ewaste



PACE Project Group 3.1

e-Waste Assessment Methodology Manual

23 February 2010, v0.4 (version for PACE)

(Based on the methodology of the e-Waste Africa project of the Secretariat of the Basel Convention)

BASEL CONVENTION
the world environmental agreement on wastes

UNEP

EMPA
Materials Science & Technology

Table of Contents

Readers guide

Editors

This document is edited by experts from the Swiss Federal Laboratories for Materials Testing and Research (Empa), based on the experience gained in e-waste projects with partners in developing countries

Motivation

It has often appeared that it is not an easy task to make an assessment of the e-waste landscape in a developing nation, where access to data may be difficult, and where e-waste management largely relies on an informal sector not covered by statistical data. Therefore this manual for an e-waste assessment aims to provide guidance to civil servants of local or national administrations, consultants, researchers, and investigators conducting assessment studies in the field of e-waste. The objective is to cover similar aspects in all countries, so that the results may be comparable and easily updated.

User

The manual was designed to be used in cooperation with specialists in the field of e-waste and is hence not entirely self explaining. Nonetheless, this introduction intends to illustrate the use of this manual. Together with the additional information given in the annexes, and after a brief technical training, users should be able to work with this manual almost independently.

Scope

The scope of this methodology is to provide approaches and strategies which have proved to be suitable when assessing the e-waste landscape of a defined region. The stakeholder's analysis and the massflow assessment are the core of the assessment methodology. However, this manual goes beyond as e-waste management in developing nations has often shown to have strong environmental, social impacts. Moreover, the material fractions which are generated when processing e-waste, such as metals, plastics and glass are highly influenced by the prices which are paid on the world market; therefore also economic aspects are covered.

Organisation

The graph below illustrates the organization and the function of the chapters, the sub-chapters and the annexes of the manual and shows links of subchapters to individual annexes. The chapters are structured in the same way as the report template provided in a separate document

The sub-chapters are a list of tasks which should be considered when conducting an e-waste assessment. Consultants and researchers which are assigned to work with this manual do have specific terms of references and might find this list too broad and all-embracing. We would like to stress that this manual was written to provide a comprehensive overview, and that users should follow selected tasks according to the specific objectives of their assessment.

For some other important elements of the manual, annexes are provided. The annexes are either examples or templates which illustrate how to go about e.g. a household survey. Others provide more scientific texts which deepen the understanding of e.g. how assessment models where designed and programmed or list references of market research institutes.

The chapters start with a short introduction followed by the purpose of the individual chapter. Specific tasks or additional information are summarised on the left and shown in detail on the right. Direct links to annexes are shown in grey.

Expected results

The results provided by such a study are meant to provide a global picture of the e-waste situation in a defined region to the relevant stakeholders. They may be suitable to estimate the potentials for employment and for improving the living conditions of the social groups traditionally involved in the scrap business. Data related to the mass flow accountancy and economic aspects may provide information for setting up the proper business models for the recycling activities.

Finally, the outcome of an e-waste assessment shall provide all the necessary information that allows drafting an action plan for implementing a proper e-waste management system in the defined region.

Chapters	Function	Sub-chapters Template for assessment report	Additional information Function: Addtional information, Provision of scientific background, Templates e.g. for questionnaires
Introduction	*Opener*	Problem identification Objective of assessment	Annexes
Methods	*Methodology toolbox with various options*	Literature review Meetings and workshops Survey, questionnaire sampling Field studies **Mass Flow Assessment**	Annex A Sources of Information and key figures Annex B Collection of questionnaires: households Annex C Collection of questionnaires: corporates
System description	*Starting point: System definition*	Geographical scope Product scope Development indicators	Annex D Weight and composition of selected tracers and categories
Policy and Legislation	*System understanding for legal aspects*	E-waste related policies & legislation Specific e-waste management legislation Institutional framework	Annex E Example of overview of legal texts Annex F Checklist for establishing / analysing legislation on e-waste
Stakeholder assessment	*System understanding: main players, quantitative and qualitative data collection*	Stakeholder overview Manufactureres and importers Distributers Consumers etc.	Annex G Example of Stakeholder Overview
Massflow accountancy	*System evaluation: Calcualtion and analysis of results*	**Mass flow system chart** **Current massflows** **Future massflow trends**	Annex H Balance and parametric equations for the mass flow model Annex J Assessment of WEEE streams
Impacts	*System evaluation: Evaluation and interpretation of results*	Overview Social Environmental Economy	Annex K Detailed guideline for the assessment of social impacts
Conclu-sion	*System evaluation: Discussion of main outcomes*	Strengh and weaknesses, opportunities etc.	Annex L Example of downstream market infrastructure
Recommen-dations	*System enhancement: Proposition of ideas and solutions*	Overall recommendations Recommendations on the massflow system	Annex M Durban declaration

1 Introduction

The introduction should give the reader an overview of the project background and existing problems and specify the objectives of the study.

1.1 Problem identification

Purpose	*Explain the motivations and rational behind the project*

1.2 Objective of the assessment

Purpose	*Define explicitly the objectives of the study. Write explicitly the questions that the study needs to address.*

2 Methods

An e-waste assessment report should contain a chapter desribing the methods used during the assessment process. The content below suggests various possible methods for data acquisition, the application of the massflow assessment method as one of the core elements of the study and a possibility on how to address limitations of such a study.

During the data acquisition period the investigators should develop a selective perception of the entire e-waste recycling sector. By doing this, the methods can be fine tuned to observe and describe very specific aspects of a particular country or region (e.g. particular habits of disposing waste from households or specific refurbishment procedures). To have an overview of important data that should be obtained during the data acquisition phase, a summary of sources of information as well as key figures are listed in annex A

The massflow assessment method is introduced as one of the core elements of this assessment. The suggested method is suitable to produce quantified data as well as future trends of e-waste generation over a certain period. Chapter 6 "Massflow assessment" describes in detail how to apply the method.

2.1 Data acquisition

Describe how the data was acquired according to the listed methods below. Alternative sources of data should be briefly described.

2.1.1 Literature review and statistical data

Purpose	*Describe sources of literature and statistical data and what type of information was obtained*
Literature review	• Internet sites • Databases • Specific reports / press
Statistical data	• National Statistics • Census • Databases
Examples	See Annex A: Sources of information and key figures

2.1.2 Meetings and workshops

Purpose	*Describe meetings and workshops arranged with stakeholders and explain what type of information was obtained.*
Method includes	• Analysis of inventories • Analysis of protocols (e.g. ISO audit) • Analysis of registers • Elaboration of questionnaires • Expert interviews • …

2.1.3 Surveys, questionnaire sampling

Purpose	*Describe surveys or questionnaires samplings that were carried out and explain what type of information was obtained.*
Method includes	• Online survey • Mail distribution to households, enterprises, government, education institutions etc. • Observations (e.g. e-waste fractions in landfills, recycling practices, …) • …
Examples	See Annex B: Collection of questionnaires: households See Annex C: Collection of questionnaires: corporate

2.1.4 Field studies

Purpose	*Describe field studies conducted and explain what type of information is obtained*
Method includes	• Photo documentation • Identification of activity areas (2nd hand market, informal recycling, ...) • Observations (e.g. e-waste fractions in landfills, recycling practices, ...) • …

2.2 Massflow assessment

Purpose	*Describe what method was selected to conduct the massflow assessment*
Method includes	• Identification of massflow system • Quantification of massflows • Extrapolation of current massflows to identify future trends • … For a detailed description of how to apply the massflow assessment methodology see chapter 6 “Massflow assessment”.

2.3 Limitations

Purpose	*Define the limitations of the selected methods and how the accuracy. Assess critically if the methods applied meet the objectives of the study*
Error estimation	For data acquisition, indicate: • If possible, calculated standard deviation (+/- x%) • Qualitative estimation of the data quality (good, average, bad) • Type of data source (statistic, estimation, calculation) • …

3 System definition

In the system definition the physical boundaries (geography and products) are set and the overall development status of the country or region investigated are analysed.

3.1 Geographical Scope

Purpose	*Define the geographical system boundaries of the study.*
Geographical areas	Specify the following information: • Country / countries in scope • Regions / provinces in scope • Focus on rural and/or urban areas • Cities in scope • Including transboundary movement (neighbouring countries, legal / illegal import through sea ports, etc.) or inland focus only

3.2 Product Scope

Purpose	*Define which electrical and electronic equipment (EEE) are in the scope of the study.*
Categories	As a base use the definition of products as given by the EU WEEE Directive: **No Category** 1 Large household appliances (e.g. Washing machines, dryers, etc) 2 Small household appliances (e.g. Hair dryers, toasters, etc) 3 IT and telecommunication equipment (e.g. PCs, Mobiles, Faxes etc) 4 Consumer equipment (e.g. TVs, DVDs, Music Players etc) 5 Lighting equipment (e.g. Tubelights, Bulbs etc) 6 Electrical and electronic tools (with the exception of large-scale stationary industrial tools) 7 Toys, leisure and sports equipment 8 Medical devices (with the exception of all implanted and infected products) 9 Monitoring and control instruments 10 Automatic dispensers
Tracer	Define tracers (components, weight) representing the relevant categories based on the data provided in Annexe D
Extrapolation	Estimate the quantity of the tracer product as a percentage of its corresponding category. Different models of a tracer product (e.g. desktop vs laptops, flatscreens vs. CRTs) as well as products attached to a tracer product (e.g. mouse, keyboard, printers per PC) should be assessed as key indicators via appropriate data assessment strategies (sales data, questionnaires, interviews, etc.)
Recommended tracers	• Category 1: refrigerators, air conditioners • Category 2: iron, kettle, microwave (depends highly on country characteristics) • Category 3: personal computers, mobile phones • Category 4: televisions, radio/hifi • Category 5: fluorescent tubes Adapt or add a tracer according to the characteristics of the assessed country or region.
Examples	See Annex D: Weight and composition of tracers and categories

3.3 Development indicators

Purpose	*Provide a background for the countries' development status which may influence e-waste generation and management and provide a basis for comparison between countries and linkages between major indicators and e-waste characteristics, quantities and distribution.*
Data sources	• World Development Indicators – World Bank 2007 • Human Development Report 2007/2008 – UNDP 2008 • National Statistics • …
Examples	See Annex A: Sources of information and key figures

3.3.1 People

Indicators

- Total population
- Number of households
- Household size
- Average annual population growth rate
- Share of economically active children
- Unemployment
- Youth unemployment
- Urban informal sector employment
- Population below international poverty line (Population bellow 1$ per day, population below 2$ per day)
- GINI index
- …

3.3.2 Environment

Indicators

- Electrification rate
- Energy use
- GDP per unit of energy use
- Emissions of organic water pollutants
- Land area
- Rural population
- Urban population
- Population in urban agglomerations of more than 1 million
- Population in largest city
- …

3.3.3 Economy

Indicators

- Gross domestic product (GDP)
- Purchasing power parity (PPP) conversion factor
- GDP per capita

- GDP (PPP) per capita
- GDP composition by sector (agriculture, industry, services)
- Labour force by sector (agriculture, industry, services)
- Consumer price index
- …

3.3.4 States & Markets

Indicators

- Telephones access
- Households with television
- Personal computers per 1000 people
- Internet users per 1000 people
- Mobile Phone subscribers per 1000 people
- Information and communications technology expenditures (% of GDP)
- Micro, small, and medium-size enterprises
- Tax revenue collected by central government
- …

4 Policy & Legislation

4.1 E-Waste related policies & legislation

Purpose	*Identify the legal regulations that may influence e-waste management. Present an overview of legal texts as proposed in Annexe E.*
Environmental legislations	• Air • Water • Solid waste • ...
Social legislations	• Freedom of association and right to collective bargaining • Forced labour and Child labour • Government programmes to foster employment and alleviate poverty • Legal status of migrants including issuing of work permits • ...
International treaties	• Basel convention • Bamako convention • ...
Example	See Annex E: Overview of legal texts

4.2 Specific e-waste management legislation

Purpose	*Identify specific legislation on e-waste management*
Legislation description	• If a legislation, or a draft legislation exists, analyse it with the use of the check list provided in Annexe F
Example	See Annex F: Checklist for legislation on e-waste

4.3 Institutional framework

Purpose

Political structure: Describe how the legislative, the executive and the judiciary systems are organised in the country with special emphasis on environmental management.

Important authorities: List governmental bodies related to e-waste at national and if important at local level, e.g.:

List ministries of environment, health, technology, communication, economy (small business development), customs, etc.

List important local governmental bodies, municipal services

Qualitative description

- How is the law enforced?
- What are the incentives / repressive measures they use?
- Important social / economic / environmental programmes
- Is e-waste a priority?
- What is the policy regarding the informal sector?
- ...

Indicators

- Number of employees
- Number of inspectors
- Environmental control material
- Government organised microfinance scheme for informal entrepreneurs
- ...

5 Stakeholders assessment

Purpose	*Define the actors involved and their role in the e-waste management system by groups of stakeholders. Characterise the stakeholder group with a set of indicators*
Description of the stakeholder group	• Who are they? • What is their role / activity? • How are they organised? • What is their impact on e-waste management? • Address, location? • …
Qualitative indicators	• What are their interests, motivation? • How do they achieve their goal? What is their respective strategy and what are the main obstacles they perceive? • …
Quantitative indicators	• Scalable answer, e.g. ratios, numbers • …

5.1 Stakeholder overview

Purpose	*Show graphically interconnections and name the main stake holders. Identify the main individual players. The following stakeholders should be listed by their company name and the main business connections should be indicated by connectors.*
Stakeholders	• Producers/importers/assemblers • Local brands/assembly • Retailers • Refurbishment programs • Repair stores • Existing collecting systems • Existing take-back programs • Existing formal e-waste recyclers • Informal e-waste recycling
Example	See Annex G: Stakeholder overview

5.2 Manufacturers and importers

Stakeholder group description	Producers are defined as any organization manufacturing, assembling and / or importing EEE. This group is composed of the hardware brands and their associations (IT association, consumer electronics, electronic components, etc...), but also of "unidentified" producers, when the equipments are non branded.
Qualitative indicators	• Marketing strategy? • Corporate social responsibility programmes (CSR)? • Special economic schemes (e.g. tax holidays, de-bonded equipment)? • Producer Responsibility Organisation? • …
Quantitative indicators	• Annual imports of new equipment (time series) • Annual imports of 2nd hand equipment (time series) • Domestic manufacturing (time series) • % import vs. % domestic • % branded vs. % non-branded

- Major brands and market shares
- Growth forecasts of sector
- % small and medium sized enterprises (SMEs) of total
- Number of employees
- …

5.3 Distributors

Stakeholder group description

Distributors are defined as all bodies selling the equipments directly to the consumers. They are composed of:

- Retailers
- Second hand market
- Organisations providing donated equipments (imports?)
- Others (e.g. online distributors, etc).
- …

Qualitative indicators

- Preferred mode of distribution?
- Mode of revenue for the distributor?
- Importance of the second-hand market / non-branded market?
- …

Quantitative indicators

- Annual sales/distribution of new equipment (time series)
- Annual sales/distribution of 2nd hand equipment (time series)
- Retail shops / inhabitant
- % retail vs. % 2nd hand market
- Size of 2nd hand market
- Take back schemes
- ...

5.4 Consumers

Stakeholder group description

Consumers are defined as the bodies that consume EEE and discard them as waste when they have reached the end of their useful life. Consumers are usually separated between:

- private (households) and
- corporate (mainly business and government). Business consumers have to be distinguished between:
  - small and medium enterprises (SMEs), as their behaviour may be closer to the one of private consumers, and
  - large enterprises

Qualitative indicators

- Modes of consumption? (e.g. lease, assembled equipments, new material, on-line purchase, etc.)
- Modes of end-of-life management? (e.g. return to retail point, storage, pick-up service, sold to 2nd hand market, etc.)
- Access to new (ICT) technology?
- Awareness on social and environmental issues?
- …

Quantitative indicators

- % private vs. % corporate
- % business and government
- % large business vs. % small business
- % urban vs. % rural
- Life span private vs. life span corporate
- Penetration rate (# equipments / 100 cap.)
- e-Waste generated / capita
- Disposal options

- Disposal habits
- …

5.5 Collectors

Stakeholder group description	Collection of e-waste may be either assured by: • Collection points (municipal points, drop-offs, retail shops, ...) or • A pick-up service. The latter may be organised (pick-up days organised by municipalities), semi-organised (e.g. door-to-door collection) or disorganised (rag-pickers, scavengers, etc.)
Qualitative indicators	• Organised or left to informal sector? • Consumer pays or is paid for his waste? • Take back-schemes? • …
Quantitative indicators	• e-Waste collected / cap. • % formal vs. % informal • Employment generated (Persons / ton collected) • Amount of people working for e-waste collection • ...

5.6 Refurbishers

Stakeholder group description	The refurbishers group comprises all the repair units, service centres, etc., that extend the life time of equipments and feed the second hand market
Qualitative indicators	• How is this sector organised? • Is it a formal economy (pays taxes, registered, etc)? • Interactions with other value adding players (Waste2Art, etc...) • …
Quantitative indicators	• % of repairable equipments • e-Waste produced by a standard repair shop (kg/year) • Lifespan of refurbished equipment (in average, how old are the equipments brought for repair, and how long is their life extended?) • Average age of equipments to repair • Revenue per refurbished equipment of a certain type (Pentium II and IV for PCs for example) • ...

5.7 Recyclers

Stakeholder group description	Recyclers are any organization dismantling, separating fractions and recovering material from e-waste.
Qualitative indicators	• How is this sector organised (formal/informal)? • Is there a specific e-waste recycling industry? • Which fractions are produced? • How are different non-valuable fractions disposed of (hazardous/non-hazardous)? • ...
Quantitative indicators	• Yearly volume handled by the recyclers (t per company or/and in total) • % formal vs. % informal • Employment generated (Persons/ton e-waste recycled)

- Resulting fractions
- Fractions disposed of
- By-products / ton e-waste (e.g. litres of acid per kg of circuit boards, kWh/ton e-waste, etc.)
- Yearly turnover (1000 $ per company or/and in total)
- ...

5.8 Downstream vendors

Stakeholder group description

Vendors are the industries buying the fractions (e.g. copper, plastics, metals, gold, etc.) produced by the recyclers. They can be national or international, and vary from jewellers to smelters, etc., for example:

- experience in India showed that the gold and silver recovered from printed circuit boards was bought by jewellers
- copper smelters purchase the copper recovered from e-waste
- plastic parts from e-waste are used to manufacture car bumpers

Qualitative indicators

- What kind of industry uses material from e-recycling?
- Does the material remain in an informal market, or is it re-injected in the formal economy?
- What gets exported and in what condition?
- …

Quantitative indicators

- % of raw material coming from e-waste (e.g. share of plastic coming from e-waste vs. plastic from other sources in a car bumper)
- Usage of raw material
- Revenue per weight of different fractions sold
- …

5.9 Final disposers

Stakeholder group description

Final disposers are organizations in charge of the final disposal of waste through incineration or landfilling.

Qualitative indicators

How is the ultimate waste treated? Is it formal, e.g. controlled landfill, energy recovery (incinerators), or informal (dumping sites, open burning, ...)

- Which agencies are in charge of solid waste disposal?
- Public vs. private?
- Are there restrictions regarding landfill space in the country?
- Infrastructure for hazardous waste?
- ...

Quantitative indicators

- Available landfill volume in the country (non-hazardous / hazardous)
- Capacity for hazardous waste (tons/year)
- E-waste observed in municipal solid waste
- Characterisation of solid waste stream
- % of formal vs. % of informal disposal
- ...

5.10 Most affected communities

Stakeholder group descrip-

Communities that have – by close neighbourship relations to collection points, refurbishment / recycling centres or disposal areas – key interests in the development of an e-waste management system. This might include interests regarding the sector's

tion	economic possibilities or interests in limiting soil, water and air pollution.
Qualitative indicators	• Does the sector pose serious health risks to the community? • What is the quality of jobs compared to local alternatives at the same level of education? • Does the sector's presence positively or negatively influence other social and economic activities (e.g. negative impacts on agriculture)? • …
Quantitative indicators	• Cases of negative health impacts or increased health risks (e.g. enhanced blood lead levels, visible soil, water and air contamination) • Number of jobs provided by the e-waste sector. • Number of low skilled jobs provided by the e-waste sector. • …

5.11 Civil society Other stakeholders

Purpose	Identify institutions having the capacity to support the implementation of an e-waste management system within the country.
NGOs & International organisations	• Organisations active in solid waste management • Organisations working with informal sectors • International funding / implementing organisations • ...
Scientific institutions	• University institutes • Consultancy offices • ...

6 Massflow assessment

6.1 Massflow system chart

Purpose

Show graphically how the e-waste flows circulate between the different actors. The actors here may be defined as "active stakeholders". This allows to see where the main stocks and flows are.

Mass flows and stocks

Show graphically the interconnections following the generic example of the in figure 1.. Identify:

- The major stocks of e-waste
- The flows between stakeholder groups

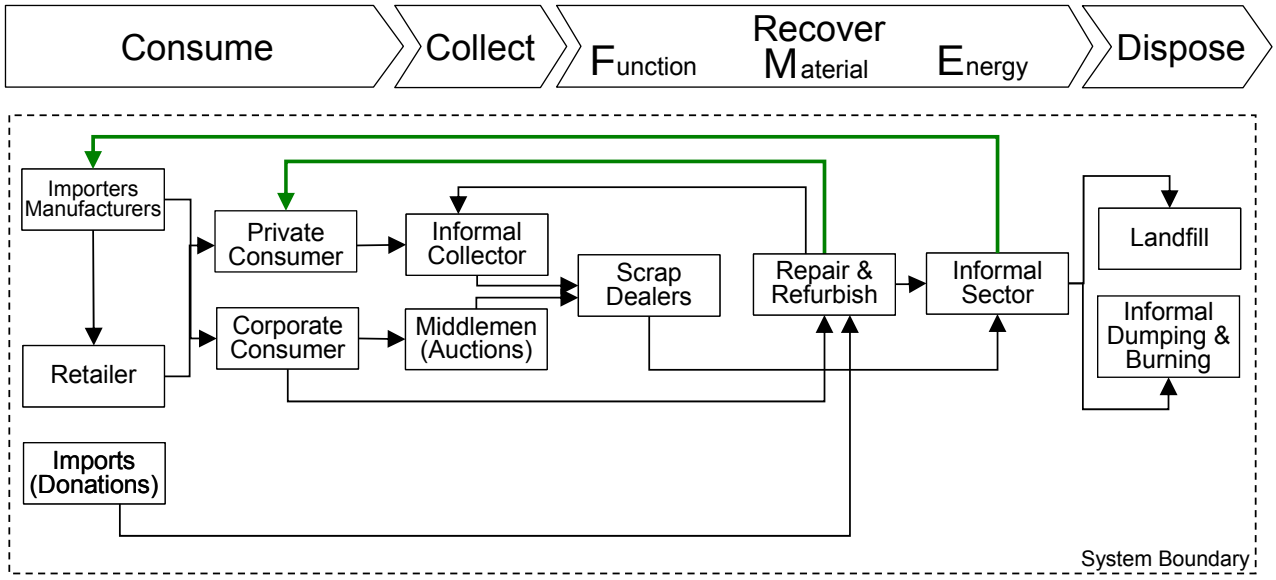


Figure 1: Example of a massflow system chart. The different actors of the system are represented with boxes, while the flows of e-waste are shown by black arrows. Flows resulting from the recovery of the function, the material or the energy contained in e-waste are shown with green arrows (in this example, no energy is recovered).

6.2 Current massflows

The current mass flows are calculated based on key figures obtained through literature review, statistical data and the stakeholder assessment. A short explanation of methods, how to calculate mass flows and important key figures that are needed for this calculations are listed below and explained more in detail in the annexes A, H and J.

Purpose	*Quantify the mass flows and stocks for the current situation.*
System definition	• Define units for time and mass (e.g. tons/year) • Represent the current massflows in the massflow system chart developed for chapter 6.1
Material flow analysis	**Mass balance equations:** Based on the mass conservation law: $\Delta S = \sum F_{in} - \sum F_{out,}$ where: • ΔS is the variation of stock in a process • $\sum$Fin is the sum of flows entering a process • $\sum$Fout is the sum of flows leaving a process **Parametric equations:** The flows and stocks of the system are interdependent and can be mathematically related through parametric equations: Fi+1 = f(ki+1; Fi, S), where: • F is a flow • S is the stock • K is the transfer coefficient These two sets of equations allow extrapolating all flows and stocks from a given value. An example of a set of mass balance equations and parametric equations describing an e-waste system is provided in Annexe H
Assessment of e-waste streams	A set of different equations to calculate e-waste flows from sales or stock data are listed and explained in Annex J

Important key figures	• Consecutive sales/distribution data for the tracer appliances ideally over 10 years+
	• Consecutive import and export data for the tracer appliances ideally over 10 years+
	And /or
	• Stock data for the tracer appliances over at least 10 years (per capita/ per household or per other denominator if feasible)
	Further important key figures:
	• Estimation or research results on medium life span for the tracer appliances
	• Estimates of e-waste generated (in tons/year)
	  o historically
	  o per year
	  o in the future
	• Collected e-waste through existing take-back or collection systems (in tons/year)
	• Formally recycled e-waste quantity per year (in tons/year materials recovered)
	• Material exports resulting from e-waste recycling (in tons/year materials recovered)

Examples	See Annex A: Sources of information and key figures See Annex H: Balance and parametric equation for the mass flow model See Annex J: Assessment of e-waste flows

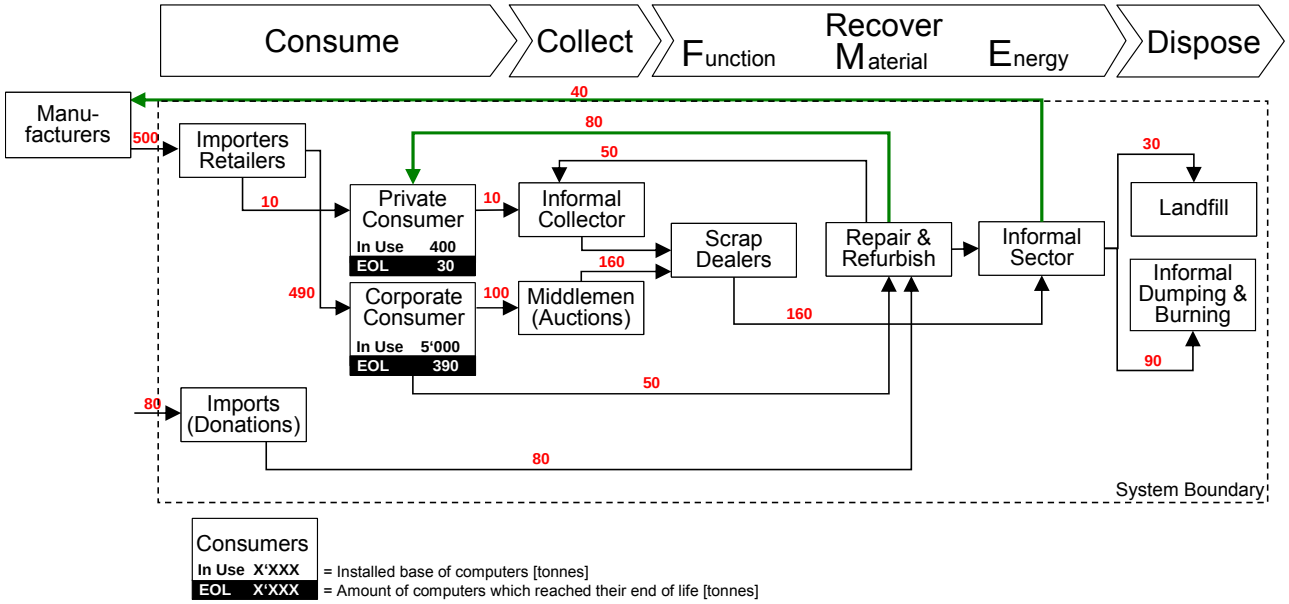


Figure 2: Example of a massflow system chart of computers stocks and flows in a small developing country. Estimated massflows are in tonnes/year, estimated stocks in tonnes. Since more new and second hand computers enter than leave the consummation process, the stock of equipment is growing. Only a small part of the end-of-life equipment is actually collected and as e-waste and further treated, the rest is stored.

6.3 Future massflow trends

Purpose *Quantify the mass flows and stocks for a future situation*

Extrapolation Quantify future massflows in the same units as the current massflows by extrapolation existing time series (e.g. of import or sales/distribution data) according to different scenarios, for example by varying parameters susceptible to change in the future, such as:

- Growth rate of imports or sales
- Life span of equipments
- IT penetration in the population
- Changes in tracer composition (e.g. CRT replaced by LCD)
- ...

For quantifying future mass flows and stocks the same equations in Annexe H and J can be used.

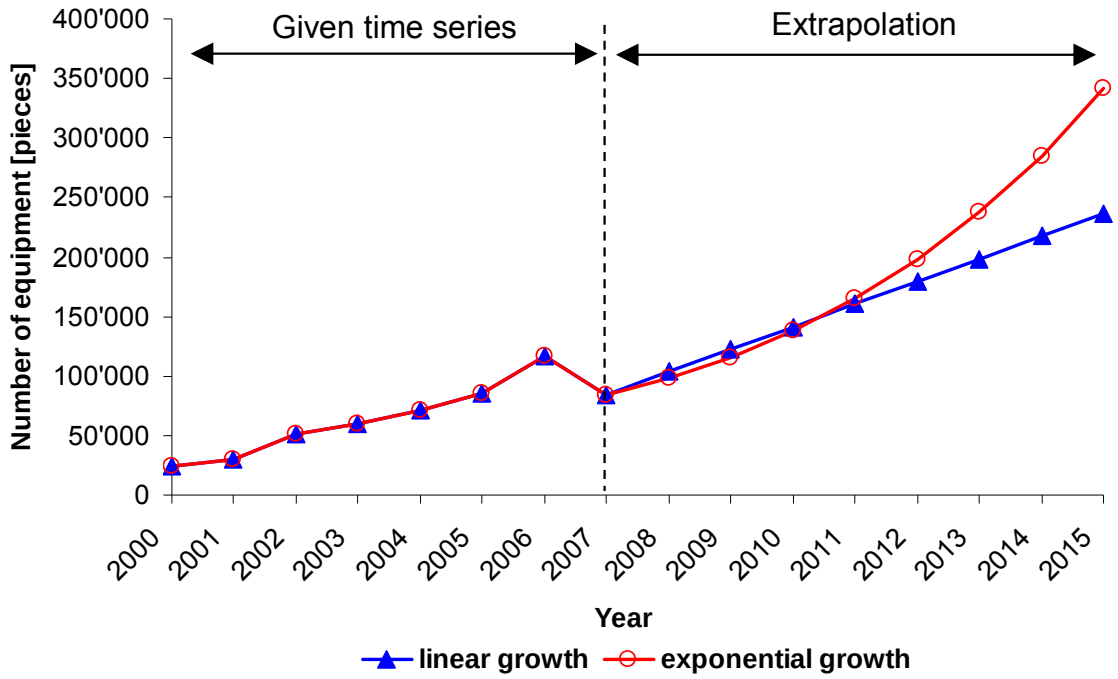


Figure 3: Example of extrapolation of an import time series. According to the growth behaviour of the imports from 2000 to 2007, two growth scenarios were assumed: Linear growth or exponential growth. The extrapolated import time series can be used to calculated future e-waste flows according to the equations in annex J-

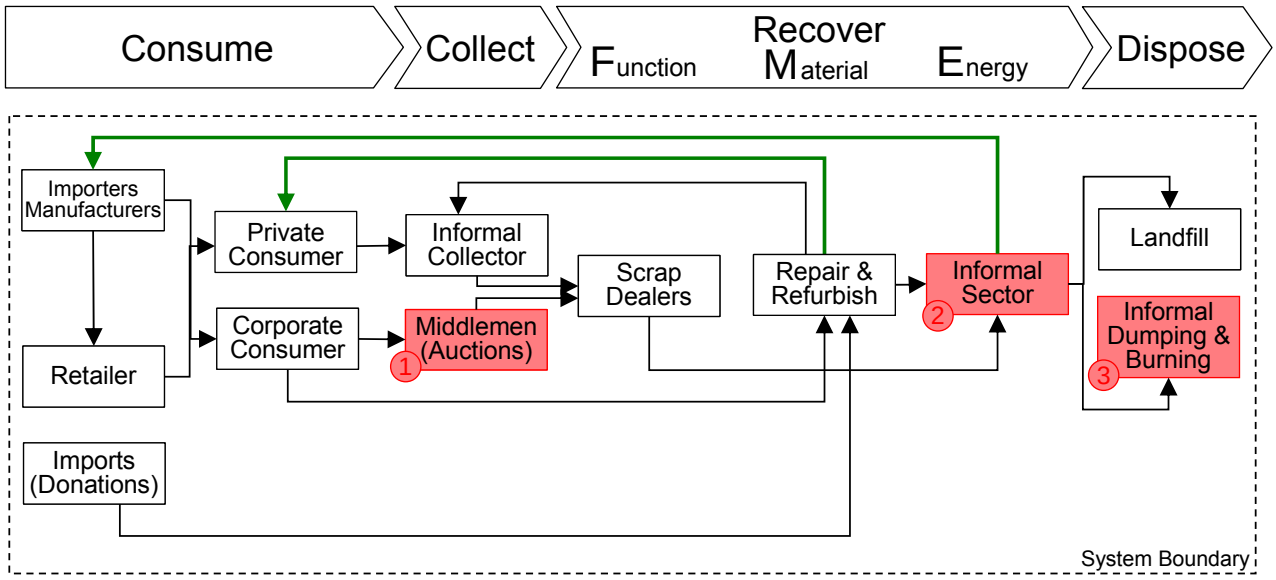
7 Impacts

7.1 Overview

Purpose *Identify undesirable operations and negative impacts in the massflow system of the country or region investigated*

"hot spots"

- Show graphically the high priority "hot spots" in the massflow system chart.
- Use a colour code according to the example in figure 3



1. **End-of-life equipment from corporate consumer:**
   - Often declared as „donation“ for cheap disposal
2. **Material recovery in the informal sector:**
   - Manual dismantling of hazardous component
   - Wires and cable burning
   - precious metal recovery in a hazardous manner (e.g. gold leaching
3. **Informal dumping and burning:**
   - Emissions from dumped residues
   - Emissions from informal burning sites

Figure 1: An example of a massflow system chart with its undesirable operations/"hot spots"

7.2 Assessment of impacts from the e-waste sector

The following research guidance is aimed to allocate the identified negative impacts or "hot spots" to social, environmental and economic impacts and evaluate them in more detail. Thereby the term "hot spot" does not only apply to negative impacts, but also to positive effects such as poverty alleviation and income generation. In order to come to meaningful results that can be used to find sustainable solutions, it is vital to subdivide the e-waste sector into the five major sub-sectors Collection, Refurbishment, Dismantling, Material recovery, Final disposal.

7.2.1 Social Impacts

The following questions are guidelines for the evaluation of social impacts. A more detailed guideline can be found in annex K.The following research guidance is aimed to identify major social hot spots in the e-waste sectors. Thereby the term "hot spot" does not only apply to negative impacts, but also to positive social effects like poverty alleviation and income generation. In order to come to meaningful results that can be used to find sustainable solutions, it is vital to subdivide the e-waste sector in different sub-sectors as this has been done in the massflow assessment chapter (figure 2 and 3).

Nevertheless the approach done in this chapter leads to a large number of sub-sectors, which is complicating practical analysis. Therefore it is proposed to focus on five major sub-sectors, which are considered decisive for a social impact analysis of e-waste management: Collection, Refurbishment, Dismantling, Material recovery, Final disposal.

Other sub-sectors like e-waste trading and the marketing of recovered materials are considered of secondary importance for the social impact analysis.

Purpose

Conduct a Qquantitative and qualitative assessment of positive and negative social impacts from the e-waste sector

Impacts on employees

- Describe major health and safety risks for workers in the different e-waste sub-sectors
  - Lay out the bases of this judgement (e.g. visible risks, systematic health surveys, widespread symptoms of occupational diseases)
  - Estimate the share of workers being affected by these risks in each sub-sector.
  - Describe measures to protect workers' health (e.g. masks, special training)
- Describe the organisation and official status of employment in the different sub-sectors
  - Are enterprises usually registered or informal?
  - Describe the typical size-structure of the enterprises in each sub-sector.
  - Elaborate on the workers' possibility to take influence on their working conditions (e.g. working hours, holidays, health and safety issues, unionisation)
- Check on the gender, ethnic and age composition of the workforce in each sub-sector
  - Share of women in each sub-sector
  - Share of women in qualified positions (Definition of "qualified position": The position requires at least reading, writing, mathematic and/or enhanced mechanical skills)
  - Share of minority ethnic groups in relation to the local population picture
  - Predominant age structure
- Check whether there are cases of people being employed involuntary or by means of coercion
  - Special attention on vulnerable groups (e.g. illegal migrants) that might be commercially exploited
- Cases of children working in the e-waste sector
  - Describe typical tasks for children in the e-waste sector
  - Indicate whether these activities are considered a risk to health and safety

- Describe the age structure of the children working in the e-waste sector
- Elaborate on working hours and general working condition of children in the e-waste sector (wages, housing, possibility to visit school, catering…)

- Lay out the wage structure of the typical types of employment in each sub-sector
  - State whether employees are compensated according to waste volumes treated, by hours of work, or by a fixed wage-level
  - Calculate average and lowest wage levels per hour / per day / per month.
  - Calculate wage-level per unit [ton] of e-waste treated in each sub-sector (IMPORTANT: Even if workers are compensated based on hours worked, it is also needed to analyse the labour costs per tonnes of e-waste)
  - Elaborate on additional benefits by working in the e-waste sector (e.g. free catering, free housing, possibility to sell refurbished products)
  - Indicate whether the sector provides a steady or interrupted source of income for workers
- Evaluate on the length of a typical working day and working month in each sub-sector
  - Working hours per day
  - Rest periods or typical breaks per working day
  - Number of working days per week / month
  - Number of paid / unpaid days off (holidays) per year
- Evaluate on the typical duration of employment in each sub-sectors
  - Indicate typical reasons for ending an employment relation in the sector (e.g. better job opportunities in other sectors, workers are dismissed because of low work performance)
  - Judge on the sector's dynamics: Is the sector likely to provide more or less jobs in the future?
- Evaluate on social security schemes of each sub-sector
  - How many workers are covered by basic social security schemes in each sub-sector? (Health, unemployment, old-age- and disability-pension, maternity).
  - Are these social security schemes grated by the government or the employer?
- Evaluate on the social recognition of employment in the different e-waste sub-sectors
- What sub-sectors are perceived as dirty or unfavourable work by the employees themselves?

Impacts on local communities

- Describe the geographic setting of major e-waste treatment facilities and sites
  - Are major collection points, refurbishment-, recovery- or disposal sites located in or nearby populated areas or agricultural land?
  - If yes: Describe the socioeconomic set-up of the settlement (economic basis, typical kind of housing-structure, population density (above / below local average), distance to e-waste treatment sites).
- Describe major health and safety risks for the local population by each sub-sector
  - Lay out the bases of this judgement (e.g. visible risks, systematic health surveys, widespread symptoms of e-waste related diseases)
  - Estimate the number of residents being affected by these risks.
  - Describe measures by the community, the government and the industry to protect the residents' health.
- Estimated the local economic importance of each e-waste sub-sector
  - Number and share of local population active in / dependent on the e-waste sector
  - Description of the sector's role in local social and economic development (e.g. stimulating local economic growth, resulting hindrances for other economic activities)
- Local perception of the e-waste sector (e.g. predominantly beneficial, regarded with suspicion)

Impacts on society	• Absolute number of jobs provided by each sub-sector and the total e-waste sector in the country • Indicate risks of corrupt practices in the industry based on expert judgement, qualitative interviews and / or press reporting • Estimate the sectors' contribution to the national economy • Estimate the sector's monthly / annual value creation based on data for revenues by the sale of refurbished equipment and recovered parts and materials. • • Indicate whether the sector was subject to any political dispute leading to conflicts • Also check whether the e-waste sector was part of larger conflict cases (e.g. conflict over land-use-changes or massive pollution of agricultural land due to industrialisation)
Additional information	This information can be derived from the collected data. Since these indicators are crucial for further impact analysis and data interpretation, the calculation should be made transparent. Furthermore the accuracy of the calculation should be cross-checked by two different calculation methodologies • Number of working hours per unit of e-waste treated in each sub-sector (e.g. 5.5 h/t in e-waste collection) • First calculation method on national scale: Number of workers x number of working hours per worker / amount of e-waste • Second calculation method on individual scale: Median of data on individual basis: Amount of e-waste treated by one worker in a certain time • Labour costs per unit of e-waste treated in each sub-sector (e.g. 8 $/t in e-waste collection) • First calculation method on national scale: (total annual sector revenues – estimated investments and running costs for material, rent, taxes…) / total annual amount of e-waste • Second calculation method on individual scale: Median of data on individual basis: Wage per day / amount of e-waste treated per day
Example	See Annex K: Detailed guideline for the assessment of social impacts

7.2.2 Environmental Impacts

Because of difficulties to access reliable data in waste management, and because of the short duration of the rapid e-waste assessment, it is not possible to scientifically quantify the impact to environment by applying a complete life cycle analysis (LCA). Therefore, a qualitative approach based on the field observations and a quantitative approach based on the material flow analysis is adopted.

Purpose	*Conduct a qualitative assessment of the impacts to environment*

Emissions to air and water	Based on the material flow assessment:
	• Identify, describe and quantify major flows of material to environment (air and water).
	• Identify the hazardous substances used for the recycling processes (e.g. nitric acid, mercury & cyanide salts used in the precious metal recovery)
	• For emissions to air:
	  • Identify and describe sources (dust during dismantling, burning of plastics, evaporation of chemicals during recycling, etc.)
	  • Identify hazardous substances emitted to the air
	  • Possible measures taken to control airborne emissions
	• For emissions to water:
	  • Identify and describe sources (leaching of solid residues into ground water, disposal of wet chemical effluents into the sewage system, etc.)
	  • Identify hazardous substances emitted to the water
	  • Possible treatment measures of effluents

Solid waste

Based on the Material Flow Analysis:

- Quantify the flow of solid waste produced.

Bellow are listed some examples of components / fractions from e-waste containing hazardous substances:

- Batteries and accumulators, notably: Nickel-Cadmium accumulators, batteries and accumulators containing Mercury, Lithium accumulators
- Condensers and ballasts (pre-switches), partly containing Polychlorinated biphenyls (PCBs)
- Mercury switches / mercury relays / mercury vapour lamps
- Parts containing Chlorofluorocarbons (CFCs) and hydro chlorofluorocarbons (HCFCs) (refrigeration cycle in refrigerators / insulation materials)
- Selenium drums in photocopying machines
- Components that release asbestos fibres
- Shredder fraction containing PCB, Cd, others
- Getter pills in electron-gun

For a selection of relevant components / fractions:

- Describe how they are disposed of (controlled landfill, incineration, wild dumping)
- Identify major substances of concern contaminating the soil. Estimate the volumes.

Human Health

- Characterise the direct exposure to:
  - The workers
  - The neighbouring communities
  - The general population
- Based on the type of emissions, assess the risk of:
  - Human toxicity (carcinogenic and non-carcinogenic), e.g. blood lead levels, observation of symptoms resulting from exposure to chemicals
  - Respiratory problems (dust, acid vapours, etc.)

Pressure on resource

- Identify, describe and quantify the types of resource involved in the recycling processes for:
  - Use of energy (coal, oil, wood, etc.)
  - Inputs to the recycling processes (water, acids, chemicals, etc.)

Pressure on ecosystems

- Identify and quantify the substances emitted to the environment which can cause:
  - Ecotoxicity (terrestrial and aquatic)
  - Acidification
  - Eutrophisation

7.2.3 Economic Impacts

Purpose	*Conduct a qualitative assessment of economic impact produced by an e-waste management system*
Positive effects	• Estimate revenues (in order of magnitudes) which are currently achieved in different activities associated with e-waste recycling: collection, refurbishment, dismantling, material recovery, final disposal; compare to country's GDP • Side effects on related businesses such as for micro-finance institutions supporting refurbishment centers and recycling operations, etc. • Access to secondary raw material which would have to be imported at higher costs
Negative effects	• Disposal costs of hazardous waste • Clean-up costs for contaminated soil and water • Restrictions on the import of good quality used equipment (threatening access to ICT equipment for e.g. SMEs)

8 Conclusion

The conclusion considers the most important outcomes of all the results in the previous chapters. Some possible evaluations are listed below.

Purpose	*Summarize the main outcome of the assessment and discuss the lessons learnt from the assessment* • Evaluate strengths and weaknesses of the current situation • Evaluate main opportunities for the different e-waste sectors • Summarize downstream market infrastructure (example see annex L) • …
Example	See Annex L: Downstream market infrastructure

9 Recommendations

9.1 Overall recommendations

Recommendations can be given regarding the seven main issues related to an improvement of the current e-waste management practices encountered on the African continent. These seven issues were elaborated by the signatories of the Durban Declaration in October 2008. The whole text of the Durban Declaration can be found in annex M.

Purpose	*Propose ideas and solutions, how the current situation could be enhanced*
Main issues to improve the current e-waste management practices	Give recommendations, how to: • improve cooperation among stakeholders • establish an institutional framework • create awareness at all levels of governance and the general public • support markets • collect and manage data • develop a legal framework • develop a qualified and efficient e-waste recycling sector
Example	See Annex M: Durban Declaration

9.2 Recommendation on the massflow system

Purpose	*Identify where and how the above recommended interventions would affect the mass-flow system of the country or region investigated*
Interventions	• Show graphically the possible interventions in the massflow system chart. • Use a colour code according to the example in figure 4

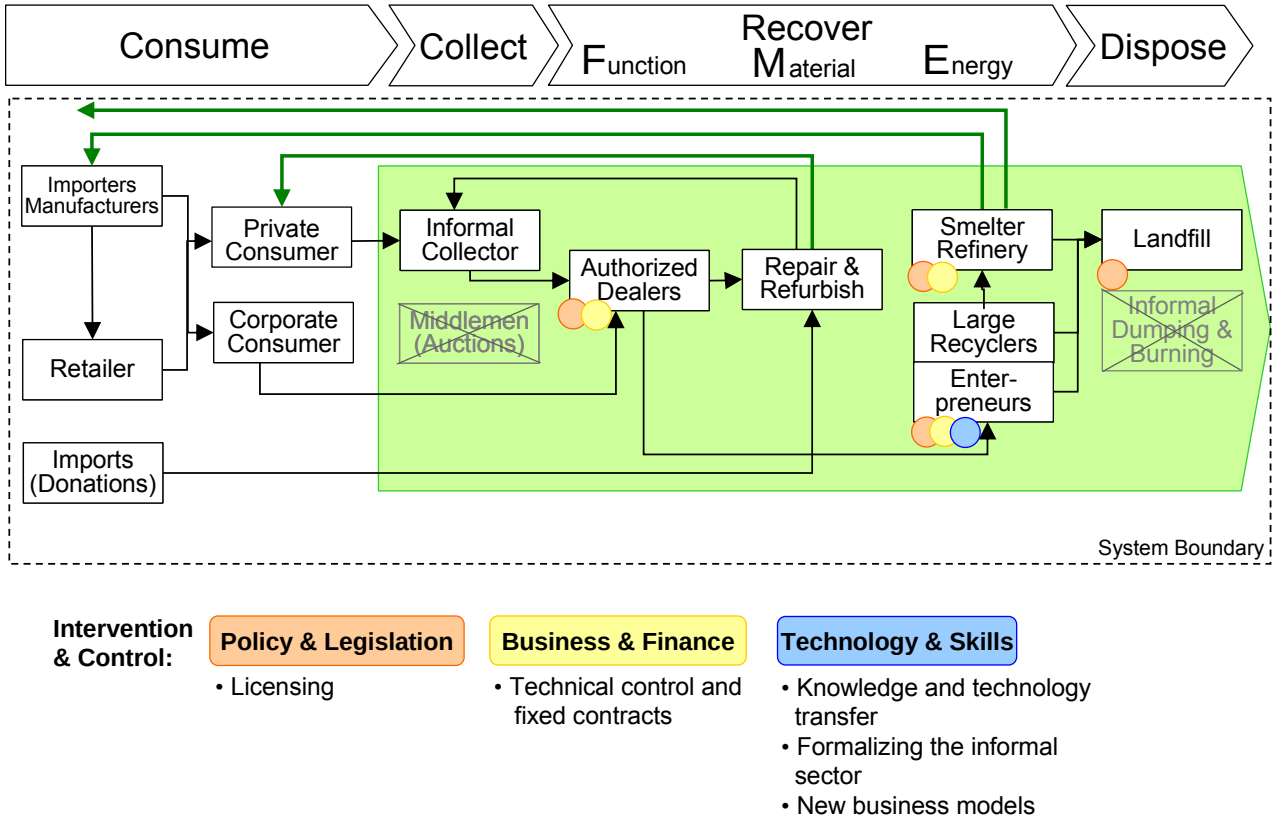


Figure 5: An example of a massflow system chart with its undesirable operations/"hot spots" and recommended interventions. The green arrow shows, which part of the system is controlled.

10 References

Purpose

State all references used in the report

Procedure

For books, reports, press, journals etc.:

- State Author, Year, Title, Name of Journal, Name of Publisher etc.

For websites:

- State address and last date of access

11 Annexes

Annex A: Sources of information and key figures

Annex B: Collection of questionnaires: households

Annex C: Collection of questionnaires: corporates

Annex D: Weight and composition of selected tracers and categories

Annex E: Example of overview of legal texts

Annex F: Checklist for establishing / analysing legislation on e-waste

Annex G: Example of stakeholder overview

Annex H: Balance and parametric equations for the mass flow model

Annex J: Assessment of WEEE flows

Annex K: Detailed guideline for the assessment of social impacts

Annex L: Example of downstream market Infrastructure

Annex M: Durban declaration