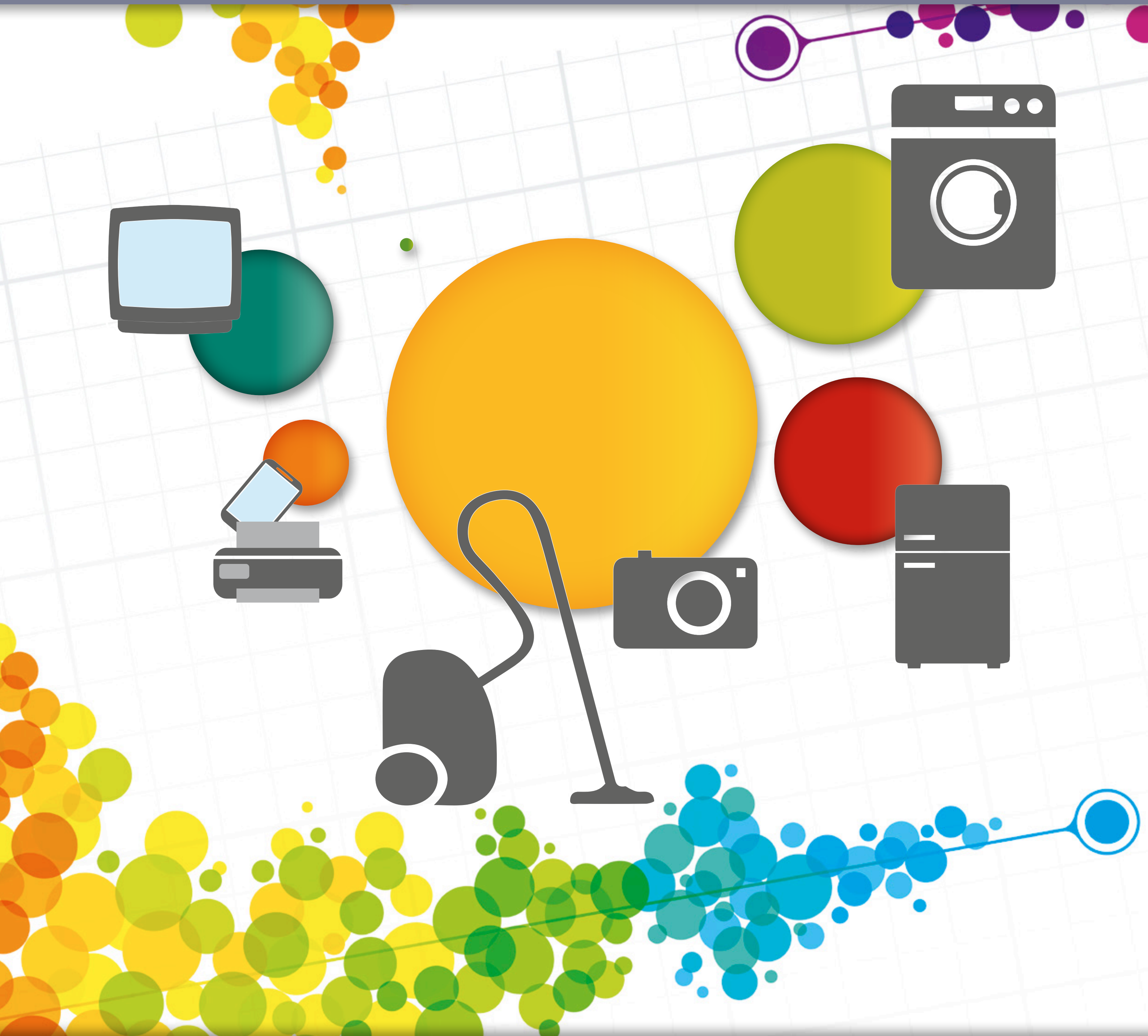
E-WASTE STATISTICS

GUIDELINES ON CLASSIFICATION REPORTING AND INDICATORS

SECOND EDITION



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Sustainable Cycles Programme

PARTNERSHIP ON MEASURING ICT FOR DEVELOPMENT

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ENDORSED BY
ESCAP, ESCWA, ITU, OECD, UNCTAD, UNECA, Eurostat, UNEP/SBC, UNU

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Global E-waste Statistics Partnership

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Foreword

Since the 1990s, electrical and electronic equipment has revolutionized people's lives. These products are ubiquitous in our households, offices, hospitals, transportation systems and communication networks. They also support development around the globe, but with ever-increasing technological innovation and rapidly increasing sales, electronic waste or e-waste has become one of the fastest-growing waste streams. This is a challenge for waste management, as many electronic products contain both hazardous and valuable materials.

In response, the Partnership for Measuring ICT for Development tasked itself with developing a first edition of the guidelines on e-waste statistics in 2015 in order to harmonise early approaches to this challenge. The guidelines have been consulted with public stakeholders, and were endorsed by all Partnership members. This second edition follows the same principles of the previously endorsed guidelines and is updated with more guidance material and examples for countries to measure the e-waste flows.

The guidelines have been developed and prepared by the Sustainable Cycles (SCYCLE) Programme of the United Nations University to support countries in their efforts to collect and disseminate information on e-waste statistics, based on internationally approved definitions and standards. The guidelines on the classifications, measurement scheme, and indicators facilitate the implementation of harmonised concepts to measure the size of a county's e-waste market, its transboundary e-waste movement and the e-waste recycling performance within that country. Measuring e-waste is an important step towards addressing the e-waste challenge. The Global E-waste Statistics Partnership, formed by United Nations University (UNU), the International Telecommunication Unit (ITU) and the International Solid Waste Association (ISWA), uses the measurement framework in their 2017 edition of the Global E-waste Monitor. According to that report, only 41 countries compile statistics on e-waste, which are not all internationally harmonized. Statistics help to evaluate developments over time, set and assess targets, and identify best practices in policies. In this way, better e-waste data will eventually contribute to minimizing e-waste generation, prevent illegal dumping and improper treatment of e-waste, promote recycling, and create jobs in the refurbishment and recycling sector. Better e-waste data will also contribute to the achievement of the Sustainable Development Goals (SDG), in particular SDG 12, to "ensure sustainable consumption and production patterns," but also to other SDGs. It will also help track the global target to reduce the amount of e-waste set by the ITU's Membership as part of the Connect 2020 agenda.

Abstract

Currently, only a few countries have a uniform measurement system for waste electrical and electronic equipment (e-waste or WEEE). However, there is already substantial data available for both developed and less-developed countries that relate to e-waste statistics. In order to improve comparability between countries, a sound measurement framework is proposed that integrates available statistical data and non-statistical data sources into e-waste statistics. The framework captures the most important elements of e-waste and is relevant to all countries that aim to gather data and compile statistics on e-waste. Finally, indicators can be constructed from the framework, which provide a useful overview of the size of the market for electronic and electrical products within a country, as well as its e-waste generated and e-waste collection performance, and serve as a resource for policymaking. The concepts of the measurement framework have been followed by the EU and have resulted in the official adoption of the common methodology to track the collection and recycling target for article 7 in the EU WEEE Directive. Next to that, the Organisation for Economic Co-operation and Development (OECD), the United Nations Statistics Division (UNSD), and the United Nations Economic Commission for Europe (UNECE) have used the measurement framework in pilots to gather data on e-waste globally. The methods have been applied successfully for the first Global E-waste Monitor published by the United Nations University, the second Global E-waste Monitor published by the Global E-waste Statistics Partnership, and two regional e-waste monitors co-authored by the United Nations University.[1]

This measurement framework is presented along with a classification of e-waste. Though the classification is, at this stage, stand-alone, it links to multiple data sources and data formats, such as the Harmonized Commodity Description and Coding System (HS) and the EU WEEE Directive reporting. Relevant data for the construction of the indicators might be already available in the countries' databases. The guidelines also give methods, country examples, and information to an open source script that helps countries to make their own estimates if no data is available. In addition to the full measuring framework, minimum requirements are proposed to collect and report on e-waste statistics for countries that are embarking on this type of data gathering for the first time.

[1] http://ewastemonitor.info/

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List of abbreviations

CFC	Chlorofluorocarbons
CN	Combined Nomenclature
CPC	Central Product Classification
CRT	Cathode Ray Tube
CRTs	cathode ray tubes
DOE	Department of Environment (Malaysia)
EEE	Electrical and Electronic Equipment
EPR	Extended Producer Responsibility
EU	European Union
FDES	Framework for the Development of Environment Statistics
HG	Household Goods
HS	Harmonised System
ICT	Information and Communications Technology
ISIC	International Standard Industrial Classification
ISWA	International Solid Waste Association
IT	Information Technology
ITU	International Telecomunication Union
JICA	Japan International Cooperation Agency
LCD	liquid crystal displays
LoW	European List of Wastes
Mt	Million metric tonnes
NACE	Statistical classification of economic activities in the European Community
NGO	Non Governamental Organization
OECD	Organization for Economic Co-operation and Development
PBB	polybrominated biphenyl
PCB	polychlorinated biphenyl
PCN	polychlorinated naphthalene
PCT	polychlorinated terphenyl
PE	Personal Effects
PiP	Person in the Port
POM	Put on Market
PPP	Purchasing Power Parity
RMC	Royal Malaysian Customs
SCYCLE	Sustainable Cycles Programme of the United Nations University
SDG	Sustainable Development Goals
SEEA	System of Environmental-Economic Accounting
SNA	System of National Accounts
TBP	Take Back Program
TCIPC	Tin Can Island Port Complex
TGEW	Task Group on Measuring E-Waste
TISU	Terms Indicating Suspected UEEE
TVs	Televisions
UEEE	Used Electric and Electronic Equipment
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNSD	United Nations Statistics Division
UNU	United Nations University
UNU-KEYS	E-waste classification defined by the United Nations University
WCO	World Customs Organization
WEEE	Waste Electrical and Electronic Equipment

Introduction

The worldwide use of information and communications technology (ICT) equipment and other electronic equipment is growing. Consequently, there is a growing amount of equipment that becomes waste after its time in use. This growth is expected to accelerate, since equipment life-time decreases with time and growing consumption (Baldé et al., 2017, Huisman et al., 2012a; Wang et al., 2013); As a result, e-waste is one of the fastest-growing waste streams. The United Nations University (UNU) calculates in their second Global E-waste Monitor that 44.7 million metric tonnes (Mt) of e-waste was generated globally in 2016 (Baldé et al., 2017).

The annual global consumption of new electrical and electronic equipment (EEE) was around 60 Mt in 2016. The consumption and use of EEE is probably most prevalent in the developed world, but developing countries show a rapid growth of consumption and use of EEE. Typically, developed countries have growth rates of 1% to 5 % annually on weight basis. Developing countries typically range from 10% to 25% (Baldé et al., 2017).

Some less-developed countries lack a waste treatment infrastructure and waste management laws and enforcement. As a result, the e-waste in those countries will often be treated in suboptimal ways by the informal sector. This leads to severe consequences for the environment and human health. In order to treat e-waste in an environmentally-sound manner, it needs to be regulated. This means that an appropriate system needs to be created and financed, a recycling infrastructure needs to be developed or improved, and workers' health and safety standards need to be implemented, to name a few prerequisites (Wang et al., 2012; Schluep et al., 2009). Those conditions aid in the creation of jobs, one of the conditions to eradicate poverty and simultaneously "green" the economy, according to the (UNEP, 2011). However, suboptimal treatment and illegal activities are not limited to low and middle-income countries. In developed countries as well, large flows of undocumented e-waste are found that may be treated (illegally or semi-legally) with inferior standards, or simply disposed of and mixed with other waste streams (Baldé et al., 2017; Magalini et al., 2012; Wielenga et al., 2013).

In order to understand the dynamics of this complex waste stream, a framework is needed to capture e-waste's most essential features. Currently, there is too much discrepancy between official/governmental data and academic data. All available data could feed into such a system, preferably linking to statistical classifications and existing frameworks. Such a harmonised framework and measurement would help to interpret e-waste-related data and to compile e-waste statistics that are comparable between countries worldwide.

Such a system should also address the practical challenges that inevitably occur during measurement. For example, e-waste is sometimes registered as metal waste rather than e-waste. The part that is e-waste is not identifiable in registers and therefore difficult to assess. In addition, there is also trade in e-waste between countries, and the statistics should also capture this.

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 as a basis for political decision making and further action on the environmentally sound management of used and end-of-life ICT equipment. The immediate objective of the task group has been met, by developing e-waste statistics framework based on internationally defined indicators that have been verified with experts in the field. The first edition of the guidelines was published in January 2015. Next to the methodological work, the first Global E-waste Monitor was published in 2015 and received great media exposure in over 70 countries. Between 2015 and 2017, United Nations University joined forces with the United Nations Economic Commission for Europe (UNECE), the Organisation for Economic Co-operation and Development (OECD) and the United Nations Statistics Division (UNSD) to improve the global data coverage. This led to the use of pilot questionnaires[2] on e-waste, following the principles of those guidelines. In 2017, the Global E-waste Statistics Partnership was established by the ITU, the UNU, and the 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 Partnership will make an important contribution to addressing 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. In December 2017, the second edition of the Global E-waste Monitor was released, and received again great exposure (Baldé et al., 2017).

[2] https://unstats.un.org/unsd/statcom/49th-session/documents/2018-31-Environment-E.pdf

E-waste classification

Before going into detail about the measurement framework, the issue of e-waste classification will be discussed. Electronic waste, or e-waste, refers to all electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use[3] (Step Initiative, 2014). There are many types of EEE products on the market, which makes it important to group them into sensible and practically useful categories. There are many classifications that can be used to describe e-waste, and each of them is potentially valuable to form the basis of e-waste statistics in the proposed measurement framework. However, there are several criteria to which the classification should comply in order to effectively harmonise e-waste measurement, and thus lead to sensible and internationally comparable indicators. In general, the categories should not be defined too specifically around products that do not pose a threat to the environment, or that do not contain valuable materials, nor have a large market share, as this leads to too many irrelevant codes and consequently imposes an unnecessary administrative burden on respondents. Moreover, there will be very few databases available from which data can be collected in the desired classification. The classification system should also not be too aggregated, as differences between countries will be difficult to interpret. For example, Cathode Ray Tube (CRT) monitors can be allocated to IT equipment, but other countries might allocate them to household appliances, whereas others might group them with screens. Another example is that microwaves can be either documented as small household appliances, or in other countries, as large household appliances. Consequently, those inconsistencies in reporting will affect data quality and should be avoided, as they hamper the usability of the results for international benchmarking and effective policymaking.

Criteria for e-waste classifications

A classification system for e-waste statistics should categorise products by similar function, comparable material composition (in terms of hazardous substances and valuable materials) and related end-of-life attributes. In addition, products within the same category should have a homogeneous average weight and life-time distribution, which can simplify quantitative assessment for similar products. Finally, large or environmentally-relevant e-waste products, for which a lot of data is potentially available, should be assigned separately. Currently, there is one classification system that fulfils those criteria: the classification developed by the UNU (Wang et al., 2012). This classification is referred to as the UNU-KEYS.

UNU-KEYS

As mentioned above, the UNU-KEYS are constructed such that product groups share comparable average weights, material compositions, end-of-life characteristics and life-time distributions. This makes the system very useful for compiling e-waste statistics. The full list of the UNU-KEYS is presented in Table 1. The 54 categories can be grouped into 10 primary categories, according to the original EU Waste Electrical and Electronic Equipment (WEEE) Directive (see the fourth column in Table 1). The classification can also be linked to the new reporting categories for the recast of the WEEE-Directive (see the third column in Table 1), which will come into effect in August 2018 in the EU. The UNU-KEYS classification is ideal to serve as a link between the EU categories and the existing classifications. The UNU-KEYS are used in the implementing Act to describe the common methodology to calculate the WEEE collection targets for article 7 (European Commission, 2017/2018).

More specifically, the resulting UNU-KEYS encompasses all possible EEE (about 900 products, clustered into 660 main product types). Here, the system closely follows the harmonised statistical coding of the international trade codes, the Harmonised System (HS)[4]. The HS codes link to the CPC product classification. The correspondence tables that translate UNU-KEY to the HS are shown in Annex 1[5]. National statistical institutes or custom organizations document all commodities and economic activities in society. Independent of current WEEE registers, this data can provide consistent and harmonised Put on Market figures for all products through historical years and serve as an alternative data source for the estimation of WEEE generation.

Statistical use of the UNU-KEYS:

The UNU-KEYS can be used in several ways statistically. First of all, the UNU-KEYS can be used to convert the 6 and 10 EEE categories of the EU WEEE Directives (see Table 1). Secondly, it can be used to collect statistical data on Put on Market. The UNU-KEYS can be used to link to available product classifications such as the HS coding (see Annex 1). The UNU-KEYS can also be used to convert the unit to weight by applying average weights. An indication on the average weights is shown in Annex 3. The life-times of the UNU-KEYS are also homogeneous, which enables the system to be used to determine e-waste generated (See Annex 2). E-waste generation is based on a time-series of Put on Market and the average life-time of a product. Since the product composition of the products within a UNU-KEY is homogeneous, the classification is also suitable for material flow analysis of the raw material components in EEE and WEEE.

[3] http://www.step-initiative.org/files/step/_documents/StEP_TF3_WPCommonDefinitions.pdf
[4] WEEE-Directive 2002/96/EC
[5] The indicative link between the UNU-KEYS and the HS codes can be downloaded here: http://i.unu.edu/media/ias.unu.edu-en/project/2238/UNU-KEYS-to-HS-Codes.xls

TABLE 1: Detailed description of the UNU product classification and its correlation to other e-waste classifications[6]

UNU KEY	DESCRIPTION	EEE CATEGORY UNDER EU-6	EEE CATEGORY UNDER EU-10
0001	Central Heating (household installed)	Large equipment	Large household appliances
0002	Photovoltaic Panels (incl. inverters)	Large equipment	Consumer equipment
0101	Professional Heating & Ventilation (excl. cooling equipment)	Large equipment	Large household appliances
0102	Dishwashers	Large equipment	Large household appliances
0103	Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)	Large equipment	Large household appliances
0104	Washing Machines (incl. combined dryers)	Large equipment	Large household appliances
0105	Dryers (wash dryers, centrifuges)	Large equipment	Large household appliances
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	Large equipment	Large household appliances
0108	Fridges (incl. combi-fridges)	Temperature exchange equipment	Large household appliances
0109	Freezers	Temperature exchange equipment	Large household appliances
0111	Air Conditioners (household installed and portable)	Temperature exchange equipment	Large household appliances
0112	Other cooling equipment (e.g. dehumidifiers, heat pump dryers)	Temperature exchange equipment	Large household appliances
0113	Professional cooling equipment (e.g. large air conditioners, cooling displays)	Temperature exchange equipment	Large household appliances
0114	Microwaves (incl. combined, excl. grills)	Small equipment	Large household appliances
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	Small equipment	Small household appliances
0202	Equipment for food preparation (e.g. toaster, grills, food processing, frying pans)	Small equipment	Small household appliances
0203	Small household equipment for hot water preparation (e.g. coffee, tea, water cookers)	Small equipment	Small household appliances
0204	Vacuum Cleaners (excl. professional)	Small equipment	Small household appliances
0205	Personal Care equipment (e.g. toothbrushes, hairdryers, razors)	Small equipment	Small household appliances
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	Small IT	IT and telecommunications equipment
0302	Desktop PCs (excl. monitors, accessories)	Small IT	IT and telecommunications equipment
0303	Laptops (incl. tablets)	Screens and monitors	IT and telecommunications equipment
0304	Printers (e.g. scanners, multi -functionals, faxes)	Small IT	IT and telecommunications equipment
0305	Telecommunication equipment (e.g. cordless phones, answering machines)	Small IT	IT and telecommunications equipment
0306	Mobile Phones (incl. smartphones, pagers)	Small IT	IT and telecommunications equipment
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	Large equipment	IT and telecommunications equipment
0308	Cathode Ray Tube Monitors	Screens and monitors	IT and telecommunications equipment
0309	Flat Display Panel Monitors (LCD, LED)	Screens and monitors	IT and telecommunications equipment
0401	Small Consumer Electronics (e.g. headphones, remote controls)	Small equipment	Consumer equipment
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	Small equipment	Consumer equipment
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	Small equipment	Consumer equipment
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	Small equipment	Consumer equipment
0405	Speakers	Small equipment	Consumer equipment
0406	Cameras (e.g. camcorders, photo & digital still cameras)	Small equipment	Consumer equipment
0407	Cathode Ray Tube TVs	Screens and monitors	Consumer equipment
0408	Flat Display Panel TVs (LCD, LED, Plasma)	Screens and monitors	Consumer equipment
0501	Small lighting equipment (excl. LED & incandescent)	Small equipment	Lighting equipment
0502	Compact Fluorescent Lamps (incl. retrofit & non-retrofit)	Lamps	Lighting equipment
0503	Straight Tube Fluorescent Lamps	Lamps	Lighting equipment
0504	Special Lamps (e.g. professional mercury, high & low pressure sodium)	Lamps	Lighting equipment
0505	LED Lamps (incl. retrofit LED lamps)	Lamps	Lighting equipment
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	Small equipment	Lighting equipment
0507	Professional Luminaires (offices, public space, industry)	Small equipment	Lighting equipment
0507	Professional Luminaires (offices, public space, industry)	Small equipment	Lighting equipment
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	Small equipment	Electrical and electronic tools
0602	Professional Tools (e.g. for welding, soldering, milling)	Large equipment	Electrical and electronic tools
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	Small equipment	Toys
0702	Game Consoles	Small IT	Toys
0703	Leisure equipment (e.g. sports equipment, electric bikes, juke boxes)	Large equipment	Toys
0801	Household medical equipment (e.g. thermometers, blood pressure meters)	Small equipment	Medical devices
0802	Professional medical equipment (e.g. hospital, dentist, diagnostics)	Large equipment	Medical devices
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	Small equipment	Monitoring and control instruments
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	Large equipment	Monitoring and control instruments
1001	Non- cooled Dispensers (e.g. for vending, hot drinks, tickets, money)	Large equipment	Automatic dispensers
1002	Cooled Dispensers (e.g. for vending, cold drinks)	Temperature exchange equipment	Automatic dispensers

[6] The UNU-KEYS are an integral part of the common methodology for making the collection target calculations for article 7 in the recast of the EU WEEE Directive. In order to be adopted as a standard, countries should ideally comment on its practical use for measuring WEEE in their country.

EU-WEEE Directives

Currently, the WEEE Directive is enforced in the EU Member States (European Commission, 2017). The WEEE Directive lists 10 categories for which data is collected. Those are: (1) Large household appliances; (2) Small household appliances; (3) IT and telecommunications equipment; (4) Consumer equipment; (5) Lighting equipment; (6) Electrical and electronic tools (with the exception of large-scale stationary industrial tools); (7) Toys, leisure, and sports equipment; (8) Medical devices (with the exception of all implanted and infected products); (9) Monitoring and control instruments; and (10) Automatic dispensers. The links from these categories to the UNU-KEYS are shown in Table 1 (right column, as Annex I). The categorisation and scope of products in the WEEE Directive are broad enough to be relevant for the rest of the world. For instance, countries like Mauritius use the same categorization. However, China applies a smaller scope that only includes refrigerators (UNU-KEY 0108); monitors and TVs (UNU-KEYS 0308, 0309, 0407 and 0408); washing machines (UNU-KEY 0104); and air conditioners (UNU-KEY 0111 and 0113) (CNBS, 2012).Since 2015 the WEEE regulations in China have also included water heaters, fax and telephone machines, mobile phones, printers, copiers, and monitors.

The recast of the WEEE Directive lists six categories that should be reported from 15 August 2018[7], which are representative of the e-waste collection streams in practice. These categories are: (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. The link between those categories to the UNU-KEYS is shown in the third column of Table 1. The EU Member States either have a collection target based on a percentage of the amounts Put on Market (POM, in other words, EEE sales) in the three preceding years, or as a percentage of e-waste generated. The change from a flat target towards to a relative target requires improving e-waste statistics. Also, a relative target improves the ability to capture the effectiveness of e-waste collection.

[7] WEEE-Directive 2012/19/EC

International trade and production statistics

Foreign trade (import and export) statistics for each product are registered under the Harmonized Commodity Description and Coding System (HS codes) developed by the World Customs Organization[8]. Similarly, production statistics use the CPC, which is linked to the HS classification. Such an integrated system allows for comparability between statistics produced in different statistical domains. Virtually all countries compile data using the HS classification. The data are compiled by the United Nations Statistical Division (UNSD) and published in the Comtrade database.

There are about 5,300 HS codes (six digits) describing all commodities per year. Within that group, there are about 270 codes regarded as relevant to EEE, according to their descriptions. Meanwhile, descriptions that refer to parts of EEE were excluded, as it would have created double counting. A list related to the UNU-KEYS is provided in Annex 1. It should be noted that the HS codes are currently unsuitable to measure trades of e-waste, as there are no specific HS codes for e-waste. E-waste is mainly traded using the same HS code as the new product, or waste processing as scrap (metal scrap, plastic scrap, etc.). For further information on import and export of e-waste, see the chapter "Data sources and Methodology."

European List of Wastes

The European List of Wastes (LoW) is the waste classification in the EU for administrative purposes (i.e. for permits and supervision in the field of waste generation and management). Many European, as well as some Caucasian and Central Asian countries use the LoW as a central framework to gather data for waste statistics. Waste statistics reporting is typically done on an aggregated level, based on the type of waste. The LoW defines 839 waste types, which are structured into 20 chapters mainly according to the source of the waste (i.e., the economic sector or process of origin). Each waste type is characterised by a six-digit code. The allocation of wastes to the defined waste types is laid out in the introduction of Decision 2000/532/EC and explained in a separate section. There are 13 LoW codes that refer to e-waste. They are subdivided into hazardous and non-hazardous waste, and listed in Table 2 below. Fractions or components that can be generated during treatment of e-waste, such as metal scrap, plastics, and lead glass, are not listed in this table.

TABLE 2: The European List of Wastes (LoW) codes that refer to e-waste.

	HAZARDOUS
09 01 11[9]	Single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03
16 02 09[9]	Transformers and capacitors containing PCBs
16 02 10[9]	Discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09
16 02 11[9]	Discarded equipment containing chlorofluorocarbons, HCFC, HFC
16 02 12[9]	Discarded equipment containing free asbestos
16 02 13[9]	Discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12
20 01 21[9]	Fluorescent tubes and other mercury-containing waste
20 01 23[9]	Discarded equipment containing chlorofluorocarbons
20 01 35[9]	Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components
	NON-HAZARDOUS
09 01 10	Single-use cameras without batteries
09 01 12	Single-use cameras containing batteries other than those mentioned in 09 01 11
16 02 14	Discarded equipment other than those mentioned in 16 02 09 to 16 02 13
20 01 36	Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23, and 20 01 35

[8] http://unstats.un.org/unsd/publication/SeriesM/SeriesM_77ver1_1E.pdf
[9] the code is hazardous waste

Those codes describe e-waste very generally and are merely useful to measure e-waste that is registered as separately-collected e-waste. For compiling e-waste statistics however, these codes lack the ability to distinguish between different types of e-waste, thus ignoring differences in environmental relevance and materials' potential when recycled. Also, in practice, e-waste is collected and registered under other LoW codes, such as non-separately-collected domestic waste or metal scrap.

Classification of e-waste under the Basel Convention [10]

Article 2 ("Definitions") of the Basel Convention defines waste as "substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law." In paragraph four of that article, it defines disposal as "any operation specified in Annex IV" to the Convention[11]. It is important to note that national provisions concerning the definition of waste may differ, and the same material that is regarded as waste in one country may be non-waste in another country.

E-waste is included in Annex VIII to the Convention with the following entry for hazardous wastes:

"A1180 Waste electrical and electronic assemblies or scrap[12] containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB capacitors, or contaminated with Annex I constituents (e.g. cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B, B1110)." [13]

E-waste is also included in Annex IX to the Convention with the following entry for non-hazardous wastes:

"B1110 Electrical and electronic assemblies:

- Electronic assemblies consisting only of metals or alloys;
- Waste electrical and electronic assemblies or scrap[14] (including printed circuit boards) not containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or not contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) or from which these have been removed, to an extent that they do not possess any of the characteristics contained in Annex III (note the related entry on list A A1180);
- Electrical and electronic assemblies (including printed circuit boards, electronic components and wires) destined for direct reuse,[15] and not for recycling or final disposal." [16]

[10] Extracted from the 23 Dec 2013 version of the Draft technical guidelines on transboundary movements of e-waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention which is available at: http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/Ewaste/tabid/2377/Default.aspx
[11] Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, website: http://www.basel.int/Portals/4/Basel%20Convention/docs/text/BaselConventionText-e.pdf
[12] This entry does not include scrap assemblies from electric power generation.
[13] PCBs are at a concentration level of 50 mg/kg or more.
[14] This entry does not include scrap from electrical power generation.
[15] Reuse can include repair, refurbishment or upgrading, but not major reassembly.
[16] In some countries these materials destined for direct reuse are not considered wastes.

Equipment will often contain hazardous components, examples of which are indicated in entry A1180 of Annex VIII. E-waste should therefore be presumed to be hazardous waste, unless it can be shown that it does not contain such components, in particular: [17]

(a) Lead-containing glass from cathode ray tubes (CRTs) and imaging lenses, which are assigned to Annex VIII entries A1180 or A2010, "Glass from cathode ray tubes and other activated glass." This waste also belongs to category Y31 in Annex I, "Lead; lead compounds" and is likely to possess hazardous characteristics H6.1, H11, H12, and H13 included in Annex III;

(b) Nickel-cadmium batteries and batteries containing mercury, which are assigned to Annex VIII entry A1170, "Unsorted waste batteries…" This waste also belongs to category Y26 in Annex I, "Cadmium; cadmium compounds" or Y29, "Mercury, mercury compounds" and is likely to possess hazardous characteristics H6.1, H11, H12, and H13;

(c) Selenium drums, which are assigned to Annex VIII entry A1020, "Selenium; selenium compounds. "This waste also belongs to category Y25 in Annex I, "Selenium; selenium compounds" and is likely to possess hazardous characteristics H6.1, H11, H12, and H13;

(d) Printed circuit boards, which are assigned to Annex VIII entry A1180, "Waste electronic and electrical assemblies...", and entry A1020, "Antimony; antimony compounds" and "Beryllium; beryllium compounds." These assemblies contain brominated compounds and antimony oxides as flame retardants, lead in solder, and beryllium in copper alloy connectors. They also belong in Annex I, to categories Y31, "Lead; lead compounds", Y20, "Beryllium, beryllium compounds", Y27, "Antimony, antimony compounds", and Y45, "Organohalogen compounds" other than substances referred to elsewhere in Annex I. They are likely to possess hazardous characteristics H6.1, H11, H12, and H13;

(e) Fluorescent tubes and backlight lamps from liquid crystal displays (LCD), which contain mercury and are assigned to Annex VIII entry A1030 "Mercury; mercury compounds". This waste also belongs to category Y29 in Annex I, "Mercury; mercury compounds" and is likely to possess hazardous characteristics H6.1, H11, H12, and H13;

(f) Plastic components containing brominated flame retardants (BFRs), in particular BFRs that are persistent organic pollutants according to the Stockholm Convention, which can be assigned to Annex VIII entry A3180, "Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCB), polychlorinated terphenyl (PCT), polychlorinated naphthalene (PCN) or polybrominated biphenyl (PBB), or any other polybrominated analogues of these compounds, at a concentration of 50 mg/kg or more." This waste also belongs to category Y45 in Annex I, "Organohalogen compounds other than substances referred to elsewhere in Annex I", and to category Y27, "Antimony, antimony compounds" and is likely to possess hazardous characteristics H6.1, H11, H12, and H13;

[17] The following list of components or constituents are non-exhaustive examples.

(g) Other components containing or contaminated with mercury, such as mercury switches, contacts, and thermometers, which are assigned to Annex VIII entry A1010, A1030, or A1180. This waste also belongs to category Y29 in Annex I, " Mercury; mercury compounds" and is likely to possess hazardous characteristics H6.1, H11, H12, and H13;

(h) Waste oils/liquids, which are assigned to annex VIII entry A4060, "Waste oil/water, hydrocarbons/water mixtures, emulsions". The waste belongs to category Y8 in Annex I, "Waste mineral oils unfit for their originally intended use" or Y9 in Annex I, "Waste oil/water, hydrocarbons/water mixtures, emulsions", and is likely to possess hazardous characteristics H3, H11, H12, and H13;

(i) Components containing asbestos, such as in wires, cooking stoves and heaters, which are assigned to annex VIII entry A2050. The waste belongs to category Y36 in Annex I, "Asbestos (dust and fibres)" and is likely to possess hazardous characteristic H11.

(j) Waste metal cables coated or insulated with plastics under A1190.

Framework for the Development of Environment Statistics (FDES) and the System of Environmental-Economic Accounting (SEEA)

The Framework for the Development of Environment Statistics (FDES) is a flexible, multipurpose conceptual and statistical framework that is comprehensive and integrative in nature. It marks out the scope of environmental statistics and provides an organizing structure to guide their collection and compilation and to synthesize data from various subject areas and sources, covering the issues and aspects of the environment that are relevant for analysis, policy, and decision-making. Subcomponent 3.3: Generation and Management of Waste includes statistics on the amount and characteristics of waste (including e-waste), defined as discarded material for which the owner or user has no further use, generated by human activities in the course of production and consumption processes. The FDES provides the structure for identifying and collecting waste statistics, including e-waste statistics. The FDES structure links waste statistics to the International Standard Industrial Classification (ISIC), which facilitates the integration with economic statistics.

The System of Environmental-Economic Accounting (SEEA) contains the internationally-adopted standard concepts, definitions, classifications, accounting rules, and tables for producing internationally-comparable statistics on the environmental-economic accounts and their relationship with the economy. The SEEA framework follows a similar accounting structure as the System of National Accounts (SNA) and uses concepts, definitions and classifications consistent with the SNA's in order to facilitate the integration of environmental and economic statistics. In the SEEA, e-waste would fall under Chapter 3.6.5 on Waste Accounting. Following the concepts of SEEA, e-waste statistics is a subset of the aggregates on waste from EEE and vehicles. The e-waste guidelines lack the origin of the waste generated (ISIC/NACE [18] or household), which is essential for SEEA. This requires additional modelling, which could be done on the UNU-KEY level. SEEA also reports on import and export data, which is also part of those guidelines. However, at this moment, a good measurement of transboundary flows of e-waste is very difficult to ascertain. The generation of secondary materials from e-waste (plastics, scrap metal, residues) is included in the concepts of SEEA, and these materials are excluded from e-waste statistics, but they could be modelled.

[18] NACE: Statistical classification of economic activities in the European Community

Correlations between the classifications

The correlations between the previously mentioned classifications are summarized in Table 3. The HS codes describe the products in the most detail. The UNU-KEYS are constructed from the HS codes, and this link is displayed in Annex 1. The UNU-KEYS, in turn, can be related to the 6 or 10 categories in the WEEE Directives, as indicated in Table 1. The Basel Codes and LoW codes, however, are difficult to relate to the HS codes. This mainly is due to the fact that the HS nomenclature defines waste as the residual streams. This is in conflict with the definition of waste in Article 1 of the Basel convention, which states that wastes are 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. Objects that are "intended to be disposed of" include a larger variety of commodities that the HS would categorize as "products" in Chapters 84 and 85, as opposed to waste, which is their legal status according to the Basel convention. A preliminary correlation table between customs nomenclature codes and waste codes was published by the European Commission in the Commission Implementing Regulation (EU) 2016/1245 (European Commission, 2016). The LoW and Basel codes are currently not correlated to each other.

TABLE 3: Correlations between various classifications/lists to gather or disseminate data for e-waste statistics

	UNU-KEYS	HS	EU LIST OF WASTE (LoW)	BASEL CODES	SEEA	EU WEEE DIRECTIVE, 6 CATEGORIES
HS	One HS code unique links to the UNU-KEYS					
EU LIST OF WASTE (LoW)	Not directly correlated	Not complete match, due to differing concepts of waste in HS classification and LoW				
BASEL CODES	Not directly correlated	EU has published a correlation table	Not directly correlated			
SEEA	One UNU-KEY can be linked to SEEA	One HS code is linked to SEEA	Not directly correlated	Not directly correlated		
EU WEEE DIRECTIVE, 6 CATEGORIES	One UNU-KEY can be correlated to the 6 categories, with the exception of the size distinction	One HS code can be correlated to the 6 categories of the WEEEDirective with the exception of the size distinction	Not directly correlated	Not directly correlated	Not directly correlated	
EU WEEE DIRECTIVE, 10 CATEGORIES	One UNU-KEY links to a category in the WEEE Directive	One HS code can be correlated to the 10 categories of the WEEE-Directive	Not directly correlated	Not directly correlated	Not directly correlated	Not directly correlated, but can be linked with UNU-KEYS

Correlations between national clustering of e-waste and UNU-KEYS

Countries that have already adopted e-waste legislation may already have a national classification of e-waste. However, the types of e-waste covered by legislations may differ considerably across the world. It could be that not all the 54 UNU-KEYS are in the scope of national e-waste legislations. These countries should still increase the coverage to include all 54 products categories. Nevertheless, if data is available from monitoring of those legislations, the national clustering can be different from the harmonised grouping presented in these guidelines (e.g. UNU-KEYS, EU 6, and EU 10). It is possible to convert the national clustering into the internationally recognized e-waste classifications by linking the individual category of national clustering to single or multiple UNU-KEYS, as shown in Table 4. Once the link is made, it is then possible to link the UNU-KEYS to the 6 e-waste categories as shown in Table 1.

TABLE 4: Example of some correlations between the Japanese national clustering and UNU-KEYS

NATIONAL CLUSTERING	UNU-KEY LINKED
TVs (for household use)	0407, 0408
Air conditioners (for household use)	0111
Fridges (for household use)	0108, 0109

Framework on e-waste statistics

There are only a few comprehensive data sources on waste statistics that have global coverage. Statistics on municipal waste and hazardous waste are compiled by UNSD, and it is the most comprehensive database with global coverage to date. Since the 2016 collection round and all preceding collection rounds of the UNSD Questionnaire on Environment Statistics did not contain any variables specific to e-waste, the compiled data are outside the scope of e-waste. As mentioned in the introduction, UNU conducted pilot questionnaires on e-waste statistics with UNDS, UNECE and OECD. The questionnaires were sent to 77 countries; however only 11 countries could provide data, which was sometimes only partial data. In this regard, UNSD is considering adding selected e-waste variables in future data collection rounds to improve the e-waste data availability. In Europe, the Waste Statistics Regulation in the EU is the main existing measurement statistical framework for waste, but this is also too generalized to get sufficient insight into e-waste. For e-waste specifically, there is a reporting obligation and target setting in the WEEE Directive. Here, reporting focuses on the amounts of EEE Put on Market and e-waste collected for the current 10, and future six, e-waste categories (to be implemented in August 2018). However, the reporting under the WEEE Directive does not capture the complete dynamics of the e-waste flows, such as cross-boundary movement. Other countries have no measurement framework at all. Therefore, there is a need for a measurement framework that considers these elements to help ensure effective policymaking. In addition, currently there is no organizational structure within the UN that ensures a sustainable mechanism to collect and validate statistics on the different flows of used electronics or e-waste. To this end, and to help facilitate data collection at the national level, the United Nations University is currently developing and testing an e-waste statistics toolkit that countries can use to collect and share data on electric and electronic appliances.

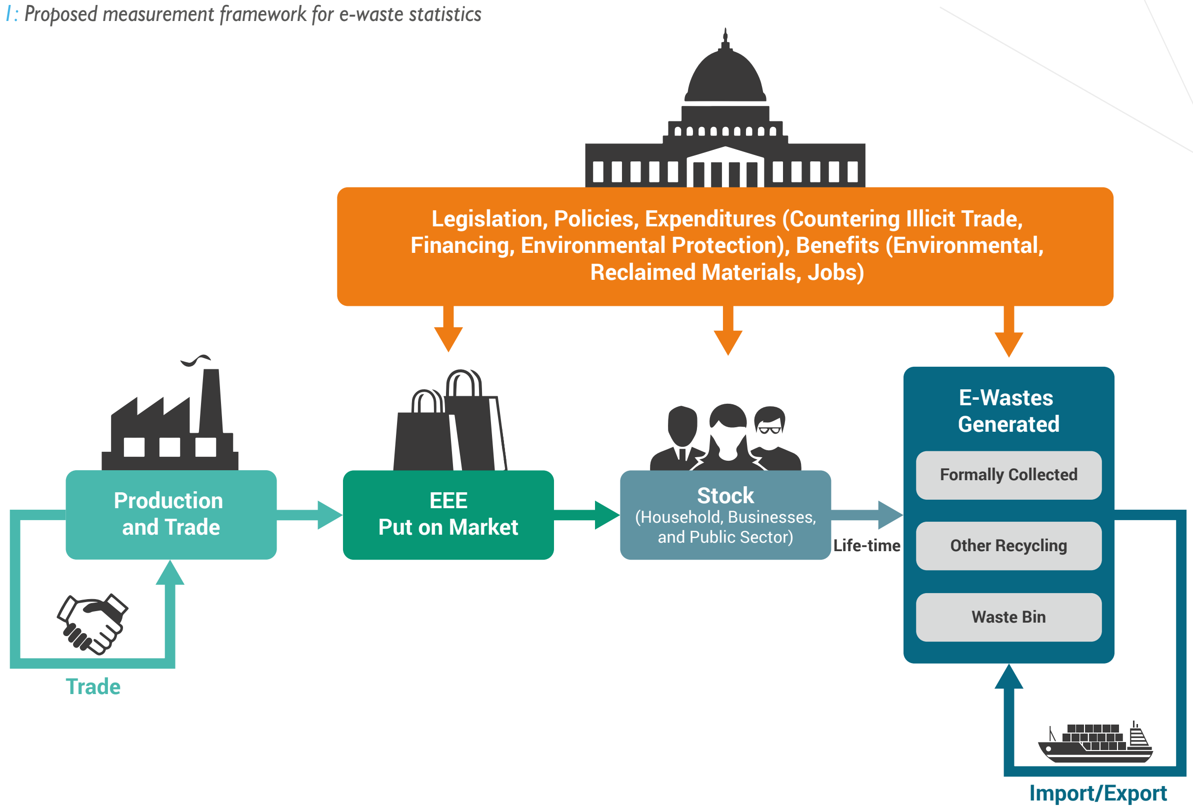
Most countries lack any official measurement of e-waste. However, there are existing datasets, such as trade statistics or use of ICT equipment, in both developed and developing countries that strongly relate to e-waste. These data are already available from national statistical institutes or harmonised data at large international organizations like ITU, OECD or UNSD. In order to improve comparability between countries, it is highly desirable to have a sound measurement framework that can integrate the harmonised existing data and can serve as the basis for e-waste statistics and e-waste indicators.

A proposal for such a measurement framework is shown in Figure 1. It is based on flows and stocks of e-goods and e-waste. The model is constructed in such a way that the stocks and flows relate to one another. For example, in a certain country, there could be data available on the possession of cell phones and time-series for Put on Market, while in another country, only data on the disposal of cell phones is known. The proposed measurement framework integrate those parameters, such that directly comparable indicators could be constructed in order to allow further cross-country comparison.

The measurement framework starts with tracking the "production and trade" of EEE. There is a strong link between trade statistics and national production statistics. In this stage, the data is collected and published by custom organizations and/or national statistical institutes.

After the equipment has been sold, it stays in households or businesses for some time until it is disposed of. This period is called "life-time". The equipment in households, businesses and public sector, is referred to as the "stock". This is destined to become e-waste in the future and is also called the "urban mine". The "life-time" includes the dormant time in sheds and exchange of second-hand equipment between households and businesses within the country.

FIGURE 1: Proposed measurement framework for e-waste statistics



When a second-hand functioning product is exported, the "life-time" in that country also comes to an end, and the product enters the stock phase market again in another country where the life-time is continued.

After a certain "life-time", which varies from product to product, the good is disposed of, and it becomes waste. This is referred to as "e-waste generated". It is the annual supply of domestically generated e-waste prior to collection, without imports of externally generated EEE waste. The outcomes of e-waste generated are an important indicator for e-waste statistics. The e-waste generated is collected in various ways.

The "formal collection" activities are usually under the requirement of national e-waste legislation, in which e-waste is collected by designated organizations, producers, and/or the government. This happens via retailers, municipal collection points, and/or pick-up services. The final destination for the e-waste that is collected is a state-of-the-art treatment facility, which recovers the valuable materials in an environmentally-sound way.

The "other recycling" activities are usually performed outside the official take-back system. The management of e-waste is very different in countries that have developed waste management practices for their municipal waste recycling versus countries that have not.

In countries that have developed waste management laws, e-waste is collected by individual waste dealers or companies and then traded through various channels. Possible destinations for e-waste in this scenario include metal recycling, plastic recycling, specialized e-waste recycling, and also exportation to developing countries. In this scenario, e-waste is often not treated in a specialized recycling facility for e-waste management.

In contrast, in most developing countries, an enormous number of self-employed people are engaged in the informal collection and recycling of e-waste. They usually work door-to-door to buy e-waste from consumers at home, and then sell it to be refurbished and recycled. Electronic products are mostly recycled through "backyard recycling" or substandard methods, which can cause severe damage to the environment and human health.

Finally, the e-waste can also end up in normal "waste bins". In this scenario, consumers directly dispose of e-waste in normal dustbins with other types of household waste. As a consequence, the disposed e-waste is then treated with the regular mixed-waste from households. This waste is most likely incinerated or landfilled without material recycling, depending on the waste management infrastructure in a country. Neither option is regarded as an appropriate technique to treat e-waste because both could potentially negatively impact the environment and lead to resource loss.

In addition, the e-waste or second-hand products are sometimes shipped to other countries. Those import or export flows also need to be documented. However, it is currently difficult to determine whether shipments of used electronics are waste or second-hand products, and whether transboundary movement is legal or illegal.

Mathematical equations

The following section contains more information on the mathematical equations following the methodology. The quantity of e-waste generated (in kg) is calculated from time-series product Put on Market from all historical years taking into account their respective rates of obsolescence in the evaluation year n. The method is represented by Eq. [1].

[1] $$E\ waste\ generated\ (n) = \sum_{t=t_0}^{n} POM\ (t) * L^{(p)}(t,n)$$

Where E waste generated *(n)* is the quantity of e-waste generated in evolution year *n*, *POM (t)* is the product sales (Put on Market) in any historical years *t* prior to year *n* ; t_0 is the initial year that a product was sold; $L^{(p)}$ *(t, n)* is the discard-based life-time profile for the batch of products sold in historical year *t*.

When a country has no data available on Put on Market of electric and electronic equipment, it can instead make estimates of the weight of POM in the year concerned using the "apparent consumption method", which is shown in Eq. [2]. The POM in a historical year t equals the sum of domestic production and imports of EEE in the year t minus the EEE exported in the same year.

[2] $$POM\ (t) = Domestic\ production(t) + Imports(t) - Exports(t)$$

The life-time, *L(p) (t, n)*, is the life-time profile of an EEE sold in historical year *t*, which reflects its probable obsolescence rate in evaluation year *n*. The discarded-based life-time profile for a product could be modelled using several probability functions. The Weibull distribution function is considered to be the most suitable to describe discard behaviour for EEE and has been applied in the European Union and in scientific literature (Wang, 2014; Xianlai et al., 2016).

Due to social and technical developments, the life-time of a product could be time-dependent. For instance, the Cathode Ray Tube Monitor rapidly became outdated, due to the technological developments of flat screen monitors. In that case, life-time distributions should ideally be modelled for each historical sales year. The Weibull function is defined by a time-varying shape parameter $\alpha(t)$ and $\beta(t)$ a scale parameter as described in Eq. [3]:

[3] $$L^{(p)}(t,n) = \frac{\alpha(t)}{\beta(t)^{\alpha(t)}}(n-t)^{\alpha(t)-1}e^{-[(n-t)/\beta(t)]^{\alpha(t)}}$$

For other, more stable products, time independent life-times sufficiently describe actual behaviour. In those cases, the variations of the shape and scale parameter over time are minor, and the variations can be neglected. Then, the distribution of product life-time can be simplified as follows in Eq. [4]:

[4] $$L^{(p)}(t,n) = \frac{\alpha}{\beta^{\alpha}}(n-t)^{\alpha-1}e^{-[(n-t)/\beta]^{\alpha}}$$

The stock, *S(n)*, can be calculated as the summation of all Put on Market in historical years, *POM (t)*, minus the summation of the E waste generated in the historical years *E waste generated (n)* as described in Eq. [5]:

[5] $$S(n) = \sum_{t=t_0}^{n} POM(t) - \sum_{t=t_0}^{n} \text{E waste generated } (n)$$

Where *n* is the evolution year and t^0 is the initial year that a product was sold.

The e-waste generated is usually collected in various ways: it can be collected in a formal system (W_{formal}), with other recycling streams (W_{other}) or can be discarded in normal waste bins (W_{bin}). W_{gap} is the quantity for which the treatment method is unknown. Therefore, the relation between e-waste generated and its discarding flows is described by Eq. [6].

[6] $$E\ waste\ generated = W_{formal} + W_{other} + W_{bin} + W_{gap}$$

In these guidelines, countries need to report on the whereabouts of the domestic generated e-waste. Thus, the formally collected amounts might be domestically further treated ($W_{coll,\ domestic}$) or exported ($W_{coll,\ exported}$).

[7] $$W_{formal} = W_{formal,\ domestic} + W_{formal,\ exported}$$

Potential data sources

The following section contains more information on the practical calculation routines and data sources following the methodology and mathematical model.

Put on Market (POM)

Data on EEE Put on Market can come from several data sources. It can come from statistics on sales from a national e-waste registry that is set up for compliance with the Extended Producer Responsibility (EPR) scheme in that country. In recent years many countries have implemented EPR schemes on Electrical and Electronic Equipment: including all EU Member States, USA, Canada, Japan, South Korea and several Latin American countries (e.g. Chile, Mexico, Brazil, Argentina and Colombia). While developing countries such as South Africa have started phasing in EPR obligations, by having declared WEEE and Lighting wastes as "priority wastes" which oblige "producers"[19] to support and finance the implementation of Industrial Waste Management plans. The data from that registry can directly serve as an important and readily available data source for sales. In some countries, the sales registration is often linked to a fee to cover the costs associated with recycling the e-waste. This could be an incentive not to report, or report too little to the register, especially when enforcement is absent or limited in countries.

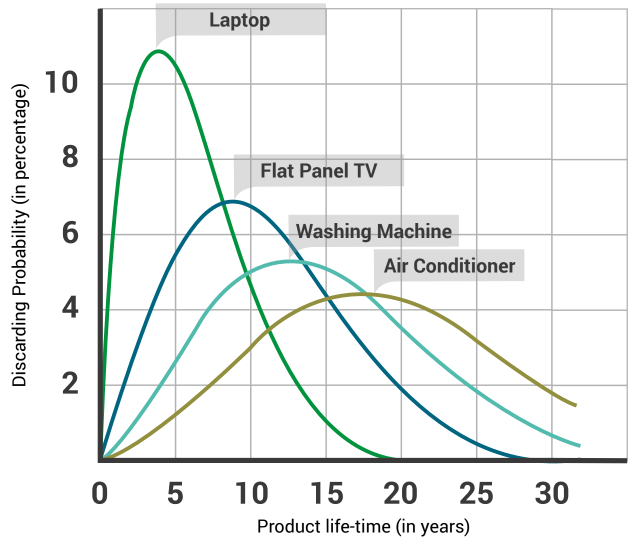
As mentioned before, the Put on Market can also be calculated using the "apparent consumption method" in equation 2. This can be used when there is no other data source available or can serve as a reference data point to find underestimations of the other data source. The methodology to calculate the EEE Put on Market using the "apparent consumption method" is published on an open source GitHub (Van Straalen et al. 2017), which includes all the input data, modelling steps and statistical routines (Van Straalen et al. 2017). The methodology described to determine EEE Put on Market is compliant with the Common Methodology approach as defined in Article 7 of the EU-WEEE Directive (European Commission, 2017).

Life-time (L)

The life-time of EEE products could vary per product and country. Figure 2 shows an example of different life-time profiles expressed as Weibull functions per type of product in the European Union. There is generally no official data collection for life-times by governments. However, several countries may have this information available through scientific literature or other studies performed in their country.

[19] this also includes EEE importers and extends to used EEE as well

FIGURE 2: Example of products life-time



As mentioned before, the life-time of EEE products could vary by product and country. For other EU countries a sensitivity analysis was carried out, and it is calculated that the margin of error for the e-waste generated related to the potential variation in life-time is approximately 10% per country (Magalini et al., 2014). Therefore, countries may wish to determine life-time empirically per product and country. The variation for the life-times between the countries in EU has been small for most products (see Annex 2) (Van Straalen et al. 2017; Magalini et al., 2014).

For countries outside the EU, the life-time distributions estimated by UNU in Annex 2 may or may not be representative of the real discard behaviour. If no other data is available, the parameters in ANNEX 2 are the best available estimation. In that case, additional research on both product life-time and up-to-date Put on Market data at the country level might be needed to improve the reliability of the calculations. However, it should be noted that the level of Put on Market are much more sensitive to the amount of e-waste generated than the life-spans.

The life-time can be constructed in various ways:
It is most precise if it is numerically solved using Eq. [1] and Eq. [5] (Wang et al., 2013). One would need high quality data to get realistic outcomes. The requirements are that one needs a time series of *Put on Market (POM)*, at least one measurement of *stock (S)*.

Alternatively, the disposal age composition when e-waste is discarded by households can also be applied to retrieve the life-time for a specific year:

[8] $$p(n-t) = \frac{E\ waste\ generated(t,n)}{E\ waste\ generated(n)} = \frac{POM\ (t) * L^{(p)}(t,n)}{\sum_{t=t_0}^{n} POM\ (t) * L^{(p)}(t,n)}$$

Where *p(n-t)* is the percentage of the e-waste with the age of *(n-t)* years proportional to the total sampled e-waste, *E waste generated (t, n)* is the amount of e-waste in evaluation year *n* generated by the POM of products in year *t*.

The life-time of EEE in stock *(S)* can also be obtained from household surveys (see Annex 4 and 5). Therefore, this type of data can also provide extra information for the life-time distribution in different historical years. It is presented in Eq. [9]:

[9] $$\frac{S(t,n)}{S(m,n)} = \frac{EEE\ sales(t) * [1 - L^{(c)}(t,n)]}{EEE\ sales(m) * [1 - L^{(c)}(m,n)]}$$

Where *S(t,n)* and *S (m,n)* are the quantity or percentage of products in stock, which was originally sold in years *t* and *m*, respectively.

Another simplified method to monitor the average life-time of appliances expressed as years through a household survey is to assume that the shape parameter α, which is a variable of the Weibull function in Eq. 3 and 4, is exchangeable between countries, and only the scale parameter differs. One could take the shape parameter (α) of the appliance from Annex 2. The corresponding scale parameter can then be calculated with Eq. [11].

[10] $$\beta = \frac{L^{(p)}}{e^{(1+\frac{1}{\alpha})}}$$

The life-time parameters obtained for Belgium, Italy, the Netherlands and France (Magalini et al., 2014) (relevant for the rest of EU and other economies) and for non-EU countries (Van Straalen et al., 2017) are listed in Annex 2. In addition, the methodology to calculate these life-time profiles is compliant with the regulation enforced in the EU.

Description of the steps used to calculate Put on Market, E-waste Generated and Stocks *(Baldé et al., 2017)*

1. Selected the relevant codes that describe EEE in the Harmonized Commodity Description and Coding System (HS)[20].

2. For the European Union, the international trade statistical data was extracted from Eurostat in the eight-digit combined nomenclature (CN) codes. Domestic production data was also extracted from Eurostat. For the other countries, statistical data on imports and exports was extracted from the UN Comtrade database. This was done for 177 countries and 260 HS codes for a time series of 1995 to 2016. Countries were then classified into five groups according to the Purchasing Power arity (PPP). This procedure was repeated for each year, since the Country's PPP changes over the years, especially for developing countries. This was useful to make statistics comparable between countries, and to calculate trends between groups.
   Group 1: highest PPP (higher than 34000 USD/inh in 2016): 40 countries
   Group 2: high PPP (34000 – 15280 USD/inh in 2016): 43 countries
   Group 3: mid PPP (15280 – 6740 USD/inh in 2016): 43 countries
   Group 4: low PPP (6740 – 1700 USD/inh in 2016): 46 countries
   Group 5: lowest PPP (lower than 1700 USD/inh in 2016): 13 countries

3. Convert the units to weight using the average weight data per appliance type. The average weights are published in the previously mentioned GitHub publication, but can also be seen in Annex 3.

4. Calculate the weight of Put on Market for the 54 UNU-KEYS by using the apparent consumption approach:
   POM = Domestic Production + Import – Export (this equation refers to the 28 EU Member States).
   For countries other than the 28 EU Member States, data on domestic production was not available; therefore, the following approach was used: POM = Import – Export. In the Global E-waste Monitor 2017 (Baldé et al., 2017) outcomes for countries other than EU-28 are not available for UNU-KEYS 0002 (Photovoltaic Panels), 0502 (Compact Fluorescent Lamps) and 0505 (LED Lamps) because data was not available in the UN Comtrade database.

5. Perform automatic corrections for outliers on the Put on Market data. This is needed to detect values that were too low (due to the lack of domestic production data in some countries where domestic production is relatively large) or too high (due to misreporting of codes or units). Those detected entries are replaced with more realistic Put on Market values either from the time series of the origin country or from comparable countries. These statistical routines lead to a harmonised dataset with a similar scope and consistent Put on Market for a country based on their own trade statistics.

6. Perform manual corrections based on the analysis of the automatic corrections. This is needed to correct unreliable data using knowledge of the market. For instance, CRT TVs have not been sold in recent years.

7. Extend the time series of Put on Market. Past POM are calculated back to 1980 based on the trends of the available data and the market entry of the appliance. Future POM are predicted until 2021 using sophisticated extrapolation methods. The principle takes into account the ratio between the POM and the PPP per county, and uses that ratio to estimate the Put on Market with the forecast of the PPP from the World Economic Outlook from the IMF (IMF, 2017).

8. Determine the e-waste generated by country by using the Put on Market and life-time distributions. Life-time data is obtained from the 28 EU Member States using the Weibull distribution (see Annex 2). The life-times of each product is ideally determined empirically per product per type of country. At this stage, only harmonised European residence times of EEE were available from extensive studies performed for the EU, and were found to be quite homogeneous across Europe, leading to a ±10% deviation in final outcomes (Magalini et al., 2014). Due to the absence of data, it was assumed that the higher residence times per product in the EU were approximately applicable for non-EU countries as well. In some cases, this would lead to an overestimation, since a product could last longer in developing countries than in developed countries because people repair products more often. However, it can also lead to an underestimation, since the quality of products is often lower in developing countries because reused equipment or more cheaply produced versions that don't last as long might enter the domestic market. But in general, it is assumed that this process leads to estimates that are relatively accurate. It should be noted that the Put on Market are much more sensitive for the amount of e-waste generated than the life-spans.

9. Determining the stock quantities as the difference between the historical Put on Market and the e-waste generated over the years.

[20] The Harmonized Commodity Description and Coding System generally referred to as "Harmonized System" or simply "HS" is a multipurpose international product nomenclature developed by the World Customs Organization (WCO)

Stock (S)

As already mentioned, the stock (S) refers to the equipment in households, businesses and the public sector. Stock levels of appliances in households and businesses are generally unavailable for all 54 UNU-KEYS, especially levels measured in a harmonised manner. There may be stock data available in some countries for some products; sometimes, national statistical institutes survey households about their household possessions or penetration rate of several types of household EEE (see two examples of households surveys in Annex 4 and 5). This data can feed into the measurement framework. It should be noted that with this methodology, both functioning and non-functioning appliances have to be counted. Another, but less reliable data source, could be the number of subscriptions. In that case, one subscription would mean a stock level of at least one appliance. But there might be appliances with two subscriptions, or appliances in stock without a subscription. Sometimes, penetration rates of ICT use is measured by countries. In that case, one can calculate the minimum stock level, as the surveys do not monitor whether a household has more than one appliance.

Formal collection of e-waste (W_{formal})

Data on formal collection of e-waste are not modelled. Data must be gathered by countries using the most appropriate data-gathering methods. The data that is reported under "formal collected e-waste" are the amounts of collected and recycled e-waste compliant with a specific e-waste management law, thus meeting the national environmental standards for recycling e-waste. This is ideally a national e-waste legislation that regulates the e-waste management system in the country, sets collection and recycling targets, and sets minimum recycling requirements or has a certification[21] to recycle e-waste in an environmentally sound manner.

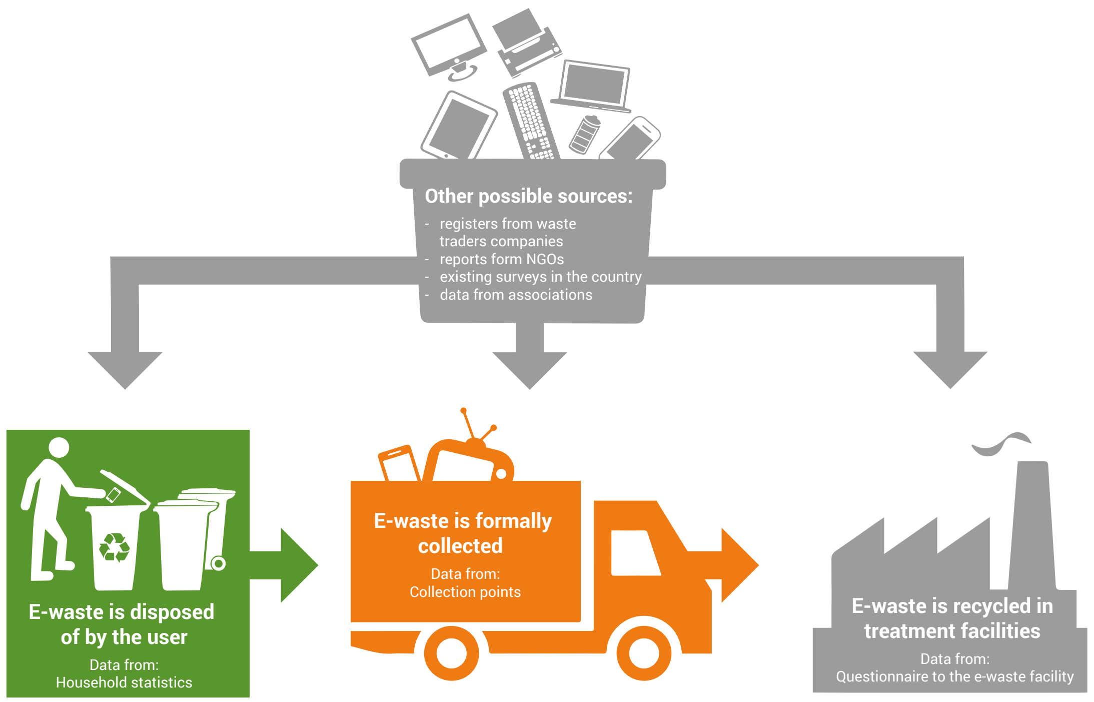
All the actors involved in the formal e-waste management system are potential sources for data. If the e-waste is collected through official take-back systems, it can be assumed that e-waste collected equals e-waste recycled, though in practice there might be losses taking place during the treatment phase. Data on e-waste formally collected and recycled can be gathered either by tracing the e-waste that is collected for recycling after its generation, and determining whether the collected e-waste is actually recycled in a treatment facility domestically or in another country. It is also possible to gather data on the amounts of e-waste that enter the treatment facility operating in an environmentally sound manner. In that case, imported e-waste for recycling should be subtracted from these amounts.

On the basis of legal provisions, data could be collected or recorded by competent authorities for licensing, monitoring and law enforcement scope. Such recording systems can also function as registers for e-waste statistics on formal collection of e-waste. This is mostly the case for countries that have adopted the Extended Producer Responsibility (EPR) principle for e-waste (Baldé et al., 2017). In an EPR scheme, e-waste along with e-waste data should be collected by designated organizations, producers, and/or by the government (formal collection). The e-waste collected via retailers, municipal collection points, and/or pick-up services should be then sent to e-waste treatment facilities. A distinction can be made between data collected or recorded by competent authorities on the basis of legal provisions and other data collected on a voluntary, economic, or other basis by the private or public sector; this includes, in particular, data collected by associations for their own purposes.

[21] http://www.weeelabex.org/standards/

If there is no EPR scheme, or register, for e-waste in the country, the e-waste can still be recycled in the country in an environmentally sound manner. For instance, it can be sent to treatment facilities that are certified to recycle e-waste. Figure 3 illustrates three ways to trace e-waste formally collected and recycled, and lists the possible data sources.

FIGURE 3: Possible flows to trace and potential data sources to gather data on formal collection



Household statistics: The collection of household statistics might also be a method to compile statistics on the collection and recycling of e-waste. In this case, a representative sample of the households in a country are sent a questionnaire in which they are asked details of the household (size, income levels, etc.), and information about e-waste. This should include which e-waste has been discarded (e-waste generated), how long the discarded product has been in use at the time of disposal (life-time "L"), and also how the product has been disposed of (Wofficial, Wbin or Wother). The information about the type of e-waste is usually reported in pieces (number of units). This will have to be converted to weight. The weight per e-waste category provided in Annex 3 can be used for that. Two proposals of household surveys can be found in Annex 4 and 5; countries could use these as examples when designing their tailored country surveys.

Survey collection points: E-waste can be collected at collection points established by municipalities or by private companies. Obsolete electric or electronic appliances can either be brought to a collection point by the previous owner, or it can be collected as bulky waste door to door (e.g. fridges or washing machines). It might be that municipalities and private companies register the collected e-waste separately from other wastes. If this separately collected e-waste is recycled, it may be reported here.

Collection points established from stores can also be a possible source of data because the possibility of returning broken or obsolete appliances to electronic stores is increasingly spreading worldwide. However, it should be ensured that the e-waste collected through these collection points are managed correctly in certified treatment facilities.

Questionnaire to e-waste treatment facility: E-waste statistics can also focus on tracing the quantities of e-waste entering the treatment facilities. Comprehensive registers are a prerequisite for the collection of facility-related information and for data on treated quantities, irrespective of the method of data collection used. For this reason, e-waste facility registers are likely to form the core of an e-waste information system. A disadvantage of focusing on waste treatment is that the constitution of the e-waste is different from the origin (it might have been dismantled into components). Also, it might be less clear which of the treated e-waste was imported, and which of the domestically generated e-waste was exported for treatment. Since the aim is to get the e-waste management data on the domestically produced e-waste, imports have to be deducted from this.

Other data sources: Other possible data sources are registers from waste companies, reports from NGOs, or other environmental surveys in the country. A number of public and industrial associations at the national level compile statistics for their own use on the management of e-waste streams. Sectoral data of this kind may be used by countries in their national statistics on e-waste treatment. Where such data are used, it is advisable to take steps to ensure that they meet the requirements and quality criteria defined by national e-waste legislations. Scientific literature may also be an interesting source for statistics on the collection and recycling of e-waste, as research in this field is making significant progresses worldwide.

Other recycling (W_{other})

The "other recycling" of e-waste, comprised of e-waste recycling or activities that are performed outside the official take-back system. The management of e-waste in the "other recycling" is very different in countries that have developed waste management practices for their municipal waste recycling versus countries that have not. Data on other collection of e-waste are not easily modelled.

In countries that have developed waste management laws, the "other recycling" channel comprises e-waste that is being collected and treated but not registered as e-waste. Those other recycling channels are mostly metal scrap dealers and plastic scrap dealers. Here, the e-waste may be registered as metal scrap or plastic scrap and is mixed with the large bulk of other scrap. Obtaining the amount of e-waste mixed in those waste streams is very difficult and could mean that estimations have to be made on how much e-waste is mixed with the other waste.

In most developing countries, the collection and recycling of e-waste is mainly handled by the informal sector. An enormous number of self-employed people collect the e-waste or used equipment to refurbish or recycle it using substandard methods. Because these activities are often not regulated in most of these countries, it is quite difficult to gather data on the informal e-waste sector, as the sector is usually not centrally organized.

With the current e-waste monitoring in the world, 76 % of the whereabouts of e-waste are unknown. This refers to the Wgap (Baldé et al., 2017). Therefore, it is extremely important to develop appropriate methodologies to collect and analyze data on e-waste collected outside the formal take-back system, both in developed and in developing countries.

Waste bin (Wbin)

Households and businesses can also dispose their e-waste directly in the mixed residual waste, i.e. the "waste bin". This e-waste is then further managed with the suboptimal standards. Typically, small appliances are discarded in that manner, and usually contain the highest concentration of valuable materials[22]. Currently, data availability on e-waste in "waste bins" is rather poor in most countries. The amount of e-waste in non-separately collected waste streams could be retrieved from a sorting analysis, which is sometimes performed by national governments or municipalities. Sometimes studies of residual waste are available in the literature for various countries. These studies should be performed regularly in order to monitor the trends of e-waste that ends up in mixed waste from households. Knowing this share would be useful for the government or municipalities to optimize the waste management system and improve the recovery of valuable resources.

Imports and exports of e-waste

Currently there are very few statistics based on hard data related to imports and exports of waste and used electronics and e-waste. Imports and exports on e-waste are usually captured in trade statistics, which use the global Harmonised Trade System (HS) codes as a classification unit. These HS codes do not distinguish between new and used electronics. Therefore, it is very difficult to use it as a data source to compile statistics from. Currently, there is one international law (the Basel Convention) that asks countries to report on quantities of imported and exported e-waste. The Basel Convention classifies hazardous waste in terms of the substances in the waste materials. Therefore, the Convention does not list, for example, computers as hazardous and keyboards as non-hazardous. Instead, it classifies wastes depending on their chemical properties. The national reporting data by Parties to the Basel Convention mandated under Article 13 provides some information to analyse flows and amounts of transboundary movement of e-waste, but it is insufficient for a comprehensive analysis because of incomplete reporting by many Parties, ambiguous definitions, incorrect categorization among the Parties, discrepancies in reporting, and data inaccuracies.

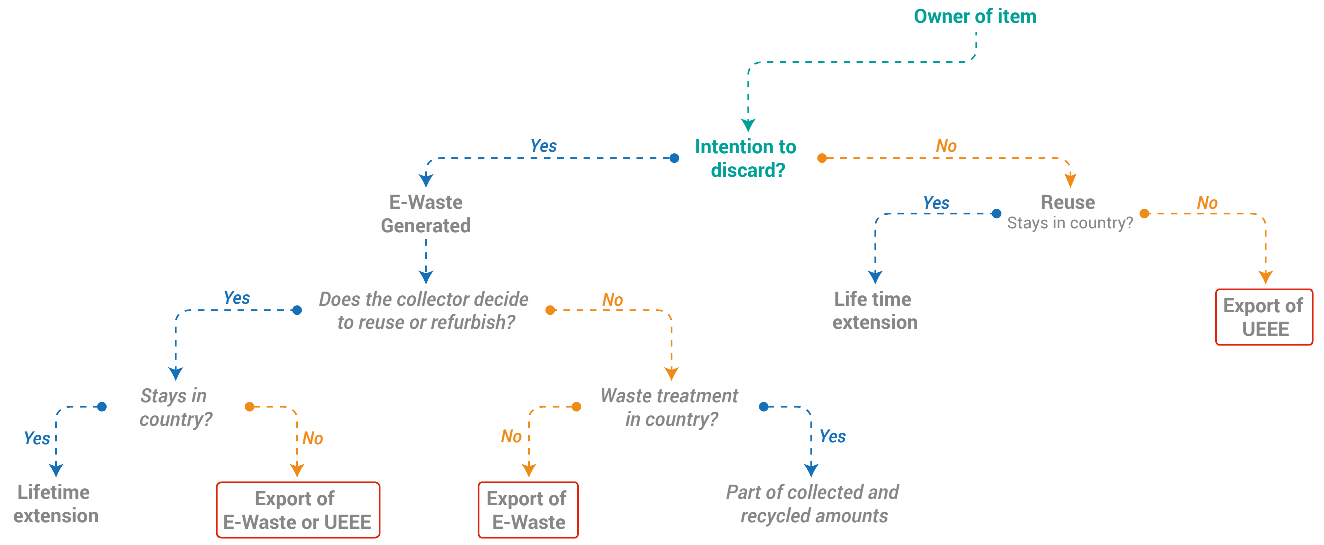
With increasing policy intention for the circular economy, and with globalizing supply chains, imports and exports do also take place for used electronic and electric equipment. This equipment should not be recycled in the country, and should also be measured for policy reasons. The illegal trade flows across countries are even more cumbersome to measure directly, due to the nature of the activity.

The diagram in Figure 4 helps to understand which consumer's or collector's behaviour lead to an export of Used Electric and Electronic Equipment (UEEE) or to an export of e-waste. It further shows which flow needs to be measured for e-waste statistics.

If the consumer intends to discard an item, this should be considered part of the e-waste generated. The discarded item is then collected by formal or informal collectors who can decide to reuse or refurbish it. After the item has been refurbished, the collector can sell it in another country. This should be considered "export of UEEE". If the collector sells it as a second-hand item but it is not functioning, this should be considered an "illegal export of e-waste". One refers to "export of e-waste" also when the collector or the e-waste dealer does not intend to reuse the item and send it to treatment facilities located in a different country. One refers to "export of UEEE" also when the consumer does not want to discard the product and intends to reuse or refurbish it in a different country then where the item was sold.

[22] http://www.prosumproject.eu

FIGURE 4: Behavior related to exports of e-waste. The boxes highlighted in red should be measured



The importing country should account the imported UEEE as part of the Put on Market only if the equipment is functioning. If the imported equipment is not functioning, it should be considered "illegal import of e-waste".

Next to these previously mentioned limitations of using the registration methods of the Basel Convention, only legal shipments of hazardous e-waste are documented here. Trade in second-hand EEE and illegal shipments are not captured by the reporting of the Basel Convention. Existing estimates on such quantities are obtained either from extrapolations from customs data on export violations, or by identifying the data gap from national material flow analysis. Usually, the calculated results from such methods have a high level of uncertainty, due to the absence of complete datasets on all e-waste flows and fluctuation caused by market and social conditions.

Several attempts have been made to measure imports and exports of used-EEE and e-waste. These attempts have included the use of: business statistics (via surveys), EPR registers (European Commission, 2014), trade codes (differentiating used EEE and e-waste from new commodities using price information) (Baldé et al., 2016), GPS technology (BAN, 2016), or using the battery waste code as a proxy for e-waste flows (Lepawsky et al., 2010). The methodologies used in those studies still contain flaws and need to be improved to yield reliable statistics. Thus, national and international efforts are highly needed to develop a common and harmonised methodology to measure these transboundary flows.

The most promising approach appears to be the Person in the Port Approach (Odeyingbo et al., 2017). In this method, a researcher is physically located in the receiving (or exporting) port. The physical inspections should be combined with import statistics to obtain information on the percentage of imports (or exports) of e-waste, and its declaration to customs authorities. This percentage can be used to extrapolate the data to national statistics. As it combines sampling techniques, together with official customs declarations, this method provides a better overview of the UEEE and e-waste shipments. This methodology has been demonstrated to be the most successful to quantify such shipments. Annex 3 presents the highlights from the most recent study.

TABLE 4: Summary of parameters that can be used to gather data for e-waste statistics. The data sources are tentatively listed for order of preference. Data sources can also be mixed to reach better coverage.

PARAMETER	*POTENTIAL DATA SOURCES*
Put on Market	• Business Statistics • National e-waste registry EPR-scheme • Apparent consumption method • Household statistics
Stock	• Households and enterprises statistics
Life-time of products	• Can be calculated with input/output analysis and household surveys.
E-waste Generated	• Can be calculated from Put on Market and life-time data
Collected e-waste (by formal take-back system)	• E-waste collected at Municipalities, retailers • E-waste entering treatment facilities, waste traders companies etc. • Register (for instance, collected through an EPR scheme)
Other recycling (outside official take-back system)	Can be obtained from estimating e-waste fraction in the other waste collection.
(E-waste in) Waste bin	Data on the fraction of e-waste in the residual waste, can be available from a sorting analysis of the residual waste in a country.
Trade legal and illegal	• Country registers • Trade data • Data from GPS tracking • Specific surveys of exporter or importer • Person in the Port approach

Tools to calculate Put on Market (POM) and E-waste generated

With regard to the calculation of the weight of Put on Market and e-waste, UNU has developed an e-waste calculation tool in Excel as an integral part of the aforementioned methodologies. The tool has been created with financial support of the European Commission and the United States Environmental Protection Agency. One tool covers one country, and more than 170 Excel tools were created, nearly covering all countries in the world. The Excel tools have been customized and pre-populated with the necessary data to allow for direct application. The prepopulated data have been estimated by UNU, and all the calculation steps are published on GitHub (Van Straalen et al., 2017). A summary of the procedure followed to perform the calculations can be found in the box "Description of the steps used to calculate Put on Market, E-waste Generated and Stocks". Countries have the opportunity to update the data used in the tool on Put on Market for past years and/or the life-time data, based on relevant data and evidence to support such updates. The e-waste calculation tools for the EU Member States are publicly available (European Commission, 2018). The e-waste calculation tools for countries other than those in the EU have the same structure as the ones set up and made available by the Commission (European Commission, 2017). The tools for the EU are already published online, while for other countries in the world these tools can be requested by contacting the corresponding author within the United Nations University.

Use of the Measurement Framework and exchangeability of parameters between countries

Additionally, some parameters can be transferred between countries if a country lacks data. A statistical analysis on the microdata of the Global E-waste Monitor found that the Purchasing Power Parity (PPP)[23] can correlate with discarding behaviour, consumption characteristics, or market saturation (Baldé et al., 2017) It was also found that the product life-time is comparable and interchangeable between countries that have similar PPP (Magalini et al., 2014).

[23] Purchasing Power Parity: PPPs are the rates of currency conversion that equalize the purchasing power of different currencies by eliminating the differences in price levels between countries. In their simplest form, PPPs are simply price relatives that show the ratio of the prices in national currencies of the same good or service in different countries (OECD, 2017).

Reporting e-waste statistics and disseminating results

After the data is collected, based on the classification, measurement framework and available data sources, the data can be compiled using the reporting matrix shown in Table 6. All indicators should be expressed as kg per inhabitant, or as tonnage. The reporting on e-waste statistics are defined as follows:

- **Put on market** is defined as any supply of a product for distribution, consumption or use on the market in the course of a commercial activity, whether in return for payment or free of charge.
- **E-waste generated** is defined as the amount of discarded electrical or electronic products (e-waste) due to consumption within national territory in a given reporting year, prior to any collection, reuse, treatment, or export.
- **The formal collection of e-waste** represents the e-waste collected as e-waste and regulated by environmental protection laws specifically designed for e-waste. This includes e-waste that is collected and later exported, and treated according to national standards in another country.
- **E-waste in waste bin** is defined by the amount of e-waste that ends up in non-separately collected waste. This can be household waste or mixed bulk waste.
- **Other recycling** involves recycling of e-waste with other waste streams, for instance, metal scrap. This type of recycling does not always meet the same efficiency and environmental standards as the formal e-waste recycling, and is financed via other (mainly market) mechanisms. The amount of e-waste treated this way is very difficult to quantify, and if data is available, it is mainly estimation.
- **E-waste imported/exported** is comprised of the e-waste that is imported or exported.

The totals can be broken down into the six e-waste categories that most closely follow the e-waste management types: Large equipment; Temperature exchange equipment; Small equipment; Screens and monitors, and equipment containing screens with a surface larger than 100 cm^2; Lamps; and IT and telecommunication equipment (with an external dimension of no more than 50 cm).

This reporting matrix provides sufficient insight to perform international comparisons, locate data gaps, perform imputations, apply statistical routines, etc. When this is done, the entries in the reporting matrix can be used to construct indicators. Those indicators can be extracted from the measurement framework and the parameters listed in Table 5.

TABLE 5: Reporting matrix

OPERATION	E-WASTE	UNIT[24]	2000	2005	2010	2013	2015	2016	2017
Put on Market of which:	**Total**	**1000 t.**	—	—	—	—	—	—	—
	Lamps	1000 t.	—	—	—	—	—	—	—
	Large Equipment	1000 t.	—	—	—	—	—	—	—
	Screens and monitors	1000 t.	—	—	—	—	—	—	—
	Small Equipment	1000 t.	—	—	—	—	—	—	—
	Small IT and telecommunication equipment	1000 t.	—	—	—	—	—	—	—
	Temperature exchange equipment	1000 t.	—	—	—	—	—	—	—
E-waste generated of which:	**Total**	**1000 t.**	—	—	—	—	—	—	—
	Lamps	**1000 t.**	—	—	—	—	—	—	—
	...	1000 t.	—	—	—	—	—	—	—
	Temperature exchange equipment	1000 t.	—	—	—	—	—	—	—
E-waste formally collected of which:	**Total**	**1000 t.**	—	—	—	—	—	—	—
	Lamps	1000 t.	—	—	—	—	—	—	—
	...	1000 t.	—	—	—	—	—	—	—
	Temperature exchange equipment	1000 t.	—	—	—	—	—	—	—
E-waste in waste bin of which:	**Total**	**1000 t.**	—	—	—	—	—	—	—
	Lamps	1000 t.	—	—	—	—	—	—	—
	...	1000 t.	—	—	—	—	—	—	—
	Temperature exchange equipment	1000 t.	—	—	—	—	—	—	—
Other Recycling of which:	**Total**	**1000 t.**	—	—	—	—	—	—	—
	Lamps	1000 t.	—	—	—	—	—	—	—
	...	1000 t.	—	—	—	—	—	—	—
	Temperature exchange equipment	1000 t.	—	—	—	—	—	—	—
Imports of e-waste of which:	**Total**	**1000 t.**	—	—	—	—	—	—	—
	Lamps	1000 t.	—	—	—	—	—	—	—
	...	1000 t.	—	—	—	—	—	—	—
	Temperature exchange equipment	1000 t.	—	—	—	—	—	—	—
Exports of e-waste of which:	**Total**	**1000 t.**	—	—	—	—	—	—	—
	Lamps	1000 t.	—	—	—	—	—	—	—
	...	1000 t.	—	—	—	—	—	—	—
	Temperature exchange equipment	1000 t.	—	—	—	—	—	—	—

[24] Solid waste is commonly collected in thousands of tonnes, except for hazardous waste which is usually collected in tonnes.
While filling in the surveys, it is important to pay attention to the unit, because mistakes in the unit of measurement are common in the data collection.

Indicators

Ideally, the indicators arising from the measurement framework should capture the most essential aspects of a country's performance of e-waste management. For e-waste, the indicators need to present a good overview of the size of a country's electronic market, national e-waste arising and the country's formal collection. Next, benchmarking should be possible, and differences in countries' performances should be visible. From this reporting matrix, the following indicators can be constructed:

1) Total EEE Put on Market (unit kg/inh)

This represents the size of the national e-goods market.

2) Total E-waste generated (unit kg/inh)

This represents the size of the national e-waste market.

3) E-waste formally collected (unit kg/inh)

This represents the amount of e-waste that is collected as such by the formal take-back system.

4) E-waste collection rate = e-waste collected / e-waste generated[25] 100 per cent

This indicator represents the performance of the formal collection systems.

Based on the estimations performed by UNU (Baldé et al., 2017; Van Straalen et al., 2017), and data from the literature (Lydall et al., 2017) or published by Eurostat (EUROSTAT, 2017) the following indicators could be constructed, as shown in Table 6.

Note: The products covered by legislation differ considerably across countries. For example, China has national legislation in effect that regulates the e-waste collection and treatment of TVs, refrigerators, washing machines, air conditioners, and computers (desktop and laptops). Therefore, many electric and electronic appliances are out of scope in China. The same applies for many other non-EU countries (e.g. USA, Japan etc.). This also explains the difficulties in comparing collected and recycled e-waste amounts reported by different countries. It is crucial for countries to adopt and implement harmonised classifications and methodologies to ensure a sustainable mechanism that collects and validates statistics on the different flows of used electronics or e-waste.

TABLE 5: Indicators for measuring e-waste statistics with real national data for several countries (Baldé et al., 2017; Van Straalen et al., 2017; Lydall et al., 2017; EUROSTAT, 2017).

	ITALY	FRANCE	SOUTH AFRICA	CHINA	CHILE
Total EEE Put on Market (kg/inh)	18.6	24.3	7.3	8.7	13.5
Total e-waste generated (kg/inh)	18.9	21.3	5.7	5.2	8.7
E-waste Collected (WEEE Directive reporting) (kg/inh) [data for 2015]	4.1	9.2	0.32	1[26]	0.04[27]
E-waste Collection Rate (percentage)	21.7	43.2	5.6	17.9	0.4

Since 2016, the European Union has enforced a new Directive on e-waste. The WEEE Directive introduced a collection target of 45% of the amount placed on the market in the three preceding years. From 2019 onwards, 65% of equipment sold in the three preceding years, or 85% of e-waste (WEEE) generated in the same year has to be collected and recycled.

[25] The scope of the products are not harmonised, and could therefore partly explain the low e-waste collection rates.
[26] Data for South Africa refers to 2013
[27] Data for China refers to 2012

Minimum requirements for e-waste statistics

In practice, there may be difficulties encountered in trying to collect the relevant information to construct the indicators in Table 6 with full coverage for all UNU-KEYS. Therefore, institutes within countries can consider starting with a minimum set to collect and report on e-waste statistics by using the UNU-KEYS to select the most relevant items.

A selection is made using the following criteria:

- The product comprises a significant share of the total market size in terms of weight. These products could include washing machines,refrigerators, and air conditioners; or
- The product contains environmentally toxic components. Such products include refrigerators and air conditioners; or
- The product contains a very high concentration of valuable resources, which would otherwise be lost if they are not properly recycled. Such products include IT equipment, mobile phones, and flat panel televisions or monitors; and
- The product should be on the market for both developing and developed countries.

When applying all those criteria, it is recommended to begin compiling e-waste statistics for the following UNU-KEYS:

- Washing machines (UNU key: 0104)
- Fridge or combined fridge/freezer (UNU key: 0108)
- Household air conditioner (UNU key: 0111)
- CRT monitors and TVs (UNU key: 0307 and 0407)
- Laptop, notebook, tablet (UNU key: 0303)
- Mobile phones (UNU key: 0306)
- Flat panel display for computer (UNU key: 0309)
- Flat panel televisions (UNU key: 0408)

The measurement should focus on: Put on Market, stock, and e-waste generated. Those can be obtained using household surveys, or through existing registers, such as the Comtrade database or production statistics. In countries where the reporting system is more developed, it may be more feasible to increase the amounts of products and to move towards the other rows in Tables 5 and 6.

Examples

Example 1:

Use of the statistical framework in Europe to measure the e-waste indicators

In the European Union (EU), the e-waste management is regulated uniformly by the WEEE Directive (2012/19/EU). The directive is meant to regulate the collection, recycling, and recovery of e-waste. It includes the provision of national e-waste collection points and processing systems, which enable the proper disposal and treatment of the e-waste. Member States shall adopt appropriate measures in order to minimise the disposal of e-waste as unsorted municipal waste, and achieve a high level of separate collection of e-waste. To guarantee environmentally sound treatment of the separately collected e-waste, the WEEE Directive lays down treatment requirements for specific materials and components of e-waste, and for the treatment and storage sites. This legal framework uses the principle of Extended Producer Responsibility, which requires producers to organise and/or finance the collection, treatment, and recycling of their products at end-of-life. Each Member State of the EU has adopted those regulations in accordance with the intrinsic conditions of the countries. In addition, Norway, Switzerland, and Iceland have implemented similar national legislation.

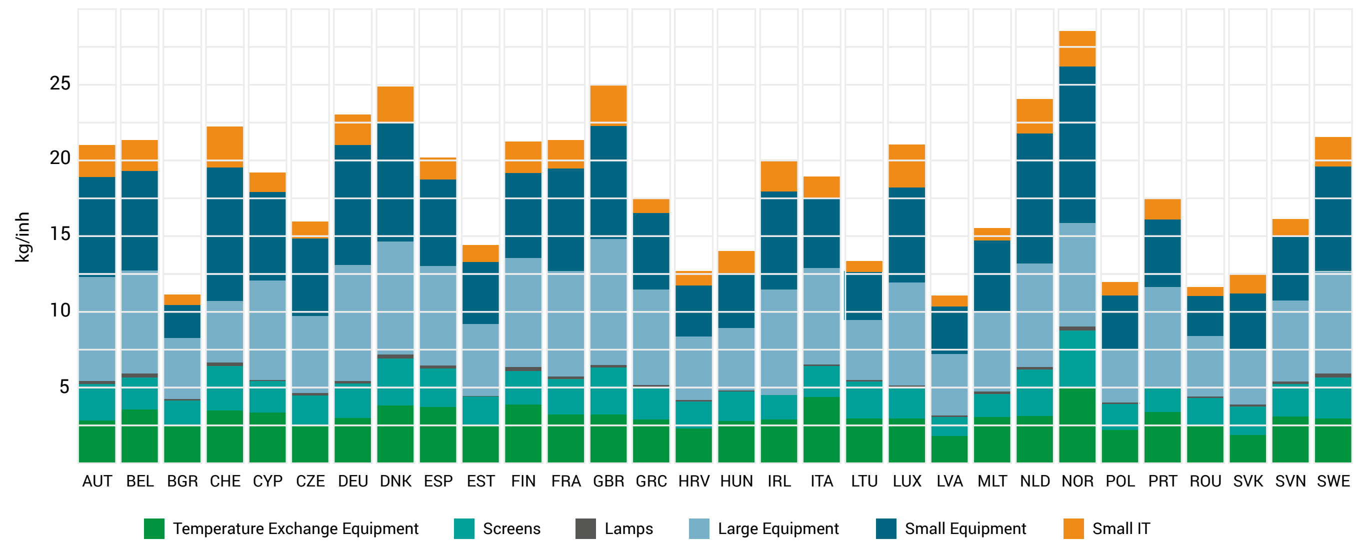
The recast of the WEEE Directive requires every Member State to collect and report data in the 6 categories, which are representative of the e-waste collection streams. An implementing act further specifies the common methodology for calculation of collection rates, and the categorization of the products in 54 UNU-KEYs (see Table 1) (European Commission, 2017).

The following graphs are an example of how the adoption of such a harmonised measurement framework allows countries to compile e-waste statistics that are comparable and harmonised among countries in the EU, including Norway and Switzerland. A graph is provided for the indicators "Total e-waste generated" and "E-waste collection rate".

1) Total e-waste generated (unit kg/inh)

The data presented in the graph are aligned with the Common Methodology approach to determine Placed on the Market and WEEE Generated as defined in Article 7 of the EU-WEEE Directive. The e-waste generated is calculated by combining data on Put on Market and life-time data. Please refer to the chapter "Data Sources and Methodology" for further information.

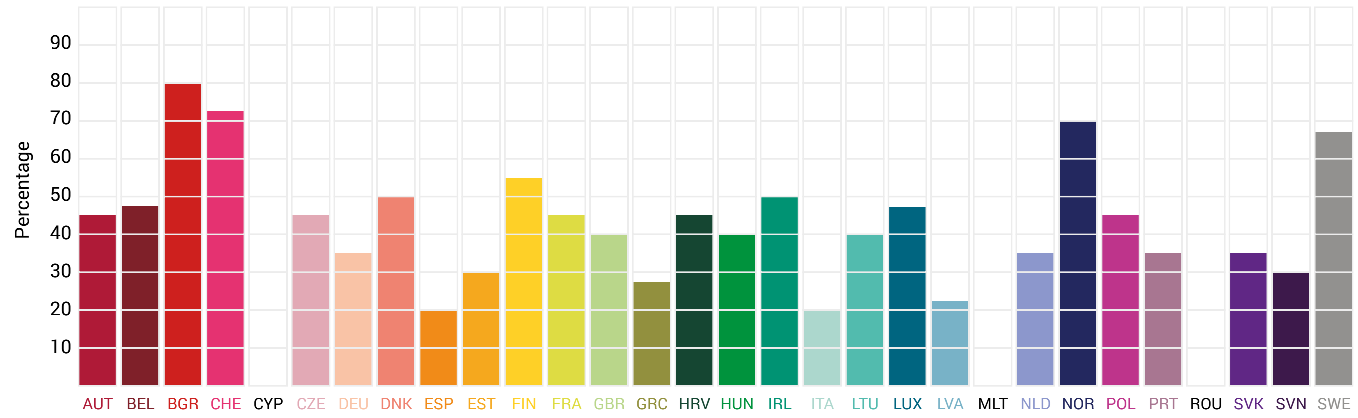
FIGURE 5: Weight per capita – e-waste generated in 2016 by country



Source: Urban Mine Platform (http://www.urbanmineplatform.eu/urbanmine/eee/weightpercolcat)

2) E-waste collection rate = Wformal / E-waste generated x 100

FIGURE 6: Percentage of collected EEE compared e-waste generated (collection rate) in 2015 for all collection categories



Source: Urban Mine Platform (http://www.urbanmineplatform.eu/urbanmine/eee/weightpercolcat)

Since 2016, EU member states have needed to collect 45% of the amount placed on the market, increasing to 65% by 2019, or 85% of the e-waste generated. Reaching these legal targets by 2019 will be very challenging. It is important to state that the lack of harmonisation across the member states, in the reporting of volumes of collected e-waste in particular, as well as in the split of total e-waste volume to individual collection categories can lead to discrepancies between the quantity of waste generated and the quantity collected.

Example 2:
E-waste quantification in China

On January 1, 2011, China implemented the Management Regulation on the Recycling of Waste Electrical and Electronic Products (WEEE regulation), supported by several technical guidelines and policies. And on January 1, 2015, a new Catalogue of WEEE Recycling was issued, increasing the coverage of WEEE regulations from 5 categories to 14: television, refrigerator, washing machine, air conditioner, personal computer, range hood, electric water-heater, gas water-heater, fax machine, mobile phone, single-machine telephone, printer, copier, and monitor.

The UNU's SCYCLE Programme and Tsinghua University jointly conducted a project aimed at qualifying and quantifying the e-waste market in China for six products (Wang et al., 2013). Figure 7 shows the Put on Market data of six EEE products on the Chinese market from 1995 to 2011. Annual Put on Market data was calculated from the total quantity of domestic manufacturing and added to the quantity of import while subtracting the quantity of export for specific type of product (comparable to the method in Example 1). The domestic manufacturing data were derived from the China National Statistic Yearbook 1996-2012 (CNBS, 2012), while the international trade data were obtained from the UN Comtrade database by tracking the corresponding Harmonised System Codes for international goods shipments. Additional data sources were also applied to validate the data (EITO, 2011).

FIGURE 7: Put on Market of major electrical and electronic equipment in China (1995-2011)

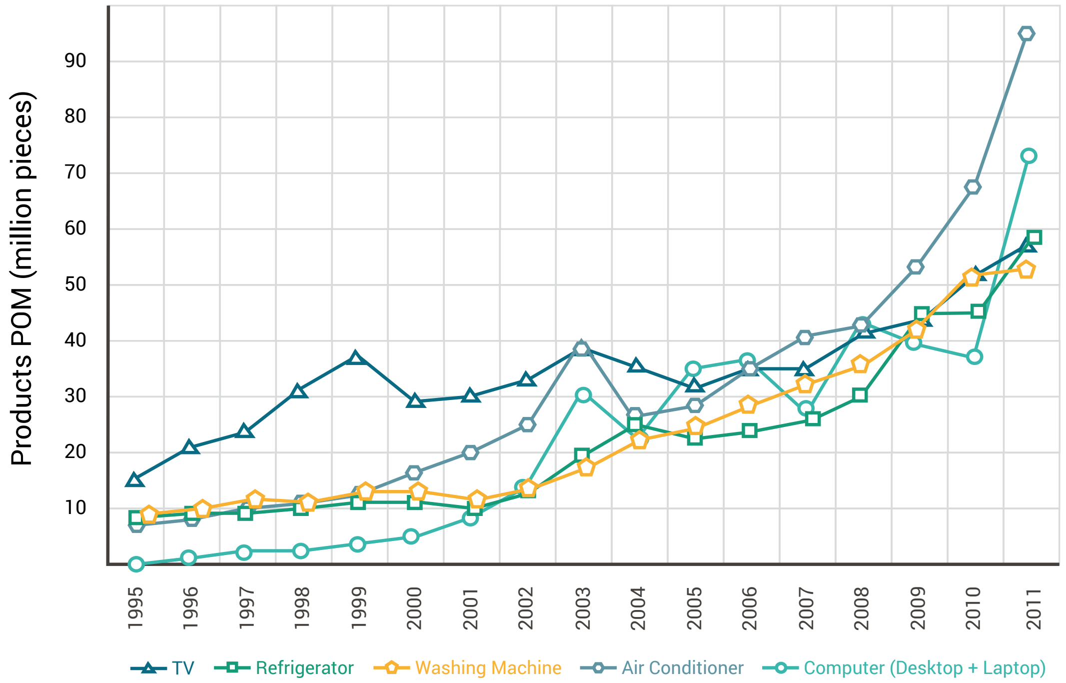


Figure 8 presents the stock of the six types of EEE in Chinese households from 2006 to 2011. The data was calculated from the statistic survey to ascertain the amount of equipment possessed in both urban and rural Chinese households (CNBS, 2012). These indicators could be proposed as household indicators to be collected through household surveys for other countries.

FIGURE 8: Stock of EEE in Chinese households (2006-2011)

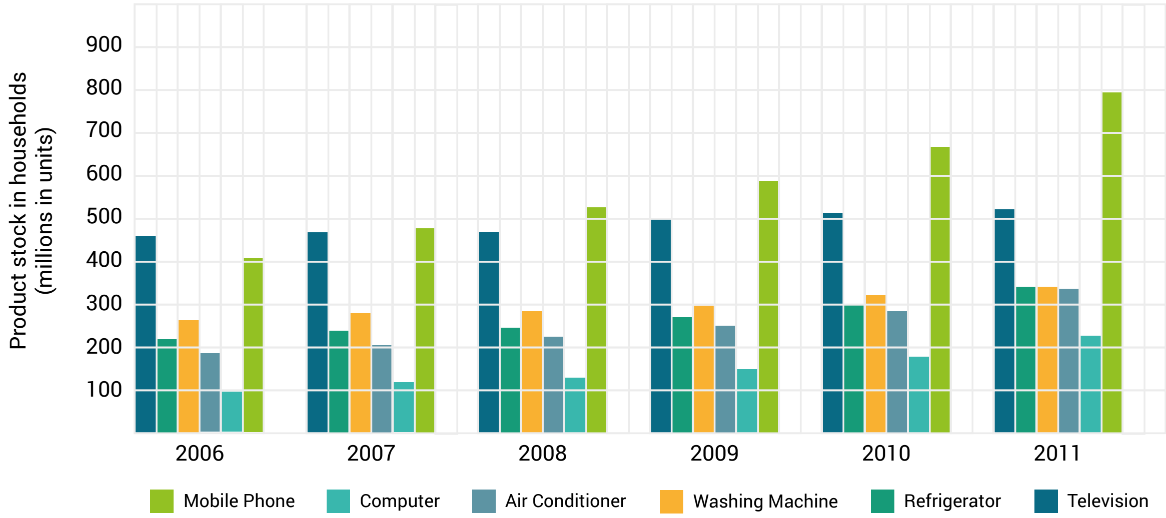
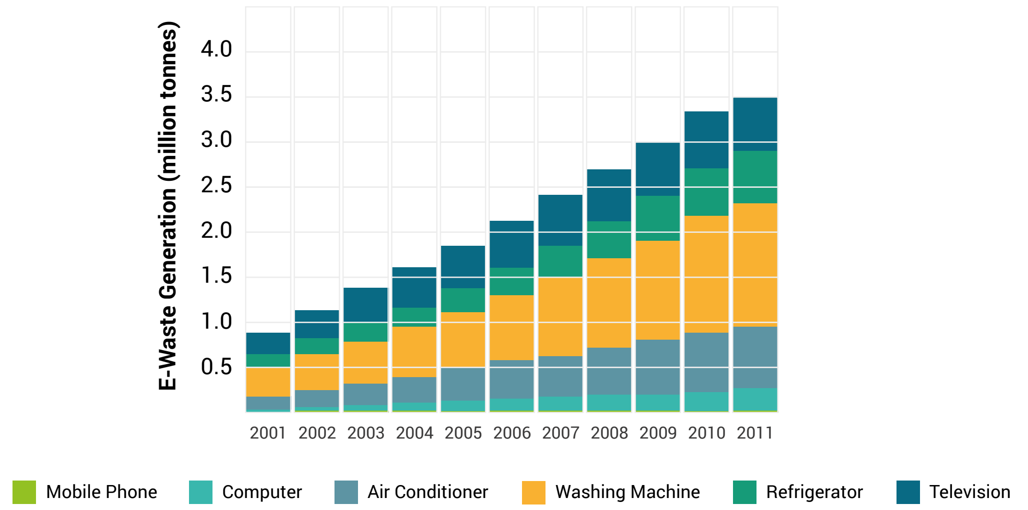


FIGURE 9: Generation of e-waste in China 2001-2011 (in million of tonnes)



Example 3:

Attempts in initiating a measurement framework in emerging countries: Malaysia

The management of e-waste in Malaysia is regulated under the Environmental Quality (Scheduled Wastes) Regulations 2005 of the Department of Environment (DOE). E-waste is categorized as scheduled wastes under code SW 110.

At present Malaysia does not have specific regulations on e-waste. However, in 2010 the DOE issued the second revision of the "Guidelines for the Classification of Used Electrical and Electronic Equipment in Malaysia"[28] to assist all parties involved in e-waste management in identifying and classifying the used EEE or components according to the regulatory codes. The guidelines define used electrical and electronic equipment or components as e-waste if it has one or more criteria: such as a defect that materially affects its functionality, physical damage that impairs its functionality or safety, etc. (PGE, 2009). The electrical and electronic equipment considered e-waste in Malaysia are listed in table 7.

TABLE 7: Electrical and electronic equipment and components in the scope of the Malaysian guidelines

Used television	Used cathode ray tube
Used air-conditioner unit	Used electric cable
Used computer	Used mobile phone
Used refrigerator	Used motherboard
Used washing machine	Used hard disk drive
Used video recorder	Used printed circuit board
Used telephone	Used lead frame
Used photocopy machine	Used patterned wafer
Use facsimile machine	Used ink cartridges
Used microwave/ oven	Used or rejected or waste of integrated circuit
Used radio	Used audio amplifier
Used printers	Used electrical and electronic equipment/product imported from other countries
Used waste metal, contaminated with heavy metals such as cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, or manganese.	Wastes or products processed out of the partial recovery facilities.

[28] The regulation is published on website. It can be seen on the following link: http://www.doe.gov.my/portalv1/en/info-untuk-industri/garis-panduan-buangan-terjadual/guidelines-for-the-classification-of-used-electrical-and-electronic-equipment-in-malaysia/311750

In Malaysia, the export and import of e-waste or used EEE is not banned, but it is restricted, and exporters or importers will be required to obtain a written approval from the Director General prior to any shipment. However, there are certain difficulties present, such as the lack of adequate information, lack of awareness of relevant entities and importers, etc. (UNEP, 2016). Currently, collaboration exists between the Royal Malaysian Customs (RMC), the Competent Authority of Basel Convention, and the private sector.

The EEE manufacturers have a significant role to play in the environmentally sound management of WEEE. In Malaysia, a number of manufacturers and companies have taken the initiative to organize a Take-Back Program (TBP) to reduce the amount of used or discarded EEE disposed of in municipal landfills and also to increase community awareness on the issue of e-waste. Malaysia is currently drafting specific regulation for household e-waste and for the take back of WEEE[29]. There is no incentive mechanism for e-waste management in Malaysia. EPR is applied in several areas, but only on a voluntary basis. There are several recycling and reuse activities being conducted by some of the manufacturers; however, the scope of the materials collected is limited (PGE, 2009). In 2016, a total of 129 e-waste facilities were present in Malaysia, consisting of 97 partial recovery e-waste facilities (physical or manual segregation of e-wastes for further processing) and 32 full recovery e-waste facilities, which can process the e-wastes to recover precious metals (UNEP, 2016).

DOE is currently cooperating with the Japan International Cooperation Agency (JICA) Technical Expert to carry out the Project for Development of Mechanism for Household E-waste Management in Malaysia.

The purpose of the project is to implement a legal structure and organizational mechanism for a sustainable and self-reliant household e-waste management system. The ultimate goal of the project is to enforce the Household E-waste Management Regulation in 2018. Items covered under the projects are: television sets, personal computers, mobile phones, refrigerators, air conditioners, and washing machines.

In 2009, DOE conducted an e-waste inventory project, "The E-waste Inventory Project"(PGE, 2009), with the purpose of gathering information and establishing a database to address the needs and issues of an environmentally sound management strategy for used and end-of-life EEE. A total of 1,200 respondents from various socioeconomic levels (households) as well as a wide range of business entities and institutional groups were required to answer questionnaires. The purpose of the survey was to obtain an indication of the volume of e-waste generation in Malaysia and the ways in which waste electrical and electronic equipment (WEEE) are managed. Unfortunately the figures presented in this study are unrealistically high and not representative of the actual e-waste generated in the country. A more recent estimate by UNU provided an e-waste arising estimate of approximately 280 kt of e-waste generated in 2016 in Malaysia (Baldé et al., 2017).

[29] Refer to the link http://www.doe.gov.my/household-ewaste/

Example 4:

Attempts to initiate a measurement framework in developing countries: South Africa

South Africa does not have a dedicated national e-waste legislation in place. However, South Africa has in principle already started to introduce legislative requirements for "Producers" to finance the responsible take-back and treatment of post-consumer WEEE through a legislative framework system (linked to the mandatory development of sector-specific "Industrial Waste Management Plans," which is based on the Extended Producer Responsibility (EPR) principle). The categorization of e-waste in South Africa takes cognizance of seven groups of e-waste, and mixed fractions (see Table 8).

TABLE 8: Categorization of e-waste in South Africa

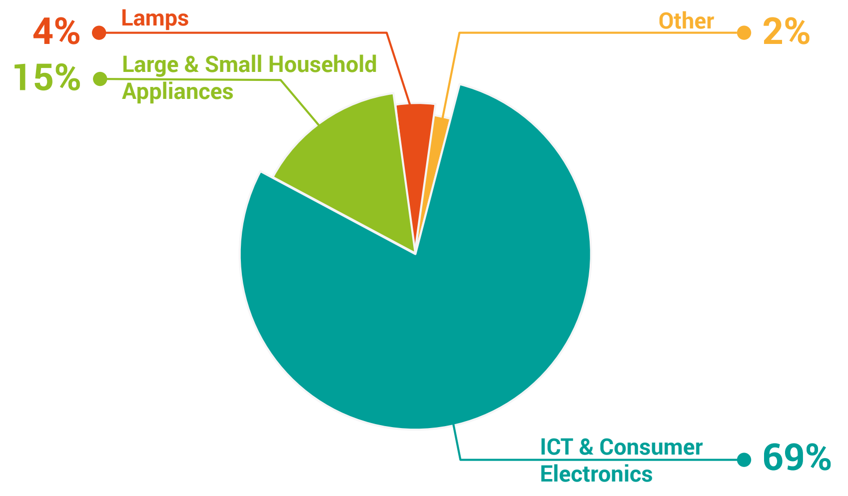
CATEGORY	DESCRIPTION
Small household appliances	Vacuum cleaners, coffee machines, toasters, irons
Large household appliances	Washing machines, refrigerators, dryers, air conditioners
Office, information and communication technology (ICT) equipment	PCs, laptops, mobile phones, fax machines, printers and photocopiers
Consumer electronics and entertainment equipment	Televisions, VCR/DVD/CD players, hi-Fi sets, radios, train sets, coin slot machines, parking ticket equipment
Lighting equipment	Fluorescent tubes and lamps, sodium lamps
Electrical and electronic tools	Drills, electric saws, sewing machines, lawn mowers, large stationary tools, machines
Security and healthcare equipment	Surveillance & control equipment, medical instruments & equipment
Mixed waste electrical & electronic equipment	Various e-waste

Source: The Waste Research Development and Innovation Roadmap Research Report (Lydall et al., 2017)

In South Africa, Electrical and Electronic Equipment Put on Market data, e-waste generation, and recycling volumes are not readily available from national statistical bodies. While there is growing interest and acknowledgement of the e-waste challenge in South Africa, there is no central database of quantitative data on volumes of e-waste generated, held in stock and/or processed, the life-time of obsolete goods, and trade flows of e-waste (Lydall et al., 2017). Aggregated Put on Market data from retailers regarding the sales of electronic goods is largely unavailable and recycling companies are not required by law to disclose the quantities and markets that e-waste fractions are sold to (Lydall et al., 2017).

The Waste Research Development and Innovation Roadmap Research Report (Lydall et al., 2017) points out that South Africa is still lacking a harmonised framework to measure the e-waste flows. However, the report shows some data on Put on Market, collection rates and discarded volumes. Those were collected via electronic questionnaires (supplemented with face-to-face and telephone interviews), and via the e-waste recycling sector in South Africa. Data was retrieved from companies that formally deal with e-waste, but not all of them provided data. However, in South Africa many informal operators are also active. Other data was retrieved from reports of relevance and publicly-available literature sources. The chart in figure 10 is an example of the findings of the study performed in the context of the aforementioned report. It shows the volume of e-waste disaggregated according to the type of waste streams: ICT and consumer electronics, small and large household goods, lamps, and other (e.g. cables). In the report, 17.733 tonnes of e-waste was handled by 23 treatment firms. Of this, 79% were ICT and consumer electronics, and 15% were large and small household appliances.

FIGURE 10: Volumes of e-waste handled across sample 17,733 t – by e-waste categories



Source: The Waste Research Development and Innovation Roadmap Research Report (Lydall et al., 2017)

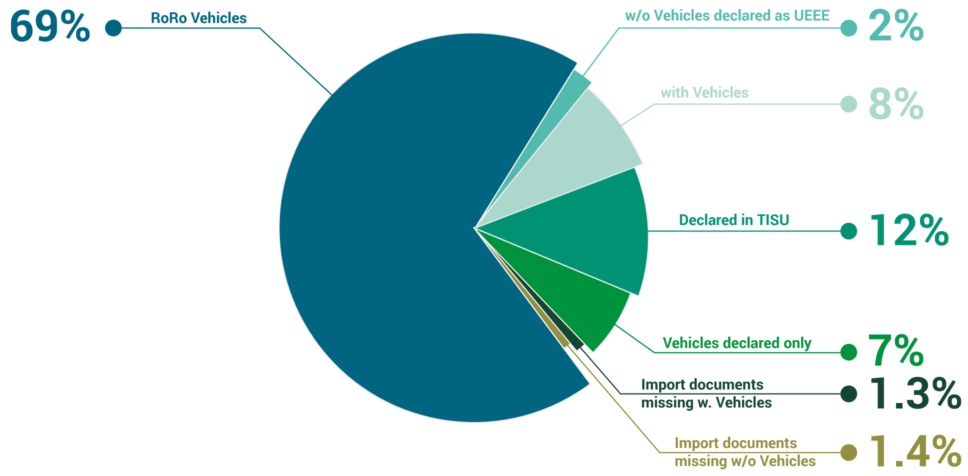
Example 5:

The person in the port method to calculate imports of e-waste or used equipment in Nigeria

The information provided in this chapter is entirely retrieved from the StEP project "Person-in-the-Port" (PiP) (Odeyingbo et al., 2017).

The Person in the Port (PiP) method was used in 2015/2016 in Nigeria to obtain a realistic picture of qualities, quantities, origin, types, and functionality of imported used-EEE and e-waste. As part of the project 201 containers and 2,184 used imported vehicles carrying UEEE were inspected at the Tin Can Island Port Complex (TCIPC) and the Lagos Port Complex Apapa in Lagos, which are the hubs of UEEE imports into Nigeria. Not all UEEE imports were caught and inspected during the project period: 3,622 official import documents for all imports of containers via these two ports in 2015 and 2016 have been additionally accessed and scanned for imports of UEEE. The data from inspections were used to quantify goods in containers not declared as UEEE in these import documents, but as "terms indicating suspected UEEE" (TISU), mainly household goods (HG) and personal effects (PE). The TISU found in these importation documents were counted as UEEE according to the percentages of TISU declared in inspected containers that were actually found to be UEEE during the inspection. The inspection data could thus be used to consolidate the data from the import documents in order to calculate the total annual volumes of UEEE imports from the documented imports, as well as the types of UEEE, their origin, etc. Some inspected containers could not be found in the import documentation. The percentage of these inspected containers missing in the import documentation was used to increase the import volumes calculated from the import documents so as to compensate for missing import documentation.

FIGURE 11: Routes of UEEE importation via the main hubs of UEEE imports into Nigeria



Source: Person-in-the-Port" (PiP), (Odeyingbo et al., 2017)

Around 8,800 t of UEEE were found to be imported in containers without vehicles per year. Another 9,500 t of UEEE entered Nigeria annually in containers with vehicles. With around 41,500 t per year, the UEEE import in roll-on/roll-off vehicles is the most significant importation route of UEEE. Overall, around 60,000 t of UEEE were imported annually in 2015 and 2016 via the above import channels. Figure 5 illustrates the shares of the importation modes in the total UEEE import.

Most of the UEEE imported in containers were clean and undamaged but improperly packaged and some hadcut cables. Basic testing showed, depending on the type of UEEE, imported UEEE are functional to different degrees, around 19% on average. Thus, every year Nigeria may have imported around 15,700 t of e-waste, most of it LCD-TVs containing mercury, and refrigerators, as well as air conditioners containing (H)CFCs. Most imported UEEE is falsely declared or even undeclared in import documents, the latter applying in particular to UEEE imports in containers with vehicles, and even more so for Roll-on/Roll-off imported vehicles.

The PiP approach provides an opportunity to understand the problem of uncontrolled import of e-waste or used equipment in many developing countries and to estimate the physical volumes of these flows. The information helps to inform global and national stakeholders who are not aware of the actual conditions of the imports from developed countries, and also to analyse the information from the perspective of making recommendations on how to improve the quality of imports to developing countries. The inspections and controls should be strengthened in particular for RoRo-imported vehicles, which have been shown to be a highly important UEEE import route in Nigeria (and this may also be true for other developing countries).

The methodology developed in this project could be adapted and replicated in other developing countries with similarly complex situations as Nigeria. The combination of import data and physical inspection gives a better overview of the UEEE and e-waste shipments, as well as the characteristics of such imports compared to pure trade statistics, which do not differentiate UEEE from EEE and give no insights into the functionality of the imported UEEE. Access and use of the customs database (ASYCUDA) would, however, reduce the required efforts for the assessment and evaluation of import documentation. Still, the combination with inspections is essential to identifying wrong declarations of UEEE imports.
In any case, the cooperation of the main stakeholders like customs and port authorities, as well as of enforcement agencies, is essential for the success of such projects.

Conclusion

In order to effectively harmonise e-waste measurement at the international level, the Partnership on Measuring ICT for Development has published the second edition of international guidelines to measure e-waste statistics. The goal of these guidelines is to help countries produce e-waste statistics that are internationally comparable and of relevance for national and international policy-making. Harmonising the measurement framework and indicators will be a substantial step towards reaching an integrated and comparable global measurement framework for e-waste.

These international guidelines provide a method to harmonise the available e-waste classifications and measuring frameworks already in use by countries, and to provide guidance on data sources and calculation routines. The harmonisation of e-waste classification is done with the product categorization, called the “UNU-KEYS”. The UNU-KEYS have been correlated to various relevant existing statistical standards.

These guidelines describe a measurement framework that captures the most important dynamics of flows and stocks of e-goods and e-waste in countries. The framework captures the amount of EEE Put on the Market of electric and electronic equipment, life-times, e-waste generated, and further traces the first collection step of the e-waste management chain. Here it distinguishes between e-waste that is formally collected, e-waste that is recycled by other methods, e-waste that is discarded in the waste-bin, and imports and exports of e-waste. The model is constructed in such a way that the parameters can be mathematically related to each other. The guidelines also provide the mathematical equations that form the basis of the measurement framework.

The guidelines also list possible data sources to measure different EEE flows and describe in detail the steps undertaken by UNU to estimate the most relevant indicators of e-waste statistics. In addition, the guidelines present examples of attempts by single countries to establish an e-waste legal framework and classifications, to gather data on different EEE flows, or to calculate and estimate data on e-waste. The four indicators have been identified to show progress and the state of e-waste in countries to inform policy makers. These are: EEE Put on the Market, E-waste generated, E-waste formally collected, and the collection rate.

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Annex

Annex 1:

Link between the UNU-KEYS and HS code

UNU-KEY	UNU KEY DESCRIPTION	HS	HS DESCRIPTION
0001	Central Heating (household installed)	840310	Boilers; central heating boilers (excluding those of heading no. 8402)
0001	Central Heating (household installed)	854140	Electrical apparatus; photosensitive, including photovoltaic cells, whether or not assembled in modules or made up into panels, light emitting diodes
0101	Professional Heating & Ventilation (excl. cooling equipment)	845110	Dry-cleaning machines
0101	Professional Heating & Ventilation (excl. cooling equipment)	845130	Ironing machines and presses (including fusing presses)
0102	Dish washers	842211	Dish washing machines; of the household type
0102	Dish washers	842219	Dish washing machines; of other than household type
0103	Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)	851660	Ovens, cookers, cooking plates, boiling rings, grillers and roasters; of a kind used for domestic purposes (excluding microwaves)
0104	Washing Machines (incl. combined dryers)	845011	Washing machines; household or laundry-type, fully-automatic, (of a dry linen capacity not exceeding 10kg)
0104	Washing Machines (incl. combined dryers)	845012	Washing machines; household or laundry-type, with built-in centrifugal drier, (not fully-automatic), of a dry linen capacity not exceeding 10kg
0104	Washing Machines (incl. combined dryers)	845019	Washing machines; household or laundry-type, not fully-automatic, without built-in centrifugal drier, of a dry linen capacity not exceeding 10kg
0104	Washing Machines (incl. combined dryers)	845020	Washing machines; household or laundry-type, of a dry linen capacity exceeding 10kg
0105	Dryers (wash dryers, centrifuges)	842112	Centrifuges; clothes-dryers
0105	Dryers (wash dryers, centrifuges)	845121	Drying machines; of a dry linen capacity not exceeding 10kg
0105	Dryers (wash dryers, centrifuges)	845129	Drying machines; of a dry linen capacity exceeding 10kg
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	841460	Hoods; ventilating or recycling hoods incorporating a fan, whether or not fitted with filters, having a maximum horizontal side not exceeding 120cm
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	851621	Heating apparatus; electric storage heating radiators
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	851629	Heating apparatus; electric soil heating apparatus and space heating apparatus (excluding storage heating radiators)
0108	Fridges (incl. combi-fridges)	841810	Refrigerators and freezers; combined refrigerator-freezers, fitted with separate external doors, electric or other
0108	Fridges (incl. combi-fridges)	841821	Refrigerators; for household use, compression-type, electric or other
0108	Fridges (incl. combi-fridges)	841829	Refrigerators; household, electric or not, other than compression or absorption-type
0109	Freezers	841830	Freezers; of the chest type, not exceeding 800l capacity
0109	Freezers	841840	Freezers; of the upright type, not exceeding 900l capacity
0111	Air Conditioners (household installed and portable)	841510	Air conditioning machines; comprising a motor-driven fan and elements for changing the temperature and humidity, window or wall types, self-contained
0111	Air Conditioners (household installed and portable)	841581	Air conditioning machines; incorporating a refrigerating unit and a valve for reversal of the cooling or heat cycle
0111	Air Conditioners (household installed and portable)	841582	Air conditioning machines; incorporating a refrigerating unit but not a valve for reversal of the cooling or heat cycle, other than window or wall type
0112	Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)	841861	Refrigerating or freezing equipment; compression type units whose condensers are heat exchangers
0112	Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)	841869	Refrigerating or freezing equipment; heat pumps, other than compression type units whose condensers are heat exchangers
0113	Professional Cooling equipment (e.g. large air conditioners, cooling displays)	841583	Air conditioning machines; n.e.s. in heading no. 8415 and not incorporating a refrigerating unit
0113	Professional Cooling equipment (e.g. large air conditioners, cooling displays)	841850	Refrigerating or freezing equipment; display counters, cabinets, show-cases and the like
0114	Microwaves (incl. combined, excl. grills)	851650	Ovens; microwave, of a kind used for domestic purposes
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	630110	Blankets; electric
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	841451	Fans; table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output not exceeding 125W
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	842310	Weighing machines; personal (including baby scales) and household scales
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	845210	Sewing machines; of the household type
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	850980	Electro-mechanical domestic appliances; n.e.s. in heading no. 8509, with self-contained electric motor
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	851640	Smoothing irons; electric
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910111	Wrist-watches; battery or accumulator powered, whether or not incorporating a stop-watch facility, with case of precious metal or of metal clad with precious metal, with mechanical display only

UNU-KEY	UNU KEY DESCRIPTION	HS	HS DESCRIPTION
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910119	Wrist-watches; battery or accumulator powered, with or without a stop-watch, with case of precious metal or metal clad with precious metal, without mechanical or opto-electronic display
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910191	Pocket-watches and other watches, including stop-watches; battery or accumulator powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910211	Wrist-watches; battery or accumulator powered, whether or not incorporating a stop-watch facility, with mechanical display only, other than those of heading no. 9101
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910212	Wrist-watches; battery or accumulator powered, whether or not incorporating a stop-watch facility, with opto-electronic display only, other than those of heading no. 9101
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910219	Wrist-watches; battery or accumulator powered, whether or not incorporating a stop-watch facility, with other than mechanical or opto-electronic display, excluding those of heading no. 9101
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910221	Wrist-watches; whether or not incorporating a stop-watch facility, with automatic winding
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910291	Pocket watches and other watches, including stop-watches; battery or accumulator powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910299	Pocket watches and other watches, including stop-watches; other than battery or accumulator powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910310	Clocks; with watch movements, excluding instrument panel clocks, battery or accumulator powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910390	Clocks; with watch movements, excluding instrument panel clocks, other than battery or accumulator powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910511	Clocks; alarm clocks, battery, accumulator or mains powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910519	Clocks; alarm clocks, other than battery, accumulator or mains powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910521	Clocks; wall clocks, battery, accumulator or mains powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910529	Clocks; wall clocks, other than battery, accumulator or mains powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910591	Clocks; (other than alarm or wall clocks), battery, accumulator or mains powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910599	Clocks; (other than alarm or wall clocks), other than battery, accumulator or mains powered
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910700	Time switches; with clock, watch movement or synchronous motor
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910811	Watch movements; complete and assembled, battery or accumulator powered, with mechanical display only or with a device to which a mechanical display can be incorporated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910812	Watch movements; complete and assembled, battery or accumulator powered, with opto-electronic display only
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910819	Watch movements; complete and assembled, battery or accumulator powered, with other than mechanical display only or opto-electronic display only
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910890	Watch movements; complete and assembled, not automatic winding or electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910910	Clock movements; complete and assembled, electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910990	Clock movements; complete and assembled, other than battery, accumulator or mains powered
0202	Equipment for food preparation (e.g. toaster, grills, food processing, frying pans)	850940	Electro-mechanical domestic appliances; food grinders and mixers, fruit or vegetable juice extractors, with self-contained electric motor
0202	Equipment for food preparation (e.g. toaster, grills, food processing, frying pans)	851672	Electro-thermic appliances; toasters, of a kind used for domestic purposes
0202	Equipment for food preparation (e.g. toaster, grills, food processing, frying pans)	851679	Electro-thermic appliances; n.e.s. in heading no. 8516, used for domestic purposes
0203	Small household equipment for hot water preparation (e.g. coffee, tea, water cookers)	851610	Heaters; electric, instantaneous or storage water and immersion heaters
0203	Small household equipment for hot water preparation (e.g. coffee, tea, water cookers)	851671	Electro-thermic appliances; coffee or tea makers, of a kind used for domestic purposes
0204	Vacuum Cleaners (excl. professional)	850811	Vacuum cleaners, with self-contained electric motor, of a power not exceeding 1,500 W and having a dust bag or other receptacle capacity not exceeding 20L

UNU-KEY	UNU KEY DESCRIPTION	HS	HS DESCRIPTION
0204	Vacuum Cleaners (excl. professional)	850819	Vacuum cleaners, with self-contained electric motor, n.e.c. in item no. 8508.1
0204	Vacuum Cleaners (excl. professional)	850860	Vacuum cleaners, other than with a self-contained electric motor
0205	Personal Care equipment (e.g. tooth brushes, hair dryers, razors)	851010	Shavers; with self-contained electric motor
0205	Personal Care equipment (e.g. tooth brushes, hair dryers, razors)	851020	Hair clippers; with a self-contained electric motor
0205	Personal Care equipment (e.g. tooth brushes, hair dryers, razors)	851030	Hair-removing appliances; with self-contained electric motor
0205	Personal Care equipment (e.g. tooth brushes, hair dryers, razors)	851631	Hair-dressing apparatus; electro-thermic hair dryers
0205	Personal Care equipment (e.g. tooth brushes, hair dryers, razors)	851632	Hair-dressing apparatus; electro-thermic, other than hair dryers
0205	Personal Care equipment (e.g. tooth brushes, hair dryers, razors)	851633	Hand-drying apparatus; electro-thermic
0205	Personal Care equipment (e.g. tooth brushes, hair dryers, razors)	901910	Mechano-therapy appliances; massage apparatus and psychological aptitude-testing apparatus
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	846900	Typewriters (other than printers of heading no. 8443) and word-processing machines
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847010	Calculators; electronic, capable of operation without an external source of electric power
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847021	Calculating machines; electronic, incorporating a printing device, needing an external source of power
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847029	Calculating machines; electronic, (not incorporating a printing device), needing an external power source
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847160	Data processing machines; input or output units, whether or not containing storage units in the same housing
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847170	Data processing machines; storage units
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847180	Data processing machines; automatic, units thereof n.e.s. in heading no. 8471
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847190	Data processing machines; n.e.s. in heading no. 8471
0302	Desktop PCs (excl. monitors, accessoires)	847141	Data processing machines; digital, automatic, (not portable, analogue or hybrid), comprising in the same housing at least a central processing unit, an input and output unit, whether or not combined
0302	Desktop PCs (excl. monitors, accessoires)	847149	Data processing machines; digital, automatic, (not portable, analogue or hybrid), presented in the form of systems, n.e.s. in item no. 8471.41
0302	Desktop PCs (excl. monitors, accessoires)	847150	Digital processing units; other than those of subheadings 8471.41 and 8471.49, whether or not containing in the same housing one or two of the following types of unit: storage units, input units or output units
0303	Laptops (incl. tablets)	847130	Data processing machines; portable, digital and automatic, weighing not more than 10kg, consisting of at least a central processing unit, a keyboard and a display
0304	Printers (e.g. scanners, multi functionals, faxes)	844315	Printing machinery; letterpress, other than reel-fed, excluding flexographic printing
0304	Printers (e.g. scanners, multi functionals, faxes)	844319	Printing machinery; offset, (excluding reel or sheet fed)
0304	Printers (e.g. scanners, multi functionals, faxes)	844331	Printing, copying, and facsimile machines; machines which perform two or more of the functions of printing, copying or facsimile transmission, capable of connecting to an automatic data processing machine or to a network
0304	Printers (e.g. scanners, multi functionals, faxes)	844332	Printing, copying, and facsimile machines; single-function printing, copying or facsimile machines, capable of connecting to an automatic data processing machine or to a network
0305	Telecommunication equipment (e.g. (cordless) phones, answering machines)	851711	Line telephony or telegraphy apparatus; line telephone sets with cordless handsets
0305	Telecommunication equipment (e.g. (cordless) phones, answering machines)	851718	Telephone sets n.e.c. in item no. 8517.1
0305	Telecommunication equipment (e.g. (cordless) phones, answering machines)	851761	Base stations
0305	Telecommunication equipment (e.g. (cordless) phones, answering machines)	851762	Communication apparatus (excluding telephone sets or base stations); machines for the reception, conversion and transmission or regeneration of voice, images or other data, including switching and routing apparatus
0305	Telecommunication equipment (e.g. (cordless) phones, answering machines)	851769	Communication apparatus (excluding telephone sets or base stations); machines for the transmission or reception of voice, images or other data (including wired/wireless networks), n.e.c. in item no. 8517.6
0305	Telecommunication equipment (e.g. (cordless) phones, answering machines)	851950	Sound recording or reproducing apparatus; telephone answering machines

UNU-KEY	UNU KEY DESCRIPTION	HS	HS DESCRIPTION
0305	Telecommunication equipment (e.g. (cordless) phones, answering machines)	903040	Instruments and apparatus; specially designed for telecommunications (eg cross-talk meters, gain measuring instruments, distortion factor meters, psophometers)
0306	Mobile Phones (incl. smartphones, pagers)	851712	Telephones for cellular networks or for other wireless networks
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	844312	Printing machinery; offset, sheet fed, office type (sheet size not exceeding 22 x 36cm)
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	844339	Printing, copying, and facsimile machines; single-function printing, copying or facsimile machines, not capable of connecting to an automatic data processing machine or to a network
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	847050	Cash registers
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	847090	Postage-franking machines, ticket-issuing machines which print tickets
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	847210	Duplicating machines
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	847230	Machines; for sorting or folding mail or for inserting mail in envelopes or bands, for opening, closing or sealing mail, for affixing or cancelling postage stamps
0308	Cathode Ray Tube Monitors	852841	Cathode-ray tube monitors; of a kind solely or principally used in an automatic data processing system of heading 84.71
0308	Cathode Ray Tube Monitors	852849	Cathode-ray tube monitors; other than of a kind solely or principally used in an automatic data processing system of heading 84.71
0309	Flat Display Panel Monitors (LCD, LED)	852851	Monitors other than cathode-ray tube; of a kind solely or principally used in an automatic data processing system of heading 84.71
0309	Flat Display Panel Monitors (LCD, LED)	852859	Monitors other than cathode-ray tube; other than of a kind solely or principally used in an automatic data processing system of heading 84.71
0309	Flat Display Panel Monitors (LCD, LED)	853120	Signalling apparatus; electric, sound or visual, indicator panels incorporating liquid crystal devices (LCD) or light emitting diodes (LED), excluding those of heading no. 8512 or 8530
0401	Small Consumer Electronics (e.g. headphones, remote controls)	851810	Microphones and stands therefor
0401	Small Consumer Electronics (e.g. headphones, remote controls)	851830	Headphones, earphones and combined microphone/speaker sets
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852712	Radio (telephony, telegraphy, broadcast) broadcast receivers; pocket-size radio cassette-players, operational without external power source, combined or not with sound recording or reproducing apparatus
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852713	Radio (telephony, telegraphy, broadcast) broadcast receivers; apparatus (other than pocket-size radio cassette-players), combined with sound recording or reproducing apparatus, not needing external power
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852719	Radio-broadcast receivers; operational without external power source, without sound recording or reproducing apparatus, including apparatus capable of receiving radio-telephony or radio-telegraphy
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852791	Radio-broadcast receivers n.e.c. in heading no. 8527; combined with sound recording or reproducing apparatus
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852792	Radio-broadcast receivers n.e.c. in heading no. 8527; not combined with sound recording or reproducing apparatus but combined with a clock
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852799	Radio-broadcast receivers n.e.c. in heading no. 8527; not combined with sound recording or reproducing apparatus and not combined with a clock
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	847290	Office machines; automatic banknote dispensers, coin-sorting machines, coin-counting or wrapping machines, pencil-sharpening machines, perforating or stapling machines
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	851840	Amplifiers; audio-frequency electric
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	851850	Amplifier sets; electric sound
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	851930	Sound recording or reproducing apparatus; turntables (record-decks)
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	851981	Sound recording or reproducing apparatus; using magnetic, optical or semiconductor media, n.e.c. in item no 8519.20, 8519.30 or 8519.50
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	851989	Sound recording or reproducing apparatus; n.e.c. in heading no 8519
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	852721	Radio-broadcast receivers; (not operational without external power source), combined with sound recording or reproducing apparatus, including apparatus capable of receiving radio-telephony or radio-telegraphy
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	852729	Radio-broadcast receivers; (not operational without external power source), without sound recording or reproducing apparatus, including apparatus capable of receiving radio-telephony or radio-telegraphy
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	920710	Musical instruments; keyboard, (other than accordions), the sound of which is produced or must be amplified electrically

UNU-KEY	UNU KEY DESCRIPTION	HS	HS DESCRIPTION
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	920790	Musical instruments; (other than keyboard), the sound of which is produced or must be amplified electrically
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	852110	Video recording or reproducing apparatus; magnetic tape-type
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	852190	Video recording or reproducing apparatus; other than magnetic tape-type
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	852560	Transmission apparatus for radio-broadcasting or television, whether or not incorporating sound recording or reproducing apparatus, incorporating reception apparatus
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	852861	Projectors; of a kind solely or principally used in an automatic data processing system of heading 84.71
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	852869	Projectors; other than of a kind solely or principally used in an automatic data processing system of heading 84.71
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	852871	Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus; not designed to incorporate a video display or screen
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	900720	Projectors, cinematographic; whether or not incorporating sound recording or reproducing apparatus
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	900850	Image projectors, photographic enlargers and reducers, excluding cinematographic
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	901010	Photographic laboratory apparatus and equipment; for automatically developing photographic (including cinematographic) film or paper in rolls or for automatically exposing developed film to rolls of paper
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	901050	Photographic laboratory apparatus and equipment; n.e.s. in item no. 9010.10 or 9010.4, for photographic (including cinematographic) laboratories; negatoscopes
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	901060	Photographic laboratory apparatus and equipment (including cinematographic); projection screens
0405	Speakers	851821	Loudspeakers; single, mounted in their enclosures
0405	Speakers	851822	Loudspeakers; multiple, mounted in the same enclosure
0406	Cameras (e.g. camcorders, photo & digital still cameras)	852580	Television cameras, digital cameras and video camera recorders
0406	Cameras (e.g. camcorders, photo & digital still cameras)	900661	Photographic flashlight apparatus; discharge lamp ("electronic")
0406	Cameras (e.g. camcorders, photo & digital still cameras)	900669	Photographic flashlight apparatus; n.e.s. in heading no. 9006
0406	Cameras (e.g. camcorders, photo & digital still cameras)	900710	Cameras, cinematographic; whether or not incorporating sound recording apparatus
0407	Cathode Ray Tube TVs	852873	Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus; incorporating a black and white or other monochrome video display or screen
0408	Flat Display Panel TVs (LCD, LED, Plasma)	852872	Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus; incorporating a colour video display or screen
0501	Small lighting equipment (excl. LED & incandescent)	851210	Lighting or visual signalling equipment; electrical, of a kind used on bicycles, excluding articles of heading no. 8539
0501	Small lighting equipment (excl. LED & incandescent)	851310	Lamps; portable, electric, designed to function by their own source of energy (excluding lighting equipment of heading no. 8512)
0503	Straight Tube Fluorescent Lamps	853941	Lamps; arc-lamps
0503	Straight Tube Fluorescent Lamps	853949	Lamps; ultra-violet or infra-red lamps, (excluding arc-lamps)
0504	Special Lamps (e.g. professional mercury, high & low pressure sodium)	853931	Lamps; discharge, (excluding ultra-violet), fluorescent, hot cathode
0504	Special Lamps (e.g. professional mercury, high & low pressure sodium)	853932	Lamps; discharge, (excluding ultra-violet), mercury or sodium vapour lamps, metal halide lamps
0504	Special Lamps (e.g. professional mercury, high & low pressure sodium)	853939	Lamps; discharge, (excluding ultra-violet, excluding fluorescent, hot cathode)
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940510	Chandeliers and other electric ceiling or wall light fittings; excluding those used for lighting public open spaces or thoroughfares
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940520	Lamps, electric; floor-standing or for table, desk or bedside
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940530	Lighting sets; of a kind used for Christmas trees
0507	Professional Luminaires (offices, public space, industry)	940540	Lamps and light fittings; electric, n.e.s. in heading no. 9405
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	846721	Tools; for working in the hand, with self-contained electric motor; drills of all kinds

UNU-KEY	UNU KEY DESCRIPTION	HS	HS DESCRIPTION
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	846722	Tools; for working in the hand, with self-contained electric motor; saws
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	846729	Tools; for working in the hand, with self-contained electric motor; other than saws and drills
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	851511	Brazing or soldering machines and apparatus; soldering irons and guns, whether or not capable of cutting
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	851519	Brazing or soldering machines and apparatus; other than soldering irons and guns, whether or not capable of cutting
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	851521	Welding machines and apparatus; for resistance welding of metal, fully or partly automatic, whether or not capable of cutting
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	851529	Welding machines and apparatus; for resistance welding of metal, other than fully or partly automatic, whether or not capable of cutting
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	851531	Welding machines and apparatus; for arc (including plasma arc) welding of metals, fully or partly automatic, whether or not capable of cutting
0602	Professional Tools (e.g. for welding, soldering, milling)	843311	Mowers; lawn, parks or sports-grounds, powered, with the cutting device rotating in a horizontal plane
0602	Professional Tools (e.g. for welding, soldering, milling)	843319	Mowers; for lawns, parks or sports-grounds, other than with the cutting device rotating in a horizontal plane
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	950300	Tricycles, scooters, pedal cars and similar wheeled toys; dolls' carriages; dolls; other toys; reduced-size (scale) models and similar recreational models, working or not; puzzles of all kinds
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	950490	Games; articles for funfair, table or parlour games, including pintables, tables for casino games, bowling alley equipment, n.e.s. in heading no. 9504
0702	Game Consoles	950450	Games; video game consoles and machines, other than those of subheading 9504.30
0703	Leisure equipment (e.g. sports equipment, electric bikes, juke boxes)	851920	Sound recording or reproducing apparatus; operated by coins, banknotes, bank cards, tokens or by other means of payment
0703	Leisure equipment (e.g. sports equipment, electric bikes, juke boxes)	871190	Motorcycles (including mopeds) and cycles; n.e.s. in heading no. 8711, fitted with auxiliary motor, with or without side-cars; side-cars
0801	Household Medical equipment (e.g. thermometers, blood pressure meters)	902140	Hearing aids (excluding parts and accessories)
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	901811	Medical, surgical instruments and appliances; electro-cardiographs
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	901812	Medical, surgical instruments and appliances; ultrasonic scanning apparatus
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	901813	Medical, surgical instruments and appliances; magnetic resonance imaging apparatus
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	901814	Medical, surgical instruments and appliances; scintigraphic apparatus
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	901819	Medical, surgical instruments and appliances; electro-diagnostic apparatus (including apparatus for functional exploratory examination or for checking physiological parameters), not electro-cardiographs
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	901841	Dental instruments and appliances; dental drill engines, whether or not combined on a single base with other dental equipment
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	853110	Signalling apparatus; electric, sound or visual, burglar or fire alarms and similar, other than those of heading no. 8512 or 8530
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	853180	Signalling apparatus; electric, sound or visual, apparatus n.e.s. in heading no. 8531, excluding those of heading no. 8512 or 8530
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	854370	Electrical machines and apparatus; having individual functions, not specified or included elsewhere in this chapter, n.e.c. in heading no. 8543
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	902519	Thermometers and pyrometers; (other than liquid filled, for direct reading), not combined with other instruments
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	902580	Hydrometers and similar floating instruments, barometers, hygrometers, psychrometers, thermometers, pyrometers; recording or not, any combination of these instruments (excluding thermometers and barometers not combined with other instruments)
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	902610	Instruments and apparatus; for measuring or checking the flow or level of liquids
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	902620	Instruments and apparatus; for measuring or checking pressure
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	902680	Instruments and apparatus; for measuring or checking variables of liquids or gases (excluding pressure or the flow and level of liquids and those of heading no. 9014, 9015, 9028 and 9032)
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	902710	Instruments and apparatus; gas or smoke analysis apparatus, for physical or chemical analysis

UNU-KEY	UNU KEY DESCRIPTION	HS	HS DESCRIPTION
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	902780	Instruments and apparatus; for physical or chemical analysis, for measuring or checking viscosity, porosity, expansion, surface tension or quantities of heat, sound or light, n.e.s. in heading no. 9025
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	903033	Instruments and apparatus; for measuring or checking voltage, current, resistance or power, without a recording device (excluding multimeters)
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	903089	Instruments and apparatus; for measuring or detecting alpha, beta, gamma, x-ray, cosmic or other ionising radiations, without a recording device
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	903180	Instruments, appliances and machines; for measuring or checking n.e.s. in chapter 90
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	903210	Regulating or controlling instruments and apparatus; automatic type, thermostats
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	901510	Rangefinders
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	901520	Surveying equipment; theodolites and tacheometers
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	901540	Surveying equipment; photogrammetrical surveying instruments and appliances
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	901580	Surveying equipment; articles n.e.s. in heading no. 9015, including hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances (excluding compasses)
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902410	Machines and appliances; for testing the hardness, strength, compressibility, elasticity or other mechanical properties of metals
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902480	Machines and appliances; for testing the hardness, strength, compressibility, elasticity or other mechanical properties of materials other than metals
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902830	Meters; electricity supply or production meters, including calibrating meters thereof
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	903020	Cathode-ray oscilloscopes and cathode-ray oscillographs
1001	Non- cooled Dispensers (e.g. for vending, hot drinks, tickets, money)	847629	Machines; automatic beverage-vending machines, not incorporating heating or refrigerating devices
1001	Non- cooled Dispensers (e.g. for vending, hot drinks, tickets, money)	847689	Machines; automatic goods-vending machines, (eg postage stamp, cigarette, food or money-changing machines, excluding beverage-vending machines), not incorporating heating or refrigerating devices
1002	Cooled Dispensers (e.g. for vending, cold drinks)	847621	Machines; automatic beverage-vending machines, incorporating heating or refrigerating devices
1002	Cooled Dispensers (e.g. for vending, cold drinks)	847681	Machines; automatic goods-vending machines, (eg postage stamp, cigarette, food or money-changing machines, excluding beverage-vending machines), incorporating heating or refrigerating devices

Annex 2:

Life-time profiles of various EEE in the Netherlands, France, Belgium, Italy and non-EU countries

UNU-KEYS * Data refers to 2016	WEIBULL LIFE-TIME DISTRIBUTION IN THE NETHERLANDS, FRANCE AND BELGIUM		WEIBULL LIFE-TIME DISTRIBUTION IN ITALY		PROXY OF WEIBULL LIFE-TIME DISTRIBUTION USED FOR NON EU COUNTRIES	
	α	β	α	β	α	β
0001	2.00	14.21	2.00	14.21	2.00	14.21
0002	3.50	25.00	3.50	25.00	NA	NA
0101	1.95	17.52	1.14	16.07	1.92	16.07
0102	1.64	14.20	1.37	14.28	1.79	17.13
0103	2.47	18.04	1.31	19.35	2.00	19.35
0104	2.20	15.16	2.20	13.65	1.85	13.32
0105	2.58	15.73	2.58	15.73	2.58	18.08
0106	2.00	13.47	1.22	18.80	2.00	13.47
0108	2.20	16.43	2.36	18.50	2.20	16.71
0109	2.74	24.20	1.28	18.55	1.28	18.55
0111	2.69	14.52	1.05	7.53	2.00	20.60
0112	2.39	13.56	1.29	8.29	2.36	13.36
0113	2.44	20.56	2.50	18.02	1.60	15.36
0114	1.90	14.07	1.33	9.05	2.07	17.99
0201	1.25	8.17	0.83	6.53	1.22	7.97
0202	2.06	11.22	1.15	9.57	2.02	11.02
0203	1.73	7.80	1.18	7.61	1.18	7.61
0204	1.45	10.25	1.22	10.59	1.22	10.59
0205	1.26	10.67	1.20	8.09	1.20	8.09
0301	1.25	5.91	1.30	6.15	1.30	6.15
0302	1.58	8.95	1.57	8.91	1.80	10.33
0303	1.60	6.57	1.66	6.81	1.94	8.76
0304	1.68	9.91	1.53	6.88	1.88	9.31
0305	1.24	7.22	1.32	7.70	1.32	7.70
0306	1.56	6.26	1.52	5.62	1.52	5.62
0307	1.46	7.78	1.46	7.78	1.46	7.78
0308	2.41	12.53	1.40	15.94	1.40	15.94
0309	2.33	7.39	2.33	7.39	2.30	12.18
0401	1.30	9.87	1.30	9.87	1.30	9.87
0402	0.79	7.97	1.11	5.56	1.50	10.01
0403	2.09	15.54	1.25	13.99	2.30	10.00
0404	1.67	10.47	1.14	8.33	1.14	8.33
0405	1.49	10.78	1.13	12.54	1.13	12.54
0406	1.41	8.12	1.19	6.75	1.19	6.75
0407	2.49	12.08	2.49	12.08	2.49	12.08
0408	2.01	11.75	2.01	11.75	1.88	10.95
0501	1.42	8.72	1.42	8.72	1.42	8.72
0502	1.60	8.43	1.60	8.43	NA	NA
0503	1.93	8.43	1.93	8.43	1.75	5.79
0504	1.60	6.90	1.60	6.90	1.60	6.90
0505	1.42	11.00	1.42	11.00	NA	NA
0506	2.34	16.59	2.34	16.59	2.34	16.59
0507	2.00	11.84	2.00	11.84	2.00	12.50
0601	1.82	11.28	1.82	11.28	1.77	14.98
0602	2.50	15.50	2.50	15.50	2.50	15.50
0701	1.43	4.56	1.43	4.56	1.43	4.56
0702	1.14	4.78	1.14	4.78	1.14	4.78
0703	2.40	11.56	2.40	11.56	2.40	11.56
0801	1.99	13.46	1.99	13.46	1.99	13.46
0802	2.41	13.52	2.41	13.52	2.41	13.52
0901	1.55	5.89	1.55	5.89	1.55	5.89
0902	1.92	11.56	1.92	11.56	1.92	11.56
1001	2.00	10.06	2.00	10.06	2.00	10.06
1002	2.00	10.06	2.00	10.06	2.00	15.00

Annex 3:

Indication of average weight for EU-28 (kg/piece)

UNU-KEY	1995	2000	2005	2010	2015	2016
0001	30.85	30.85	30.85	30.85	30.85	30.85
0002	17.00	17.00	17.00	17.00	17.00	17.00
0101	124.61	124.61	124.61	124.61	124.61	124.61
0102	49.35	47.62	45.46	43.30	43.30	43.30
0103	41.86	43.52	45.59	47.66	47.66	47.66
0104	69.36	70.27	71.40	72.54	72.54	72.54
0105	38.27	40.47	43.23	45.98	45.98	45.98
0106	12.14	12.14	12.14	12.14	12.14	12.14
0108	33.59	35.65	38.22	40.79	40.79	40.79
0109	43.59	43.73	43.91	44.09	44.09	44.09
0111	26.70	26.70	26.70	26.70	26.70	26.70
0112	41.70	41.70	41.70	41.70	41.70	41.70
0113	90.00	95.74	102.92	110.10	110.10	110.10
0114	16.34	18.21	20.56	22.90	22.90	22.90
0201	1.30	1.21	1.10	0.99	0.99	0.99
0202	3.27	3.27	3.27	3.27	3.27	3.27
0203	1.89	1.89	1.89	1.89	1.89	1.89
0204	4.88	5.17	5.52	5.88	5.88	5.88
0205	0.55	0.55	0.55	0.55	0.55	0.55
0301	0.65	0.58	0.49	0.40	0.40	0.40
0302	10.31	9.87	9.32	8.77	8.77	8.77
0303	4.50	4.14	3.68	2.13	1.26	1.26
0304	7.00	7.95	9.13	10.32	10.32	10.32
0305	0.82	0.71	0.58	0.45	0.45	0.45
0306	0.12	0.11	0.10	0.09	0.09	0.09
0307	40.00	40.00	40.00	40.00	40.00	40.00
0308	14.60	16.71	19.36	22.00	22.00	22.00
0309	5.00	5.14	5.32	5.50	5.50	5.50
0401	0.39	0.39	0.39	0.39	0.39	0.39
0402	0.40	0.35	0.29	0.23	0.23	0.23
0403	4.15	4.03	3.88	3.73	3.73	3.73
0404	3.51	3.51	3.51	3.51	3.51	3.51
0405	3.00	2.75	2.45	2.14	2.14	2.14
0406	1.00	0.80	0.54	0.29	0.29	0.29
0407	25.00	27.34	30.27	33.20	33.20	33.20
0408	7.00	9.20	11.95	14.70	10.20	10.20
0501	0.09	0.09	0.09	0.09	0.09	0.09
0502	0.08	0.08	0.08	0.08	0.08	0.08
0503	0.11	0.11	0.11	0.11	0.11	0.11
0504	0.08	0.08	0.08	0.08	0.08	0.08
0505	0.08	0.08	0.08	0.08	0.08	0.08
0506	0.45	0.45	0.45	0.45	0.45	0.45
0507	2.67	2.67	2.67	2.67	2.67	2.67
0601	2.60	2.57	2.53	2.49	2.49	2.49
0602	23.17	23.17	23.17	23.17	23.17	23.17
0701	0.45	0.45	0.45	0.45	0.45	0.45
0702	0.48	0.48	0.48	0.48	0.48	0.48
0703	7.37	7.37	7.37	7.37	7.37	7.37
0801	0.18	0.18	0.18	0.18	0.18	0.18
0802	67.04	67.04	67.04	67.04	67.04	67.04
0901	0.24	0.24	0.24	0.24	0.24	0.24
0902	5.51	5.51	5.51	5.51	5.51	5.51
1001	44.00	44.00	44.00	44.00	44.00	44.00
1002	92.22	92.22	92.22	92.22	92.22	92.22

Annex 4:

Example 1 of household statistics survey on e-waste disposal

This survey template focuses on the disposal patterns of all the electric and electronic appliances present in the house. The questionnaire is structured in the following way:

Column A: UNU_Key, a code that identifies the type of e-waste
Column B: Description, a detailed description of the type of e-waste
Column C: Was it second-hand?
Column D: Which of these 54 types of e-waste did you dispose of during the last year?
Column E: How many units per e-waste category did you disposed of?
Column F: What was the approximate age when you discarded it?
Column G: How did you discard the product?

The user should put a cross in correspondence with the electronic item that has been disposed of during the last year. The user should then indicate how many units they disposed of, the approximate age when the item was disposed of, and how it was discarded, reporting the letter corresponding to each of the following options:

Column E: What was the approximate age when you discarded it?

- **A.** Less than 1 year
- **B.** 1 year
- **C.** 2 years
- **D.** 3 years
- **E.** 4 -5 years
- **F.** 6-10 years
- **G.** 11-15 years
- **H.** 16-20 years
- **I.** 21-40 years
- **J.** >40 years
- **K.** Do not remember/do not know

Column F: How did you discard the product?

- **A.** Bring to the shop
- **B.** Retailer pick-up at home
- **C.** Bring to Municipal Collection Point
- **D.** Municipality pick-up at home
- **E.** Sold on e-bay, parents, given to friends for free
- **F.** Moved it to my old/other house
- **G.** Sold to a refurbisher
- **H.** Waste bin
- **I.** With plastic waste
- **J.** Warranty substitution
- **K.** Do not remember/do not know

A	B	C	D	E	F	G
UNU KEY	*DESCRIPTION*	*WAS IT SECOND-HAND?*	*WHICH OF THESE 54 TYPES OF E-WASTE DID YOU ISPOSE OF DURING LAST YEAR?*	*HOW MANY UNITS DID YOU DISPOSE OF?*	*WHAT WAS THE APPROX. AGE WHEN YOU DISCARDED IT?*	*HOW DID YOU DISCARD THE PRODUCT?*
		Put a cross	*Put a cross*	*Indicate the number*	*Choose one option from A to K*	*Choose one option from A to K*
0001	Central Heating (household installed)					
0002	Photovoltaic Panels (incl. converters)					
0101	Professional Heating & Ventilation (excl. cooling equipment)					
0102	Dishwashers					
0103	Kitchen (e.g. . large furnaces, ovens, cooking equipment)					
0104	Washing Machines (incl. combined dryers)					
0105	Dryers (wash dryers, centrifuges)					
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)					
0108	Fridges (incl. combi-fridges)					
0109	Freezers					
0111	Air Conditioners (household installed and portable)					
0112	Other Cooling (e.g.. dehumidifiers, heat pump dryers)					
0113	Professional Cooling (e.g. large air conditioners, cooling displays)					
0114	Microwaves (incl. combined, excl. grills)					
0201	Other Small Household (e.g., small ventilators, irons, clocks, adapters)					
0202	Food (e.g. toaster, grills, food processing, frying pans)					
0203	Hot Water (e.g. coffee, tea, water cookers)					
0204	Vacuum Cleaners (excl. professional)					
0205	Personal Care (e.g. tooth brushes, hair dryers, razors)					
0301	Small IT (e.g. routers, mice, keyboards, external drives & accessories)					
0302	Desktop PCs (excl. monitors, accessories)					
0303	Laptops (incl. tablets)					
0304	Printers (e.g. scanners, multifunctionals, faxes)					
0305	Telecom (e.g. (cordless) phones, answering machines)					
0306	Mobile Phones (incl. smartphones, pagers)					
0307	Professional IT (e.g. servers, routers, data storage, copiers)					
0308	Cathode Ray Tube Monitors					
0309	Flat Display Panel Monitors (LCD, LED)					
0401	Small Consumer Electronics (e.g. headphones, remote controls)					
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)					
0403	Music Instruments, Radio, HiFi (incl. audio sets)					
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes)					
0405	Speakers					
0406	Cameras (e.g. camcorders, photo & digital still cameras)					
0407	Cathode Ray Tube TVs					
0408	Flat Display Panel TVs (LCD, LED, Plasma)					
0501	Lamps (e.g. pocket, Christmas, excl. LED & incandescent)					
0502	Compact Fluorescent Lamps (incl. retrofit & non-retrofit)					
0503	Straight Tube Fluorescent Lamps					
0504	Special Lamps (e.g. 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 (e.g. drills, saws, high pressure cleaners, lawn mowers)					
0602	Professional Tools (e.g. for welding, soldering, milling)					
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers)					
0702	Game Consoles					
0703	Leisure (e.g. large exercise, sports equipment)					
0801	Household Medical (e.g. thermometers, blood pressure meters)					
0802	Professional Medical (e.g. hospital, dentist, diagnostics)					
0901	Household Monitoring & Control (alarm, heat, smoke, excl. screens)					
0902	Professional Monitoring & Control (e.g. laboratory, control panels)					
1001	Non Cooled Dispensers (e.g. for vending, hot drinks, tickets, money)					
1002	Cooled Dispensers (e.g. for vending, cold drinks)					

Annex 5:

Example 2 of household statistics survey on e-waste disposal

This survey template focuses on the disposal patterns of the six e-waste categories present in the houses.

TEMPERATURE EXCHANGE EQUIPMENT	More commonly referred to as cooling and freezing equipment. Typical equipment includes refrigerators, freezers, air conditioners, heat pumps.
SCREENS, MONITORS	Typical equipment includes televisions, monitors, laptops, notebooks, and tablets
LAMPS	Typical equipment includes fluorescent lamps, high intensity discharge lamps, and LED lamps
LARGE EQUIPMENT	Typical equipment includes washing machines, clothes dryers, dish-washing machines, electric stoves, large printing machines, copying equipment, and photovoltaic panels
SMALL EQUIPMENT	Typical equipment includes vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments
SMALL IT	Typical equipment includes mobile phones, Global Positioning Systems (GPS), pocket calculators, routers, personal computers, printers, telephones
ELECTRICAL AND ELECTRONIC TOOLS	Drills, electric saws, sewing machines, lawn mowers, large stationary tools, machines
SECURITY AND HEALTHCARE EQUIPMENT	Surveillance & control equipment, medical instruments & equipment
MIXED WASTE ELECTRICAL & ELECTRONIC EQUIPMENT	Various e-waste

1a. Did you dispose of an "E-WASTE CAT" during the last year?

1. Yes
2. No

If YES:

1b. How did you dispose of the product?

1. Took it to the shop
2. A retailer picked it up at home
3. Took it to municipal collection point
4. Municipality picked it up at home
5. Sold it or gave it to family, friends for free
6. Moved it to my old/other house
7. Sold it to a refurbisher
8. Threw it into a waste bin
9. Threw it away with plastic waste
10. Warranty substitution
11. Do not Know/Do not Remember

1c. How many items did you dispose of?

ABOUT THE PARTNERSHIP ON MEASURING ICT FOR DEVELOPMENT:

The Partnership on Measuring ICT for Development is an international, multi-stakeholder initiative to improve the availability and quality of ICT data and indicators, particularly in developing countries. It was launched in June 2004. Current partners include ITU, OECD, UNCTAD, the UNESCO Institute for Statistics, the United Nations University, the World Bank, the UN Department of Economic and Social Affairs (UN-DESA), the UNEP Secretariat of the Basel Convention, the UN Regional Commissions (UNECLAC, UNESCWA, UNESCAP, UNECA) and EUROSTAT. The UN ICT Task Force was a member of the Partnership until the end of its mandate in 2005. The Partnership Steering committee is composed of ITU, UNCTAD and UNECLAC.

The overall objective of the Task Group is to support the compilation of reliable data on e-waste as basis for political decision making and further action on the environmentally sound management of used and end-of-life ICT equipment. The Task Group developped a framework for monitoring e-waste based on internationally defined indicators and help countries produce reliable and comparable e-waste statistics.

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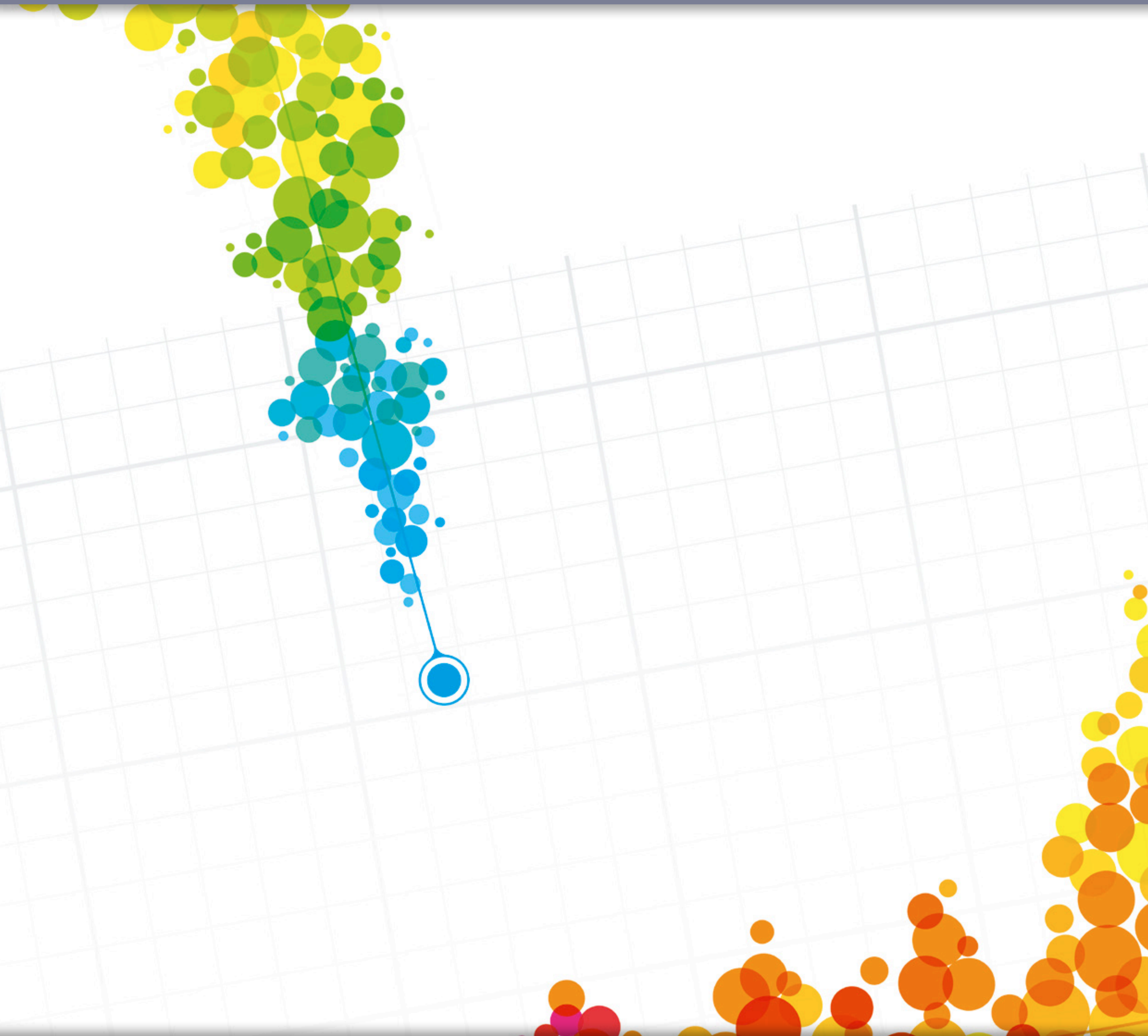

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