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International Telecommunication Union
Standardization Sector

Recommendation

ITU-T L.1031 (06/2024)

SERIES L: Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant

E-waste and circular economy

Guideline for the development of an e-waste management system and achieving the e-waste targets of the Connect 2030 Agenda

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Recommendation ITU-T L.1031

Guideline for the development of an e-waste management system and achieving the e-waste targets of the Connect 2030 Agenda

Summary

Recommendation ITU-T L.1031 describes a three-step approach to achieve the e-waste targets set in the Connect 2030 Agenda. These steps consist of guidance on developing an e-waste inventory, approaches to design e-waste prevention and reduction programmes and the supportive measures required for successfully implementing the Connect 2030 e-waste targets.

This Recommendation is intended to be utilized by relevant stakeholders, for example, national authorities in charge of ICTs and communications, e-waste and waste management authorities, ministries of the environment, local authorities and entities involved in e-waste management, to take their first step in addressing target 3.2 of the Connect 2030 Agenda that is to increase the global e-waste recycling rate to 30% and target 3.3 that is to raise the percentage of countries with e-waste legislation to 50%.

History*

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Keywords

Circular economy, Connect 2030, extended producer responsibility, e-waste, green procurement, ICT, infrastructure, transboundary movement, urbanization, waste prevention, waste reduction.

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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Introduction

The e-waste challenge

The global e-waste monitor (2024) [b-UNITAR 2024] estimated that, in 2022, 62 billion kilograms (kg) of e-waste were generated worldwide. In 2010, the world generated 34 billion kg of e-waste, an amount that has since increased annually by an average of 2.3 billion kg with only 22.3% being collected in an environmentally sound manner. Europe was the larger e-waste generator per capita (17.6 kg), followed by Oceania (16.1 kg), the Americas (14.1 kg), Asia (6.4 kg), and Africa (2.5 kg). The economic value of the metals contained in the e-waste generated globally in 2022 is estimated at USD 91 billion. It is projected that 82 billion kg of e-waste will be generated in 2030. [b-UNITAR 2024]. For updated data on e-waste generation, please visit: E-waste Monitors (itu.int).

This growing amount of e-waste is the by-product of technological advancement, poor product design, low consumer awareness and lack of regulations to encourage e-waste reduction as well as rapid urbanization. ICT products' prices are falling through stiff market competition; in turn more urban citizens can afford to own multiple devices including phones, laptops, tablets, etc. The desire for the latest devices and poor service life are cited as the main contributors to the shortening lifespan of consumer electronics and subsequently, generating more e-waste than ever.

In 2022, around 5.1 billion kg of used EEE/e-waste were shipped from one country to another annually. Of that total, 3.3 billion kg (65 per cent) are uncontrolled transboundary movements of used EEE/e-waste from high- to middle- and low-income countries. The uncontrolled shipments may be made up of 33 to 70 per cent e-waste declared as used electrical and electronic equipment (EEE) goods. Most controlled transboundary movements occur within and to Europe and East Asia. [b-UNITAR 2024].

The UNEP report *Waste crime – waste risks gaps in meeting the global waste challenge: a rapid response assessment,* suggests that in 2015, a staggering 60% to 90% of e-waste was illegally traded or dumped. Due to the high costs of treating and disposing of hazardous waste, the dumping grounds of e-waste are often countries with weak environmental regulations, poor enforcement and low environmental awareness, which is the case in most developing countries [b-UNEP 2015].

In December 2019, the ban-amendment to the Basel convention entered into force, for its parties and prohibited the export of hazardous waste from members of the OECD, EC and from Liechtenstein to other countries, including hazardous electrical and electronic waste. The ban amendment does not apply to "other wastes", listed in Annex II of the convention. The Basel convention defines and includes in its scope electrical and electronic waste, which are classified both as hazardous and non-hazardous. Non-hazardous electrical and electronic waste is listed in Annex II, and it was added in the scope of the Basel convention in 2022, becoming effective at the national level, in January 2025. The convention requires a prior informed consent procedure in case of transboundary movements of hazardous and non-hazardous electrical and electronic waste when these are not banned or restricted. In addition, it explicitly forbids dumping of hazardous and other wastes, which is defined as illegal traffic under the convention. However, inconsistency in the definition of e-waste, often allows waste producers to falsely declare e-waste as second-hand goods and export it to developing countries [b-UNEP 2015]. On top of that, countries such as the United States of America and the Republic of (Haiti) have not yet ratified the Basel convention. To avoid such cases, the parties to the Basel convention agreed upon a technical guideline, including criteria to clarify the distinction between waste and used electrical and electronic equipment, which for some countries, may not be classified as waste. [b-BC 2023].

According to the global e-waste monitor report [b-UNITAR 2024], in 2023, 81 countries had developed e-waste legislation, policies or regulations out of 193 countries (42%). Official e-waste take-back and processing legislation also based on the extended producer responsibility (EPR) policy schemes, does exist in developing countries such as the People's Republic of (China) and the Republic of (India), covering around 72% of the world population. However, as noted in the report *United*

Nations system-wide responses to e-waste by the United Nations Environment Management Group (UNEMG) in 2017, e-waste take-back legislation often does not cover all e-waste categories. This is compounded by the fact that ICT devices such as mobile phones and electrical toothbrushes are composed of different residual waste that do not fit in a single category [b-UNEMG 2017].

E-waste is being managed in developing countries with weak environmental regulations mainly in the following ways: open dumping, which involves non-functional parts being disposed of in undesignated locations or in some cases with other municipal solid waste, including surface water and drains; incineration, which involves open burning of selected components of e-waste in order to recover valuable materials such as indium, copper and gold; or other informal recycling and recovery operations which are non-sustainable since these are conducted without environmental or health precautions.

The impacts of using the above methods for e-waste disposal are well-documented. The World Health Organization indicates that burning cable will result in the inhalation of toxic substances such as lead, cadmium, chromium, and polychlorinated biphenyl (PCBs), as well as releasing those harmful chemicals into soil, water and food [b-WHO 2018].

ITU and Connect 2030

In response to the e-waste challenge, ITU-T Resolution 200 was revised in the Plenipotentiary Conference in Dubai, 2018, which established the Connect 2030 Agenda. Among other targets, the Connect 2030 Agenda has called for the following targets (Target 3.2)

"Increase the global e-waste recycling rate to 30% by 2023"

and (Target 3.3)

"Raise the percentage of countries with an e-waste legislation to 50% by 2023"

The Connect 2030 Agenda is a global initiative headed by ITU. It set out the shared vision, goals and targets for global telecommunication/ICT development that Member States have committed to achieve by the year 2030.

Through the Connect 2030 Agenda, ITU Member States have committed to work towards the shared vision of "an information society, empowered by the interconnected world, where telecommunication/ICT enables and accelerates socially, economically and environmentally sustainable growth and development for everyone". ITU has invited all stakeholders to contribute with their initiatives and their experience, qualifications and expertise to the successful implementation of the Connect 2030 Agenda.

This Recommendation specifies a three-step guideline that relevant stakeholders can use to reach the e-waste targets of the Connect 2030 Agenda. Depending on the national circumstances, these steps might be implemented in a different order.

Additionally, the Connect 2030 e-waste targets are in alignment with the following sustainable development goals (SDGs):

SDG 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

SDG 11 Make cities and human settlements inclusive, safe, resilient and sustainable.

SDG 12 Ensure sustainable consumption and production patterns.

SDG 13 Take urgent action to combat climate change and its impacts.

Recommendation ITU-T L.1031

Guideline for the development of an e-waste management system and achieving the e-waste targets of the Connect 2030 Agenda

1 Scope

This Recommendation describes a three-step approach for implementing the e-waste reduction target set-forth in the Connect 2030 Agenda and establishing an e-waste management system. These steps consist of guidance on developing an e-waste inventory, approaches to design e-waste prevention and reduction programmes and the supportive measures required for successfully implementing the Connect 2030 e-waste targets. Step one details guidance on developing an e-waste inventory based on techniques developed by the Basel Convention, the Swiss Federal Laboratories for Materials Science and Technology (EMPA) and the Global Partnership for Measuring E-waste which authored the "E-Waste Statistics: Guidelines on Classification, Reporting and Indicators" [b-UNU 2018].

The three-step approach described in this Recommendation forms a holistic guideline to reach the e-waste reduction target in the Connect 2030 Agenda. An e-waste inventory establishes the baseline scenario for evaluation and assessment. It classifies e-waste based on the existing standards, estimates the amount of e-waste using a chosen methodology and identifies the role of key stakeholders as well as the flow of e-waste among them. This information allows the relevant stakeholder/reader to decide the best approach in developing e-waste prevention and reduction strategies. This Recommendation contains a wide array of prevention and reduction strategies drawing from sources including ITU-T, UNITAR and others.

This Recommendation is intended to be utilized by relevant stakeholders to take their first step in addressing target 3.2 of the Connect 2030 Agenda, that is to increase the global e-waste recycling rate to 30% by 2023 and target 3.3 that is to raise the percentage of countries with an e-waste legislation to 50% by 2023.

The revised Recommendation recognizes that sustainable development goals (SDGs) and corresponding targets for 2030 have been adopted by world leaders at the historic UN summit in 2015. Rankings are often constructed in order to hold countries accountable to achieve these targets. Studies illustrate the sensitivity of rankings to the choice of indicators and methodological assumptions. The results of some studies suggest that a country's relative position depends almost entirely on the chosen method and indicators [b-Miola].

Accordingly, the revised Recommendation will present an integrated approach to measuring e-waste inventories, using different methodologies, in different stages of the development of e-waste management frameworks and policy schemes, for example, extended producer responsibility schemes.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T L.1000] Recommendation ITU-T L.1000 (2019), *Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices.*

[ITU-T L.1001] Recommendation ITU-T L.1001 (2012), *External universal power adapter solutions for stationary information and communication technology devices.*

[ITU-T L.1002] Recommendation ITU-T L.1002 (2016), *External universal power adapter solutions for portable information and communication technology devices.*

[ITU-T L.1005] Recommendation ITU-T L.1005 (2014), *Test suites for assessment of the universal charger solution*.

[ITU-T L.1006] Recommendation ITU-T L.1006 (2016), *Test suites for assessment of the external universal power adapter solutions for stationary information and communication technology devices*.

[ITU-T L.1007] Recommendation ITU-T L.1007 (2016), *Test suites for assessment of the external universal power adapter solutions for portable information and communication technology devices*.

[ITU-T L.1010] Recommendation ITU-T L.1010 (2014), *Green battery solutions for mobile phones and other hand-held information and communication technology devices.*

[ITU-T L.1020] Recommendation ITU-T L.1020 (2018), *Circular economy: Guide for operators and suppliers on approaches to migrate towards circular ICT goods and networks.*

[ITU-T L.1021] Recommendation ITU-T L.1021 (2018), *Extended producer responsibility – Guidelines for sustainable e-waste management*.

[ITU-T L.1022] Recommendation ITU-T L.1022 (2019), *Circular economy: Definitions and concepts for material efficiency for information and communication technology*.

[ITU-T L.1023] Recommendation ITU-T L.1023 (2023), *Assessment method for circularity performance scoring*.

[ITU-T L.1024] Recommendation ITU-T L.1024 (2021), *The potential impact of selling services instead of equipment on waste creation and the environment – Effects on global information and communication technology*.

[ITU-T L.1027] Recommendation ITU-T L.1027 (2023), *Assessment of material efficiency of ICT network infrastructure goods (circular economy) – Server and data storage product disassembly and disassembly instruction*.

[ITU-T L.1030] Recommendation ITU-T L.1030 (2018), *E-waste management framework for countries.*

[ITU-T L.1032] Recommendation ITU-T L.1032 (2019), *Guidelines and certification schemes for e-waste recyclers*.

[ITU-T L.1034] Recommendation ITU-T L.1034 (2022), *Adequate assessment and sensitization on counterfeit information and communication technology products and their environmental impact*.

[ITU-T L.1035] Recommendation ITU-T L.1035 (2022), *Sustainable management of batteries*.

[ITU-T L.1036] Recommendation ITU-T L.1036 (2022), *Scheduled waste management for a base station (inclusive of e-waste)*.

[ITU-T L.1040] Recommendation ITU-T L.1040 (2022), *Effects of information and communication technology-enabled autonomy on vehicles longevity and waste creation*.

[ITU-T L.1050] Recommendation ITU-T L.1050 (2022), *Methodology to identify key equipment for environmental impact and e-waste generation assessment of network architectures*.

[ITU-T L.1061] Recommendation ITU-T L.1061 (2023), *Circular public procurement of information and communication technologies*.

[ITU-T L.1070] Recommendation ITU-T L.1070 (2023), *Global digital sustainable product passport opportunities to achieve a circular economy*.

[ITU-T L.1100] Recommendation ITU-T L.1100 (2012), *Procedure for recycling rare metals in information and communication technology goods.*

[ITU-T L.1101] Recommendation ITU-T L.1101 (2014), *Measurement methods to characterize rare metals in information and communication technology goods*.

[ITU-T L.1102] Recommendation ITU-T L.1102 (2016), *Use of printed labels for communicating information on rare metals in information and communication technology goods*.

[ITU-T L.1400] Recommendation ITU-T L.1400 (2023), *Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies.*

[ITU-T L.1410] Recommendation ITU-T L.1410 (2014), *Methodology for environmental life cycle assessments of information and communication technology goods, networks and services*.

[ITU-T L.1420] Recommendation ITU-T L.1420 (2012), *Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations*.

[ITU-T L.1061] Recommendation ITU-T L.1061 (2023), *Circular public procurement of information and communication technologies*.

[ITU-T L.Sup.5] ITU-T L-series Recommendations – Supplement 5 (2014), *Life-cycle management of ICT goods.*

[ITU-T L.Sup.20] ITU-T L-series Recommendations – Supplement 20 (2015), *Green public ICT procurement.*

[ITU-T L.Sup.27] ITU-T L-series Recommendations – Supplement 27 (2016), *Supplement on success stories on e-waste management.*

[ITU-T L.Sup.28] ITU-T L-series Recommendations – Supplement 28 (2016), *Circular economy in information and communication technology; definition of approaches, concepts and metrics.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 circular economy [ITU-T L.1020]: A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value, at all times while reducing waste streams.

A concept that distinguishes between technical and biological cycles, the circular economy is a continuous, positive development cycle. It preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows, while reducing waste streams.

NOTE – The definition is based on [b-EMF] and amended.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 e-waste/WEEE: Electrical or electronic equipment that is waste, including all components, sub-assemblies and consumables that are part of the equipment at the time the equipment becomes waste.

NOTE – For the purpose of this Recommendation, the term e-waste and waste electrical and electronic equipment (WEEE) are used interchangeably. The term e-waste may have different definitions in different contexts.

3.2.2 hazardous wastes: Wastes defined as hazardous under the Basel convention. (See article 1 paragraph 1 of the Convention).

NOTE 1 – This includes wastes containing lead, mercury, cadmium and other hazardous substances which may be released into the environment.

NOTE 2 – For more information on hazardous waste and hazardous waste classification, refer to clause 7.1.1.

3.2.3 other wastes: Wastes included in Annex II of the Basel convention.

NOTE – See article 1 paragraph 2 of the convention.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CE	Circular Economy
CPC	Central Product Classification
CPE	Customer Premise Equipment
DfE	Design-for-Environment
EEE	Electrical and Electronic Equipment
EoL	End of Life
EPD	Environmental Product Declaration
EPR	Extended Producer Responsibility
ESM	Environmentally Sound Management
HS	Harmonized System
ICT	Information Communication Technology
IPR	Individual Producer Responsibility
LCA	Life Cycle Assessment
NIE	Network Infrastructure Equipment
PCB	Polychlorinated Biphenyl
PRO	Producer Responsibility Organization
StEP	Solving the E-waste Problem
TBC	Take-Back Committee
TPO	Third Party Organization

WEEE Waste Electrical and Electronic Equipment

5 Conventions

None.

6 The waste hierarchy

The concept of waste hierarchy indicates the preference for actions in managing waste, including e-waste. This five-tiered hierarchical structure is formed in relation to the environmental impacts and the potential to minimize the final waste of various policy options for waste treatment. A visual representation of the waste hierarchy is shown in Figure 1.

Figure 1 – The waste hierarchy – Adapted from [b-EC 2012]

At the top of the waste hierarchy is waste prevention. Waste prevention is placed at the top of the waste hierarchy, indicating that minimizing both the quantity (total e-waste generated) and the hazardousness (toxicity) of waste is among the most effective strategies employed to tackle waste streams such as e-waste. Waste prevention encompasses components including strict avoidance, source reduction, direct re-use, re-use and recycling [b-BC 2016]. According to the report '*Preparing a waste prevention programme*' produced by the European Commission in 2012, waste prevention can be achieved by reducing the quantity of material used in the creation of products, designing and consuming products that generate less waste as well as encouraging the extension of a product's lifetime. [b-EC 2012].

Re-use, recycling, and recovery aim to keep products in the consumption cycle for as long as possible by diverting used products from the waste stream.

Disposal is ranked as the last option since common waste disposal practices such as incineration and landfills remain hazardous to the environment and human health to different degrees.

The concept of the waste hierarchy underpins the action plan outlined in this Recommendation. The e-waste targets of Connect 2030 explicitly calls for increasing the global e-waste recycling rate to 30% and raising the percentage of countries with an e-waste legislation to 50%. The waste hierarchy provides a useful blueprint to achieve both targets. However, this action plan also emphasizes policies and practices that encourage re-use and recycling as they can form an integral part of the development of a sustainable e-waste management system.

The guideline on implementing the Connect 2030 e-waste agenda consists of three steps:

Step 1: Develop a comprehensive e-waste inventory;

Step 2: Develop a sustainable e-waste management system;

Step 3: Outline the requirements for successfully implementing e-waste programmes.

7 Guideline for achieving the e-waste targets of the Connect 2030 agenda

7.1 Step 1: Develop a comprehensive e-waste inventory

The objectives of developing an e-waste inventory are as follows:

– To obtain an indication of the volume of e-waste generated in a country or in a given city and the ways in which waste electrical and electronic equipment (WEEE) are managed.

– Results provide the foundation for planning and designing different e-waste reduction programmes.

– A visual representation of the steps of constructing an e-waste inventory is provided in Figure 2.

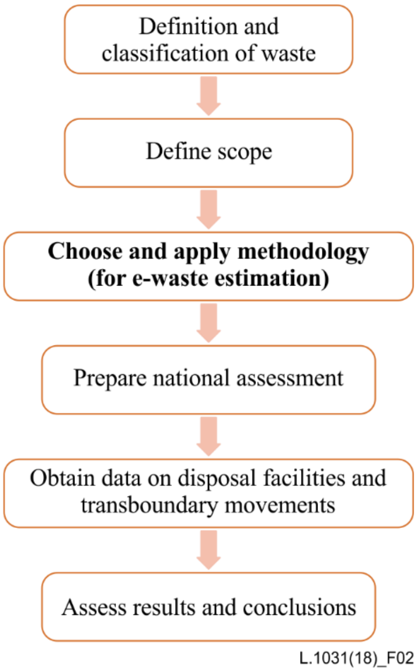

Figure 2 – The six-steps of developing e-waste inventory based on the Basel convention practical guidance

NOTE – The six-step methodology of e-waste inventory is developed by the Basel convention [b-BC 2017]. The technique used to create a national assessment of e-waste is developed by EMPA. An example of the approach adopted by UNITAR SCYCLE for conducting assessments is also mentioned.

7.1.1 Definition and classification of e-waste (hazardous and non-hazardous waste electrical and electronic equipment)

Definition of waste electrical and electronic equipment

The Basel convention defines waste in Article 2.1 as "Substances or objects that are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law".

Waste electrical and electronic equipment are defined as "Electrical or electronic equipment that is waste, including all components, sub-assemblies and consumables that are part of the equipment at the time the equipment becomes waste" [b-BC 2023].

Classification of e-waste:

Proper classification of e-waste provides the necessary framework for collecting e-waste statistics. They are inextricably linked to the development of a sustainable e-waste management programme and waste prevention strategies. At the same time, adopting an internationally approved classification will ensure comparability, compatibility and the effective dissemination of best practices across the globe.

In 2018, the United Nations University (UNU) published a comprehensive guideline on e-waste classification. The UNU's classification of EEE, which is dubbed the UNU-KEYS, follows the criteria specified here [b-STEP 2018].

1) It categorizes products based on similar functions and material composition, including hazardous substances and valuable materials and other related end of life (EoL) attributes.
2) Products within the same category have the same average weight and lifespan distributions which simplify quantitative assessment for similar products.
3) Large e-waste products with lot of data potentially available are assigned separately.

A visual representation of the UNU-KEYS is provided in Figure 3.

UNU Key	Description
0001	Central Heating (household installed)
0002	Photovoltaic Panels (incl. converters)
0101	Professional Heating & Ventilation (excl. cooling equipment)
0102	Dishwashers
0103	Kitchen (f.i. large furnaces, ovens, cooking equipment)
0104	Washing Machines (incl. combined dryers)
0105	Dryers (wash dryers, centrifuges)
0106	Household Heating & Ventilation (f.i. hoods, ventilators, space heaters)
0108	Fridges (incl. combi-fridges)
0109	Freezers
0111	Air Conditioners (household installed and portable)
0112	Other Cooling (f.i. dehumidifiers, heat pump dryers)
0113	Professional Cooling (f.i. large air conditioners, cooling displays)
0114	Microwaves (incl. combined, excl. grills)
0201	Other Small Household (f.i. small ventilators, irons, clocks, adapters)
0202	Food (f.i. toaster, grills, food processing, frying pans)
0203	Hot Water (f.i. coffee, tea, water cookers)
0204	Vacuum Cleaners (excl. professional)
0205	Personal Care (f.i. tooth brushes, hair dryers, razors)
0301	Small IT (f.i. routers, mice, keyboards, external drives & accessories)
0302	Desktop PCs (excl. monitors, accessories)
0303	Laptops (incl. tablets)
0304	Printers (f.i. scanners, multifunctionals, faxes)
0305	Telecom (f.i. (cordless) phones, answering machines)
0306	Mobile Phones (incl. smartphones, pagers)
0307	Professional IT (f.i. servers, routers, data storage, copiers)
0308	Cathode Ray Tube Monitors
0309	Flat Display Panel Monitors (LCD, LED)
0401	Small Consumer Electronics (f.i. headphones, remote controls)
0402	Portable Audio & Video (f.i. MP3, e-readers, car navigation)
0403	Music Instruments, Radio, HiFi (incl. audio sets)
0404	Video (f.i. Video recorders, DVD, Blue Ray, set-top boxes)
0405	Speakers
0406	Cameras (f.i. camcorders, photo & digital still cameras)
0407	Cathode Ray Tube TVs

0408	Flat Display Panel TVs (LCD, LED, Plasma)
0501	Lamps (f.i. pocket, Christmas, excl. LED & incandescent)
0502	Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
0503	Straight Tube Fluorescent Lamps
0504	Special Lamps (f.i. professional mercury, high & low pressure sodium)
0505	LED Lamps (incl. retrofit LED lamps & household LED luminaires)
0506	Household Luminaires (incl. household incandescent fittings)
0507	Professional Luminaires (offices, public space, industry)
0601	Household Tools (f.i. drills, saws, high pressure cleaners, lawn mowers)
0602	Professional Tools (f.i. for welding, soldering, milling)
0701	Toys (f.i. car racing sets, electric trains, music toys, biking computers)
0702	Game Consoles
0703	Leisure (f.i. large exercise, sports equipment)
0801	Household Medical (f.i. thermometers, blood pressure meters)
0802	Professional Medical (f.i. hospital, dentist, diagnostics)
0901	Household Monitoring & Control (alarm, heat, smoke, excl. screens)
0902	Professional Monitoring & Control (f.i. laboratory, control panels)
1001	Non Cooled Dispensers (f.i. for vending, hot drinks, tickets, money)
1002	Cooled Dispensers (f.i. for vending, cold drinks)

Figure 3 – The UNU-KEYS of e-waste classification [b-UNU 2018]

The UNU-KEYS underpins the framework for compiling e-waste statistics. One of the key strengths of the UNU-KEYS is that it follows closely to the harmonized statistical coding of the international trade codes, the harmonized system (HS), which is also closely tied to the central product classification (CPC). To create an effective framework for e-waste statistics, it is vital to be able to integrate existing datasets into the calculation of e-waste statistics. Existing datasets on trade statistics or the use of ICT equipment give important clues on the landscape of e-waste. The UNU-KEYS also has notable compatibility with the HS coding as well as the EU-WEEE Directives. The correspondence between UNU-KEYs and the six categories in which e-waste is classified in the WEEE directive (recast) is available on [b-UNU 2018]. The UNU KEYS encompass all the six categories. The six categories of e-waste in the WEEE directive (recast) [b-EU WEEE 2019], were defined to group different WEEE by main take-back and collection systems and by treatment operators:

1) temperature exchange equipment (referred to as cooling and freezing in table 1);
2) screens and monitors (referred to as screens);
3) lamps;
4) large equipment;
5) small equipment; and
6) small IT and telecommunication equipment with an external dimension of less than 50 cm.

Therefore, the UNU-KEYS allow for the integration and comparison with different data sets [b-UNU 2018]. The UNU-keys are also suitable for the collection of statistical data to be used in different methodologies for the calculation of the inventories: e.g., the methodology that calculates the inventory based on the EEE put on market or the methodology based on the material flow analysis (use and consumption methodology), requiring to convert the unit to weight by applying average weights in each UNU-KEYS category.

Accordingly, this Recommendation suggests the adoption of the UNU-KEYS or the use of it as the basis for classifying e-waste.

It is noted that there is no existing classification system that is capable of covering every aspect of e-waste. For example, the UNU-KEYS does not cover items such as radio base stations (Base stations are covered under UNU 0305 HS 851761 Telecommunication equipment, which is a catch all entry), optical transport equipment, it is also likely covered under UNU 0305 HS 851762 Telecommunication equipment, or power feeding equipment batteries. Batteries are classified differently in the UNU. Various SCYCLE projects, such as a methodology for the identification of unit-to-weight conversion factors for rechargeable batteries, provide quantitative information on portable battery flows in the Netherlands. SCYCLE is also in the development stages of preparing both global and regional batteries monitors. However, the UNU-KEYS provides the blueprint for relevant stakeholders to begin classifying e-waste. Additional adjustments based on a city's needs and priorities are encouraged.

Classification of hazardous waste:

E-waste often contains hazardous substances including lead, mercury, cadmium, selenium, arsenic, beryllium, brominated flame retardants which are persistent organic pollutants (POPs), etc. These hazardous substances may be released in the environment when being disposed of improperly, resulting in adverse effects for both the environment and human health.

Under the Basel convention, hazardous wastes are defined as:

a) wastes that belong to any category contained in its Annex I (list of waste categories defined by hazardous substances contained in them and wastes to be controlled), unless they do not possess any of the characteristics contained in Annex III (hazardous characteristics such as flammable, poisonous, infectious, corrosive, toxic, etc.); and

b) wastes that are not covered by this definition but are defined as, or are considered to be hazardous wastes by the domestic legislation.

For reference, Annex A of this Recommendation contains the Basel convention's Annex 1 and III referred to above.

Annex II of the convention includes "other wastes", which are included in the scope of the convention by being listed in this Annex.

Moreover, Annex VIII and Annex IX of the Convention assist in identifying wastes which are, respectively included and excluded from the scope of the Basel convention. Annex VIII includes wastes that are presumed to be hazardous and electrical and electronic waste is classified with the code A1181. Non-hazardous electrical and electronic waste is included in Annex II with the code Y49 "electrical and electronic waste". Both categories of waste electrical and electronic equipment classified as hazardous as well as non-hazardous are subject to the Basel convention and require the PIC procedure to be moved transboundary. Non-hazardous electrical and electronic waste was added to the scope of the Convention in 2022 and it was previously excluded from its scope.

7.1.2 Define the scope of the inventory

The scope of the inventory includes its purpose, desired outcomes, category of equipment to be included, geographical area to be covered, relevant stakeholders and specific exclusion and limitations due to factors such as access to information sources and budget.

7.1.3 Choose and apply the methodologies used for estimating the quantities of WEEE

Two methodologies, market supply methodology and consumption-based methodology, which is based on a simplified mass flow analysis are described in this Recommendation, for estimating the quantities and generation of WEEE. Both methodologies can be based on the calculation of EEE placed on the market, as proposed in the 'E-waste statistics: Guidelines on classification, reporting and indicators' methodology.

– **The market supply methodology**

The market supply methodology proposed in [b-UNU 2018], is based on a framework considering: the production and trade of EEE, stock (households, businesses and public sector) of EEE, formally collected e-waste, and other recycling and waste bin sources.

This methodology relies on already available statistics on EEE including import/export statistics, but it requires extracting this data and developing subsequently the analysis proposed below. This methodology or approach is developed by the UNU under the partnership for measuring ICT for development [b-ITU/UNU/ISWA].

- In this methodology, the inventory is developed in two steps:
  1) Estimation of EEE put on the market for the relevant equipment categories based on key data such as the amount of new/second-hand imports, the amount of exports as well as domestic production.
  - Formula for calculation:

    Amount of EEE put on market = Domestic production + Amount of new imports + Amount of second-hand imports – Amount of export.
  - Where do the data come from?
    – Domestic production: Usually available through national statistical information activities. For example, from the ministries of industry, commerce, finance and other national offices.

    – Import/export: The most commonly used database for statistics on import and export is the UN COMTRADE database.

    – Second-hand imports: Since most of the imported second-hand equipment does not appear in official records, this type of import can only be assessed by conductive interviews/surveys of importers and port authorities.
  2) Estimation of e-waste generated based on the average lifespan of each equipment category.
  - Formula for calculation:

    Amount of e-waste generated in a year t = amount of EEE put on the market in a year (t – average lifespan of equipment)

  Where *t* represents the year of the inventory.
  - Where does the data come from?
    – Lifespan of EEE data: Data on the lifespan of EEE is usually readily available. It should be noted that it is preferable to use data from recent reports and national sources if possible as data could become outdated quickly.
  3) As noted earlier, these indicators are vital in determining the e-waste landscape of a country which would serve as the framework to determine the appropriate response.

In this methodology, the main data source is from tools available, but additional data can be collected, for example: existing stock, e-waste generation, collection of e-waste in various flows, recycling, illegal imports and exports, etc. This data may be collected on products but also on components as well as on materials at country and regional levels. National on-the-ground data through e.g., household surveys are also verified and can be integrated in this methodology. An approach to the development of household surveys, accepted by the e-waste sub-group under the expert group on ICT household indicators (EGH) of the partnership on ICT for development, takes into account the recently developed ITU-EACO-UNITAR pilot surveys. [b-ITU-UNITAR-EACO 2023].

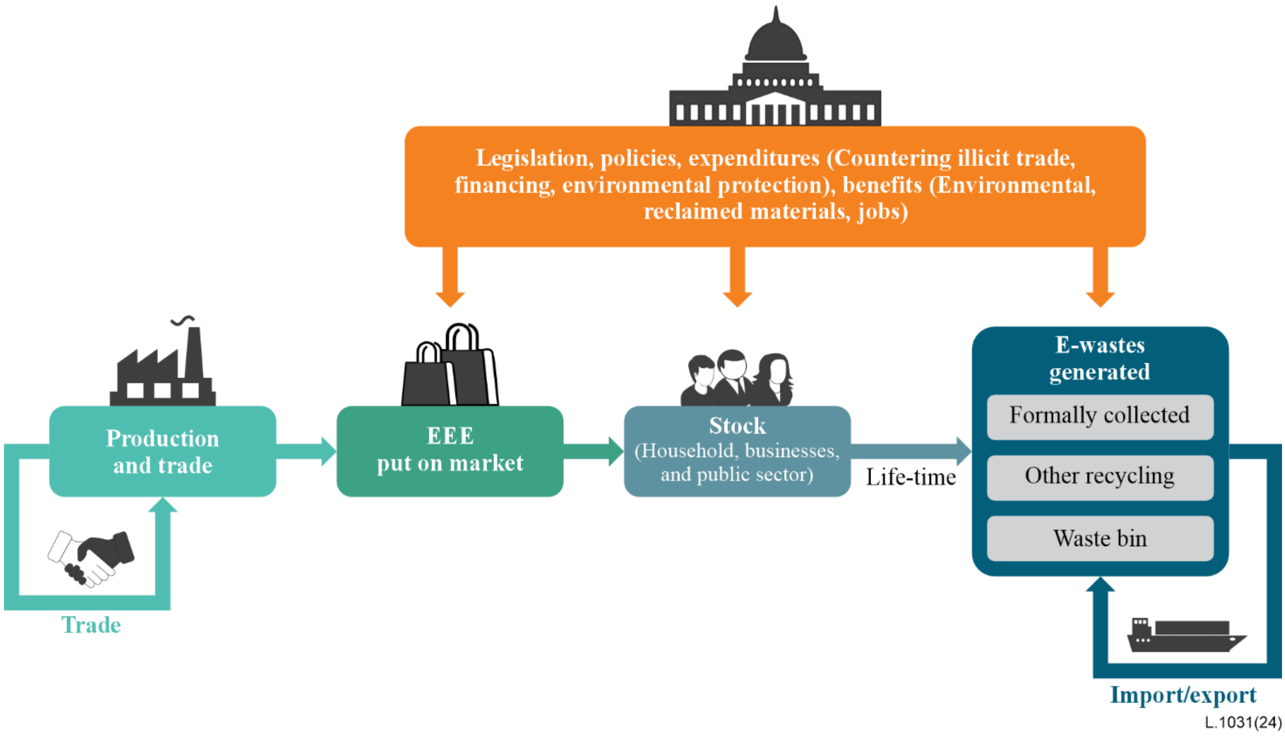

Figure 4 – Proposed measurement framework for e-waste statistics. [b-UNU 2018]

– **The consumption-based methodology** is the second methodology proposed in the Recommendation which can be implemented starting from the statistics based on the UNU-KEYS and the COMTRADE database, coupled with data collection methods such as field surveys and questionnaires. This methodology was employed by EMPA.

- In this approach, the inventory is also developed in two steps:
  1) Assessment of the amount of EEE in use or stored at the consumer level (i.e., stocks) based on consumer surveys and questionnaires. The goal is to obtain key data on private and institutional consumers, type and amount of EEE, average life span, size of household/organizations and income class/economic activity.
  - Where does the data come from?
    – As suggested the data sources of this approach are based on consumer surveys and questionnaires. Consumers of EEE are classified into the following two groups:
      1) Private consumers (households) – household surveys should be carried out in both rural and urban areas to reflect the differences in the consumer behaviours. The survey should request information for the following indicators:
         - The type and amount of installed EEE
         - Average lifespan of each equipment
         - Size of the household.
  - Income class of the household
      2) Institutional and corporate consumers – should consider different economic sectors that entail different consumer behaviours. The survey should request information for the following indicators:
         - The type and amount of installed EEE in the organization
         - Average lifespan of each equipment

- Size of the organization (number of staff)
- Type of organization and main activity.

2) Estimation of e-waste generated based on the information obtained from the surveys.

- Formula for calculation:

  Amount of e-waste generated (metric tons) annually = amount of equipment stockpiled/average lifespan of the equipment.

Both of these approaches are useful for conducting a first-generation inventory in situations when a national system for collecting data from waste generators is not yet fully developed. In cases where the amount of e-waste generated has been calculated based on the amount of EEE put on the market, the results represent a national estimate (Approach 1). In cases where the consumption method is used, data should be collected that allow the extrapolation of the results to the national level (Approach 2). Additionally, the underlying assumptions and limitations of the national estimate should be indicated when reporting on this information. This second methodology based on surveys and questionnaires is normally utilized to bridge the desk-study with the reality of a country's e-waste management practices and it is useful when developing a waste management system, and extended producer responsibility policy schemes for e-waste streams. The implementation of the consumption-based methodology should be prepared with suitable resources for its implementation.

7.1.4 Prepare a national e-waste assessment

The e-waste assessment is the key component of an e-waste inventory, which is not only conducted as a desk study, and can also link a desk study to the reality of the stakeholders involved in e-waste management. It compiles the results of the e-waste estimation from the previous step, examines the target country's legislation and policy on e-waste, identifies the relevant stakeholders and their roles, analyses the flow of e-waste and how it circulates between actors and related sectors and assesses the environmental and socio-economic impacts of e-waste.

In essence, a national e-waste assessment establishes the baseline scenario for relevant stakeholders to take their first step in tackling e-waste. This is particularly useful for developing countries or countries in transition as they often lack the legal and institutional framework needed to fulfil the growing demands of e-waste management. Assembling an e-waste assessment is a necessary component for fostering a comprehensive e-waste management system and environmentally sound waste management practices.

Therefore, this Recommendation suggests conducting e-waste assessments, while developing for the first time a strategy to develop a management framework for e-waste and periodically repeat it to assess the effectiveness of the management framework in place. Desk studies can be conducted on a yearly basis to monitor the generation of e-waste and determine collection targets for take-back schemes and extended producer responsibility policy schemes.

An e-waste country assessment should contain four essential components (Training tools are available in [b-ITU-D 2023]:

1) **Policy and legislation**: This component should examine the country's existing political and legal framework and policy related to e-waste. There are three areas of policy and legislation that should be taken into consideration:

   - E-waste related policies and legislation: Legal regulations that may influence e-waste management including, but not limited to environmental legislation related to water, solid waste, and social legislation related to the right to collective bargaining and child labour.
   - Specific e-waste management legislation: Refers to legislation that are in place specifically to tackle e-waste.

- Institutional framework: Refers to the political structure of a defined region. It describes the legislative, executive, and judiciary branches of government with special emphasis on environmental management.

2) **Stakeholder assessment**: The purpose of the stakeholder assessment is to identify the actors, and their roles involved in e-waste management, i.e., explaining who they are, what is their role, how are they organized and how will they impact e-waste management. Each group of stakeholders is characterized by a set of qualitative and quantitative indicators, which will also provide the basis for calculating the e-waste mass flow assessment.

   - Stakeholders include the following: Consult the ITU-D e-learning course on 'An Introduction to E-waste Policy' https://academy.itu.int/training-courses/full-catalogue/introduction-e-waste-policy which is aimed at supporting national stakeholders in developing e-waste policy and regulation, it includes information on the roles and responsibilities of different government stakeholder groups and interests.
     - Manufacturers, importers, distributors,
     - Consumers,
     - Collectors, refurbishers, recyclers,
     - Final disposers, most affected communities.

3) **Mass flow assessment**: This is an important component of the surveys and assessments because comparisons of different scenarios can also be done, also to evaluate the impact of human health and the environment of the e-waste management framework in place. The purpose of mass flow assessment is to describe, quantify and analyse the flows of e-waste and how they circulate between the key stakeholders by using graphic representations. The mass flow assessment consists of three main components:

   1) A mass flow system chart, which is a graphic representation of the flows of e-waste and how they circulate between the different stakeholders. An example is provided below. A visual representation of a mass flow system chart is shown in Figure 5.

   2) Current mass flow, which involves using a series of calculations to quantify the mass flows and stocks based on key data obtained through statistical data and literature review for a current situation. This step involves a series of complicated and lengthy calculations. A visual representation of a current mass flow chart is provided in Figure 6 to give readers a visual impression of this step.

      NOTE – For details on the equations involved, refer to page 23 of [b-EMPA 2012].

   3) Future mass flow trends, which aim to quantify the mass flows and stocks for a future situation by extrapolating existing data according to different scenarios such as growth rate of imports and sales, life span of equipment, IT penetration in the population, and changes in tracer composition.

4) **Impact assessment**: The impact assessment highlights the socioeconomic and environmental impacts (which are called 'hot spots') by conducting qualitative and quantitative assessments. The results can then be visualized using the mass flow system chart described in the previous section. A visual representation of a mass flow system with its 'hot spots' highlighted is shown in Figure 7.

   - Environmental impacts may include the following areas:
     - Emissions to air and water
     - Solid waste
     - Human health
     - Pressure on resources
     - Pressure on the ecosystem

- Socio-economic impacts may include the following areas:
  - Impacts on employees
  - Impacts on local communities
  - Impacts on society.

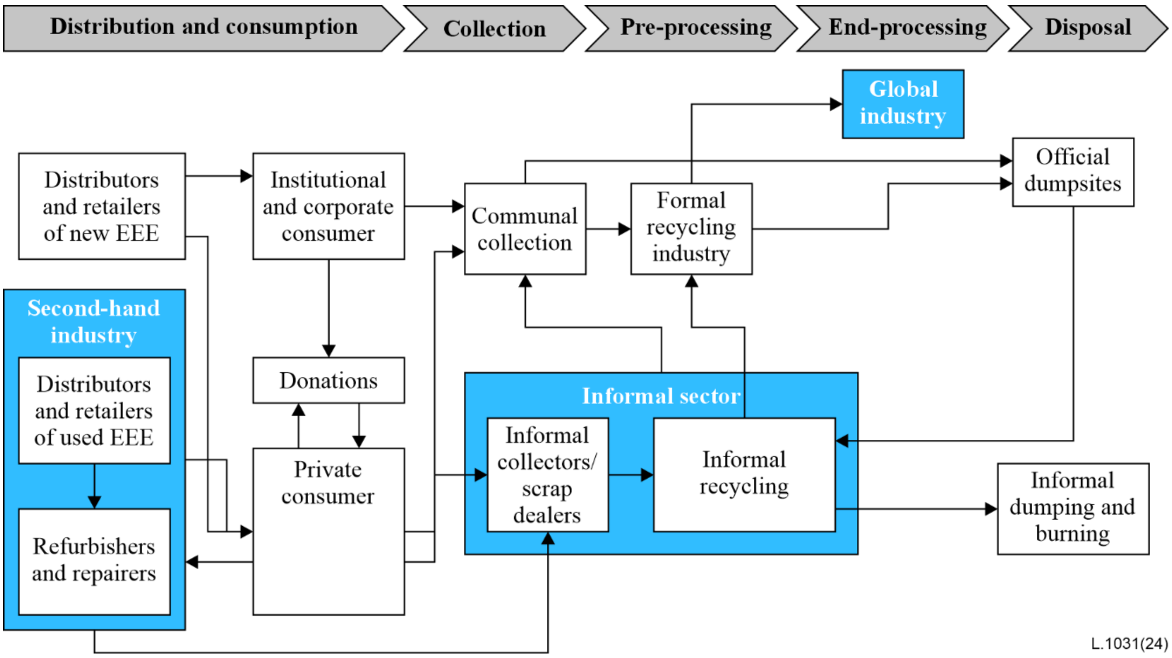

Figure 5 – An example of a mass flow system chart. Adapted from [b-EMPA 2012]

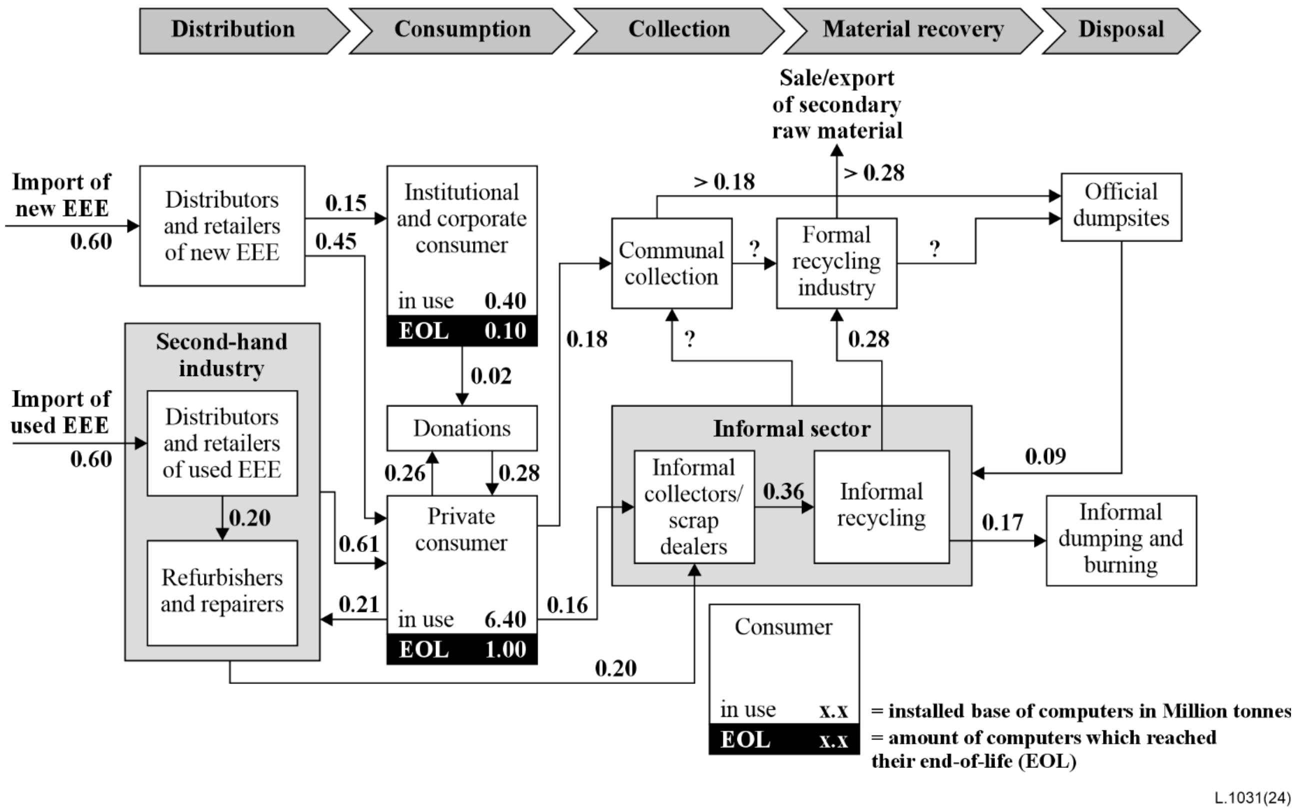

Figure 6 – An example of a current mass flow chart. Adapted from [b-EMPA 2012]

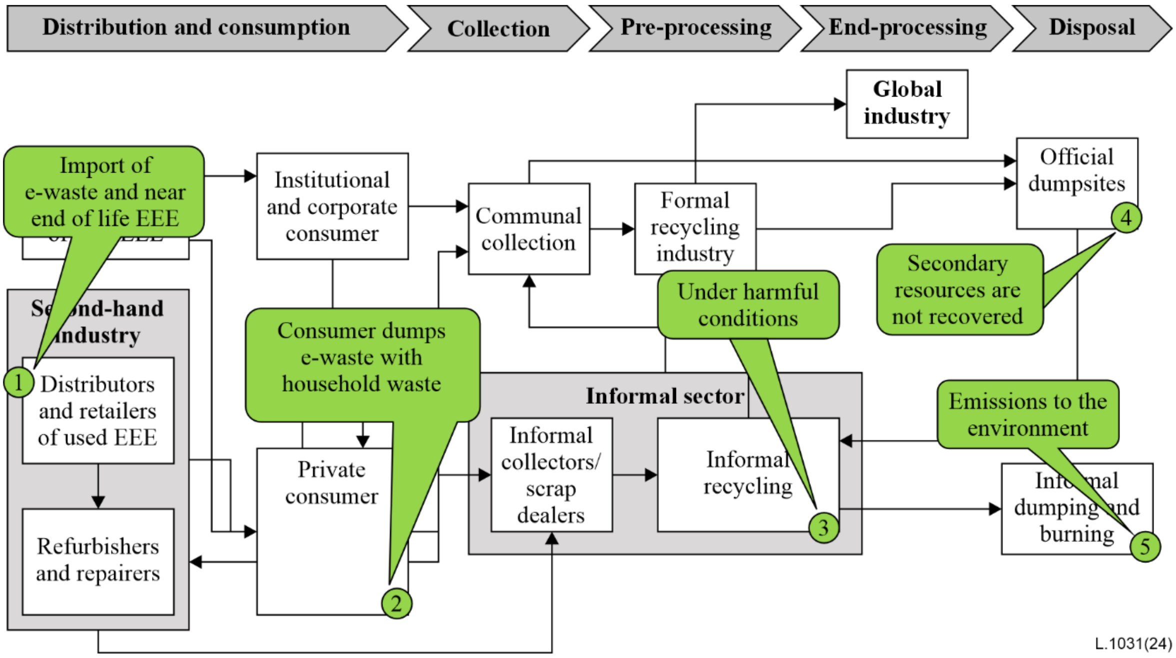

Figure 7 – An example of a mass flow system with its hot spots highlighted. Adapted from [b-EMPA 2012]

7.1.5 Obtain data on disposal facilities and transboundary movement

It is essential to obtain data on options for waste disposal and recovery and on transboundary movements of hazardous waste. Information on existing waste disposal and other related facilities should be recorded during the course of developing the inventory, through field studies and by holding interviews with key stakeholders of the waste sector. Countries which are parties to the Basel convention are required to record all transboundary movements of electrical and electronic wastes.

7.1.6 Update and assess results and conclusion

To update and assess the inventory on a regular basis it is recommended that data collected in the inventory and its results be managed in a database and shared with governmental agencies responsible for statistics and resource and waste management. The assessment can also be validated by carrying stakeholder consultations and validation processes.

Establishing a procedure for requesting data from stakeholders will ensure that the inventory is updated. Obtained results can then be compared and utilized when developing a sustainable and environmentally sound waste management programme.

7.2 Step 2: Development of sustainable e-waste management systems

A sustainable e-waste management system comprises a wide array of waste prevention and minimization strategies. The preference of waste treatment strategies is as indicated in the waste hierarchy, see clause 6.

The principles of implementing a sustainable e-waste management system are listed as follows [b-STEP 2015]:

– Encourages eco-design and measures. For example, by banning the use of toxic and hazardous substances such as lead, mercury, cadmium and chromium in EEE as is the case in the European Union (EU) as well as in China and California. Or by obliging EEE manufacturers to disclose the environmental performance of their products with eco-labels, thus helping consumers to select eco-friendly products, and thereby driving the energy consumption of EEE down, such as the U.S. environmental protection agency's (EPA) energy star programme.

– Encourages responsible consumption and increases the longevity of EEE by extending the use phase of an EEE and delaying reaching the end-of-life phase. Studies indicated that a consumer is more likely to have a product repaired if the product is warranted by the manufacturers. It is also important to promote awareness raising campaigns when changing consumption patterns, which emphasize reuse, repair and recycling. In addition, policymakers can facilitate access to repair services by promoting the visibility of the sector or by implementing measures such as tax breaks on repair services.
– Advocate for solutions using less materials. This means to advocate changes in consumption patterns from buy-use-waste to services "where a product can have several owners". Businesses and policymakers should encourage the sharing of goods and equipment leasing. Special emphasis should be placed on advocating second-hand markets and specialized shops where consumers can sell their used EEE to others.
– Reduce packaging through policies regulating packaging wastes. Packaging refers to all materials whose purpose is the containment, protection, shipping or presentation of goods, from their natural condition to saleable form, as handled by the producer or the consumer. Packaging is often divided into three broad categories: primary packaging referring to the principal material enveloping the product, secondary packaging for grouping products together and tertiary packaging for shipping and handling. Packaging waste is generated at all levels of the supply chain but principally by consumers as the end user. Packaging waste policies may address tertiary packaging use with distinct measures as it is involved in a specific phase of the life cycle and may implicate different stakeholders.

Derived from existing literature, this Recommendation will outline the most prominent e-waste management measures that will assist relevant stakeholders in handling e-waste in an environmentally sound manner.

7.2.1 Extended producer responsibility and the take-back system

Detailed guidance on implementing extended producer responsibility (EPR) and developing a take-back system is provided in [ITU-T L.1021]. This Recommendation will highlight the key elements of EPR and take-back systems based on said Recommendation along with the related knowledge and techniques developed by 'solve the e-waste problem' or STEP.

Extended producer responsibility (EPR) can be defined as the following:

A policy principle to promote total life cycle environmental improvements of product systems by extending the responsibility of the manufacturers of the product to various parts of the entire life cycle of the product and especially to the take-back, recycling and final disposal of the product.

Benefits of EPR systems include:

– Encourages eco-design in electrical appliances that are cost-effective and minimize pollution
– Encourages responsible use of electronics
– Encourages reuse and refurbishment of electronic products
– Encourages the use of non-toxic materials and manufacturing processes
– Improves resource efficiency in material inputs and energy consumption
– Reduces pollution from production and waste treatment
– Creates new profitable business opportunities and a recycling industry niche
– Moves towards a circular economy (CE) that promotes sustainable production and consumption.

Collective producer responsibility versus individual producer responsibility

One of the key elements of EPR policy is to determine whether responsibility is assigned individually or collectively. Individual producer responsibility (IPR) suggests that producers are responsible for their own products while collectively producers of the same product type or category fulfil the responsibility for end-of-life management together. It is recommended that the responsibility of EPR should be with the IPR because a producer will be more inclined to improve design when able to reap the benefits of the improvements [b-STEP 2015].

Voluntary versus legislation or compulsory

Extended producer responsibility (EPR) implementation schemes can be undertaken on a voluntary basis via corporate social responsibility. However, more and more countries are considering EPR as mandatory or as a combination of both such as negotiated agreements between government and industries [ITU-T L.1021].

Allocation of responsibilities and stakeholders

Four key stakeholders are involved in operating EPR systems: governments, producers, retailers/importers and consumers. A summary of their responsibilities is listed in Table 1.

Responsibility of governments:

Governments play the regulatory and operational role in an EPR system. Government entities are responsible for setting up regulations and mandates to introduce and enforce EPR. Governments may also be involved in designing EPR implementation schemes. Governments should set performance requirements for producers and should act as an enforcer to ensure that the EPR systems and related initiatives are operating with maximum efficiency with minimal intervention.

Responsibility of producers:

The responsibility of producers consists in designing the EPR programmes, determining the management and financial schemes and implementing end-of-life management of their products as a condition for sale. Producers can have financial or physical responsibility or both. Producers are also held liable for environmental damage through the "polluters pay" principle and its cost, in addition to informing retailers and customers about the environmental repercussions of their products.

Responsibility of retailers and vendors:

Retailers and vendors are encouraged to sell product brands that are made by producers that have implemented an EPR scheme. Vendors and retailers have a responsibility to inform customers of how to access information on take-back systems and the recycling procedures after usage.

Responsibility of consumers:

Consumers have the responsibility of using electronic products that promote the reuse of the product. Consumers should be conscious about the environmental impacts when purchasing products. If the products they purchase incorporate take-back or other collection programmes, then they should return the used products accordingly to ensure a safe and environmentally sound end of life (EoL) management processes.

Table 1 – Summary of stakeholders' responsibilities

Governments	Assessment of e-waste; stakeholders' buy-in; regulations and laws, waste management practices at national and local levels
Producers	Design, management and finance schemes for EoL
Retailers/importers	Selection of brands and informing consumers, choice of schemes for collection. In case there is no national production of EEE, retailers and importers become the producers in an EPR scheme
Consumers	Sustainable usage
Collection, recovery and disposal facilities	Collection; temporary storage; sorting; dismantling; preparation for reuse; refurbishment; processing for recycling; final disposal

Take-back system

One of the most common EPR programmes is a take-back system. A take-back system is a system to collect and process e-waste usually introduced by policymakers. An effective take-back system underpins the development of a sustainable e-waste management. Developing a comprehensive take-back system is a complex task involving three key components [ITU-T L.1021] [b-STEP 2009].

Defining the scope of a take-back system:

This is to determine the products that are to be included in a take-back system and the different stakeholders' roles in governing it. This component is vital in determining the volume of material to be handled and also the requirement for different activities since not every product needs the same treatment. A take-back system that includes all types of products will mean that the system will require more resources to operate, more equipment to be processed and collected, and involve more logistical providers and storage space. The product scope of a take-back system can be full scope or phased scope as shown in Table 2, [ITU-T L.1021] [b-STEP 2015]:

– Full product scope covers all EEE products with a small list of exemptions. This option is more prevalent in countries that have sophisticated local recycling infrastructures and a culture to leverage it. For example, the EU WEEE directives and the Swiss legislation opted for adopting this option.
– Phased scope focuses on a specified subset of products. Most system designers choose to adopt this option. Problematic products are listed as priority and a take-back system will be designed to tackle these problematic products first. This approach is particularly popular in cases where there is little or no e-waste management infrastructure.

Table 2 – Full and phased product scopes. Adapted from [b-STEP 2015]

	Advantages	Disadvantages
Full scope	Covers all products. Does not need further legislation when a new product comes on the market or if a new environmental problem is identified.	Adds complexity to the system. Adds strain to recycling infrastructures. Leads to a focus on recycling of non-problematic but valuable fractions.
Phased scope	Focuses take-back system on specific product types/groups. Can allow for iterative build-up of scope and infrastructure in parallel. Can ensure that problematic products and fractions are dealt with as a priority.	Leaves a large part of the e-waste without an official take-back system. Many will be reluctant to move on to full scope.

Deciding the entity that will control the take-back system

This is to decide who will retain overall control and responsibility for the successful operation of the system. This entity will coordinate actions among stakeholders, enforce the system rules and ensure compliance. Two types of entities are to be considered, see Table 3 [b-STEP 2015]:

– Government. Once a take-back system is established government agencies may be tasked to maintain the systems. Agencies that handle environmental affairs are often assigned for supervising system operations. The government can play a vital role in enforcing the take-back system.
– Third party organizations (TPOs). Their memberships may include manufacturers, producers, recyclers, collectors, or even government entities. They are tasked to manage and administer the take-back system often in coordination with the national government. For

example, SWICO, a Switzerland based TPO, is a non-profit organization responsible for taking back discarded EEE and maintaining the take-back system.

Table 3 – Options for managing a take-back system.
Adapted from [b-STEP 2015]

	Advantages	Disadvantages
Government	Have powers of enforcement, levying fines and banning noncompliant producers. No potential conflict of interest.	Adds complexity to the system. Adds strain to recycling infrastructures. Leads to focus on the recycling of non-problematic but valuable fractions.
TPO	More flexible. Can adjust rules and outcomes easily. Easier to develop relationships with relevant stakeholders. Strong business incentive to minimize costs while optimizing operation process.	Lacks enforcement mechanisms. Potential excessive focus on their members, may ignore stakeholders and community concerns. Potential conflict of interest.

Deciding the mode of collection

This is to determine both the mechanism for collecting and transporting e-waste to reuse and recycling facilities/locations. There are three types of collection methods: Permanent drop-off facility; special drop-off events; and door-to-door pick up [ITU-T L.1021], [b-STEP 2009]. Depending on the stakeholders responsible for collection, these modes of collection can be facilitated in different ways.

Permanent drop-off facilities offer locations for waste producers to drop-off e-waste year-round. They are often associated with government entities such as municipalities. It is not uncommon that these facilities are co-located with other hazardous waste drop-off sites. Policymakers can also encourage separate collection by establishing realistic and achievable collection targets. The best target for a given region or countries will depend on the information available, the maturity of the system, its socio-economic setting and complexity, as well as the availability of recycling infrastructures. A retailer could also operate a drop-off facility within its retail outlets. It is important that any drop-off facility must be capable of storing and transferring e-waste as recyclers rarely collect e-waste on a daily basis.

Special drop-off events are one or two-day events dedicated to generating the dropping-off of e-waste at a designated location. The most important component of this type of event is publicity. Publicity increases collection amounts while educating the public on e-waste recycling options.

Door-to-door pick-up is dependent on the stakeholders. Government entities can initiate curb-side pickup services for white or brown goods. Commercial entities are often more incentivized to collect e-waste from other commercial clients that generate large volumes of e-waste.

Defining the financing of the take-back system

It is vital to determine the allocation of financial responsibilities when operating a take-back system among the relevant stakeholders. Potential financial sources may include the entire society through contribution in the form of taxation; the consumers, involving them by paying a fee when purchasing a new product which would contribute to a central fund designed to meet the costs associated with the take-back system; and the producers depending on the various degrees of the EPR principles, producers may also internalize the cost by reducing the producer's sales margins and increasing sales price [b-STEP 2009].

Suggested structure for take-back systems

Adapted from [ITU-T L.1021], the structure of a take-back system can be summarized in Table 4.

Table 4 – Structure of take-back systems

Phase	Description
Modes of collection for take-back	– Permanent drop-off facility – Special drop-off events – Special drop-off points – Door to door collection
Modes of processing	– Pre-processing: separation of products, primary dismantling, secondary dismantling – End-processing: re-use and recycling of components, recovery of precious metals, exporting components, final disposal through landfill or incineration
Modes of management	– Producer responsibility organizations (PROs) – Producers individually – Government entities
Financing schemes	– Financing methods: adopting eco-designs that are cost-effective to offset the costs of EPR or using recycling materials to offset the costs of EPR

Furthermore, a take-back committee (TBC) can be established to support the implementation of a take-back system. Small focus groups can be set up within the committee to discuss and consolidate inputs. The following working groups are proposed:

1) Working group on e-waste policy and legislation: This group focuses on examining the existing legislative and regulatory mechanisms and recommends the building blocks of an e-waste policy and draft e-waste legislation.

2) Working group on e-waste financing: This group focuses on evaluating the cost of collecting, recycling/recovery and disposing of e-waste.

3) Working group on standards, monitoring and capacity building: This group focuses on examining the technical aspects of recycling, setting standards and evaluating the compliance with the standards.

The TBC must involve all key stakeholders in order to gather feedback and generate consensus early on in the consultation process and achieve buy-in from all stakeholders. Key stakeholders in this case may include key government departments; manufacturers, producers, importers/retailers; representatives from trade associations; formal and informal recyclers; related NGOs and civil society organizations; academia and technical experts.

[ITU-T L.1021] contains further details on structuring a TBC along with a roadmap on implementing it.

Challenges in implementing EPR and take-back systems

However, implementing EPR could be particularly challenging in the developing world due to their limited legal capacity to operate and enforce EPR policy. Below are listed three key challenges and the potential solutions to overcome the hurdles to implementing EPR [b-STEP 2015] This list offers examples and is not exhaustive by any means:

– Challenge no.1: Lack of formal recovery and final disposal facilities:
  - Implementing EPR is particularly challenging in the developing world because there is a lack of formal recovery and final disposal facilities (RFDF) compliant with international standards. When formal RFDFs do not exist, producers simply do not have the channel necessary to implement any EPR measures.
  - Potential solution: This can be alleviated by either harnessing the power of government support or adopting a market-orientated approach to create the necessary RFDF infrastructure. For example, some governments have adopted the government support approach and created RFDFs under full public ownership, while the EU and Japan have opted for the market-orientated approach, where the governments set standards to be met by RFDFs in order to operate. Some governments offer loans and subsidies for RFDFs that meet the compliance requirements.

– Challenge no.2: An established informal sector:
  - In most developing countries, the informal sector of e-waste management is far more common than the formal sector. The informal sector refers to the part of an economy that is not "taxed or monitored by any form of legal authority". In the absence of any formal environmental legislation, the informal sector of e-waste management has a clear advantage over a formal collection and recycling system due to the lower cost of treatment, as it does not have to comply with any standards, environmental regulations or pay local taxes.
  - Potential solution: It is recommended that in any attempt to establish a formal sector in areas with a vibrant informal e-waste management sector, it is necessary to consider integrating the existing system and drivers behind the informal sectors into the overall solutions. Furthermore, official RFDFs should be incentivized for responsibly treating e-waste that do not offer any potential value in order to avoid said e-waste being treated in an environmentally damaging way in the informal sector.

– Challenge no.3: Undisclosed imported EEE at the point of entry into a country:
  - This is specific for countries that do not manufacture EEE but rely entirely on importation (especially the developing countries). Here there are no strict rules on point of entry and some imported goods do not go through the authorized regulatory channels. The importers may include local distributors importing branded goods into a country for sale and where EPR responsibility does not assign to them; the perceived threat to the local reuse market when implementing the official EPR system; as well as the common 'no brand' equipment where there are no identifiable producers to undertake EPR.
  - Potential solution: It is recognized that these challenges remain valid and further study is required in order to propose a viable solution. Challenges may also be many more than those described, depending on the national situations.

Appendix I contains information on the national framework of the EPR programme in Canada. It further explains the principles of implementing the EPR programme using Canada as an example. Other case studies are available in [b-ITU-D Toolkit].

It is strongly recommended that readers should consider the resources listed below for more details on constructing a competent EPR programme and take-back system along with more examples:

- [ITU-T L.1021] Recommendation ITU-T L.1021 (2018), *Extended producer responsibility – Guidelines for sustainable e-waste management*.
- [b-STEP 2015] STEP (2015), *E-waste Prevention, Take-back System Design and Policy Approaches*.
- [b-STEP 2009] STEP (2009), *E-waste Take-Back System Design and Policy Approaches*.

7.2.2 Sustainable products and design

One of the best practices to prevent the generation of e-waste is the development of sustainable products to incorporate an environmentally conscious design scheme throughout the life cycle of a product, from development and manufacture through to end-of-life treatment. By 'greening' the production line, less waste will be produced, and less toxic materials will be contained in the waste.

This is particularly relevant to the ICT sector because infrastructures and consumer products that are being built and produced by the ICT sector have contributed significantly to the rising volume of e-waste. By integrating environmentally conscious design into ICT products, not only will it reduce the amount of waste that is being produced but it will also minimize the environmental impacts of the produced waste.

ITU has developed the toolkit on environmental sustainability for the ICT sector which outlines a set of technical guidelines on designing ICT products with an environmentally conscious design in mind. Accordingly, environmentally conscious design, or design-for-environment (DfE), is defined in as follows [b-ITU 2012]:

The systematic integration of environmental considerations into product and process design.

This Recommendation will highlight the four-key life-cycle phases of network infrastructure equipment (NIE) and customer premise equipment (CPE) and how each stage can be made more sustainable from the ITU's toolkit on environmental sustainability for the ICT sector. The four phases are:

– environmentally conscious product development,

– eco-efficient manufacturing,

– smart usage,

– end-of-life treatment.

Network infrastructure equipment (NIE) includes equipment that is "set up and operated by service providers to offer shared network services to private and public end users". It is possible to implement an environmentally conscious design throughout the different stages of the NIE's lifespan [b-ITU 2012].

Environmentally conscious product development

– Ensuring sustainability of resources by specifying; renewable and abundant resources; renewable forms of energy; mutually compatible materials for recycling; non-composite and non-blended materials (e.g., avoid alloys where possible).

– Ensuring inputs and outputs in the product life cycle do not cause environmental degrading by; installing protection against the release of pollutant and hazardous substances; specifying non-hazardous and environmentally clean substances; ensuring wastes are water-based and biodegradable; concentrating any environmentally hazardous elements for easy removal and treatment.

– Enabling eco-design in the product development process by minimizing material and energy use and maximizing reuse and recycling.

– Ensuring appropriate durability of the product and components by; reusing high-embedded energy components; ensuring minimal maintenance and minimizing failure modes in the product and its components; indicating on the product which parts are to be cleaned/maintained in a specific way; allowing for repetitive disassembly/reassembly.

– The designers need to consider the use pattern of their products and highlight the product life cycle stage that will consume the most energy. All energy saving features should also be documented and ideally made available to the end user. Additionally, the designers should enable the most energy efficient "on-mode" and transitions to "energy-saving modes" as the default mode. If this is not achievable, the end user should be made aware of the proper use of the available energy saving features.

– The designers should also consider reducing the variety of materials used; reducing the amount and weight of the product; using materials that can be easily recycled; and avoiding the use of materials that have end-of-life concerns.

– When selecting packaging materials, the material type and amount should be consistent with the functional requirement of the package and its content. The use of post-consumer and post-industrial materials in packaging is strongly encouraged. Materials that are reusable and have minimal environmental impacts (e.g., paperboard, recyclable plastics) when disposed of in either landfills or incinerators are recommended. Plastics that contain flame retardants as well as chlorine-based plastics should be avoided in new packaging designs.

Eco-efficient manufacturing

Eco-efficient manufacturing refers to the minimization of resource consumption in the production and transport of the ICT products. The following may be taken into consideration:

– Product designers should communicate the key environmentally conscious criteria to the manufacturers, including the selection of materials, specification on assembling and packaging, in order to deliver the expected eco-benefits.

– Manufacturers should use minimal resources in the production phase by specifying lightweight materials and components; materials that do not require additional surface treatment; minimizing the number of components; and simplifying as few manufacturing steps as possible.

Smart usage

Smart usage refers to issues relating to the deployment and use of ICT products at customer facilities. The following may be taken into consideration:

– Ensuring efficiency of resources during use of the installed ICT product by implementing reusable supplies and fail-safes against heat and material loss; minimizing the volume and weight of parts and materials to which energy is transferred; ensuring rapid warms and power-down; implementing feedback mechanisms to indicate energy usage; and incorporating intuitive controls for resource-saving features.

– Monitoring real-time energy consumption to help manage and reduce energy consumption of all types of industries and organizations.

– Establishing a green data centre. A green data centre has mechanical, lighting, electrical and computing systems designed for maximum energy efficiency (noticeably in areas such as heat density/cooling, uptime, power density, etc. and minimum environmental impacts. A green data centre employs energy saving techniques such as inducing cold air into the server room during the winter season.

End-of-life treatment

This concerns the end-of-life treatment of ICT products. The following may be taken into consideration:

– Enabling disassembly, separation and material purification by indicating how the product should be opened and making the access points obvious; minimizing the number and variety of joining elements; ensuring reusable parts can be cleaned and removed without damage; and making component interfaces simple and reversible.

Customer premises equipment (CPE) refers to 'equipment that is set up and operated by individual entities to provide dedicated private applications and services for their respective end use'. This includes most consumer ICT products such as phones, laptops, desktops, etc. Similar to NIE, CPE's sustainability can be improved by adopting an environmentally conscious design during different stages of production, employing eco-efficient manufacturing, smart usage techniques and end-of-life design [b-ITU 2012]. Therefore, in order to improve the sustainability of CPR, the following should be considered:

– Assessment of the current product portfolio and rationalize packaging, finishes and materials. Review of current energy performance and aim to match best practices.

– Obtain eco-label accreditation on products. Standardize and optimize product portfolio packaging and the packaging should be as compact as possible. Aim to meet an external gold standard ranking.

– To construct an environmental product declaration (EPD) to demonstrate production transparency. An independent practitioner may also be employed to review the product's life cycle eco-impact.

– Avoid using a large number of different plastics. All plastic components should be made of one material only. Such plastic material should also be recycled in high percentages and should not contain flame retardants and other hazardous compounds.

– Reduce the weight of the product's packaging while using recycled materials. All packaging inks can be vegetable-based.

– ICT products should be designed to accommodate end-of-life treatment, meaning; the electronic parts should be easily separable, that is during the design phase a limited number of screws and snap fits must be adopted while satisfying the safety requirements; recycled plastic or bioplastic should be preferred over other forms of plastics; and incentives should be offered to promote the return of the ICT products for recycling and refurbishment.

– Similar to NIE, packaging size and weight should be minimized while using renewable materials and as few types of plastics as possible.

NOTE – The development of sustainable products also involves measures such as the utilization of metrics for measurements, ensuring compliance with different international standards on eco-design and labelling and more.

Therefore, it is strongly recommended that readers should consider the resources listed below for extensive details on developing sustainable products that would reduce the amount of e-waste generated:

• [b-ITU 2012] ITU (2012), *Toolkit on environmental sustainability for the ICT sector*.

• [b-OECD 2011] OECD (2011), *Sustainable Manufacturing Toolkit: Seven Steps to Environmental Excellence*.

7.2.3 Green procurement for the ICT sector

The procurement process of ICT organizations has significant impacts on its environmental performances. A comprehensive green procurement process reduces waste and expenditure.

Purchasing from a greener supplier entails that the purchased products or services are designed to have a longer lifespan with minimal environmental impacts. This Recommendation will highlight the key elements of ITU's green procurement guideline [b-ITU-T 2012]. See also Recommendation [ITU-T L.1061] on circular public procurement of information and communication technologies and [b-ITU Academy course].

A general procurement process of ICT organizations can be described as follows (see also Figure 8):

– It begins with identifying the need for a resource in order to achieve a production goal. In this step, IT organizations determine the most cost-effective solutions based on variables such as expenditures, standardization and environment;

– The next step is to evaluate options and select suppliers. ICT organizations select the suppliers that can provide the most cost-effective and environmentally friendly solutions. The concept of EPR may also be applied in this step which calls upon both ICT organizations and suppliers to develop more sustainable products, materials and practices;

– The third step is procurement and payment. Formal contractual agreement between buyers and suppliers is mandatory. Electronic procurement enables transactions to be made quicker and in a more energy efficient way. Environmental pricing, taxation and credits should also be taken into consideration at this stage;

– The last step is to manage and control purchased resources. It is suggested that it is necessary to constantly evaluate the performance of what has been procured with regard to the performance and functionality. Performance indicators are the ideal tool to assess the efficiency of the application of green procurement practices and track the effectiveness of the applied procurement processes.

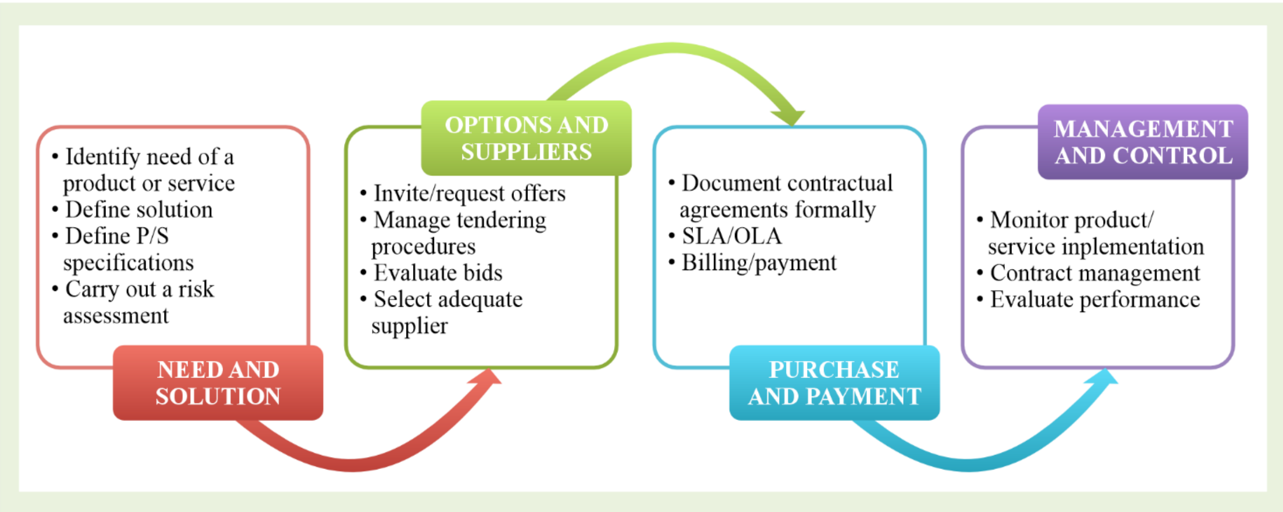

Figure 8 – General procurement process for ICT organizations. Adapted from [b-ITU-T 2012]

Every step listed above can be made greener by taking into consideration the following:

How to buy

ICT organization's procurement process can be made greener by applying standardized energy, environment and carbon decision-making criteria to their products and services. It is recommended that ICT organizations should conduct an environmental life cycle assessment (LCA) according to the international standards.

Specifically, [ITU-T L.1410] *Methodology for environmental life cycle assessments of information and communication technology goods, networks and services*, details the methodology to apply LCA assessment. It is strongly recommended that readers should refer to [ITU-T L.1410] for further details.

Whom to buy from

ICT companies are encouraged to partner with suppliers when developing environmental friendly products and services by adopting international standards such as [ITU-T L.1420] *Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations*, which would assist them in quantifying and reporting energy consumption. On top of that ICT companies should support and purchase products that meet internationally recognized green labelling standards.

What to buy

ICT companies can look to product designs that consume fewer natural assets. Recommendation [ITU-T L.1000] provides such examples which recommend the establishment of a universal charger.

7.3 Step 3: Adopt supportive measures to facilitate a sustainable e-waste management system

7.3.1 Stakeholders' involvement

The proper identification and management of stakeholders' involvement is key to the success of any e-waste management policy. This is particularly important when attempting to integrate the informal recycling sector into the formal waste management system. According to the East African Communications Organization (EACO), managing and coordinating key stakeholders through a clear and transparent coordination mechanism at the national and regional level is imperative to effectively executing management policy [b-EACO 2017].

When implementing any e-waste management initiatives or reduction/minimization scheme, the following points should be taken into consideration:

– Establish a common platform that allows for the open exchange of information and close engagement to foster partnerships and development among different stakeholders.

– In cases where the national policy is linked to a regional scheme, then the regional stakeholders should also be connected through a regional steering committee for review, coordination, and implementation of the plan.

– Collaborative frameworks of different forms could also be adopted with different regulatory bodies or government agencies in charge of the environment or the ICT sectors.

– In some cases, a regional producer association could also act as the mechanism for the implementation of a number of policies such as EPR and recycling fees as well as for the purpose of information dissemination among different regional and national stakeholders.

– Key stakeholders in this case include *development partners* such as UNIDO, UNEP, ITU, UNITAR, UNU and GESP, as well as other donors. WB with the interest of building lasting partnerships and fostering economic development; *private investors* with the interest of creating an enabling environment for investment; *member state*, with the interest of building a harmonized e-waste management policy; others include *recyclers*, *collectors*, *the informal sectors*, *producers*, *importers*, *distributors*, *NGOs*, *universities* and *research institutions* each has its own interest in engaging in the development of an e-waste management scheme.

– Engagement strategies may include meetings, workshops, projects, regulations, publications, guidelines, agreements and media campaigns.

7.3.2 Awareness raising and capacity building

Stakeholders' awareness on the importance of managing e-waste in an environmentally sound manner serves as the cornerstone of any e-waste management or prevention plan. Awareness raising activities could take several forms depending on the stakeholders:

– A structured capacity building scheme: including e-waste management training which could be delivered online or through video streaming of training programmes.

– To conduct regular workshops for different stakeholders to keep them informed and aware of the latest developments on e-waste regulations, policies and plans.

– To involve importers and manufacturers chambers to conduct regular sessions.

– On top of that any reduction scheme or strategy will remain ineffective if it is not supported by a proper communication and advocacy plan. The success of the advocacy and communication plan will depend on the proper formulation of the message which corresponds to different stakeholders.

– Consequently, the EACO further suggests that a simple mapping of identified stakeholders, along with their interests or roles and in relation to the e-waste strategy would complement the advocacy and communication plan and thus maximize the chances of successfully implementing a different e-waste strategy.

7.3.3 Monitoring the implementation of the strategy and plan

In tracking progress and ensuring the transparency and credibility of any strategy, plan or measure, it should be identified who will do the tracking and what verification mechanisms might be employed. Possible monitoring approaches include:

– Self-monitoring with regular reporting;

– Government monitoring and reporting;

– Third-party monitoring through an accreditation or certification scheme;

– A combination of the abovementioned approaches is also possible [b-BC UNEP 2017].

7.3.4 Strengthening international cooperation

International organizations and initiatives can play an important role in disseminating knowledge and providing tools that would facilitate and foster cooperation between stakeholders at all regional, national and international levels, for the purpose of preventing e-waste. Operating at the international level in tackling e-waste is also the ideal method to generate the necessary consensus to standardize key definitions and classification on e-waste.

Technical standards are vital in developing a responsible management of e-waste. They are important tools for stakeholders in the absence of specific legal frameworks. International standards can also improve product design by standardizing best practices/design. In addition, international organizations can perform vital monitoring and enforcement functions that would otherwise be difficult to achieve. This clause describes some of the key international initiatives and organizations that are actively tackling the e-waste challenge.

International Telecommunication Union (ITU), the United Nations specialized agency on information communication technology (ICT), has been at the forefront in tackling the e-waste problem. ITU works with governments, companies from the ICT sector, academia and other expert agencies dealing with WEEE management to develop international standards and guidelines (ITU-T Recommendations). ITU can also serve as a platform for knowledge sharing at the international level. ITU-D (Development) provided assistance to more than 70 countries and developed the global e-waste statistics partnership (GESP), in cooperation with UNU/UNITAR and ISWA (See Appendix I).

Figure 9 illustrates ITU-T Recommendations relating to e-waste management and reduction. Additionally, Annex B contains a detailed list of ITU-T Recommendations on e-waste management. Annex C contains a list of ITU-T Recommendations and Supplements related to e-waste.

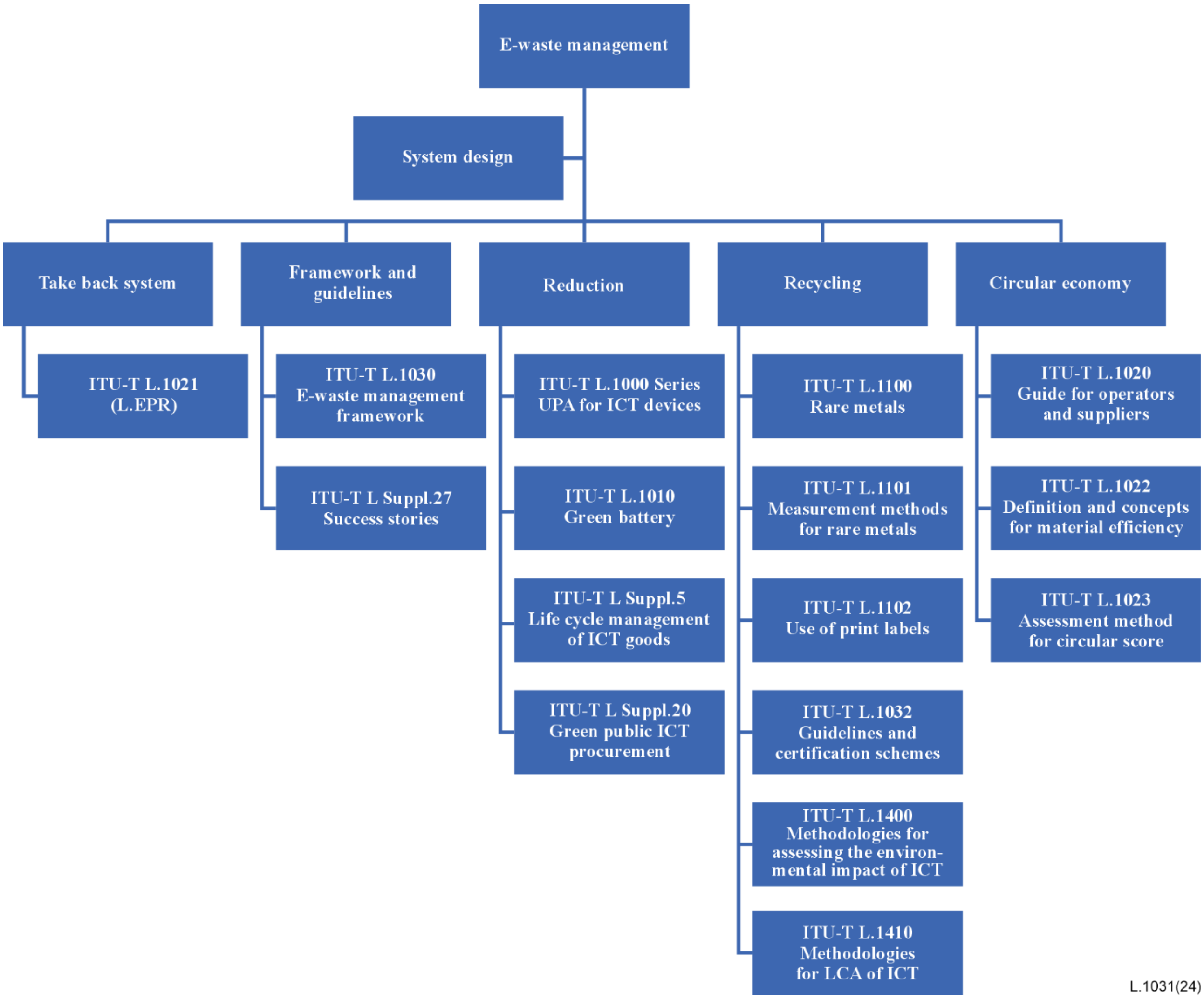

Figure 9 – Examples of ITU-T Recommendations on e-waste management (the complete list is included in Annexes A and B)

The Basel convention

The Basel convention on the *Control of transboundary movements of hazardous waste and their disposal*, adopted on 22 March 1989 by the Conference of Plenipotentiaries in Basel, came into force in 1992 and represents one of the most prominent international initiatives in tackling the e-waste challenge. The objective of the Basel convention is "to protect human health and the environment against the adverse effects of hazardous wastes" [b-BC 2001]. Accordingly, the Basel convention regulates illegal transboundary movement of waste by applying the 'Prior informed consent' clause indicating that shipments between its parties require consent and each party is required to introduce appropriate national measures to prevent and punish illegal traffic. On top of that the convention obliges its parties to ensure hazardous and other wastes are managed and disposed of in an environmentally sound management (ESM) [b-BC 2001].

UNITAR SCYCLE (formally UNU SCYCLE)

The UNITAR SCYCLE programme former UNU SCYCLE established a global partnership with ITU and ISWA to develop global and national e-waste monitor reports, based on the statistical methodology included in [b-UNU 2018]. UNU vice-rectorate in Europe (UNU-ViE) of which

SCYCLE was part, initiated the *Solving the E-waste Problem (StEP)* with the goal of dramatically reducing e-waste through policy changes, product redesign, reuse, recycling and capacity building. Today, the StEP initiative has more than 60 members from all sectors working internationally to foster solutions-oriented dialogue, stimulate practical responses to e-waste prevention and lead e-waste management discussion worldwide by providing a global platform for scientific knowledge sharing (See also Appendix I).

United Nations Industrial Development Organization (UNIDO)

UNIDO recognizes e-waste is a ticking time bomb. UNIDO focuses on fostering the development of an environmentally sound e-waste recycling industry in developing countries. They also focus on promoting an environmental service industry in developing countries, preparing national e-waste assessment reports (along with EMPA see clause 7), establishing partnerships with national and international institutions and facilitating the establishment of local and regional e-waste dismantling and recycling facilities.

United Nations Educational Scientific and Cultural Organization (UNESCO)

UNESCO seeks to build peace and prosperity through international cooperation in education, the sciences and culture. UNESCO's programmes contribute to the achievement of the sustainable development goals and provide tools to help global citizens to live a better life. Over the years, UNESCO has developed reports and guidelines along with other UN agencies on managing e-waste sustainably. For example, UNESCO was one of the partners in developing the report "*Sustainable Management of Waste Electrical and Electronic Equipment in Latin America"* along with ITU. UNESCO also partnered with the private sector in developing *Guidelines for starting up a computer recycling business*.

7.3.5 Towards a circular economy

The concept of circular economy (CE) encompasses all of the previous components described in this Recommendation. Eco-design, repair, reuse, refurbishment, product sharing, waste prevention and recycling are all important concepts in the framework of building a circular economy. A circular economy is defined as:

'Restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all time'.

Embracing the CE model of development can reap numerous benefits ranging from improving resource security, lessening environmental impact, creating economic growth and opportunities, to developing sustainable consumer behaviours [b-EEA 2016].

The World Economic Forum further elaborates on the benefits of a circular economy. Linear consumption which refers to the linear pattern of take-make-dispose consumption, has reached its limits with resource prices being high, frequent disruptions in the supply chain, and insufficient increases in productivity, not to mention the waste that is being generated. The benefits of a circular economy go beyond just the reduction of waste generation. For example, the cost of remanufacturing mobile phones could be reduced by 50% per device, and eliminating waste from the industrial chain by reusing materials represents an opportunity for cost savings of $340 to $380 billion, it inspires innovation and job creation by embracing a new industrial model and forging a lasting and more resilient economy [b-WEF 2014].

Therefore, it is recommended that policymakers and producers should consider moving towards a circular economy. ITU has already developed guidelines and international standards that would support relevant stakeholders to ease the transition to a circular economy (see Annex C).

8 List of performance indicators

The performance indicators on e-waste management should indicate the following:

1) The most essential aspects of a country's performance in e-waste management.

2) An overview of the size of a country's electronic market and its formal waste collection methods.

3) Benchmarking differences in countries performance should be visible.

Accordingly, the following indicator can be constructed:

"E-waste Collection rate = E-waste collected/E-waste generated × 100 percent"

This indicator indicates the performance of the formal collection system. It is calculated based on the total e-waste collected divided by the total e-waste generated. It indicates the strength of the formal waste collection systems, and it should be supported by data including:

– Total EEE put on the market (unit kg/inh). This represents the size of the national e-good market.

– Total e-waste generated (unit kg/inh). This represents the size of the national e-waste market.

– Total e-waste collected (unit kg/inh). This represents the amount of e-waste that is collected.

– Total e-waste collected which is destined for re-use and recycling (unit kg/inh).

– Total e-waste collected sent for final disposal (unit kg/inh).

An example based on statistics from 2010 is provided in Table 5 below.

Table 5 – Example of indicators for measuring e-waste statistics 2024[1]

	Americas (North America if data is available)	**Africa**	**Asia**	**Europe**	**Oceania**
Total EEE put on market (billion kg)	19	5.5	56	14	0.75
Total e-waste generated (kg/inh)	14.1 (21)	2.5	6.6	17.6	16.1
E-waste formally collected and recycled (million kg)	4 300 (8 000)	25	3 600	5 600	292
E-waste collection rate (%)	30 (52)	0.7	11.9	42.8	41.4

Another key performance indicator which could measure target 3.2 of the Connect 2030 Agenda to increase the global e-waste recycling rate to 30% by 2023 was proposed in the ITU strategic plan 2020-2023. It indicates the percentage of e-waste formally collected that is recycled [b-ITU 2018]. This indicator is measured as the:

– Total e-waste collected and recycled / e-waste generated × 100

Another proposed indicator is the number of countries with e-waste legislation and the proposed target is raise the number of countries with e-waste legislation of 50% [b-ITU 2018].

Comparison table of the methodology based on EEE put on the market and the consumption and use-based methodology is given below.

[1] Source: [b-UNITAR 2024].

Methodology	Market supply methodology	Consumption-based methodology
Scope	Country-level (surveys may be carried out at the city level).	The survey is carried out at the city level and the data is standardized at the country level, depending on the area in which the surveys are conducted.
Type of data collected	Based on the HS codes grouped in the UNU keys and tracers for each key (the equipment with an average weight for that UNU key category, which can represent all others in that given category). Each UNU key has multiple HS codes. There are 54 UNU KEYS. The UNU keys are grouped into the six categories defined in the EU waste shipment regulation: Temperature exchange equipment: fridges, freezers, air conditioning, etc. Screens, monitors, and equipment containing screens having a surface greater than 100 cm²: TVs, computer monitors, etc. Lamp bulbs Large equipment (any external dimension more than 50 cm): washing machines, dishwashers, cooking stoves and ovens, cookers, luminaries, large printers, copying equipment, large equipment in general, and so on. Small equipment (no external dimension more than 50 cm): vacuum cleaners, calculators, video cameras, cameras, radio equipment, watches and clocks, smoke detectors, payment systems, etc. Small IT and telecommunication equipment (no external dimension more than 50 cm): mobile phones, tablets, routers, laptops, GPS, printers, etc.	Based on the indicators or tracers' main categories of products defined in the methodology, this methodology can also be based on the 54 UNU KEYS and can be grouped in the same categories. In addition to the products data other data is collected in surveys: <u>Figures on EEE products:</u> – Local imports – Local production – Local export – Products in use (penetration rate) – Number of products/capita – Number of products/household – Expected average lifespan per product – Growth forecast of sector <u>Impacts:</u> – Negative impacts on health, environment and economy.
Methodology for data collection	Products/COMTRADE database.	Surveys, field studies, COMTRADE database.
Model applied for the assessment/calculation	Mass flow balance of products. Waste generation is estimated by the K function.	Mass flow balance of products, waste is calculated based on the average life time for each category. The average life-time applied for each category is verified in the surveys. In addition, the methodology collects indicators of social impacts, environmental impacts and economic impacts of e-waste recycling.
Indicators for mass flow balance of products and wastes collected or calculated for the calculation model	Indicators for mapping of flows: products placed on the market, stock, e-waste generation, collection of e-waste in various flows, recycling, illegal imports and exports at country level and regional levels (only global e-waste statistics [b-UNU 2018]). National on-the-ground data through e.g., household surveys and business surveys.	

Annex A

Basel convention waste categories

(This annex forms an integral part of this Recommendation.)

The annexes reproduced from the Basel convention shown below list the categories of waste to be controlled (Annex I); other wastes (Annex II); hazardous characteristics (Annex III) and waste presumed to be hazardous unless they do not show Annex III hazardous characteristics (Annex VIII).

Annex I of the Basel convention: Categories of waste to be controlled

<u>Waste Streams</u>

Y1	Clinical wastes from medical care in hospitals, medical centers and clinics
Y2	Wastes from the production and preparation of pharmaceutical products
Y3	Waste pharmaceuticals, drugs and medicines
Y4	Wastes from the production, formulation and use of biocides and phytopharmaceuticals
Y5	Wastes from the manufacture, formulation and use of wood preserving chemicals
Y6	Wastes from the production, formulation and use of organic solvents
Y7	Wastes from heat treatment and tempering operations containing cyanides
Y8	Waste mineral oils unfit for their originally intended use
Y9	Waste oils/water, hydrocarbons/water mixtures, emulsions
Y10	Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)
Y11	Waste tarry residues arising from refining, distillation and any pyrolytic treatment
Y12	Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish
Y13	Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives
Y14	Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known
Y15	Wastes of an explosive nature not subject to other legislation
Y16	Wastes from production, formulation and use of photographic chemicals and processing materials
Y17	Wastes resulting from surface treatment of metals and plastics
Y18	Residues arising from industrial waste disposal operations

<u>Wastes having as constituents</u>:

Y19	Metal carbonyls
Y20	Beryllium; beryllium compounds
Y21	Hexavalent chromium compounds
Y22	Copper compounds
Y23	Zinc compounds
Y24	Arsenic; arsenic compounds
Y25	Selenium; selenium compounds
Y26	Cadmium; cadmium compounds
Y27	Antimony; antimony compounds
Y28	Tellurium; tellurium compounds
Y29	Mercury; mercury compounds
Y30	Thallium; thallium compounds
Y31	Lead; lead compounds
Y32	Inorganic fluorine compounds excluding calcium fluoride
Y33	Inorganic cyanides

Y34 Acidic solutions or acids in solid form
Y35 Basic solutions or bases in solid form
Y36 Asbestos (dust and fibres)
Y37 Organic phosphorus compounds
Y38 Organic cyanides
Y39 Phenols; phenol compounds including chlorophenols
Y40 Ethers
Y41 Halogenated organic solvents
Y42 Organic solvents excluding halogenated solvents
Y43 Any congenor of polychlorinated dibenzo-furan
Y44 Any congenor of polychlorinated dibenzo-p-dioxin
Y45 Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44)

Annex II of the Basel convention (only electrical and electronic waste)

Y49 Electrical and electronic waste[2]:

- Waste electrical and electronic equipment
  - not containing and not contaminated with Annex I constituents to an extent that the waste exhibits an Annex III characteristic, and
  - in which none of the components (e.g., certain circuit boards, certain display devices) contain or are contaminated with Annex I constituents to an extent that the component exhibits an Annex III characteristic.
- Waste components of electrical and electronic equipment (e.g., certain circuit boards, certain display devices) not containing and not contaminated with Annex I constituents to an extent that the waste components exhibit an Annex III characteristic, unless covered by another entry in Annex II or by an entry in Annex IX.
- Wastes arising from the processing of waste electrical and electronic equipment or waste components of electrical and electronic equipment (e.g., fractions arising from shredding or dismantling), and not containing and not contaminated with Annex I constituents to an extent that the waste exhibits an Annex III characteristic, unless covered by another entry in Annex II or by an entry in Annex IX.

[2] This entry becomes effective on 1 January 2025.

Annex III of the Basel convention: List of hazardous characteristics

UN Class[1]	Code	Characteristics
1	H1	Explosive An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such speed as to cause damage to the surroundings.
3	H3	Flammable liquids The word "flammable" has the same meaning as "inflammable." Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc., but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60.5E C, closed-cup test, or not more than 65.6EC, open-cup test. (Since the results of open-cup tests and of closed-cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition.)
4.1	H4.1	Flammable solids Solids, or waste solids, other than those classed as explosives, which under conditions encountered in transport are readily combustible, or may cause or contribute to fire through friction.
4.2	H4.2	Substances or wastes liable to spontaneous combustion Substances or wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up on contact with air, and being then liable to catch fire.
4.3	H4.3	Substances or wastes which, in contact with water emit flammable gases Substances or wastes which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

5.1	H5.1	Oxidizing Substances or wastes which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials.
5.2	H5.2	Organic Peroxides Organic substances or wastes which contain the bivalent-O-O- structure are thermally unstable substances which may undergo exothermic self-accelerating decomposition.
6.1	H6.1	Poisonous (Acute) Substances or wastes liable either to cause death or serious injury or to harm health if swallowed or inhaled or by skin contact.
6.2	H6.2	Infectious substances Substances or wastes containing viable micro organisms or their toxins which are known or suspected to cause disease in animals or humans.
8	H8	Corrosives Substances or wastes which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport; they may also cause other hazards.
9	H10	Liberation of toxic gases in contact with air or water Substances or wastes which, by interaction with air or water, are liable to give off toxic gases in dangerous quantities.
9	H11	Toxic (Delayed or chronic) Substances or wastes which, if they are inhaled or ingested or if they penetrate the skin, may involve delayed or chronic effects, including carcinogenicity.
9	H12	Ecotoxic Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.
9	H13	Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above.

Annex VIII of the Basel convention (only electrical and electronic waste)

A1181 Electrical and electronic waste[3]:

- Waste electrical and electronic equipment
  - not containing and not contaminated with Annex I constituents to an extent that the waste exhibits an Annex III characteristic, and
  - in which none of the components (e.g., certain circuit boards, certain display devices) contain or are contaminated with Annex I constituents to an extent that the component exhibits an Annex III characteristic.
- Waste components of electrical and electronic equipment (e.g., certain circuit boards, certain display devices) not containing and not contaminated with Annex I constituents to an extent that the waste components exhibit an Annex III characteristic, unless covered by another entry in Annex II or by an entry in Annex IX.
- Wastes arising from the processing of waste electrical and electronic equipment or waste components of electrical and electronic equipment (e.g., fractions arising from shredding or dismantling), and not containing and not contaminated with Annex I constituents to an extent that the waste exhibits an Annex III characteristic, unless covered by another entry in Annex II or by an entry in Annex IX.

[3] This entry becomes effective on 1 January 2025.

Annex B

List of ITU-T Recommendations and Supplements on e-waste management

(This annex forms an integral part of this Recommendation.)

The following Table lists e-waste management ITU-T Recommendations and Supplements:

Recommendations/Supplements	Scope
Frameworks and guidelines	
[ITU-T L.1030] (E-waste management framework for countries)	Summarizes the different steps that countries need to adopt in order to put in place an e-waste management system. The different steps of the e-waste management system described in this Recommendation will be further elaborated in future Recommendations. In addition, the Recommendation provides highlights concerning the environmental impact of improper handling of e-waste as well as the economic opportunities that could emerge from the sustainable management of e-waste.
[ITU-T L.Sup.27] (Supplement on success stories on e-waste management)	Presents different countries and regions success stories on adequate e-waste management. This Supplement examines the different procedures and processes adopted by different regions to adequately manage their e-waste.
[ITU-T L.1010] (Green battery solutions for mobile phones and other hand-held information and communication technology devices)	Describes the general requirements for green battery solutions for mobile phones and other terminals able to connect to a mobile network and other hand-held information and communication technology (ICT) devices. This Recommendation applies to all battery chemistries utilised within the product described. This Recommendation aims at identifying green battery solutions. Some of the aspects considered include environmental compliance, safety and reliability, lifetime and eco-design.
Reduction	
[ITU-T L.1000] (Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices)	Technical specifications for a universal charger compatible with a wide range of electronic devices, especially mobile phones. This global Recommendation expects to eliminate the generation of 82 000 tonnes of unnecessary chargers and the reduction of 13.6 million tonnes of CO_2 production.
[ITU-T L.1001] (External universal power adapter solutions for stationary information and communication technology devices)	Technical specifications for a universal power adapter (UPA), which is designed to be used with the majority of fixed ICT devices. This Recommendation will substantially reduce the number of manufactured power adapters.

Recommendations/Supplements	Scope
Reduction	
[ITU-T L.1002] (External universal power adapter solutions for portable information and communication technology devices)	Defines the requirements and provides guidelines on the environmental aspects of universal power adapter solutions (UPA) designed for use with portable information and communication technology (ICT) devices. It is complementary to [ITU-T L.1000] and [ITU-T L.1001] and aims to cover the widest possible range of ICT devices for portable use within the identified voltage and power ranges.
[ITU-T L.1024] (The potential impact of selling services instead of equipment on waste creation and the environment – Effects on global information and communication technology)	[ITU-T L.1024] utilizes information compiled from stakeholders that provides insights into cases in the information and communication technology (ICT) ecosystem, in which ICT goods are sold as services or subscriptions rather than products. Currently, these cases are not clearly understood from an environmental point of view. Current estimates are that billions of new ICT goods – smartphones and others – are sold annually and sales are expected to be higher in 2025 than in 2020. Business models based on servitization which would – most effectively – improve the circularity of these ICT goods are not well understood, e.g., prolonging the lifetime or increasing the e-waste collection rate.
[ITU-T L.1005] (Test suites for assessment of the universal charger solution)	This Recommendation describes the general test suites applicable to the universal charger solution (UCS) defined in [ITU-T L.1000]. It establishes a test list necessary to assess the UCS with respect to the requirements described in [ITU-T L.1000].
[ITU-T L.1006] (Test suites for assessment of the external universal power adapter solutions for stationary information and communication technology devices)	This Recommendation describes the general test suites applicable to the universal power adapter solution (UPA) designed for ICT devices for stationary (non-portable) use defined in [ITU-T L.1001].
[ITU-T L.1007] (Test suites for assessment of the external universal power adapter solutions for portable information and communication technology devices)	Describes the general test suites applicable to the universal power adapter (UPA) solution designed for information and communication technology (ICT) devices for portable use specified in [ITU-T L.1002].
[ITU-T L.1034] (Adequate assessment and sensitization on counterfeit information and communication technology products and their environmental impact)	[ITU-T L.1034] provides awareness and guidance on the health and environmental impacts of counterfeit information and communication technology products. The intention is to create awareness and sensitization on human health and environmental risks, as well as the measures implemented in different countries for risk mitigation.

Recommendations/Supplements	**Scope**
Take back systems	
[ITU-T L.1021] (Extended producer responsibility – Guidelines for sustainable e-waste management)	Describes and defines the role of EPR in dealing with e-waste. This Recommendation also provides guidance on the roles and responsibilities of stakeholders in implementing EPR as well as the funding mechanism behind it.
Recycling	
[ITU-T L.1100] (Procedure for recycling rare metals in information and communication technology goods)	Basic guidelines regarding the importance of recycling rare metals and the procedures applied to preserve them. This Recommendation lists the points that should be considered in all phases of the recycling process, and it provides guidelines on how organizations can report in an accurate and transparent way on the recycling of rare metals.
[ITU-T L.1101] (Measurement methods to characterize rare metals in information and communication technology goods)	Provides reference characterization procedures for efficient recycling of rare metals by using XRF and ICP-MS measurement methods
[ITU-T L.1102] (Use of printed labels for communicating information on rare metals in information and communication technology goods)	This Recommendation explains printed label methods for communicating information on rare metals contained in information and communication technology (ICT) goods and describes requirements from [ITU-T L.1100] and [ITU-T L.1101] specifying the disclosure of information on contained rare metals to consumers and recyclers. This Recommendation recommends appropriate label printing methods for rare metals, provides a standard way of obtaining information on rare metals in ICT goods and specifies how to encode rare metals information, as defined in [ITU-T L.1100], into a printed label.
[ITU-T L.1032] (Guidelines and certification schemes for e-waste recyclers)	This Recommendation considers requirements for recyclers of waste information and communication technology (ICT) addressing in particular the informal sector that is involved in WEEE collection and dismantling. By working on the guidelines and certification schemes for WEEE recyclers, this Recommendation aims to support the WEEE informal sector with a view to developing and formalizing its working practices, while recommending interventions that may boost the sector's activities towards being environmentally friendly and protect workers in the sector as well as identifying the steps, needs and methodology required to transform this sector into a formal one.

Recommendations/Supplements	Scope
Recycling	
[ITU-T L.1035] (Sustainable management of batteries)	[ITU-T L.1035] provides guidance on the sustainable management of used batteries from information and communication technology (ICT) equipment and their environmentally responsible management, including waste prevention, minimization, recycling, recovery and final disposal. This Recommendation also provides information on best practices in recycling batteries for dissemination. Batteries are crucial for the functioning of ICTs. Improving their design, prolonging their lifespan, improving their recyclability and preventing the dumping of waste batteries can lower their overall energy consumption, reduce exposure of humans and the environment to hazardous substances, as well as reducing global greenhouse gas emissions.
Circular economy	
[ITU-T L.1020] (Circular economy: Guide for operators and suppliers on approaches to migrate towards circular ICT goods and networks)	Provides guidance to operators and suppliers on how to improve circularity of products through supply chain actions. The objective of the guide is to provide options to improve circularity and to enable operators and their suppliers to create business models for the promotion of circular networks including optimum solutions that use all the loops of circularity – from sharing to recycling.
[ITU-T L.1022] (Circular economy: Definitions and concepts for material efficiency for information and communication technology)	[ITU-T L.1022] contains a guide to the circular economy (CE) aspects, parameters, metrics and indicators for information and communication technology (ICT) based on current approaches, concepts and metrics of the CE as defined in existing standards, while considering their applicability for ICT.
[ITU-T L.1040] (Effects of information and communication technology-enabled autonomy on vehicles longevity and waste creation)	[ITU-T L.1040] establishes guidelines and requirements for information and communication technology original equipment manufacturer vendors providing equipment to autonomous vehicles aiming to reduce the amount of future e-waste. [ITU-T L.1040] analyses the e-waste risks and other sustainability indicators of autonomous vehicles and proposes how these potential challenges can be mitigated. [ITU-T L.1040] utilizes information compiled from stakeholders that can provide good insights into the specified potential challenge.

Recommendations/Supplements	Scope
Circular economy	
[ITU-T L.1023] (Assessment method for circularity performance scoring)	This Recommendation outlines an assessment methodology for circularity scoring of ICT goods. The assessment method consists of three steps: 1) Setting the relevance and applicability (R) of each criteria for circular product design (CCPD) for the ICT good at hand, 2) Assess the margin of improvement (MI) of each CCPD, 3) Calculate the circularity score from 0 to 100% for the ICT good at hand for all three circular design guideline groups (CDGGs). This includes: – Using a predefined value matrix to identify the % score from 0 to 100 for each combination of R×MI. - Average the included CCPDs for the ICT good at hand separately for all three CDGGs: product durability, ability to recycle, repair, reuse, and upgrade from equipment and manufacturer level.
[ITU-T L.Sup.28] (Circular economy in information and communication technology; definition of approaches, concepts and metrics)	Provides an overview of the parameters, indicators, metrics, results and business models used for estimating the resource efficiency (RE) and circular economy (CE) characteristics of ICT infrastructure goods. This Supplement describes; the concept of CR and RE; CE as used in the ICT industry; existing CE and RE metrics and examples of their use; and the next steps in CR and RE standardization.
[ITU-T L.1027] (Assessment of material efficiency of ICT network infrastructure goods (circular economy) – Server and data storage product disassembly and disassembly instruction)	[ITU-T L.1027] contains methods to assess the ability to disassemble certain key components of servers and data storage products, and the provision of information on these disassembly operations. It places a special emphasis on aspects relevant to the circular economy, such as fostering durability and reparability, in particular by third parties.
[ITU-T L.1070] (Global digital sustainable product passport opportunities to achieve a circular economy)	

Annex C

List of ITU-T Recommendations and Supplements related to EEE and WEEE

(This annex forms an integral part of this Recommendation.)

The following table lists EEE and WEEE ITU-T Recommendations and Supplements:

Recommendation/Supplement	Scope
[ITU-T L.1400] (Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies)	Presents the general principles on assessing the environmental impact of information and communication technologies (ICT) and outlines the different methodologies that are being developed: • Assessment of the environmental impact of ICT goods, networks and services • Assessment of the environmental impact of ICT projects • Assessment of the environmental impact of ICT in organizations • Assessment of the environmental impact of ICT in cities • Assessment of the environmental impact of ICT in countries or groups of countries. This Recommendation also provides some examples of opportunities to reduce the environmental load due to ICT.
[ITU-T L.1410] (Methodology for environmental life cycle assessments of information and communication technology goods, networks and services)	Deals with environmental life cycle assessments (LCAs) of information and communication technology (ICT) goods, networks and services. It is organized in two parts: • Part I: ICT life cycle assessment: framework and guidance • Part II: Comparative analysis between ICT and reference product system (Baseline scenario); framework and guidance. Part I deals with the life cycle assessment (LCA) methodology applied to ICT goods, networks and services. Part II deals with comparative analysis based on the LCA results of ICT goods, networks and services product system and a reference product system.
[ITU-T L.1036] (Scheduled waste management for a base station (inclusive of e-waste))	[ITU-T L.1036] has been developed following the general environment quality act of a member country. As the 5G era proceeds, a huge global discharge of telecommunication equipment and upgrading of equipment are expected at each base station (BS) globally. [ITU-T L.1036] is an extension to any requirement stipulated in the national environment quality or protection acts, a technical requirement for the telecommunication industry to adopt as a practice to reduce scheduled waste including e-waste at a BS. In addition, [ITU-T L.1036] provides guidance

Recommendation/Supplement	Scope
	on how to dispose of e-waste from a BS including the shared responsibility of owners and third parties involved.
[ITU-T L.Sup.5] (Life-cycle management of ICT goods)	Provides information for the practical implementation of the life-cycle approach in companies, facilities, plants and distributors including chapters on best practices with a specific focus on material usage and selection.
[ITU-T L.Sup.20] (Green public ICT procurement)	Provides guidance to public authorities on how to improve their procurement practices when purchasing ICT goods and services. This Supplement also presents relevant standards, ecolabels and certification from different organizations to help public authorities achieve green ICT public procurement practices.
[ITU-T L.1061] (Circular public procurement of information and communication technologies)	Green procurement policies, which focus on purchasing durable information and communication technology (ICT) equipment and recycling e-waste, can help reduce emissions and resource extractions and influence the market by increasing demand and stimulating research and product development. [ITU-T L.1061] provides technical guidance to public sector organizations on improving their procurement practices to purchase more circular ICT goods and services. The Recommendation covers the purchase of ICT equipment such as personal computers, terminals, network equipment and servers, and imaging equipment, and recommends specific requirements in procurement to, 1) minimize the generation of e-waste and its adverse effects; 2) maximize the use of energy-efficient equipment; 3) maximize the useful life of equipment; and 4) maximize recyclability. It also covers design for e waste prevention and procurement recommendations which are relevant for the management choices of the e-waste hierarchy, as well as specific requirements and guidance on procurement to enhance the energy efficiency, reduce greenhouse gas (GHG) emissions to mitigate climate change and reduce the emissions of hazardous substances in e-waste.

Recommendation/Supplement	Scope
[ITU-T L.1050] (Methodology to identify key equipment for environmental impact and e-waste generation assessment of network architectures)	While a framework for assessing the environmental impacts of the ICT sector exists (developed by the ITU in, for example, [ITU-T L.1410] on environmental life cycle assessments of information and communication technology goods, networks and services), best practices for equipment identification, developed specifically to assess the environmental impacts of network architecture, are lacking. In this Recommendation, key equipment in networks is identified for smoother life cycle assessment (LCA) calculations. Different types of network architecture employ different goods which entail differences in terms of energy usage, e-waste generation and environmental footprints. This Recommendation will examine three types of network architectures and will suggest an appropriate set of equipment to be considered for each. This Recommendation will begin to support network designers in determining the environmental and circular performance of different network architectures. Recommendation [ITU-T L.1050] utilizes information compiled from stakeholders which can provide good insights into the specified potential challenges.

Appendix I

The e-waste statistics guidelines and the global e-waste statistics partnership

(This appendix does not form an integral part of this Recommendation.)

The 'E-Waste Statistics: Guidelines on Classification, Reporting and Indicators' were first published in 2015 and the second version published in 2018. The E-waste Statistics Guidelines contains a recognized e-waste measurement framework and a classification of e-waste intended to facilitate the implementation of harmonized concepts to measure the size of a country's e-waste market, its transboundary e-waste movement and the e-waste recycling performance within its borders. [b-UNU, 2018].

Developed under the Partnership on Measuring ICT for Development which co-authored and endorses the 'E-Waste Statistics: Guidelines on Classification, Reporting and Indicators' It has undergone a public consultation through Member States and has been endorsed by ITU, ESCAP, ESCWA, OECD, UNCTAD, UNECA, UNU, Eurostat and UNEP/BRS. and is also now used as a methodology for Sustainable Development Goal indicators 12.5.1 and 12.4.2 for the sub-indicators on e-waste. In addition, the methodology is also endorsed by the UN Statistical Commission. The OECD, Eurostat and UNSD have adapted their global waste questionnaires to cover e-waste following the 'E-Waste Statistics: Guidelines on Classification, Reporting and Indicators'. Parts of the methodology are legislated in the European Union Implementing Regulation (EU) 2017/699 of establishing a common methodology for the calculation of the weight of electrical and electronic equipment (EEE) placed on the market of each Member State and a common methodology for the calculation of the quantity of waste electrical and electronic equipment (WEEE) generated by weight in each Member State as an implementing act to the European WEEE Directive. The 'E-Waste Statistics: Guidelines on Classification, Reporting and Indicators' is also often used by national governments, academia and businesses in their efforts to channel the ever increasing e-waste issue.

The Partnership on Measuring ICT for Development is an international, multi-stakeholder initiative that was launched in 2004 to improve the availability and quality of ICT data and indicators, particularly in developing countries. The initiative is a direct response to the request made by the World Summit on the Information Society (WSIS). The Partnership on Measuring ICT for Development established a Task Group on Measuring E-Waste (TGEW) in 2013 to support the compilation of reliable data on e-waste. The immediate objective of the task group was to develop an e-waste statistics framework, based on internationally defined indicators that have been verified with experts in the field. The first Global E-waste Monitor was published by United Nations University (UNU) in 2015, used the methodology in the 2015 version of the guidelines. Between 2015 and 2017, UNU joined forces with the UNECE, the OECD and the UN Statistics Division to pilot test global data gathering using the statistical guidelines.

In 2017, the Global E-waste Statistics Partnership (GESP) was established by the ITU, the UNU, and ISWA. Its objective is to help countries produce e-waste statistics and to build a global e-waste database to track developments over time. The GESP helps address the global e-waste challenges by raising awareness, encouraging more governments to track e-waste, and by carrying out workshops to build national and regional capacities for their respective e-waste inventories. It further aims to map recycling opportunities from e-waste, pollutants, and e-waste-related health effects, along with contributing to Sustainable Development Goals (SDG) 11.6 and 12.5 by monitoring relevant waste streams and tracking the ITU Connect 2020 target 3.2. The Partnership supported the publication of the second and third editions of the Global E-waste Monitor, respectively in 2017, and in 2020. Since 2022, UNITAR is replacing UNU in GESP because of the transition of the SCYCLE Programme from UNU to UNITAR. Over 70 countries have now been trained using this methodology and this number is growing annually. More information is available at: E-waste Monitors (itu.int).

Appendix II

The consumption-based methodology

(This appendix does not form an integral part of this Recommendation.)

The consumption-based methodology is described in the "e-waste assessment methodology training & reference manual", developed in the context of the e-waste Africa project under the Basel convention.

E-waste management needs to fulfil different objectives which go beyond pure technical implementation. Especially in developing countries and countries in transition, with a lack of legal and institutional framework, as well as missing infrastructure, e-waste management demands for a comprehensive and structured approach. This has been echoed by various international organizations and initiatives, including the United Nations Developing Organization (UNIDO), United Nations Environment Programme (UNEP), Basel convention, solving the e-waste problem (StEP) initiative and the partnership for action on computing equipment (PACE). Several development cooperation projects adopted a three-step approach:

1) Performing a country assessment in order to **understand the current framework conditions**, including a review of the current legislation, a stakeholder assessment, a mass flow assessment (inventory) and an environmental and socioeconomic impact assessment.
2) Developing a **structured strategy in a multi-stakeholder approach** by assigning objectives and main activities to the following five topics:
    1) Policy & legislation,
    2) Business & finance,
    3) Technology & skills,
    4) Monitoring & control, and
    5) Marketing & awareness.
3) Implementing the strategy through a **roadmap with assigned responsibilities and a timeframe**.

This Recommendation presents the methodology for the first step of this approach. In order to define a strategy and implement the most suitable e-waste management system, it is necessary to understand the framework conditions on local, national or regional level. An e-waste country assessment, as proposed with this methodology allows acquiring a detailed knowledge of the current situation in a comprehensive approach. The methodology has been summarized in the comparison table of clause 8 of the present Recommendation and applied in various countries.

The first step of an e-waste country assessment usually consists of defining the organizational setup of the study. This not only means structuring the assessment team, but also identifying the local stakeholder(s) to whom the study results will be delivered, and who will take ownership of the e-waste problem in the country. The approach also includes setting up a national e-waste strategy group, comprising representatives of relevant stakeholders related to the e-waste problem. The constitution of such a multi-stakeholder platform ensures that the further implementation of a proper e-waste management system will not be rejected by one or another interest group, as all strategic decisions resulting from the assessment study are debated and adopted within the group.

The scope of the assessment study has to be defined by the geographical focus, as well as by the equipment category. The geographical focus defines which cities and/or regions will be focused on, whether rural areas are considered and if the transboundary movement is included in the study. Finally, the modes of data acquisition are also defined and planned, which may include a review of the existing literature and statistical data, holding meetings and workshops for additional data gathering, field investigations and stakeholder surveys.

The assessment study eventually leads to a qualitative and quantitative description of the framework conditions related to the specific country situations. One of the main results is the understanding of the stakeholder interactions, mass flows and the identification of hotspots which need to be tackled in order to achieve a sustainable e-waste management system.

Results 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 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. [b-BC and EMPA 2012].

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