products. Third, there are valuable materials in e-waste and recovery of these materials can alleviate mining of virgin materials. Finally, in many cases the costs of recycling e-waste exceed the revenues generated from the recovered materials. This is primarily due to the difficulty of separating highly commingled materials in complex products.

These concerns have led policymakers across the world to create systems to collect and process e-waste, also known as "take-back systems". The current in-place systems are nascent and many were developed concurrently without the benefit of learning from existing systems. This leaves policymakers and system architects in the unenviable position of creating systems that are essentially experimental in nature – they must use policy instruments that are new and have not been well-tested. A tangible result is that there is a patchwork of different implementations of e-waste take-back systems in many states and regions. However, in this feat lies various opportunities; through the establishment of a neutral platform for interactive discussion and sharing of experiences among both policymakers and e-waste practitioners, stakeholders are offered a unique position to learn from e-waste approaches and develop a tailored system corresponding to local boundary conditions.

2.2 Life Cycle Approach: Addressing all links in the e-waste value chain

The entire life-cycle chain for modern electronics is quite complex. It involves design and manufacturing/assembly with multiple implications having not only economic but even environmental and social dimensions: product development cannot disregard the analysis concerning the functionality, user expectations and thus marketing and technologies required to implement such functionalities, product manufacturing costs and distribution.

The use phase of electronics represent sometimes the major part of the entire environmental load during the life-cycle of the product. This is mainly due to the impact of energy consumption of the products and sometimes to the long lifespan of the products themselves.

The use and disposal attitude from consumers vary as well across different products and sometimes depending also on geographical and social characteristics of consumers. When consumers decide to dispose the device, a second "cycle" might also occur, sometimes in different countries, with a key role of proper control over trans-boundary movements of second-hand goods or illegal waste shipments; in other cases the recycling chain starts.

The recycling chain for e-waste consists of three main subsequent steps. The first, fundamental one is the collection; the aim is ensuring waste arising is actually available for entering the recycling chain for sub-sequent steps, either under a refurbishment and reuse scenario or under a recycling one.

In some cases after the collection phase, depending on different aspects like the status of the product or social and economic conditions, refurbishment is a valid option as it gives the product a second life usually at a cheaper cost than purchasing a new product. Refurbishment can have many positive implications, especially in developing countries where purchasing power for new products is substantially lower.

After the collection phase, in case recycling is chosen as end-of-life option, e-waste enters plant where sorting, dismantling and pre-processing (sometimes the entire process is called just pre-processing) occur; the aim is to liberate the materials and direct them to adequate subsequent final treatment processes. Hazardous substances have to be removed (so-called de-pollution phase) and stored or treated safely while valuable components/materials need to be taken out for reuse or to be directed to efficient recovery processes. At the very end, the so-called end-processing phase takes place; the aim is to ensure the final recovery of materials is taking place (or safe disposal of hazardous components/substances), in order to ensure raw materials are again entering the commodities market and used in the production of new products.

Usually for each of these steps, specialized operators/plants exist. Treatment processes of e-waste have twofold aims: the first one is removing the hazardous components or substances carried out usually during the so-called de-pollution phase and, sometimes, in specific, high-tech processes occurring in downstream activities. The second one is the separation and recovery of as much of the main recyclable fractions (e.g. ferrous metals, copper, aluminium, glass, plastics) as possible carried out in the pre-processing phase as well in further refining processes carried out in downstream activities.

2.2.1 EXPERT PRESENTATION: Luis Neves (GeSI): ICT and Sustainability – Opportunities and Challenges

Luis Neves, chairman of the Global e-Sustainability Initiative (link to Sponsor section), pointed out the challenges for a sustainable future through proper development of certain ICT solutions. Use of natural resources increased over past years at global level, despite in some regions of the world, consumption of natural resources is much lower than levels seen in developed countries. Over the past decades ICT has transformed our lifestyle, offering new products with broader functionalities and subsequent applications and services. The SMART2020 Report highlighted that by 2020 global CO_2 emissions of the ICT sector will represent roughly 3% of the global volume; at the same time, ICT-enabled solutions can contribute to a 15% reduction of emissions, equal to EUR 600 billion.

A recent study on online household activities enabled by use of broadband showed a net energy savings equivalent to 2% of total energy consumption of the US plus 5 European countries (France, Germany, Italy, Spain and UK). Improvements and benefits of ICT-enabled solutions include energy efficiency efforts from the ICT sector as such, e.g. through the development of common energy-efficiency standards, voluntary codes of conduct for data centres or KPIs for telecommunications networks.

Because all ICT will reach their end-of-life at a certain point in time, the growing, global use of ICT results in an increasing amount of either used or obsolete appliances, requiring effective downstream solutions that take into account environmental, economic, social and political aspects. Sometimes relevant reduction of potential e-waste being generated could be achieved by means of agreement between Industry: in 2010 1.6 billion chargers were placed on the marked and estimations for 2014 forecast a rise to 2.2 billion. The International

Telecommunication Union (ITU) developed a Universal Charger Standard to be used for mobile phones, mp3 players and other devices; the recommendations also include energy efficiency requirements, use of eco-friendly materials and proper consumer awareness. ITU is currently working on an External Power Supply recommendation too.

See the Video

Download the presentation

2.2.2 EXPERT PRESENTATION: Mushtaq Memon (UNEP IETC): UN Approach to E-waste Management / Pilot Project in Cambodia

Mushtaq Memon, Programme Officer at UNEP – IETC (UNEP – IETC), highlighted the main steps required to build a successful pilot project on e-waste collection at the municipal level, using the Phnom Pehn City case study to elaborate on these requirements. Mushtaq pointed out that changes on waste management as such occurred between 20th and 21st century: the shift from a pure waste-oriented perspective (i.e. disposing of waste with minimum damage to human health and environment) to a more integrated resource management perspective (i.e. how to secure proper resource management of waste to ensure sustainable development for future generations).

Pre-requisites for a successful pilot project have been identified and, particularly: establishment of support from a broad composition of stakeholders – high-level stakeholders, a local project team, support from the local political community, as well as cooperation and integration of the project into a broader vision. Training material (UNEP Volume on E-waste Part I, Part II) developed by UNEP could also be of help in planning of the pilot phase.

The set-up of pilot in Cambodia demonstrated the importance of:

- Data and information collection, particularly on volumes of WEEE and current management systems and stakeholders' role in the process
- Visual mapping of activities and location of different steps in the value chain (shops, refurbishers, recyclers...)
- Development of different scenarios taking into account volumes of potential WEEE generated (main appliances included in the scope of the pilot)

Technologies, polices and voluntary measures need to be evaluated from a technical, economic and implemantability perspective under the specific boundary conditions of a municipality, region or country.

Mushtaq also pointed out the main differences by means of a SWOT (Strengths, Weakness, Opportunities, Threats) Analysis between conventional waste management programmes, public-private partnerships and extended producer responsibility-driven approaches when it comes to e-waste collection and treatment. The main recommendations derived from the analysis of case study presented include:

- The importance of multi-stakeholder support through in-depth awareness raising efforts at high-levels but also local ones
- Proper training of the local project team
- Development of proper training and information material to be continuously disseminated (face-to-face meetings or virtual forums) among stakeholders in the value chain

See the Video

Download the presentation

2.2.3 EXPERT PRESENTATION: Oladele Osibanjo (BCRC Nigeria): E-waste: A Challenge To Sustainable Development and Millennium Development Goals In Africa

Prof. Oladele Osibanjo, Executive Director of Basel Convention Regional Centre for African Region (BASEL Convention), presented the current challenges for Africa in order to meet the UN Millennium Development Goals (MDG) and in particular the main elements of a proper e-waste management in the region. Prof. Osibanjo gave an overview of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted back in 1989: in particular on its basic principles, the goals and the main scope. The Basel Convention foresees specific roles for different authorities and stakeholders involved in any transboundary shipment of waste (hazardous and non), based on the Prior Informed Consent principle. In the African Region there are other two relevant conventions for e-waste management:

- The Bamako Convention, prohibiting all imports of hazardous waste in Africa.
- The Basel Ban amendment, banning the export of hazardous waste from OECD to non OECD countries.

Unfortunately the status of ratification and transposition into national legislation of such international conventions in Africa is still quite poor; from a ratification perspective 89% of African Countries ratified Basel, 44% Bamako and 24% the Ban amendment. Only 6 countries in Africa ratified all the three conventions. None of the 3 conventions has been anyway transposed into national laws, even despite ratification from countries.

From an e-waste management specific perspective, the main issues hampering national solutions are linked to the absence of proper infrastructure and legislation or frameworks for implementation of EPR concepts, lack of common approaches at the regional level and inadequate public education and awareness. Environmental concerns for improper e-waste management are strongly linked with social factors and the large role of informal sector in collection and treatment of waste.

Currently momentum has been created through various initiatives and pilot projects with support of different stakeholders: those actions lead to publication of studies, guidelines and input to policies and also some formal recycling pilot projects.

Prof. Osibanjo analysed in detail the Nigeria case study and derived some common opportunities for the African continent, particularly with establishment of regional approaches, strengthening the cooperation between countries in order to better control transboundary movements of waste and build up capacities and ensure volumes are available for the start-up phases of recycling plants.

See the Video

Download the Presentation

2.3 Relevant Documents and Publications

2.3.1 StEP TF1 White Paper: Take-Back System Design

This paper describes of the generic structure of a take-back system, followed by details on the alternatives available to fulfil each component of the system and strengths and weaknesses of various alternatives.

A list of key considerations in system design and examples of current system models from different regions is included at the conclusion of the document.

Read the document

2.3.2 Where are WEEE in Africa

The study provides an overview of African situation in terms of volumes of EEE being imported (new and used), current use and potential e-waste being generated. The report investigates the socio-economic impacts of e-waste recycling and how to prevent illegal incoming flows from developed countries

Read the document

2.3.3 StEP Comments to Ghana E-waste Regulations

In 2011 the Ghanaian authorities approached the StEP Initiative with the request to provide comments and scientific-supported advice on their draft e-waste legislation. Within a multi-stakeholder subgroup in TF1 Policy, StEP developed a comprehensive compendium of comments and recommendations to the Ghanaian government on the draft e-waste legislation.

Read the document

2.3.4 Future Flows Final Report

In 2011 one of the main compliance schemes in the Netherlands, Wecycle, financially supported a project to quantify WEEE arising flows in the Netherlands. The aim of the project was to develop a detailed quantitative assessment of the EEE and WEEE flows as well as qualitative insights into the mechanisms and pathways of collection, recycling, disposal and import plus export from the Netherlands.

The research comprised an extensive survey on consumers, businesses and existing registers, to track sales, discarding behaviour as well as disposal paths for different types of equipment

Read the document

2.3.5 WAIT Final Report

The study, carried out in 2012, focused on the quantification of WEEE Arising and the definition of main complementary streams in Italy.

The study provides evidences in order to support future definition of collection targets and quantifying of household WEEE Generated. It illustrates consumer habits and disposal attitudes for WEEE at consumers. Secondly, it determines the main complementary streams like the waste bin and non-reported recycling, which are a major share of the WEEE destinations.

Through a detailed reconstruction of the historical sales for different types of EEE, the quantification of the accumulated EEE stock in households, and the definition of life-time profiles the quantities of WEEE Generated annually is estimated

Read the document

2.3.6 EMPA Country Assessment series

In the beginning of the 1990s, Switzerland was the world's first country to introduce a national e-waste management system. Since 2003 the Swiss Federal Laboratories for Materials Testing and Research (EMPA), one of the technical control bodies of this system, is passing on the experiences gained in Switzerland on a global scale, focusing specifically on developing countries. Meanwhile, EMPA has been working on dozens of e-waste projects in Africa, Asia and Latin and South America. The ultimate aim of the e-waste projects and programmes is the improvement of living conditions for local residents based on better managed e-waste streams, resource protection, reduced health risks and an improved economic situation. Through the county studies, it's possible to learn more on how to quantify the "size" of e-waste problem in different countries under specific boundary conditions.

Read the document

2.4 Groupwork: Practical Application of Concepts

The underlying concept of the EWAM programme was to foster interaction and collaboration among the participants and experts while also ensuring that participants would be able to validate the content presented by experts through practical application exercises. The EWAM organizers therefore developed interactive group work activities taking place each afternoon following the morning expert lectures; group work results were presented by each group at the end of each day allowing for discussion rounds, rigorous feedback from the expert faculty and sharing of insights and knowledge across the four groups. Additionally, the group work exercises were developed in such a manner that group work results and conclusions generated from the previous day would be interlinked, and quite often serve as inputs, to the group work exercises taking place on the following day. Inclusion of such a dynamic and collaborative group work strategy visually demonstrated the interconnectedness of downstream processes and stakeholder interactions, complexity of e-waste management systems as well as the bottlenecks and smart ideas and systems-oriented solutions along the WEEE value chain.

Practically, all 20 EWAM participants, 10 policymakers and 10 SMEs, were divided into four groups prior to the EWAM where each group consisted of a balanced mix of policymakers and SMEs, ensuring targeted discussion and subsequently group work results incorporating the various perspectives and experiences from political and e-waste management perspectives. Group composition remained the same throughout the 5-day programme and all group work activities were guided by international facilitators coming from industry.

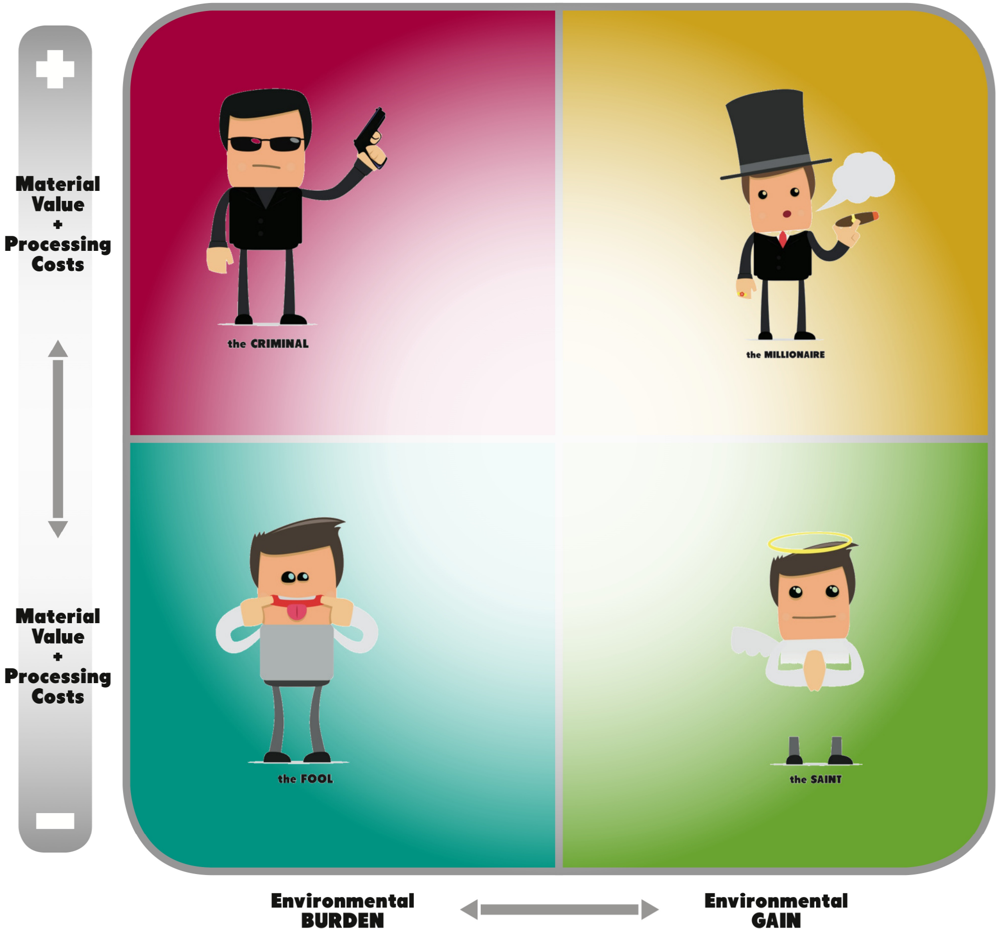
One of the overarching guiding models for all group work activities is the grid explained below. The combination of economic and environmental dimensions into an eco-efficiency diagram enables the understanding of different implications for end-of-life alternatives of scenarios. On the Y-axis of the diagram (see below) we can plot an economic indicator (in this case €) for the total revenues occurring during the recycling process, taking into account the intrinsic material value of products plus the technical costs to allow such fractions to be accessed and sold on the market. The X-axis represents the environmental indicator (LCA scores using any indicator like Eco-Indicator).

Positive values on the Y-axis represent economic revenues, while positive values on X-axis represent environmental gains; contrastingly, negative values on the Y-axis represent costs while negative values on the X-axis represent environmental burdens. These positive areas represent “specific” bests from a purely economic or environmental perspective. Positive values on the Y-axis could represent local bests for companies in the recycling or remanufacturing business, while X-axis positive values could represent local best regulators and policymakers targets. It is important to note that various policy instruments (such as financing mechanisms) and legislation (such as e-waste regulations) can enable moving from one quadrant to another which can allow for visual and spatial depictions from moving from one quadrant to another.

Different end-of-life scenarios/options for the same product (or component), could end up in different areas of the diagram:

- Quadrant red (the criminal): options/activities leading to profits but having negative environmental impacts. Examples include cable burning for recovering copper wire. Usually these options should be prevented by local regulations.
- Quadrant yellow (the millionaire): options leading to profits with positive environmental impacts. Examples include proper recycling of PCBs. These represent win-win situations and scenarios to be promoted.
- Quadrant blue (the foolish) : Options leading to economic losses and environmental burdens. Common sense should, generally speaking, avoid or prevent such alternatives.
- Quadrant green (the saint): Options leading to economic losses despite having a positive environmental impact. Those cases are usually not directly pursued by companies (as leading to losses) but can be encouraged by policymakers and regulators, as leading to environmental benefits; this could be the case of mandatory recycling programs, where the financing of activities leading to environmental improvements or

benefits is required through Extended Producer Responsibility principles or other tools. Examples include proper recycling of light bulbs or CRTs.



3 Design, Production & Distribution

3.1 Introduction

Design and manufacturing/assembly of modern electronics embrace a wide range of activities with multiple implications having not only economic but even environmental and social dimensions: design involves many different aspects; in fact all designers know that development of any product cannot disregard the analysis concerning the functionality, user expectations and thus marketing and technologies required to implement such functionalities, product manufacturing costs and distribution as well as the possible involvement in the end-of-life management according to the paradigms of the expended producer responsibility (EPR). One of the key paradigms of EPR is also fostering of Eco-design: it can be seen as a set of activities aiming at reducing environmental burdens related to the production and use of the product. It involves both the activities aimed at reducing the environmental impact in production and distribution (f.i. selection of materials, use of recycled materials, removal of hazardous substances, improvement and reduction of packaging) and the typical ones related to improvement during use (f.i. reduction of energy consumption) as well as end-of-life (f.i. easier access to and liberation of hazardous components/material, minimize potential recycling accidents and avoid dissipative applications).

3.2 Relevant Documents & Publications

3.2.1 StEP TF2 Green Paper on Substance Restrictions

The paper was developed to depict the worldwide impacts of substance restrictions of ICT equipment. It comprises an overview on hazardous materials in electronics and on the world- wide substance restrictions, which were implemented in the European Union, China, California, Japan and other countries. The direct and secondary impacts of substance restrictions on materials in electronics are described, including the environmental impacts of the substance restrictions and of the substance substitutions, the effects on recycling, the economic impacts and other effects, for example on technological innovation. Present technology trends result in the restriction of further substances that are not part of the scope of the legislation through voluntary agreements and initiatives launched by the manufacturers.

Read the document

3.2.2 StEP TF1 Green Paper on Scarce Metals

The paper takes account of international policies that relate to potential supply and demand distortions of geochemically scarce metals, using indium and tellurium, which are found in thin film photovoltaics, as examples. The findings of a search among major global institutions for such policies, including initiatives and other actions that may lead to policy shifts, are presented and discussed with regard to how supply risks of the selected metals may be affected by policy, as well as in terms of intergenerational equity. This exploratory study concludes that there is a lack of international policy aimed at affecting change relating to the supply and demand patterns of these metals. Recommendations to change this unsatisfactory situation are offered that highlight the importance of international resource data, the need for academic foundation and relevance to resource efficiency in general.

Read the document

4 Use, Collection, Refurbishment & Re-Use

4.1 Introduction

The use phase of electronics represent sometimes the major part of the entire environmental load during the life-cycle of the product. This is mainly due to the impact of energy consumption of the products and sometimes to the long lifespan of the products themselves. Electronic products are highly heterogeneous – ranging from refrigerators to tablets, from car-radios to washing machines – in terms of size and weight, features, and material composition (all of which change over time, even for the same products, as technologies change and the ratios of electronic components increase).

The use and disposal attitude from consumers vary as well across different products and sometimes depending also on geographical and social characteristics of consumers.

When consumers decide to dispose the device, usually the recycling chain starts. Sometimes discarded products are not directly being recycled but entering the re-use channel: in some cases refurbishment might take place, otherwise a direct re-use can also happen. Quite often reuse is taking place in countries different from the one where the first "cycle" occurred. In such cases a proper movement of physical flows of appliances (second-hand) should be compliant with regulations defined by Basel Convention, preventing improper and illegal shipments of waste.

4.2 Experts

4.2.1 EXPERT PRESENTATION: Klaus Willke and Simonne Rufener (IMPEL): WEEE or UEEE: How to distinguish between waste and second hand goods – Classification of e-waste fractions

Klaus Willke and Simonne Rufener from the European Union Network for Implementation and Enforcement of Environmental Law (IMPEL), explained how to distinguish between waste and second hand goods, and how to classify e-waste fractions according to the Basel Convention classification list. Klaus Willke explained how IMPEL-TFS carried out its work on the practical implementation and enforcement of international and European waste shipment rules, through organized projects consisting of awareness raising, capacity building, inter-agency and cross-border collaboration, and operational enforcement activities.

In the context of EU-Africa collaboration, he remarked that countries having ratified the Basel and Bamako Conventions needed to enhance implementation of these Conventions, by transposing them into national legislation and by learning how to correctly and effectively implement the PIC (procedure of informed consent) regulatory system. He noted that there are only two possibilities for equipment at end of first usage: either the item is functional (or can be refurbished), in which case it is classified as a second-hand good, or it is not functional, and classified WEEE. In the latter scenario, WEEE must be further distinguished as hazardous or non-hazardous.

Simonne Rufener presented the E-waste Inspection and Enforcement Manual (produced by IMPEL-TFS under the E-waste Africa project), a practical tool to be used whenever a waste shipment involves transboundary movement, in order to determine whether the waste in question is hazardous or not, and to classify it under the appropriate waste classification code.

She added that the Manual was for general use and could be supplemented by more specific laws. Regarding the classification of waste as hazardous or non-hazardous (respectively, Annex VIII or Annex IX under the Basel Convention) she referred to the national guidelines of the Netherlands, Norway and Switzerland, which provide specific examples of items that are classified as waste at these countries' ports.

At the end the Waste(s) Watch tool was presented, a color-coded, multilingual and visual booklet for classifying waste according to the Basel Convention coding system.

See the Video

Download the presentation

4.2.2 EXPERT PRESENTATION: Jaco Huisman (UNU): Advantages of Manual Dismantling and Pre-Processing

Jaco Huisman from United Nations University – Institute for Sustainability and Peace (UNU-ISP) explained the differences between manual dismantling and mechanical shredding. He guided participants through the learning objective of the dismantling discarded appliances, paving the road for the test carried out by participants. The aim of the dismantling session was essentially for participants to familiarize themselves with product architecture, occupational health, safety, efficiency and toxicity issues related to dismantling, and to assess the value of resulting fractions, in order to finally adopt a business model based on their findings.

See the Video

Download the presentation

4.3 Relevant Documents and Publications

4.3.1 VROM: Export of second hands electronic equipment

The document published by Dutch Inspectorate of Housing, Spatial Planning and the Environment contains information about the export of used electronic equipment. Within European legislation, second-hand electronic equipment is rapidly viewed as waste, unless it still works and can well be used. Only if the conditions stipulated in this information leaflet are complied with, can electronic equipment be considered as a product or second-hand goods. If it does not comply with these conditions, it is considered as waste, and export may occur only under special conditions, or not at all.

Read the document

4.3.2 FOEN: Exporting consumer goods – Second-hand articles or waste?

The document published by Swiss federal office for the environment gives tips for distinguishing between waste and second-hand goods and contains practical advice on how to conform to the relevant environmental regulations. It is directed principally at traders, carriers and relief organisations and aims to bring to their notice the problems associated with the illegal export of waste disguised as trade in second-hand goods.

Read the document

4.3.3 Sft: A guide for exporters of used goods

The document published by Norwegian Pollution Control Authority provide some guidelines (with pictures) on how to distinguish between used goods (to be shipped) and waste, highlighting how to prevent also illegal shipments.

Read the document

4.3.4 StEP TF3 White Paper on Re-use Definitions

The paper is intended to provide StEP definitions for terms associated with "re-use" of electrical and electronic equipment (EEE) or its components.

The term "re-use" (and its associated terminology) has several definitions in international legislations, norms and re-use practice, all embracing different contexts and not following a global standard for communication. These mixed definitions of key terms became barriers for solutions as well as created confusion among academia, government, business and consumers, eventually hindering an efficient re-use market. The purpose of this paper is to present re-use terminology based on a holistic approach and create one "dictionary" of key terms, their definitions and underlying concepts for establishing a global standard for communication.

Read the document

4.3.5 Bo2W Paper (UNU, Umicore, Empa)

E-waste is a complex waste category containing both hazardous and valuable substances. It demands for a cost-efficient treatment system which simultaneously liberates and refines target fractions in an environmentally sound way. In most developing countries there is a lack of systems covering all steps from disposal until final processing due to limited infrastructure and access to technologies and investment. This paper introduces the 'Best-of-2-Worlds' philosophy (Bo2W), which provides a network and pragmatic solution for e-waste treatment in emerging economies. It seeks technical and logistic integration of 'best' pre-processing in developing countries to manually dismantle e-waste and 'best' end-processing to treat hazardous and complex fractions in international state-of-the-art end-processing facilities. The Bo2W philosophy can serve as a pragmatic and environmentally responsible transition before establishment of end-processing facilities in developing countries is made feasible. The executive models of Bo2W should be flexibly differentiated for various countries by adjusting to local conditions related to operational scale, level of centralized operations, dismantling depth, combination with mechanical processing and optimized logistics to international end-processors.

Read the document

5 Pre-Processing & End-Processing

5.1 Introduction

E-waste recycling chain could be divided into three main subsequent steps: collection, dismantling and pre-processing, end-processing for final recovery. Technology plays a crucial role especially in the second and third steps and, in particular, in pre-processing and end-processing. After the collection phase end-of-life appliances are treated in order to obtain components (to be reused or refurbished) or materials fractions (to be recycled and reused as raw materials). Components or material fractions that are not reused or recycled (due to their intrinsic hazardous content or lack of secondary markets) are sent to a suitable disposal site. Notwithstanding different approaches and methods the aim of second and third step of the recycling chain is mainly to:

- Take care of hazardous components and fractions in an environmentally sound manner,
- Economically recover components and material fractions.

The two dimensions are inter-linked by means of eco-efficiency, intended as the effort of obtaining attractive economic results (revenues and costs) without compromising the environment. Any approach has furthermore different social implications so that a full, in-depth assessment needs to be carried out before the optimal solution in different contexts can be identified. Depending on:

1. the type of equipment and treatment technologies available,
2. the socio-economic boundary conditions and
3. the legislative requirements to be fulfilled, different options that can ensure the full treatment of e-waste exist.

While collection, dismantling and pre-processing can differ across different e-waste streams, depending on the constituent components or materials as well as on the technologies available, end-processing technologies have been developed with a focus on the material streams, regardless of the e-waste device stream they come from.

5.2 Waste Streams and Pre-Processing Technologies

The aim of pre-processing phase is to liberate the materials and direct them to adequate subsequent final treatment processes. Pre-processing technologies can vary accordingly to the specific waste stream. E-waste and generally speaking different devices are grouped for the end-of-life management according to specific technologies and processes needed in the downstream phases. Hazardous substances have to be removed and stored or treated safely while valuable components/materials need to be taken out for reuse or to be directed to efficient recovery processes. This includes removal of batteries, capacitors etc. prior to further (mechanical or manual) pre-treatment. The batteries from the devices can be sent to dedicated facilities for the recovery of cobalt, nickel and copper.

For devices containing ozone depleting substances such as refrigerators and air-conditioners, the de-gassing step is crucial in the pre-processing stage as the refrigerants used (CFC or HCFC in older models) need to be removed carefully to avoid air-emissions. For CRT containing appliances (e.g. monitors and TVs) coatings in the panel glass are usually removed as well before end-processing. LCD monitors with mercury-containing backlights need special care too, as the backlights need to be carefully removed before further treatment.

The circuit boards present in ICT equipment and televisions contain most of the precious and special metals as well as lead (solders) and flame retardant containing resins. They can be removed from the devices by manual dismantling, mechanical treatment (shredding and sorting) or a combination of both.

It has to be noted that pre-processing of e-waste is not always necessary. Small, highly complex electronic devices such as mobile phones, MP3 players etc. can (after removal of the battery) also be treated directly by an end-processor to recover the metals.

After removal of the hazardous and other special components described above, the remainder of the ICT, cooling or television devices can be further separated in the material output streams by manual dismantling or mechanical shredding and (automated) sorting techniques. Fractions are usually iron, aluminium, copper, plastic etc. It is of utmost importance that the generated output streams meet the quality requirements of the feed materials for the end-processors. A mismatch between the two can lead to the creation of difficult or non-recyclable fractions. Well-known examples are the limits on copper content in fractions for iron/steel recycling, or the limits on iron, nickel and chromium content in aluminium fractions**Error! Reference source not found.**. Furthermore, a quality mismatch can lead to the loss of material resources. For example, aluminium would not be recovered during end-processing when mixed with an iron/steel fraction or with a printed wiring board fraction, iron/steel is not recovered during aluminium recycling, and copper/precious metals are not recovered during iron/steel recycling. The challenge is to define the right priorities and find a balance in metals recovery that considers economic and environmental impacts instead of only trying to maximize weight based recovery rates, regardless of the substances involved. Another aspect could be the mismatch in physical aspects of the materials, such as particle size. One could think of shredded e-waste material while the smelters can easily take un-shredded material.

5.3 End-Processing Technologies

The end-processing from output fractions after pre-treatment takes place at multiple destinations, depending on the fractions. Ferrous fractions are directed to steel plants for recovery of iron, aluminium fractions are going to aluminium smelters, while copper/lead fractions, circuit boards and other precious metals containing fractions are going to e.g. integrated metal smelters, which recover precious metals, copper and other non-ferrous metals, while isolating the hazardous substances. Hazardous fractions are also directed to specific environmentally sound treatments/plants.

Both ferrous and non-ferrous smelters need to have state-of-the-art off-gas treatment in place to deal with the organic components present in the scrap in the form of paint layers and plastic particles or resins containing flame retardants. During smelting formation of volatile organic compounds (VOCs), dioxins can appear and their formation and emission have to be prevented. Alternatively, painted scrap, such as painted aluminium can be delacquered prior to smelting using appropriate technologies with off-gas control equipment.

For treatment of circuit boards, it is of utmost importance that the smelter is equipped with state-of-the-art off-gas treatment equipment, since otherwise dioxins will be formed and emitted. Standard copper smelters or hydrometallurgical (leaching) plants however, are not advisable for circuit board treatment due to inadequate handling of toxic substances (such as lead, cadmium or organics) and lower metal yields. In hydrometallurgical plants the special handling and disposal requirements necessary for the strongly acidic leaching effluents (e.g. cyanide, nitric acid, aqua regia) have to be diligently followed to ensure environmentally sound operations and to prevent tertiary emissions of hazardous substances.

5.4 Experts

5.4.1 EXPERT PRESENTATION: Mathias Schluep (EMPA): Stakeholder Collaboration along the Recycling Chain

Mathias Schluep, programme manager at EMPA Technology and Society Lab (EMPA-TSL), presented the overall concept of e-waste recycling chain. He identified the stages of the e-waste chain as composed of distribution & consumption, collection, pre-processing, end-processing and disposal. For each stage the main objectives has been presented: improved access, collection rate, recovery of resources/segregation of hazardous waste, safe disposal at end-of-life. The main stakeholders has been also identified across different stages. Stages in the recycling chain are also characterized by unwanted processes like the import of e-waste and near end-of-life EEE, improper dumping of e-waste with household waste, harmful working conditions, secondary resources not effectively covered, as well as environmental emission through open incineration.

In each step of the recycling chain there are various intervention mechanisms: policy & legislation, business & finance, technology & skills, monitoring & control. Those mechanisms need to be tailored depending on specific boundary conditions, but different examples has been presented, highlighting the link between the mechanisms and the goal of that stage of the recycling chain.

Link to PPT Video

Download the presentation

5.4.2 EXPERT PRESENTATION: Alexis Vandendaelen (Umicore): Case Study, Printed Wire Boards (PWBs)

Alexis Vandendaelen from UMICORE Precious Metals Refining (UMICORE), presented the challenges of e-waste recycling from a end-processor dealing with precious and special metals recovery. Nowadays the concentration of some elements in waste streams is much more relevant compared to primary mining deposits and despite amounts used in electronic product are often very small, the total number of appliances produced every year make this number not neglectable.

Alexis explained how the overall efficiency of the entire recovery process is a combination of efficiency in all the subsequent steps of the recycling chain (collection, pre-processing and end-processing): whereas developing countries are maybe collecting 95% of their e-waste, recovery of precious metals such as gold stand at paltry 25%; at same time developed countries might collect 50% of e-waste generated in their countries, precious metal recovery rate stands at 95%. But in both cases the overall efficiency in recovery is not that much different.

Based on these facts, Alexis underscored the need to build synergies between the emerging economies and developed economies, according to the Best of 2 world philosophy (link paper), developed by the multi-stakeholder Solving the E-waste Problem (StEP) Initiative. In particular Alexis pointed out the bottlenecks that hamper the overall efficiency on the recycling chain and provided recommendation to increase efficiency in different stages of the recycling chain, namely collection and manual sorting, pre-processing and end-processing (final refining).

He explained also different business models existing for end-processing and particularly the difference between those fractions having an intrinsic economic value and those resulting in negative one.

Link to PPT Video

Download the presentation

5.4.3 EXPERT PRESENTATION: Chris Slijkhuis (MBA Polymers): Case Study, Plastics

Chris Slijkhuis, from MBA Polymers (MBA Polymers), presented the challenges of recycling of e-waste plastics. Chris explained the challenges of post-consumer plastics recycling compared to other fractions like glass, steel, paper or aluminium and pointed out the environmental benefits achievable when producing plastics from recycling compared to virgin materials. Recycling plastics from e-waste is even more important because of legislative requirements in some regions of the world plus increasing pressure from NGOs and other international organizations. Chris shown the environmental benefits achievable in the case of proper recycling of plastics from e-waste arising in Europe and suggested some recommendations to be taken into account in design and production phase to promote and facilitate the end-of-life processing of such material.

One of the key aspects of e-waste plastic recycling is linked with the presence of brominated flame retardants (BFR) in most of the plastic fractions used in electronic products. Some BFRs have been banned by legislations but they are sill widely used for safety reasons in may products and a proper EoL management of such fractions should be ensured for the health risks associated mainly with uncontrolled burning.

Chris presented and compared two different approached to plastic recycling: the case of China, with low-tech recycling processes, and the case of Europe/US, with hi-tech recycling facilities for plastic fractions. He provided also examples of products produced using recycled plastics, both in the case of closed-loop recycling (plastics from electronic products back to the same Industry) and open loop ones.

In the last part of the presentation the main elements to ensure a proper management of EoL plastic fractions from e-waste: how to avoid plastics ending up in informal recycling circuits, the pre-processing requirements, and technological infrastructures needed.

Link to PPT Video

Download the presentation

5.5 Relevant Documents and Publications

5.5.1 UNEP/StEP Study – From E-waste to Resources

Sustainable Innovation, understood as the shift of sustainable technologies, products and services to the market, requires a market creation concept and one common global agenda. This study focuses on a consistent set of different types of metals (ferrous and non-ferrous metals) such as aluminium (Al), copper (Cu), palladium (Pd) and gold (Au). Toxic and hazardous elements are present in e-waste, which are partially drivers for the implementation of sound collection and treatment processes. Therefore in the discussion of recycling technologies, the proper handling and treatment of such harmful elements to prevent environmental or health impact is included. Furthermore, the use and generation of toxic/hazardous substances during e-waste processing (for example, a mercury-gold amalgam or combined dioxins from inappropriate incineration) is critically evaluated with respect to the sustainability criteria for innovative technologies.

Read the document

5.5.2 Panel Session Discussion on Pre-Processing approaches and alternatives

Analysis and evaluation of different alternatives for pre-processing of waste streams can be done taking into account some key elements; those elements should guide in evaluation of alternatives as a checklist rather than providing a turn-key solution applicable in any context. In most cases an open consultation with stakeholders involved in the recycling chain can address the majority of the elements listed below.

1. Collection of waste stream
   - 1.1. What is effective e-waste collection strategy in the country/region? What/How could be ensured the involvement of formal/informal sector?
   - 1.2. Which products/waste streams are being collecting? How the collection can ensure safe and effective dismantling7refurbishment/pre-processing?
   - 1.3. Is there any fraction/waste stream not being collected? What's the driver behind such refusal?
   - 1.4. Are collectors bringing waste streams/factions being paid for the material delivered? Or do they pay to deliver the material at the pre-processing/refurbishment plant?
   - 1.5. Which are them main drivers allowing that all waste streams are collected?
2. Recycling Technologies
   - 2.1. What waste streams can be recycled in different plants?
   - 2.2. Which kind of technologies/tools are used in different plants? Manual/Semi-automatic/Automatic
   - 2.3. What's the capital investment needed for technologies used?
   - 2.4. Which are the main operational costs faced?
3. Training & Safety for employees
   - 3.1. What measures are taken to protect health and ensure safety of workers in different plants?
   - 3.2. What are the training programs available in the country/region or employees attended?
   - 3.3. Are there any national standards/guidelines available in the country for recycling activities? Are those binding?
4. Downstream market for fractions
   - 4.1. How can the value of secondary raw material be maximized?
   - 4.2. How are problematic (hazardous/negative value) fractions handled?
   - 4.3. Do plants have materials/fractions they don't know where/how to sell/dispose? Is any regional (neighbor countries) alternative?
   - 4.4. What steps should be taken to close material loops in your country/region?
5. Start-up & operational Business Model
   - 5.1. How can be financed the start-up costs for e-waste collection & recycling facilities?

5.2. How are financed in the medium-long run operations costs?

6 Monitoring & Enforcement

6.1 Introduction

E-waste management and generally speaking system design should not just rely on a well structured legislation. There are two main fundamental pillars to be taken into account:

- Enforcement of applicable legislation, standards and rules, and
- Monitoring of performances of different actors in the recycling chain.

The first one might include proper control over waste permits and applicable legislation in order to make sure the environmental sound management of e-waste is achievable.

The second one embraces auditing of recyclers and other relevant stakeholders, under specific protocols to be defined. The goal is to ensure maintaining of compliance from stakeholders and improvement of quality. Monitoring and auditing is also helping in maintaining a level playing field, especially in the recycling industry, avoiding unfair competition.

6.2 Experts

6.2.1 EXPERT PRESENTATION: Klaus Willke and Simonne Rufener (IMPEL) – Notification Procedure and Return Shipments

Klaus Willke and Simonne Rufener (IMPEL) gave a presentation on notification procedures. They explained the aim of notifications - to obtain the prior informed consent of all competent authorities before any transboundary movement of a hazardous shipment takes place. A detailed explanation of all the steps needed in the Notification, Consent & issuance of movements document, transboundary movement of hazardous waste and finally confirmation of disposal has been provided; practical examples with forms has been given.

Take back operations requested for un-wanted goods from developing countries has been discussed, using few real case studies from Ghana, Indonesia and Nigeria; the aim of the exercise was to illustrate the information exchange dynamics and prompt collaboration that are necessary between competent authorities in order to divert illegal exports of WEEE into countries.

Link to PPT Video

Download the presentation

6.2.2 EXPERT PRESENTATION: Mathias Schluep (EMPA) – Recycling Standards and Auditing

Mathias Schluep, programme manager at EMPA Technology and Society Lab (EMPA-TSL), highlighted the importance of conformity assessment, which aims to assess whether a treatment operator conforms to prescribed quality and environmental standards, and to rate its performance against the recycling and recovery targets. He elaborated on how governments can ensure the continuous improvement and compliance of the e-waste sector through conformity assessment schemes promoting high-standard operations.

Mathias described the case study of take-back systems in Switzerland, with a detailed view into the auditing scheme and the role of EMPA as independent body in charge of auditing recyclers; different steps of auditing has been discussed, starting from the planning of the audits till the review and recommendation steps with the audited plant.

Technical regulations and guidelines has been finally addressed providing insight into the key aspects of the standards setting process, and also provided an overview of current international standards in place addressing end-of-life management of e-waste.

Link to PPT Video

Download the presentation

6.2.3 EXPERT PRESENTATION: Margaret Bates (Northampton University): Permits, Policy and Regulation – A consistent, pragmatic approach

Margaret Bates from University of Northampton (NH University) addressed the need for stringent national legislation in order to achieve effective technical control over the environmentally sound management of wastes. She began with a detailed explanation on the specific roles and content of policy, strategy and regulation, and the relationship between them.

She further provided insight into the essential components of legislation, including provisions on enforcement, clear designation of stakeholder responsibilities, a framework for the implementation of international conventions and an effective monitoring process. She also provided examples of the possible socio-economic repercussions of good/strong and bad/weak policies.

On the ESM of e-wastes, she highlighted certain key issues that should not be overlooked in legislation: clarity in import policy, public and occupational health protection, environmental protection, resource recovery and dumping prohibitions.

She comparatively analysed UK and Nigerian permit conditions for e-waste treatment plants, and then provided guidance on the general structuring of policy and guidelines, with closing remarks on the importance of clearly definitions in any policy bills (particularly linked to roles and responsibilities of stakeholders) and of creating effective enforcement mechanisms.

Link to PPT Video

Download the presentation

6.3 Relevant Documents and Publications

6.3.1 StEP GP on International Recycling Standards

The goal of the paper is to be a guide for the setup of country or region-specific EoL standards taking into account best practices and best available technologies (BAT). This paper is not an EoL standard. Rather, it gives an overview of the principles for the setup of EoL standards, suggests requirements standards for EoL of EEE should address and proposes approaches for translating the requirements into stipulations of an EoL standard.

Because standards, alone, will have little effect if EoL operators' compliance is not reliably audited, this paper also addresses principles and practices of sound auditing and certification. Finally, as several EoL standards have been set up and are about to be implemented recently, care must be taken to ensure that EoL operators do not have to work under multiple standards, which would increase both administrative burdens and operational costs. This paper proposes strategies for the application and harmonization of EoL standards, and for increasing their overall quality and effectiveness over time.

Read the document

7 Biographies Experts

7.1 Luis Neves

Luis Neves is Chairman of the Global e-Sustainability Initiative (GeSI), and Climate Change and Sustainability Officer, Executive Vice President, at Deutsche Telekom Group. With over thirty years of experience at the national and international level in the field of telecommunications and Information Society, Luis has played a fundamental role in promoting the role of ICT in relation to climate change. Luis was the driving force and chairman of the steering committee of the landmark study “SMART 2020 - Enabling the Low Carbon Economy in the Information Age”. Luis currently holds positions and participates in a range of international projects and initiatives including GeSI, the United Nations Global Compact Group and Steering Committee of the United Nations “Caring for Climate Initiative”.

7.2 Mushtaq Memon

Mushtaq Memon holds Doctorate in Environmental and Resource Economics and Management from Japan, Masters in Project Planning and National Development from UK, Postgraduate Diploma in Transport and Bachelors in Civil Engineering.

He is currently a Programme Officer with United Nations Environment Programme at its International Environment Technology Centre, working on urban environmental issues including urban waste and urban water. He is currently responsible for project planning and implementation of urban integrated solid waste management, E-waste and the Global Partnership on Waste Management.

Before joining UNEP, he was working as a Senior Policy Researcher with Institute for Global Environmental Strategies (Japan). He was also working as Director of Human Resources and Training with World Bank project – Sindh Rural Water Supply and Sanitation in Sindh, Pakistan.

He has a vast experience working with Port Planning and Integration of a Sea Port within a City.

7.3 Prof. Oladele Osibanjo

Oladele Osibanjo holds a Master Science and PhD in Analytical Chemistry from University of Birmingham. He is currently Executive Director in Basel Convention Coordinating Centre for Training and Technology Transfer in Hazardous Waste Management for the African Region.

He supports parties in the Africa region to effectively implement their obligations on the Basel Convention on trans-boundary movements of hazardous and other wastes and its amendments in close partnership with the BCRCs in Africa. Prof. Osibanjo is also strengthening the framework for Environmentally Sound Management (ESM) of Hazardous and other wastes across the Africa region and promoting the implementation of ESM of Hazardous and other wastes as an essential contribution to the attainment of sustainable livelihood, the Millennium Development Goals (MDGs) and the protection of human health and the environment. Furthermore he is involved in organisation of training workshops for building capacity of government experts, private sector, NGOs and the informal sector in the ESM of –––hazardous waste, including electronic wastes.

Hi competences in e-waste field include policy development and formulation of E-waste sustainable management, e-waste inventory planning and execution at the country and regional level, training in enforcement of regulations on the prevention of illegal traffic in e-waste, development of national regulations for control of used and End-of Life electronic equipment and analysis of e-wastes and environmental samples (soils, plants, water, fish) for pollutants especially heavy metals (e.g. Lead, Cadmium , Nickel, etc) and organic pollutants (e.g. PCBs, Brominated Flame Retardants).

7.4 Klaus Willke

Klaus Willke hold a Dipl. Ing. in process engineer and specific training courses in waste management. He has been serving as Public senior official in the sub unit of waste shipments at the State Ministry for Urban Development and Environment in Hamburg until 2011.

Previously he has worked as Public official in the department of waste management at the State Ministry of Environment in Hamburg, as volunteer with the German Voluntary Service in Winneba (NVTI) and Accra (NBSSI), as Millwright at the National Railways of Zimbabwe and as an Engineer in different companies in Germany.

Beside past job duties in the State Ministry until 2011 in the field of notifications and enforcement of the Waste Shipments Regulations in Hamburg, Klaus took part in several IMPEL-TFS projects: EU – Africa enforcement collaboration, E-waste, Seaport Phase I & II.

7.5 Simonne Rufener

Simonne Rufener holds a Master of Advanced Studies in Development and Coordination (MAS) from the Swiss Federal Institute of Technology, ETH Zurich and a Master of Natural Science in Geography (MsC) from University of Bern. She also studied at Faculty of Geography at University of Valaencia..

Since 2009 is working in Federal Office for the Environment Switzerland, waste recovery and treatment section, Bern, as Scientific officer responsible for enforcement of transboundary shipment of waste and resource efficiency. She has also worked as Project Assistant at Swiss Tropical Institute, focusing on drinking water quality, water treatment (SODIS) and hygiene practices on household level and between 2005 and 2006 she has been engaged at Swiss aquatic research institute, EAWAG and Universidad de Cochabamba, Bolivia focusing on projects in the same area.

Simonne has been involved in implementation of environmental law (IMPEL) and Basel Convention e-waste Africa project, particularly being facilitator at the national e-waste workshops in Ghana and Benin, active also in EU-Africa network for transboundary shipment of waste. In 2011 has carried out a Project in Ghana with the Swiss Federal Institute for Material Science and Technology, Empa, focusing on formal e-waste management in Ghana and providing a baseline research on cable recycling.

7.6 Jaco Huisman

Jaco Huisman completed his M.Sc. in chemical engineering at Eindhoven University of Technology in 1999 and his Ph.D. in 2003 at Delft University of Technology. His Ph.D. thesis focused on how to look at the recycling of electronic products with an environmental and eco-efficiency lens, which is still highly relevant and cited today. Since 2004 he runs his own consultancy company, OsevenfortytwO, where he gives advice to a large number of producers, national take-back systems, governments and recyclers in Europe, the US and China to improve eco-efficiency operations, waste policies, system organization and product design. Since 2003 he has also continued his work as an Associate Professor at Delft University of Technology teaching one day per week on product recycling and environmental assessment.

Since 2006 Jaco is the Scientific Adviser to the SCYCLE operating unit of the UNU Institute for Sustainability and Peace (UNU-ISP) and focuses his activities on electronics recycling in a global context. He leads the UNU-ISP Electronics Recycling Group and co-coordinates Task Force Capacity Building of the UNU-hosted *Solving the E-waste Problem (StEP) Initiative*. In this role he is responsible for a large international project to further quantify the e-waste amounts and problems worldwide in cooperation with key research institutes and universities, primarily in Europe, China, the US and the Middle East. Jaco is also leading various international research projects related to "e-waste" and was the lead author of the UNU study supporting the European Commission's 2008 Review of the European rules for electronics recycling.

7.7 Mathias Schluep

Mathias Schluep received his MSc in Environmental Engineering and his PhD in natural sciences from the Swiss Federal Institute of Technology in Zurich, Switzerland (ETH).

He is currently a programme manager and senior scientist at the Technology and Society Lab at Empa in Switzerland, a research institution belonging to the Swiss Federal Institute of Technology (ETH) domain. He is leading Empa's research related to e-waste management in the broader context of secondary raw materials. Mathias is responsible for several cooperation projects with developing countries in e-waste management in Africa, Asia and Latin America. His special focus is in Africa, where he was implementing various e-waste projects for the Swiss States Secretariat of Economic Affairs (SECO), Hewlett Packard, Microsoft, UNIDO, UNEP, the Secretariat of the Basel Convention and the European Union.

Before that he worked in the private sector in the field of environmental and general business consultancy at national and international levels for several years.

7.8 Alexis Van Den Daelen

Alexis Vandendaelen holds a Master Degree in Bio-Engineering from Gembloux Agro-Bio-Tech in Belgium, with a more specifically in the field of Agricultural Economics. He studied also in Montréal, at McGill University. In 2010 he joined Umicore, an international materials technology group, based in Brussels. He started in the Government Affairs department, and moved in January 2012 to Umicore Precious Metals Refining as Manager Marketing and Business Development. Umicore Precious Metals Refining is one of the world's largest precious metals recycling facilities, and the world market leader in recycling complex waste streams containing precious and other non-ferrous metals. He is currently responsible for market analysis around e-waste.

7.9 Chris Slijkhuis

Chris Slijkhuis holds a Master Science in Horticulture and a Master of Business Administration from the University of Antwerp.

Since 2005 is Director of sourcing and logistics at MBA Polymers, responsible for developing and implementing sourcing strategies for several MBA facilities in Europe and China.

He as been Director of Supply chain Management at Flextronics, between 2000 and 2005, working at a strategy for this contract manufacturer to become active in the field of E-Waste and implementation of the WEEE Directive and RoHS requirements.

He is also actively involved in the European Electronic Recyclers Association (EERA), taking part in several projects to work on policy issues regarding plastics, flame retardants and waste shipment issues.

7.10 Margaret Bates

Margaret Bates holds a BSc (Hons.) in Applied Biology from Polytechnic of East London and a PhD from University of East London.

She is currently manager of the Centre for Sustainable Wastes Management and reader in Sustainable Wastes Management at the University of Northampton. She is chairing the Chartered Institution of Wastes Management (CIWM) Scientific and Technical Committee, CIWM Executive Committee, Anglian Centre Councillor for CIWM, and is Evidence Advisory Panel of the Collaborative WReSCE (Waste, Resources & Sustainable Consumption Evidence Programme).

Currently teaching and developing undergraduate and postgraduate courses on all aspects of wastes management including BScWastes Management, MSc Wastes Management, MSc International Wastes Management and MBA Wastes. Margaret is supervising PhD students and other research projects and advising businesses on waste management issues. She is also reviewer for *Waste Management* journal, *Waste Management Research*, *Resources, Conservation and Recycling*, *Science of the Total Environment, Communications in Waste and Resource Management,* and *Chemical Speciation and Bioavailability*.

Margaret is also assessor for Engineering and Physical Sciences Research Council, Waste and Resources Action Programme, Department for Environment, Food and Rural Affairs, Technology Strategy Board, WRAP, European Commission, British Council and other grant applications.

She is developing and delivering training/capacity building for the informal sector in Lagos, Nigeria. Advising NESREA on development of Nigerian National Environmental (Electrical/Electronic, Sector) Regulations.

Furthermore Margaret is working with OEM Alliance to develop recycling infrastructure in Africa, particularly focussing on capacity building.

Finally, she is Member of Individual Producer Responsibility sub group of WEEE Advisory Board (UK).