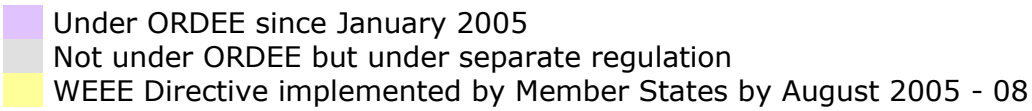
e-Waste Definition

e-Waste for short - or Waste Electrical and Electronic Equipment (WEEE) - is the term used to describe old, end-of-life or discarded appliances using electricity. It includes computers, consumer electronics, fridges etc which have been disposed of by their original users.
On this website - the e-Waste Guide - "e-waste" is used as a generic term embracing all types of waste containing electrically powered components. e-Waste contains both valuable materials as well as hazardous materials which require special handling and recycling methods. This guide covers all categories of e-waste but emphasizes categories which contain problematic, scarce and valuable or otherwise interesting materials.
Examples: Computers, LCD / CRT screens, cooling appliances, mobile phones, etc., contain precious metals, flame retarded plastics, CFC foams and many other substances.

The graphic below compares the categories of e-waste as used in the Swiss and EU legislation (CH ORDEE and the EU WEEE Directive)

Swiss ORDEE regulations	EU WEEE Directive
Household Appliances Washing machines, Dryers, Refrigerators, Air-conditioners, Vacuum cleaners, Coffee Machines, Toasters, Irons etc.	**Large Household Appliances** Washing machines, Dryers, Refrigerators, Air-conditioners, etc. **Small Household Appliances** Vacuum cleaners, Coffee Machines, Irons, Toasters, etc
Office, Information & Communication Equipment PCs, Latops, Mobiles, Telephones, Fax Machines, Copiers, Printers etc. **Entertainment & Consumer Electronics** Televisions, VCR/DVD/CD players, Hi-Fi sets, Radios, etc	**Office, Information & Communication Equipment** PCs, Latops, Mobiles, Telephones, Fax Machines, Copiers, Printers etc. **Entertainment & Consumer Electronics** Televisions, VCR/DVD/CD players, Hi-Fi sets, Radios, etc
Lighting Equipment Fluorescent tubes, sodium lamps etc. (Except: Bulbs, Halogen Bulbs) **Electric and Electronic Tools** Drills, Electric saws, Sewing Machines, Lawn Mowers etc. (Except: large stationary tools/machines) **Toys, Leisure, Sports and Recreational Equipment** Electric train sets, coin slot machines, treadmills etc.	**Lighting Equipment** Fluorescent tubes, sodium lamps etc. (Except: Bulbs, Halogen Bulbs) **Electric and Electronic Tools** Drills, Electric saws, Sewing Machines, Lawn Mowers etc. (Except: large stationary tools/machines) **Toys, Leisure, Sports and Recreational Equipment** Electric train sets, coin slot machines, treadmills etc.
Medical Instruments and Equipment **Surveillance and Control Equipment** **Automatic Issuing Machines**	**Medical Instruments and Equipment** **Surveillance and Control Equipment** **Automatic Issuing Machines**

Legend:
Under ORDEE since 1998


Under ORDEE since January 2005
Not under ORDEE but under separate regulation
WEEE Directive implemented by Member States by August 2005 - 08

WEEE generated

Submitted by esther.mueller on Wed, 2009-03-18 15:04.

e-Waste generated from all categories

The following charts and table present an overview of e-waste quantities generated in 15 different countries. Please note, that it is difficult to make direct country-to-country comparisions regarding e-waste quantities, because each country has different categories of appliances counted as e-waste and different methodologies of estimation.

State-of-the-art Recycling Technologies

The state-of-the-art recycling of e-waste comprises three steps:

Detoxication

The first step in the recycling process is the removal of critical components from the e-waste in order to avoid dilution of and / or contamination with toxic substances during the downstream processes. Critical components include, e.g., lead glass from CRT screens, CFC gases from refrigerators, light bulbs and batteries.

Shredding

Mechanical processing is the next step in e-waste treatment, normally an industrial large scale operation to obtain concentrates of recyclable materials in a dedicated fraction and also to further separate hazardous materials. Typical components of a mechanical processing plant are crushing units, shredders, magnetic- and eddy-current- and air-separators. The gas emissions are filtered and effluents are treated to minimize environmental impact.

Refining

Source: Umicore

The third step of e-waste recycling is refining. Refining of resources in e-waste is possible and the technical solutions exist to get back raw with minimal environmental impact. Most of the fractions need to be refined or conditioned in order to be sold as secondary raw materials or to be disposed of in a final disposal site, respectively. During the refining process, to three flows of materials is paid attention: Metals, plastics and glass.

For more detailed information, please visit the website of the Swiss e-waste competence: www.e-waste.ch

Hazardous Technologies

Incineration

Incineration is the process of destroying waste through burning. Because of the variety of substances found in e-waste, incineration is associated with a major risk of generating and dispersing contaminants and toxic substances. The gases released during the burning and the residue ash is often toxic. This is especially true for incineration or co-incineration of e-waste with neither prior treatment nor sophisticated flue gas purification. Studies of municipal solid waste incineration plants have shown that copper, which is present in printed circuit boards and cables, acts a catalyst for dioxin formation when flame-retardants are incinerated. These brominated flame retardants when exposed to low temperature (600-800°C) can lead to the generation of extremely toxic polybrominated dioxins (PBDDs) and furans (PBDFs). PVC, which can be found in e-waste in significant amounts, is highly corrosive when burnt and also induces the formation of dioxins.
Incineration also leads to the loss valuable of trace elements which could have been recovered had they been sorted and processed separately.

Open Burning

Since open fires burn at relatively low temperatures, they release many more pollutants than in a controlled incineration process at an MSWI-plant. Inhalation of open fire emissions can trigger asthma attacks, respiratory infections, and cause other problems such as coughing, wheezing, chest pain, and eye irritation. Chronic exposure to open fire emissions may lead to diseases such as emphysema and cancer. For example, burning PVC releases hydrogen chloride, which on inhalation mixes with water in the lungs to form hydrochloric acid. This can lead to corrosion of the lung tissues, and several respiratory complications. Often open fires burn with a lack of oxygen, forming carbon monoxide, which poisons the blood when inhaled. The residual particulate matter in the form of ash is prone to fly around in the vicinity and can also be dangerous when inhaled.

Landfilling

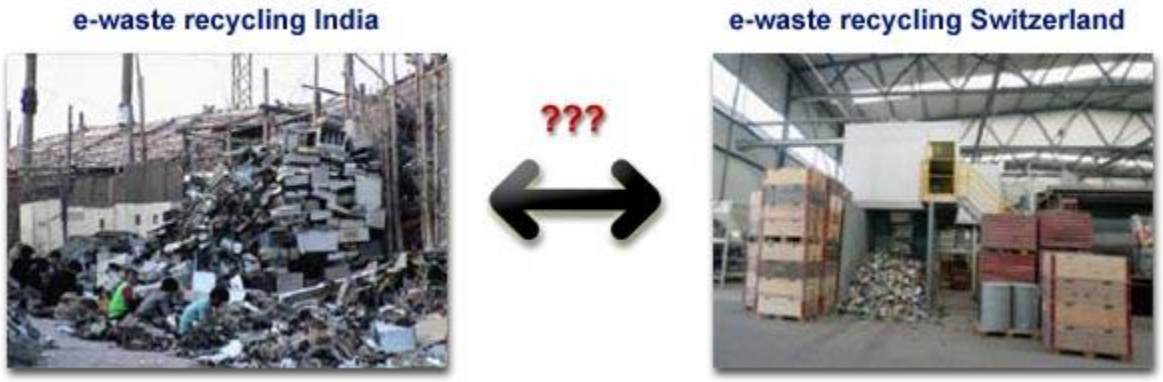
Landfilling is one of the most widely used methods of waste disposal. However, it is common knowledge that all landfills leak. The leachate often contains heavy metals and other toxic substances which can contaminate ground and water resources. Even state-of-the-art landfills which are sealed to prevent toxins from entering the ground are not completely tight in the long-term. Older landfill sites and uncontrolled dumps pose a much greater danger of releasing hazardous emissions.

Mercury, Cadmium and Lead are among the most toxic leachates. Mercury, for example, will leach when certain electronic devices such as circuit breakers are destroyed. Lead has been found to leach from broken lead-containing glass, such as the cone glass of cathode ray tubes from TVs and monitors. When brominated flame retarded plastics or plastics containing cadmium are landfilled, both PBDE and cadmium may leach into soil and groundwater. Similarly, landfilled condersers emit hazardous PCB's.

Besides leaching, vaporisation is also of concern in landfills. For example, volatile compounds such as mercury or a frequent modification of it, dimethylene mercury can be released. In addition, landfills are also prone to uncontrolled fires which can release toxic fumes.

Significant impacts from landfilling could be avoided by conditioning hazardous materials from e-waste separately and by landfilling only those fractions for which there are no further recycling possibilities and ensure that they are in state-of-the-art landfills that respect environmentally sound technical standards.

Methodology



- What is important to **focus** on?
- What can be **seen**?
- Do we **understand** what happens?
- How can we **compare** the two situations?
- Can we **learn** from each other?

Procedures in 5 steps

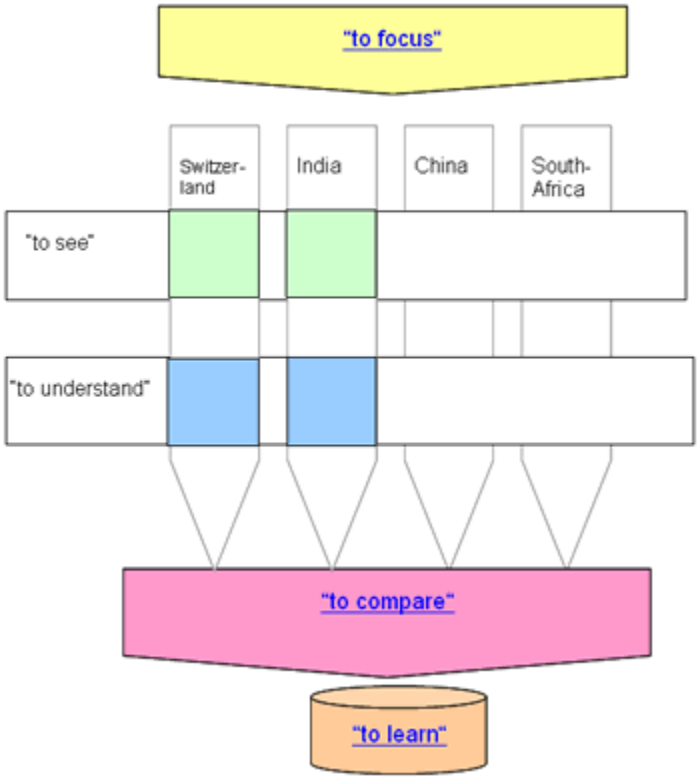
1. Find the most important aspects to describe the e-waste system

2. Get to know the e-waste aspects by visiting local actors

3. Understand, evaluate and map what has been seen

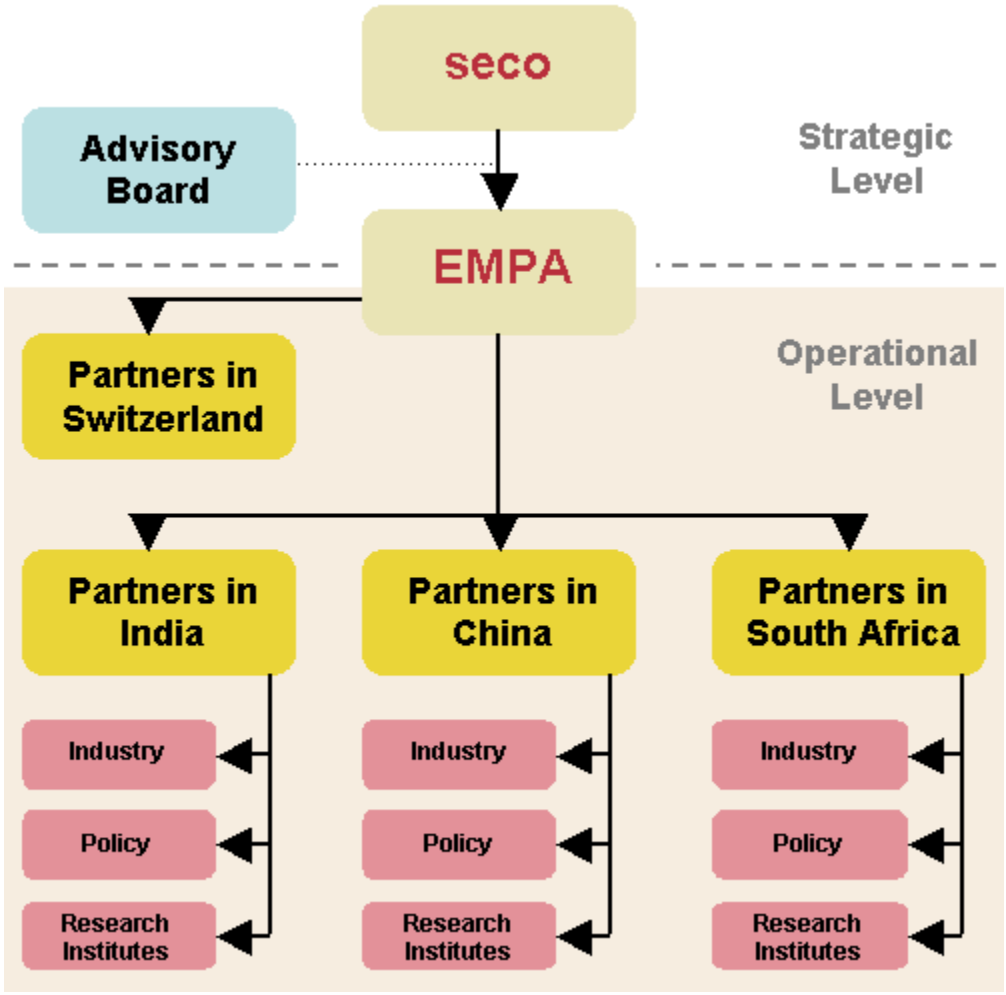
4. Compare findings among the assessed countries

5. Identify concrete actions, based on a shared understanding of the situation



Project Organigram

The project is based on national and international partnerships with research institutes, government bodies, profit and non-profit organisations.



Actors in the SWICO Recycling System

In Switzerland two take-back systems financed by an advance recycling fee (ARF) are installed, one each for electrical and electronic devices. The first system, which covers household equipment including small devices like hair dryers and big devices like electric furnaces and refrigerators, is managed by the Stiftung Entsorgung Schweiz (http://www.sens.ch (in German, French and Italian only) ">SENS). The second system, which covers office electronic and IT equipment, mobile telephones, equipment used in the graphics industry, telephones and telephone switchboard systems, as well as consumer electronics, is operated by the Swiss Association for the Information, Communication and Organisational Technologies (SWICO). The two systems are co-operating on the level of material flow control.

Because the topic of this guide is electronic waste, the focus is on the SWICO system. It involves different actors with each of them having their own responsibilities. The following parties exercise important functions: importers & manufacturers, traders & retailers, consumers, collection points, dismantlers, refiners & conditioners and finally disposers.

Importer/Manufacturer

Manufacturers and importers of electronic equipment are responsible for their products up to the end of the products useful life, and therefore jointly operate a return and recycling system via their association. It is their job to collect the advance recycling fee (ARF) imposed on new electronic equipment. They further guarantee a smooth recycling operation, paying special attention to the recycling quality and the utilization of funds.

Trader/Retailer

Traders/retailers are an important element in the entire recycling chain, as 58 % of all end-used electronic appliances end up at their stores (SWICO Activity Report 2002). Traders charge an advance recycling fee (ARF) on each newly sold piece of electronic equipment. This fee stays with the trader who paid the same amount to the importer/manufacturer as part of the products delivery price. As a result, traders/retailers do not make any financial profit out of the SWICO recycling system. On the other hand the SWICO Recycling scheme provides them with a convenient outlet for e-waste as retailers and traders are obliged to take back any electronic equipment of the kind offered in their assortment by the Swiss ordinance on the return, take-back and disposal of electrical and electronic appliances (ORDEA).

Consumer

Upon purchase of a new electronic product, consumers have to pay an advance recycling fee (ARF). This entitles them to return any old equipment to importers, traders or authorized collection points. Furthermore, the ARF on new equipment finances the take back of old equipment bought at a time when the ARF had not been implemented yet.

Authorized E-waste Collection Points

The SWICO and SENS recycling systems run a number of authorized collection points (total in 2003: about 500) all over Switzerland, where electronic equipment of any kind can be returned free of charge. Arrangements for home collections can also be made via hotline.

Licensed Sorting and Dismantling Companies

The SWICO recycling system operates with 15 licensed sorting and dismantling companies spread all over Switzerland, which process electronic waste according to the Swiss Ordinance on the Return, Take-back and Disposal of Electrical and Electronic Appliances (ORDEA). Processing includes manual and mechanical sorting and dismantling, shredding and recovery of materials. Depending on their composition, the resulting fractions are passed over to refiners, conditioners or final disposers.

Refiner/Conditioner

Most of the fractions need to be refined or conditioned in order to be sold as a secondary raw material or to be disposed of in a final disposal site, respectively. Refining is performed in refining companies inside and outside Switzerland for fractions like aluminium, batteries, CRT's, ferrous and non-ferrous metals, recyclable plastics and printed boards. Conditioning is mainly performed in Switzerland and includes Municipal Solid Waste Incineration (MSWI) in of the 36 Swiss MSWI plants for fractions such as plastics waste, and Hazardous Waste Incineration for fractions such as condensers. More than 75% (by weight) of the material entering the SWICO and SENS recycling systems is refined to secondary raw materials like aluminium, copper, gold and silver. 20% (by weight) of the material mainly plastics - is incinerated (Waste Management World 2002: Managing Electric and Electronic Waste. November-December 2002 Edition. Peter Bornand, President of SWICO Environmental Commission, SWICO. http://www.jxj.com/wmw/, archive November-December 2002).

Final Disposer

Some 3% (by weight) of the material entering the SWICO Recycling System ends up in (mostly Swiss) landfills. Swiss landfills are subject to a relatively strict emission control and are comparatively restrictive regarding the materials accepted: since the year 2000 combustive materials have no longer been admitted for final disposal in landfills.

Technologies applied in Switzerland

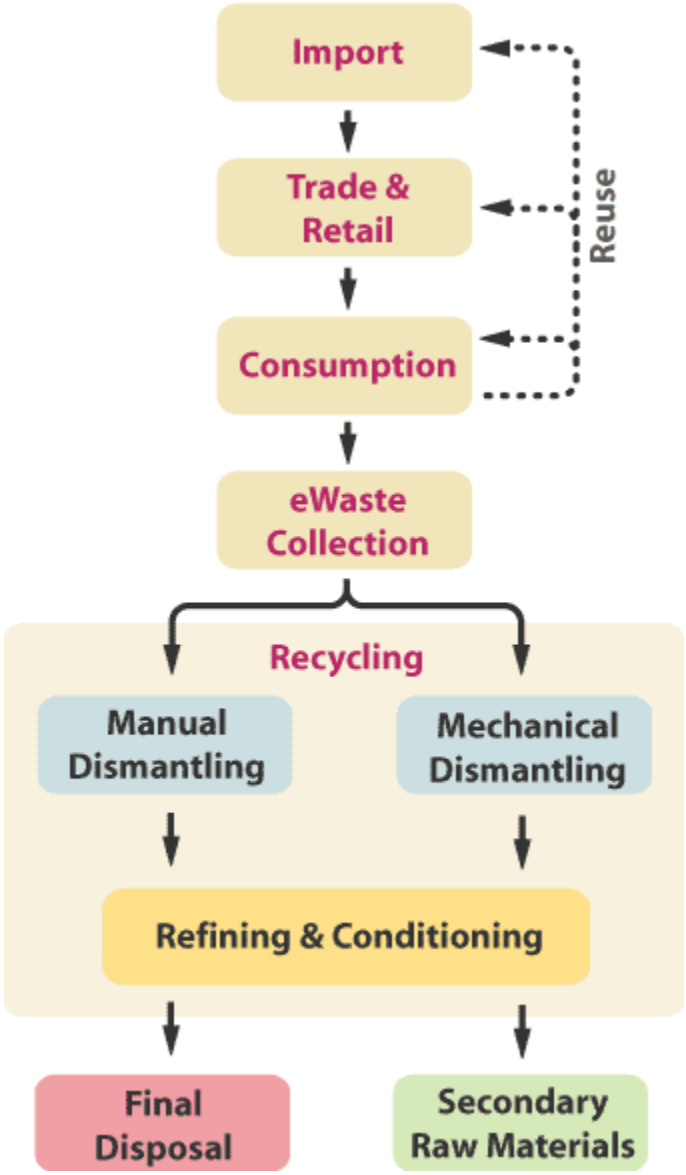
Manual dismantling is the first, more traditional way to separate hazardous materials from recyclable materials, and to generate recyclable materials from electronic waste. In a pre-sorting process, the incoming electronic waste first is separated into the different categories, which are to be handled separately in the following dismantling and sorting process. The dismantling process itself is performed with simple tools such as screwdrivers, hammers and tongs.

Mechanical dismantling is the second, more modern way to separate hazardous materials and to generate recyclable materials from electronic waste. In a pre-sorting process, the incoming electronic waste first is separated into the different categories, which are to be handled separately in the following dismantling and sorting process. The dismantling process itself is performed mechanically. Typical components of a mechanical dismantling plant are crushing units, shredders, magnetic separators and air separators. The exhaust gases are cleaned up in waste gas purification plants and the dust generated collected with dust filters. Indoor exposure to is monitored and assessed relative to the Swiss Maximum Allowable Concentration (MAC)-values.

Refining and Conditioning
Most of the fractions need to be refined or conditioned in order to be sold as secondary raw materials or to be disposed of in a final disposal site, respectively.Refining includes mechanical, thermal and chemical processes. It is typically performed for fractions such as batteries, CRT's, ferrous and non-ferrous metals, recyclable plastics and printed boards. Many refining processes take place outside Switzerland, entailing greater transport distances.Conditioning includes Municipal Solid Waste Incineration (MSWI) of fractions such as plastics waste in one of the 36 Swiss MSWI plants and Hazardous Waste Incineration (HWI) of fractions such as condensers in one of the 7 Swiss HWI plants.

The final disposal of materials from dismantling, refining and conditioning processes takes place in landfills. Swiss landfills are subject to relatively strict emission controls and are comparatively restrictive regarding the materials accepted: since the year 2000 combustive materials have no longer been admitted for final disposal in landfills.

SWICO Recycling Guarantee â€“ Material Flow

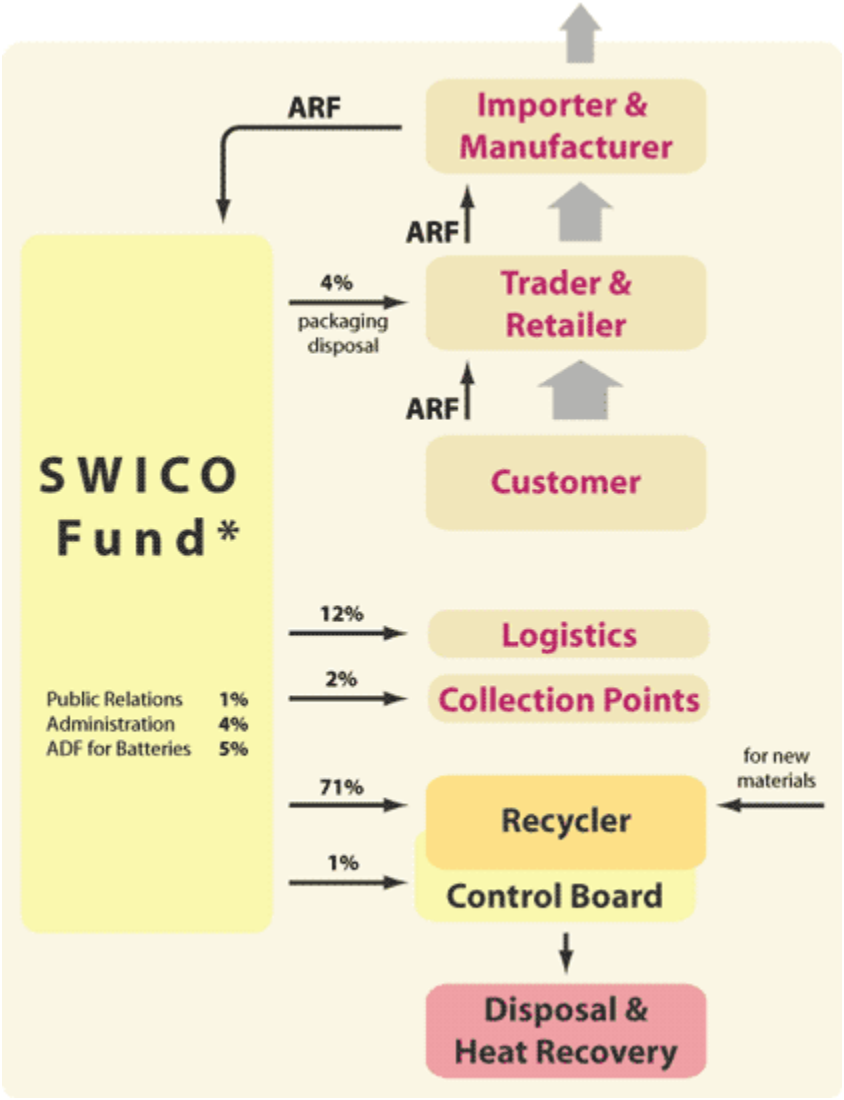


In order to assume the responsibility for the environment for their members, in 1993 the SWICO Environmental Commission created a regulation that outlines the prerequisites for recycling companies. Also a financing and logistic scheme was established. These were implemented in 1994. The recycling companies that satisfy the requirements are granted a license to process SWICO material. The SWICO Environmental Commission co-ordinates the licensed partners and provides regular technical controls of the recycling and disposal companies (carried out by a control team from EMPA St. Gallen). End-used electronic appliances are collected through 3 different channels: 18 % go back to importers/manufacturers, 58 % are returned to traders/retailers and 24 % are delivered to authorized SWICO collection points (data for 2002, SWICO Activity Report)*. From these three channels, most of the collected e-waste is transported to the 15 different licensed recycling companies. The processing of electronic waste includes manual and mechanical sorting and dismantling, shredding and recovery of materials. Most of the fractions need to be refined or conditioned in order to be sold as a secondary raw material or to be disposed of in landfills, respectively.

Conditioning is mainly performed in Switzerland in one of the 36 Municipal Solid Waste Incineration Plants. Some 3 % (by weight) of the material entering the SWICO Recycling System ends up in landfills.

* Traders/retailers check the returned equipment to separate functioning appliances and components to be sold for reuse. SWICO tries to encourage traders and consumers to reuse as many products as possible in order to reduce the amount of e-waste generated every year.

Financial Flow in the SWICO Recycling System



Legend:

ARF	Advance Recycling Fee
SWICO	Swiss Association for Information, Communication and Organisation Technology (see www.swico.ch)
* SWICO Fund	Option I: Manufacturers/Retailers handle the ARF account themselves, SWICO has control-function Option II: Manufacturer/Retailer pays ARF into SWICO Fund, SWICO takes care of the finances
Recycler	Presently one third of the revenue comes from the sold raw materials and two thirds from the SWICO Fund

SWICO Recycling Guarantee Financial Flow

The Advance Recycling Fee (ARF) serves as the method of financing the SWICO Recycling System. This method was chosen on the basis of surveys to the respondents which included consumers,

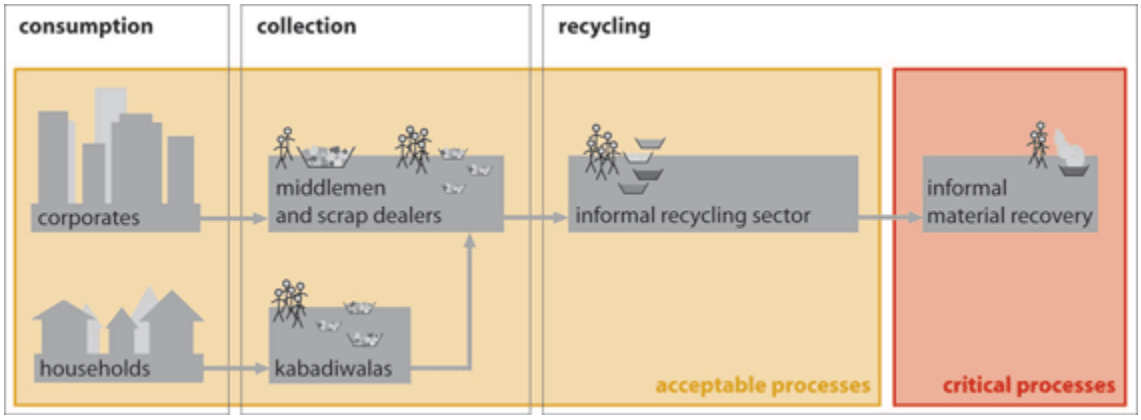
representatives from the trade, and authorities. The consumer pays the so-called ARF on the purchase of new electronic equipment. This fee is openly published, transferred by the importers/manufacturers (or their traders) to a recycling account held by SWICO. This SWICO Fund in turn, is used to settle current costs such as recycling, logistics, remuneration to collection points, monitoring and administration. The fees may be reduced if surpluses are accumulated in these accounts. However, if additional costs arise, the fees are increased (see also Waste Management World 2002: http://www.jxj.com/wmw/, Nov/Dec 2002 edition).

E-waste situation in India

Electronic waste, abbreviated as e-waste, consists of discarded old computers, TVs, refrigerators, radios – basically any electrical or electronic appliance that has reached its end-of-life. While e-waste contains both valuable materials such as gold, palladium, silver and copper, it also contains harmful substances like lead, cadmium and mercury. In the absence of suitable techniques and protective measures, recycling e-waste can result in toxic emissions to the air, water and soil and pose a serious health and environmental hazard. In India, e-waste is mostly generated in large cities like Delhi, Mumbai and Bangalore. In these cities a complex e-waste handling infra-structure has developed mainly based on a long tradition of waste recycling. This is mainly operated by a very entrepreneurial informal sector. Rag pickers and waste dealers found it easy to adapt to the new waste stream, resulting in a large number of new businesses focus-ing on the re-use of components or extraction of secondary raw materials. So far, the e-waste recycling system is purely market driven.

Some of the recycling processes are extremely harmful and have negative impacts on the workers‘ health and the environment. A study on the burning of printed wiring boards that was conducted 2004 showed an alarming concentration of dioxins in the surrounding areas in which open burning was practiced. These toxins cause an increased risk of cancer if inhaled by workers and local residents or by entering the food chain via crops from the surrounding fields.

Watch a short Greenpeace documentary "Where does E-waste end up "...



Initial e-waste situation in India. The e-waste from corporate consumers and households enters a city specific informal e-waste recycling system. The collection and allocation of e-waste is done by middlemen, scrap dealers and rag pickers, also known as «kabadiwalas». The informal recycling system includes acceptable processes such as dismantling and sorting but also very harmful processes such as burning and leaching in order to extract metals from electronic equipment.

Harmful techniques like burning wires are common practice in the informal recycling sectors in big cities in India.

E-waste actors in India ›

E-waste actors in India

Importer/Manufacturer: Almost 50% of the PC's sold in India are products from the secondary market and are re-assembled on old components. The remaining market share is covered by multinational manufacturers (30%) and Indian brands (22%) [Source: annual report 2003, MAIT] Besides manufacturers are major contributors of e-waste. The waste consists of defective IC chips, motherboards, CRTs and other peripheral items produced during the production process. It also includes defective PCs under guarantee procured from consumers as replacement items.

Consumer: Individual households: Individual households account for 22% of junk computers in India (Toxics Link report: Scrapping the Hi-tech Myth: Computer Waste in India, Feb. 2003: www.toxicslink.org). The preferred practice to get rid of obsolete computers is to get them in exchange from retailers when purchasing a new computer, or passed on to elatives or friends. Â· Government, public and private sector: The business sector accounts for 78% of all installed PC's in India (Toxics Link report: Scrapping the Hi-tech Myth: Computer Waste in India, Feb. 2003: www.toxicslink.org). Obsolete computers from the business sector are sold by auctions. Sometimes educational institutes or charitable institutions receive old computers for reuse.

Import of e-waste: Import of e-waste is legally prohibited. Nevertheless, there are reports (Toxics Link report: Scrapping the Hi-tech Myth: Computer Waste in India, Feb. 2003: www.toxiclink.org) of e-waste imports from abroad. Analyses by the ministry of environment showed no results concerning import of e-waste, but the ministry admits that a 100% control of the borders is not possible.

Traders / Scrap dealers / disassemblers: One single person can work as a a trader, scrap dealer as well as disassembler all over Delhi. Some of these traders carry out, for example, the primary work of disassembling obsolete computers, they reuse the working components, assemble new computers and sell them again on the secondary market. Non working components are sold to recyclers.

Recyclers: The market for e-waste in Delhi is not concentrated in a single place, but spread over different areas, each handling a different aspect of recycling. No sophisticated machinery or personal protective equipment is used for the extraction of different materials. All the work is done by bare hands and only with the help of hammers and screwdrivers. Children and women are routinely involved in the operations.

Disposal: Computer waste, which does not have any resale or reuse value, is openly burnt or disposed off in landfills.

Recycle steps in India

Manual Dismantling: The accrued electronic and electric waste in India is dismantled and sorted manually to fractions printed wiring boards (PWB), cathode ray tubes (CRT), cables, plastics, metals, condensers and other, nowadays invaluable materials like batteries, LCDs or wood. The valuable fractions are treated in refining and conditioning processes

Refining and Conditioning : The different e-waste fractions are processed to directly reusable components and to secondary raw materials in a variety of refining and conditioning processes.

Final Disposal: Solid waste is deposited in a municipal landfill. Systematic gas and water collecting systems are not installed; hence significant emissions to water and air are caused. The site is crowded with informal waste pickers. The people collect valuable materials for recycling.

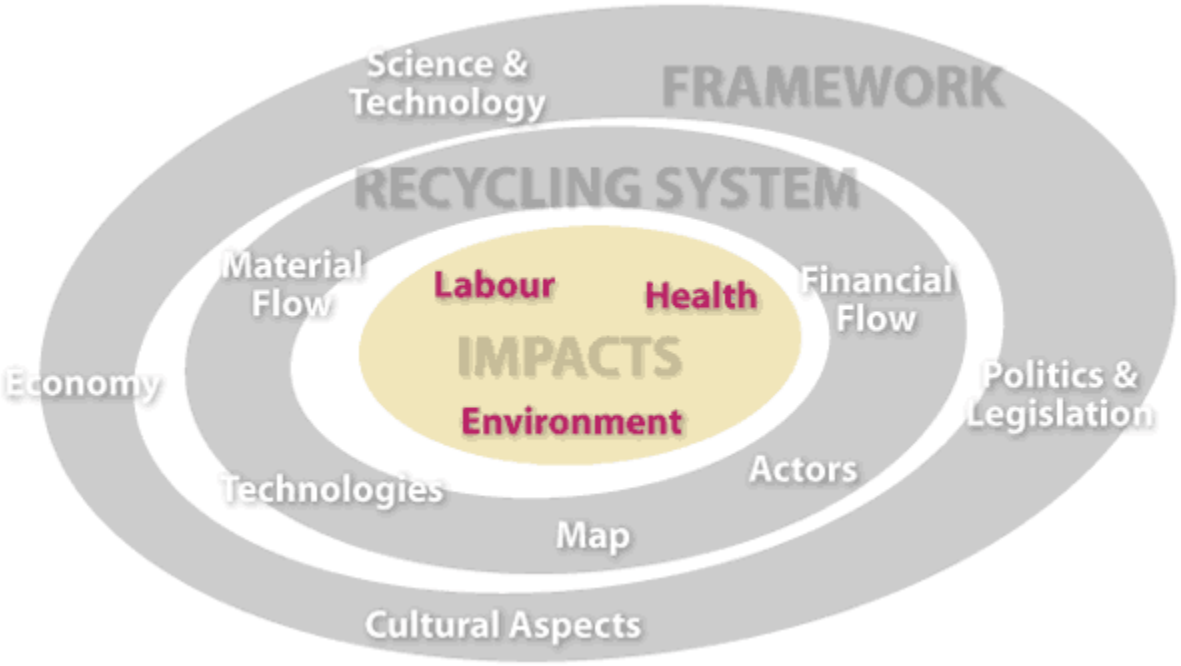
Development of a national e-waste strategy

A national framework is required as a basis for the implementation and more importantly for the replication of Clean e-Waste Channels . This framework is developed in a joint effort of all relevant stakeholders. The cooperation platform, led by the Ministry of Environment (MoEF), is the National e-Waste Strategy Group which is subdivided into five committees that work in the following crosscutting areas:

- **Policy & Legislation:** Building up a legal framework to support the national e-waste strategy.
- **Data & Baseline:** Studying the present e-waste recycling system in India, assessing the e-waste quantities in Indian cities and establishing relationships to the informal recycling sectors.
- **Skills & Technologies :** Transferring expert knowledge in e-waste management and recycling technologies to India.
- **Industry Participation & e-Waste Management:** Establishing a national e-waste management strategy to be accepted by the relevant stakeholders. This includes a stakeholder agreement on the applied e-waste management concept (responsibilities, financing, control and regulation of Clean e-waste Channels).
- **Awareness & Campaigning :** Increasing the public awareness for the e-waste problem in India, especially in the large cities.

The main objective of EMPA is the implementation of Clean e-Waste Channels in large Indian cities as well as the development & application of a national e-waste strategy. While the e-waste management framework built on a national level provides a basis for the regional implementation, the practical experience of the field work is used to improve the national e-waste strategy.

Impacts of the SWICO Recycling System in Switzerland



Both the framework conditions and the SWICO recycling system have qualitative and quantitative impacts on labour conditions, employment and value created with recycled materials. Some impacts on the environment and health set in with a marked delay, but can be extremely hazardous if not taken seriously at an early stage. Therefore the impacts on human beings and the environment are an essential element of the investigations. System impacts are assessed using sustainability criteria.

Limited financial resources and/or missing know-how are reasons for carrying out processing steps without protection measures in dealing with hazardous substances. This can cause serious health impacts.
An extensive analysis of environmental impacts is intended to identify pollution sources. Life cycle assessment (LCA) will be applied to the system under study. First LCA results are available for the Swiss SWICO recycling system. Value-added chains will be analyzed and interpreted in the next months. The manpower intensity will be quantified.
Impacts can be roughly divided into: labour / added value, environment and health

Case Study on Environmental Impacts of the SWICO System: 2. Methodology

2.1 General overview

For the study a combination of material flow analysis (MFA) and Life-Cycle Analysis (LCA) has been used: as for the MFA of the SWICO system, a simplified LCA was added in order to calculate the respective environmental impacts. The LCA was performed using the UmbertoÂ® software tool.

2.2 System boundaries

The system considers material flows related to electronic equipment from the point where it becomes waste until the point where the fractions resulting from sorting, dismantling, recycling and disposal processes become secondary raw materials or are disposed of in a landfill. The emissions from landfill were considered according to Doka (2003).

Within the system modelled, distinctions were made among collection processes, transportation processes, sorting and dismantling processes and finally recycling and disposal processes. Recycling processes were included in the system boundaries whenever they were required for the generation of secondary raw materials from these fractions. For the materials not recycled, the respective disposal processes were included. An overview of the system modelled is shown in figure 2.

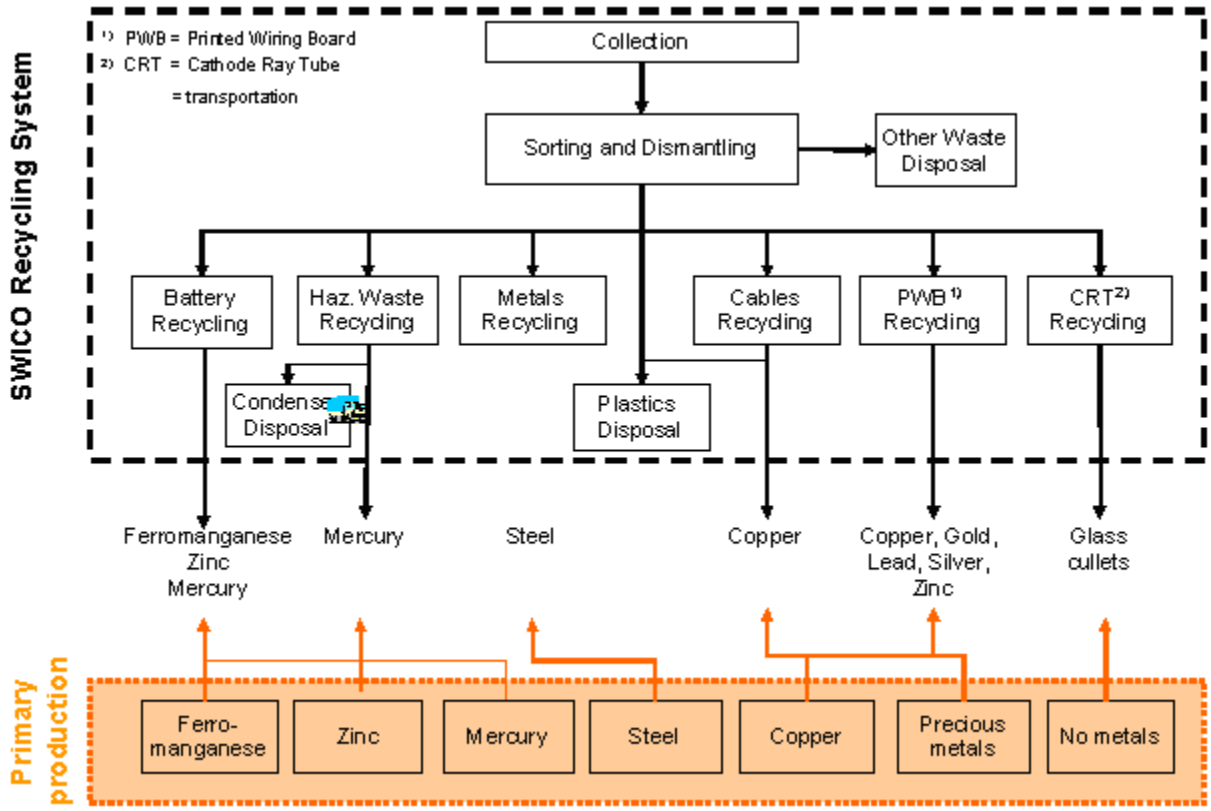


Figure 2 System boundaries

2.3 Model Representation

Due to time and data restrictions, the various processes were not modelled in every detail. Moreover, easily available LCI data (e.g. from the recently finalized Swiss national LCI database ecoinvent) were used instead of specific data. In order to check whether the assumptions and simplifications made are justifiable in this specific context or not, sensitivity analyses were performed.

2.3.1 Sorting and Dismantling

The dismantling and sorting process is performed either manually or mechanically. Based on the analysis of

material flow data it was assumed that 74 % of electronic scrap entering the SWICO recycling system is mechanically recycled, consuming 137.5 MJ of electricity per ton of electronic scrap processed.

2.3.2 Transportation

Transportation processes include transport from the consumers to the licensed companies and transport from the licensed companies to the recycling and disposal sites. Transportation modes were defined to be a mix of lorry and train.

The transport Distance and the modal split depend on the specific transport way taken as well as on the specific goods transported. For an estimate of the transport distances and the modal split, the number of recycling or disposal sites was taken into account. The resulting transport distances used for the calculations varied between 50 km (80% lorry/20% train) for incineration in a MSWI up to 1500 km (30% lorry/10% train/ 60% boat) for printed wiring boards.

2.3.3 Recycling and Disposal

Batteries: Based on the processing of alkaline batteries in the Swiss Batrec battery recycling plant, a simplified model for the production of secondary ferromanganese, zinc and mercury was established. The battery model included energy consumption, the consumption of auxiliaries as well as the emissions to air and water caused by the processing of the batteries. Not included was the treatment of NiCd-, NiMH- or Li-accumulators. These types of batteries were not examined within this system due to a lack of appropriate data.

Condensers: No distinction was made between those condensers containing polychlorinated biphenyls (PCB) and those not containing PCB. At present, in Switzerland all of them are incinerated in hazardous waste incineration plants. The data used in this model are from Doka (2003).

Other hazardous materials: Mercury-containing parts as well as selenium-coated photocopying machine cylinders constituted the quantitatively most relevant fractions of the remaining hazardous materials. In this model, the following assumptions were used for this type of waste: - mercury would be recovered and reusable; - the selenium coating would be incinerated in a hazardous waste incinerator; - the remaining metal cylinder would be recovered for the secondary metals production.

Metals: For a comparison with the respective primary production, the production of metals from secondary raw materials resulting from the sorting and dismantling process has been included in the system analysed. Most of the metals resulting from sorting and dismantling were Fe-metals, which is why only the steel production has been taken into account. Both data for the primary and secondary production process were taken from the ecoinvent database (ecoinvent 2003). It was assumed that 10% of the SWICO fraction would be non-metallic material.

Plastics: Corresponding to the present situation in Switzerland, it was assumed that 100% of the recovered plastics would be incinerated in a municipal solid waste incineration (MSWI) plant. The data used in this model are from Doka (2003).

Cables: Most cables in Switzerland are processed by two companies. Based on the information provided by one of these two recyclers, a simplified system has been modelled. The resulting plastics fraction is incinerated (see above), while the copper fraction is sold to the copper industry. The latter is considered as a secondary raw material.

Cathode Ray Tubes (CRT): The latest Cathode Ray Tube (CRT) treating plant in Switzerland (SwissGlas, MÃ¼llheim) was used as a reference for modelling this recycling step. The quantification is based on personal information from the owner of the CRT treating plant.

Printed Wired Boards (http://www.pwbrc.org/faq10.cfm ">PWB): Data have been taken from the ecoinvent database about secondary copper production (ecoinvent 2003) due to a lack of specific data on production sites extracting precious metals and copper from Printed Wired Boards (PWB).

Other waste: This SWICO category consists mainly of packaging materials. As landfilling is not allowed in Switzerland, it was assumed that 30% of these materials are separated for recycling while the remaining 70% are incinerated in an MSWI plant.

2.3.4 Primary Production Processes

The environmental impacts of the SWICO system were compared with the environmental impacts of the primary production processes, which would have been necessary to produce the same amounts of raw materials leaving the SWICO system. For the primary processes, European average process data according to ecoinvent were used, including transportation (ecoinvent 2003).

2.4 Environmental Impact Assessment

The environmental impacts were assessed under consideration of the following indicators:

- Global warming potential (GWP) according to the Intergovernmental Panel on Climate Change (IPCC);

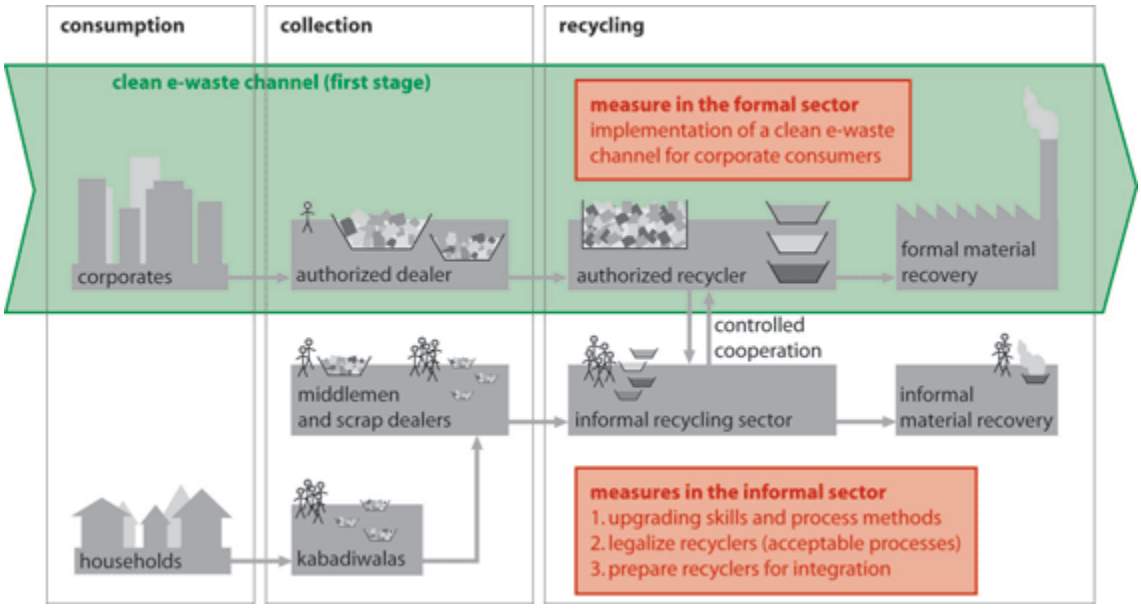
- Cumulative Energy Demand (CED);
- Eco-points according to the Swiss eco-points method UBP '97.

Implementation of Clean e-Waste Channels

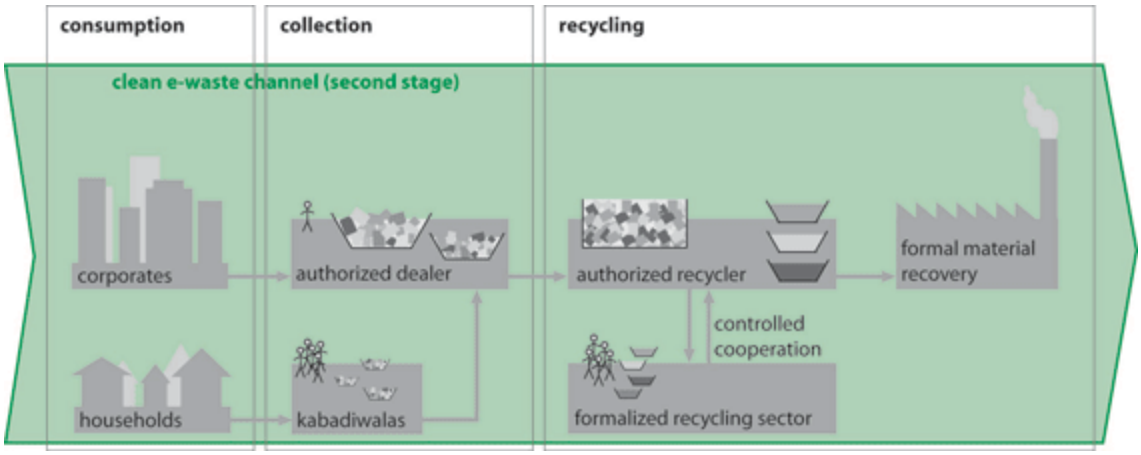
For the implementation of the Clean e-Waste Channels in India‘s large cities EMPA follows a two-stage strategy.

In a first stage a Clean e-Waste Channel for corporate consumers is implemented while taking necessary measures in the informal recycling sector. During this project stage EMPA helps to gather experiences for setting up and running a Clean e-Waste Channel. Simultaneously the informal sector shall be trained to handle the critical recycling processes and is prepared for the second project stage to be integrated in the improved e-waste management system.

In a second stage private households and SME‘s (small and medium enterprises) are linked to the established Clean e-Waste Channels for instance by integrating the existing door to door informal collection system (kabadiwalas) and buying back their collected e-waste at dedicated collection points. Furthermore the informal recyclers are integrated in the formal recycling processes for labour intensive manual operations such as dismantling and material segregation. As all actors in the foreseen system, they receive a licence after attending the required training.



First stage of the implementation strategy. A Clean e-Waste Channel for corporate consumers is implemented by diverting the corporate e-waste stream to a formal recycling system including authorized dealers (collection), authorized recyclers (dismantling, sorting, shredding) and formal material recovery plants. In the informal sector the harmful impacts of the critical recycling processes are reduced by training the recyclers in improved e-waste handling. As a step by step process, the recyclers should be legalized and motivated by economic incentives to join the Clean e-Waste Channel in the second stage of the implementation strategy.



Fully operational Clean e-Waste Channel. After the second stage of the implementation strategy the informal sector is formalized and fully integrated in the Clean e-Waste Channel. This situation represents a long term vision.

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