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Finally, but certainly not least, UNITAR thanks the financial support given by the UNEP project *Enhancing countries' capacities for measuring progress on the transition towards a circular economy*. The project, with funds originating from the European Union, aims to support evidence-based policies for accelerating the transition towards a circular economy by enhancing the technical capacity of national statistical offices to produce official statistics on the circular economy and waste. The project focuses on three key areas: (i) developing or enhancing methodologies at the global level, (ii) regional capacity building and dialogue between data users and producers, and (iii) enhancing statistical capacities through tailored national activities. A summary of the project and its activities can be found here.

Foreword

It is difficult to overstate the transformative effect that electronic products have had on large parts of society over the last half-century. Their influence is visible today in how we communicate, produce goods, and sell services, power our homes, our transport and healthcare. Electrification and digitalisation are being advanced, furthermore, as key mechanisms to achieve sustainable development, digital inclusion, and mitigate and adapt to a changing climate. As observed in the *2024 Global E-waste Monitor*, the use of electrical and electronic equipment (EEE) is rapidly increasing. In 2022, an estimated 96 million metric tonnes (Mt) of EEE were placed on the market (POM) globally - up more than 50% from the equivalent figure in 2010.

A consequence of the growing use of EEE has been an increase in the amount of electronic waste (e-waste)[1] generated. Latest figures from the *Global E-waste Monitor* show a record 62 Mt of e-waste were produced globally in 2022, and, considering data trends, this is anticipated to rise to more than 80 Mt by 2030. With e-waste generated currently increasing five times faster than documented collection and recycling, these developments pose significant risks to the environment and human health.

Data and statistics play a critical role in addressing the escalating e-waste challenge.

Data and statistics play a critical role in addressing the escalating challenges related to e-waste. This role entails helping to identify opportunities to turn waste into a resource, setting and monitoring progress against public and private sector targets, and evaluating best practice in policy-making. Given this point and the scale of the growing e-waste challenge, the Partnership on Measuring ICT for Development published the first edition of *E-waste Statistics: Guidelines on classifications, reporting and indicators* in 2015. The aim behind the publication was to formalise a measurement framework that would harmonise early approaches to monitoring e-waste and support the production of reliable and internationally comparable statistics and indicators on the topic.

The guidelines were endorsed by all members of the Partnership on Measuring ICT for Development and consulted on with international organisations dealing with statistics on the environment and ICT, academia, industry, national authorities of the Solving the E-waste Problem (StEP) network, and other stakeholders, including EU Member States. The second edition of *E-waste Statistics* was published in 2018. It expanded on the first edition by further detailing the underlying mathematical formulas of the measurement framework, provided additional guidance on calculation steps, and showcased a wider number of countries that were applying the outlined methods to help successfully construct statistics on e-waste.

[1] *Otherwise referred to as waste electrical and electronic equipment (WEEE), discarded equipment or e-scrap.*

The *E-Waste Statistics* guidelines have been cited widely to date and have informed a range of assessments on e-waste. Several international agencies, such as the United Nations Statistics Division (UNSD), Eurostat, the Organisation for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP), and the United Nations Economic Commission for Europe (UNECE), have adopted the approaches outlined to gather data on e-waste across the globe. The methods have also been applied successfully in policy advice, through the production of various global, regional, and national e-waste monitors published by national governments and by the United Nations Institute for Training and Research (UNITAR), International Telecommunication Union (ITU), UNEP, United Nations University (UNU), and United Nations Development Programme (UNDP).

The objective of the guidelines is to support data producers in constructing official statistics on e-waste using a globally harmonised approach.

The preparation of this third edition of *E-waste Statistics* has been coordinated by the Sustainable Cycles (SCYCLE) Programme of UNITAR. As with previous editions, the objective of this edition of the guidelines is to support data producers in making official statistics on e-waste and facilitate the production of globally harmonised statistics in this area. By setting out a classification for electronics and e-waste, a measurement framework, data sources to populate that framework, and reporting indicators, the guidelines help facilitate the implementation of a comprehensive and harmonised approach to measure the scale of a country's EEE consumption, e-waste generated, transboundary e-waste movement, and e-waste recycling based on internationally approved definitions, standards, and methods.

This edition of the guidelines provides updates in areas including revisions to the UNU-KEYs classification, an outline of new data sources and approaches to measure areas such as transboundary e-waste flows and e-waste legislation and includes refreshed technical parameters such as average weights and product lifetime distributions that can be used as inputs of the framework. The guidelines have been compiled with contributions from various leading agencies and experts in e-waste statistics.

Throughout the guidelines, we signpost to further guidance and tools that can be used to build national capacity in the production of high-quality and comparable statistics on e-waste. Key resources to support e-waste measurement and case examples can be found at the Global E-waste Statistics Partnership website (globalewaste.org), the E-waste Monitor website (ewastemonitor.info), and the UNITAR SCYCLE website (scycle.info). Training materials are available from the Scycle Academy for Circular Economy (ACE) website (academy-ce.info).

Executive Summary

These guidelines lay out a measurement framework intended for use by national statistical offices, other government agencies, and interested parties to guide the production of robust and internationally comparable statistics on e-waste.

The first and second editions of the *E-waste Statistics* guidelines, published in 2015 and 2018, respectively, defined a robust measurement framework for compiling statistics on e-waste, key data inputs for populating the framework and reporting metrics. This measurement framework has been expanded and built upon over the last decade, refined in several areas - including new indicators and measurement approaches - and applied across a wide and growing number of cases, both at the national and global level. Through these applications, the methodology put forward in the guidelines has demonstrated an ability to help derive statistics on e-waste from widely available and emerging sources, be tailored to reflect different national circumstances, and produce outputs that are comparable between countries. This comparability has an important role in benchmarking and aggregating data for national, regional, and global e-waste statistics.

As with the previous two editions, the methodology laid out in this third edition of *E-Waste Statistics: Guidelines on classifications, reporting, and indicators* is centred around measuring the life cycle of electronics from their production, consumption, and use, to the generation and treatment of used electrical and electronic equipment (UEEE) and e-waste. As part of the methodology, the various stages in the life cycle of electronics are linked to each other through mathematical equations as well as the use of a consistent product classification system - the UNU-KEYs - which has emerged as a global statistical standard for documenting flows and stocks of electronics and linked parameters such as product lifetimes. Though standalone in its descriptive ability, a key part of the usefulness of the UNU-KEYs lies in its explicit and updated correlations to other classifications, such as the Harmonized Commodity Description and Coding System (HS) used for describing trade flows, and the EU WEEE Directive reporting categories. This facilitates access to a breadth of data for populating the measurement framework, while also increasing interoperability in the ecosystem of classifications used to describe EEE and e-waste globally.

Building on this foundation, the measurement framework defined in these guidelines harnesses widely available data in both developed and developing countries and integrates this data through well-documented calculation steps to populate key indicators on e-waste in a statistically sound way. These indicators include the size of the market for EEE products, e-waste generated and collected, performance in e-waste management, and transboundary e-waste flows. For countries embarking on measuring e-waste for the first time, minimum reporting recommendations are summarised in Section 1.5 "Getting started with e-waste measurement" of these guidelines and further detailed in Box 10 "Recommended core indicators and products for reporting on e-waste statistics". The technical annexes of these guidelines present updated inputs to the measurement framework such as average weights per UNU-KEYs and product lifetime distributions. The main updates and improvements with this edition of the *E-waste Statistics* guidelines are:

- Revisions to the UNU-KEYs classification and the introduction of the UNU-KEYs Version 2 (UNU-KEYS-v.2) to capture evolving markets for EEE products (Section 2.4)
- A summary of recent and upcoming changes in linked statistical classifications, including under the Basel Convention (Section 2.6)
- Newly developed approaches to measure areas such as transboundary e-waste flows, the recovery of secondary raw materials from e-waste management, and legislation are detailed (Sections 3 and 4)
- A detailed description of routes to report on e-waste statistics at the international level (Section 5)
- Updated illustrative questions that can be used in surveys on EEE and e-waste behaviours (Annex 1)
- The technical parameters that input to the framework have been refreshed - including correlations between the UNU-KEYs on one hand and HS and Central Product Classification (CPC) classifications on the other, average weights and lifetime distributions for each UNU-KEY across various parts of the world, as well as, for the first time in the guidelines series, a breakdown of the material composition of EEE products (Annex 2-7)
- Improved mapping of Persistent Organic Pollutants (POPs) in e-waste for Stockholm Convention national source inventories (Annex 8).

Adding to the case studies showcased in previous releases, this third edition of the guidelines provides further examples from countries and regional bodies who have implemented the methods outlined, as well as challenges faced and learning in the process of doing so. The updated examples cover data collection in the East African region, at the European Union (EU) level, and for countries including the United Republic of Tanzania, Nigeria, Belarus, Bosnia and Herzegovina, Colombia, Netherlands (Kingdom of the), and Lebanon. These cases reflect the increasingly widespread adoption of the methodologies outlined in the guidelines publication, which now input to various policy and legislation globally, by helping provide regular data on e-waste and as part of tracking collection and recycling targets.

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Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
Basel Convention	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Bamako Convention	Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa
BRS Conventions	Basel, Rotterdam, and Stockholm Conventions
CFCs	Chlorofluorocarbons
CN	Combined Nomenclature
CPC	Central Product Classification
DecaBDE	Decabromodiphenyl ether
EACO	East African Communications Organisation
EEE	Electrical and Electronic Equipment
EPR	Extended Producer Responsibility
EU	European Union
EU WEEE Directive	Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast) (Text with EEA relevance)
E-waste	Electronic Waste
EWC	European Waste Catalogue/List of Waste (LoW) Code

Acronym/ Abbreviation	Definition
EWC-Stat	European Waste Classification for Statistics
FDES	Framework for the Development of Environment Statistics
HBCD	Hexabromocyclododecane
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
Hexa/ HeptaBDE	Hexabromodiphenyl/ Heptabromodiphenyl ethers
HS	Harmonized Commodity Description and Coding System
ICT	Information and Communications Technology
ILO	International Labour Organization
ISIC	International Standard Industrial Classification
ISWA	International Solid Waste Association
IT	Information Technology
ITU	International Telecommunication Union
kg	Kilogram
kt	Thousand metric tonnes
LCD	Liquid Crystal Displays
LED	Light-Emitting Diode
LoW	European List of Waste
MCCP	Medium-chain chlorinated paraffins

Acronym/ Abbreviation	Definition
Mt	Million metric tonnes
NACE	Statistical classification of economic activities in the European Community
NGO	Non-Governmental Organization
c-OctaBDE	Octabromodiphenyl ether
OECD	Organisation for Economic Co-operation and Development
PCB	Polychlorinated Biphenyl
PCC	Product Classification of Commodities
PCN	Polychlorinated Naphthalene
PCT	Polychlorinated Terphenyl
POM	Placed on the Market/Put on the Market
POPs	Persistent Organic Pollutants
PRO	Producer Responsibility Organisation
PPP	Purchasing Power Parity
PVC	Polyvinyl Chloride
Rotterdam Convention	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
SCCPs	Short-chain chlorinated paraffins
SCYCLE	Sustainable Cycles Programme of United Nations Institute of Training and Research

Acronym/ Abbreviation	Definition
SDG(s)	Sustainable Development Goal(s)
SEEA	System of Environmental-Economic Accounting
SNA	System of National Accounts
StEP Initiative	Solving the E-waste Problem Initiative
t	Metric tonne (1000 kg)
UEEE	Used Electrical and Electronic Equipment
UN Comtrade	United Nations Commodity Trade Statistics Database
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNITAR	United Nations Institute for Training and Research
UNSD	United Nations Statistics Division
UNU	United Nations University
UNU-KEYs	E-waste classification maintained by UNITAR SCYCLE
WHO	World Health Organization
WEEE	Waste electrical and electronic equipment

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Chapter 1.
Introduction

1.1 The growing e-waste challenge

The use of electrical and electronic equipment (EEE) has grown swiftly worldwide and continues to do so. In 2022, an estimated 96 million metric tonnes of EEE were placed on the market globally, up 50% from 2010 (Baldé et al., 2024). Once EEE or its components are discarded without the intent of reuse, it becomes electronic waste (e-waste), otherwise referred to as waste electrical and electronic equipment or e-scrap. Increasing quantities of e-waste are also being generated worldwide, amounting to a record 62 million tonnes (Mt) in 2022 (Baldé et al., 2024).[2] Only 22 percent of e-waste, furthermore, was documented as entering formal e-waste collection systems. The remainder is managed outside of these systems, including by the informal waste management sector, often with the use of environmentally sub-standard methods. In many cases, e-waste continues to be treated at the lowest rungs of the waste hierarchy and either landfilled or incinerated (Baldé et al., 2024). Significant transboundary movement of e-waste has also been documented, particularly from high-income to middle- and low-income countries. The current way in which e-waste is managed globally poses substantial and frequently realised risks of damage to the environment and human health (Baldé et al., 2024; WHO, 2023).

1.2 The status of e-waste statistics production globally

Better data and statistics have an important role to play in tackling the e-waste challenge. However, data on EEE and e-waste across countries has historically been limited in its coverage and detail, likely accuracy[3], comparability[4], and timeliness[5] (when it is even produced at all). To establish a baseline picture of e-waste statistics production globally, in 2016, the UNU in conjunction with United Nations Statistics Division (UNSD), United Nations Economic Commission for Europe (UNECE), and Organisation for Economic Co-operation and Development (OECD), conducted pilot surveys of national statistical bodies' practices in the area (which included all countries, except for those already reporting WEEE statistics to Eurostat). These surveys were sent to 77 countries, and at the time, only 11 countries could provide data, which in many cases was only partial. Since then, the OECD, UNSD, Eurostat, the United Nations Institute for Training and Research (UNITAR), and the ITU have systematically incorporated questions on e-waste as part of questionnaires distributed at the international level to compile data on waste arisings and waste management.

[2] *There are nonetheless large disparities between countries regarding levels of electrification and digitalisation, as well as the scale of EEE flows and stocks in absolute and per capita terms (Baldé et al., 2024; World Bank, 2024). While the consumption and use of EEE is most prevalent in high-income countries, middle- and low-income countries appear to be following a similar path, with EEE POM growth rates ranging from 10% to 25% annually (Baldé et al., 2017).*

[3] *The property exhibited by data values when reflecting the true state of the world to a degree necessary for an intended purpose (ISO, 2022).*

[4] *The extent to which differences in concepts and calculation methods lead to difficulties in comparing statistics on a like basis (Bergdahl et al., 2007).*

[5] *Reflecting the period between the availability of data and the phenomenon it describes (Bergdahl et al., 2007).*

The OECD has been collecting data on EEE and e-waste across OECD countries since 2015 through the Annual Quality Assurance of the OECD State of the Environment Questionnaire. The questionnaire on e-waste was developed in collaboration with UNU and includes data on EEE POM, e-waste generated, e-waste collected, e-waste recycled, and e-waste reused and remanufactured. It breaks EEE down into six product categories: large equipment, small equipment, laptops, screens/monitors, and temperature exchange equipment. The questionnaire further includes qualitative questions on the legal framework and institutional arrangements for collecting and managing e-waste in countries. The questionnaire is sent annually to OECD countries that are not reporting to Eurostat, and data is validated with the support of UNITAR. Data for all OECD countries are published on the OECD Data Explorer and the OECD Environment at a Glance indicators platform.

For data collection by the OECD, data availability is best for e-waste collected (provided by 31 countries out of 38 in 2024) and recycled (30 countries), but many gaps remain for e-waste generated, with only 12 countries able to supply data on this. In addition, differences in definitions and estimation methodology still affect cross-country comparison. The OECD strives to improve this data and organised a workshop on enhancing e-waste data and statistics in January 2025. The objective of this workshop was to help countries produce and improve the quality of data and statistics on e-waste, by sharing experiences across countries regarding methods and tools, data sources used, and the main challenges to produce these data.

Questions on e-waste generation and e-waste collection have been included by UNSD as part of the UNSD/United Nations Environment Programme (UNEP)[6] Questionnaire on Environment Statistics (the Questionnaire) since the 2018 data collection round. The Questionnaire is part of the biennial UNSD data collection from all countries, except those that are covered by OECD and Eurostat data collection.

Since first being collected on a regular basis via the Questionnaire in 2018, the provision of e-waste data by United Nations (UN) Member States has struggled to meet demand to help better inform policy decision-making on this pressing issue. *Ex poste* the 2022 cycle of collection via the Questionnaire, 23 countries (out of about 165 recipient countries in total) were able to provide data on e-waste collected in their territory, and 19 countries were able to provide data on e-waste generated. This data was validated with the support of UNITAR. While this presents a better picture of e-waste than in the absence of any data collection and what has been achieved in past collection rounds, much remains unknown about volumes of e-waste generated and collected across the countries surveyed.

[6] *United Nations Statistics Division, Questionnaire on Environment Statistics https://unstats.un.org/unsd/envstats/questionnaire*

Through comments and descriptions of statistics from countries, UNSD has learned of increased awareness of the issue of e-waste. This has been achieved through references to relevant legislative processes, the presence of administrative records concerning e-waste, memoranda of understanding between institutions, etc. Treatment of e-waste, especially the percentage recycled, is of great interest for Sustainable Development Goal (SDG) indicator 12.4.2[7] (the proportion of hazardous waste treated), with the Questionnaire being regarded as the best source for this purpose for many countries. The most recent opportunity for approximately 165 countries to provide e-waste data to the Questionnaire was in the second half of 2024. The next data collection round is planned for 2026.

Eurostat plays the leading role in collecting e-waste statistics mandated for reporting across European Union (EU) Member States. The EU Waste Statistics Regulation defines the primary statistical measurement framework for quantifying waste. Through this, data on waste generation and waste treatment is submitted by EU Member States every two years, including with a breakdown of waste using the European Waste Classification for Statistics (EWC-Stat). Level 2 EWC-Stat categories most relevant to e-waste are: "Discarded electrical and electronic equipment." (08.2) and "waste containing PCB" (07.7)[8]. "Batteries and accumulators waste" (08.41) are reported separately.

There are additional reporting obligations and targets under the WEEE Directive that yield relevant information on e-waste across EU Member States, Norway, Iceland, Liechtenstein and Bosnia and Herzegovina[9]. Under this mechanism, reporting generally focuses on the quantities of EEE POM, e-waste generated, and e-waste collected, as well as that received for treatment including reuse, recycling, and wider recovery. While offering useful insight on key variables and including with detail across six product categories or greater, reporting under the WEEE Directive does not provide a complete picture of e-waste flows. This includes missing components such as transboundary movements. This lack of transparency is also reflected in the fact that, despite the Basel Convention and the EU's Waste Shipment Regulation requiring reporting of hazardous e-waste, not all e-waste is considered hazardous and therefore not all cross-boundary movements are recorded.

Data collection by the OECD, UNSD and Eurostat points to an increasing number of countries compiling e-waste statistics at the national level.

Data collection by the OECD, UNSD and Eurostat points to an increasing number of countries compiling e-waste statistics at the national level. Advancements have been observed in countries across all populated continents and all income levels. This is now being done at a sufficient pace, that benchmarking with other countries and calculation of global averages is possible. Nevertheless, there remain gaps and areas for improvement in the measurement of e-waste globally. This includes a wider uptake of measurement across countries, greater coverage of variables tracked, and more consistency in methodologies used to generate statistics in the area.

[7] *United Nations Statistics Division, https://unstats.un.org/sdgs/metadata/files/Metadata-12-04-02.pdf*
[8] *https://unstats.un.org/unsd/classifications/Family/Detail/1065*
[9] *ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en*

1.3 Work on e-waste statistics by UNITAR, Global E-waste Statistics Partnership, and the Task Group on Measuring E-Waste

To aid the compilation of reliable and comparable data on e-waste across countries, the Partnership on Measuring ICT for Development established the Task Group on Measuring E-Waste in 2013. This was to enable more informed policy-making and wider action on the environmentally sound management of Used Electrical and Electronic Equipment (UEEE) and e-waste. As part of the work of the Task Group on Measuring E-Waste, the first edition of the *E-Waste Statistics* guidelines was published in January 2015 (Baldé et al., 2015). This was following a verification process with experts in the field and public consultation.

The guidelines define a measurement framework based on standardised definitions, that incorporates widely available data sources mapped to a statistical classification of electronic products.

The guidelines define a measurement framework based on standardised definitions that incorporates widely available data sources mapped to a statistical classification of electronic products (the UNU-KEYs), and details processing steps to derive consistent outputs in the form of indicators on the scale of e-waste and its fate. The framework has been expanded on through the second (Forti, Baldé and Kuehr, 2018) and, now, third editions of the E-Waste Statistics guidelines. These subsequent editions have incorporated further methods to fill data gaps, outlined case examples and learning from these, and addressed practical challenges that can exist in the measurement of e-waste. For example, measuring trade of e-waste and UEEE between countries, assessing the recovery of secondary raw materials from e-waste management and estimating e-waste processed in scrap metal waste streams.

Alongside these methodological developments, the Global E-waste Statistics Partnership was established by the ITU, the UNU SCYCLE Programme, and the International Solid Waste Association in 2017. Its objective has been to help countries produce e-waste statistics, and to build a global e-waste database to track developments in the treatment and regulation of e-waste over time. Key achievements of the Global E-waste Statistics Partnership to date include: the publication of the *Global E-Waste Monitor* in 2017, 2020, and 2024, alongside a range of regional monitors; the establishment of the globalewaste.org website to publish data on key indicators such as e-waste generated and e-waste formally collected; and regional capacity-building workshops conducted in East Africa, Latin America, Eastern Europe, and the Arabian states to train national statistical bodies on the methodology. You can find many of these resources under the publication page of the globalewaste.org website.

The Global E-waste Statistics Partnership has made an important contribution to addressing the global e-waste challenges by raising awareness, encouraging more governments to track e-waste, and administering workshops and trainings to build national and regional capacities in producing e-waste statistics. In 2022, the UNU-SCYCLE Programme migrated to UNITAR-SCYCLE, and the Global E-waste Statistics Partnership continues through the work of the ITU and UNITAR-SCYCLE.

1.4 Structure of the guidelines

The guidelines are intended for use by national statistical offices, other government agencies, and interested parties in producing internationally comparable statistics on e-waste.

This document provides guidance on undertaking the measurement of e-waste. It is intended for use by national statistical offices, other government agencies, and interested parties in producing internationally comparable statistics on e-waste. It assumes limited prior knowledge of the user around quantifying EEE and e-waste flows and stocks and provides recommendations for how to get started on measurement in the area. The text is paired with figures, boxes and case examples to aid understanding of how to apply the methods. Links are also provided to throughout the document to supporting materials and capacity-building resources.

The content of each section of the guidelines builds on one another as part of an overall measurement framework and these are described below:

- Section 2 proposes characteristics for an effective classification to underpin e-waste statistics, introduces the "UNU-KEYs" designed to meet these criteria, and outlines changes brought in with its latest revision, the UNU-KEYs-v.2.
- Section 3 outlines the measurement framework for producing e-waste statistics, including its underlying mathematical equations. Newly developed approaches to measure the uptake of e-waste legislation globally are outlined here.
- Section 4 details the data sources that can be used to populate each variable in the e-waste framework, and associated calculation steps.
- Section 5 defines indicators for use in summarising the statistical outputs from the measurement framework, alongside minimum requirements for reporting.
- Section 6 showcases examples of measurement of e-waste being undertaken across countries and regions, many of which are based on the methodology outlined in these guidelines and UNITAR tools. Best practice and 'lessons learned' are highlighted across the case examples.
- The Annexes to this document include: examples of questions that can be included in surveys relating to EEE/e-waste; correlations between the UNU-KEYs-v.1 and v.2 as well as between the UNU-KEYs and Harmonized Commodity Description and Coding System (HS) and Central Product Classification (CPC) classifications; lifetime profiles for each UNU-KEY in the form of Weibull distribution parameters; average weights per UNU-KEY over time; and, for the first time, material composition breakdowns per waste category and Persistent Organic Pollutant (POP) impact factors.

Data on material and substance compositions can be used to convert mass-based estimates of EEE products/e-waste, into constituent materials. Potential applications of the data include estimating the recovery of materials across different end-of-life processes, monitoring the implied market value of e-waste, and tracking hazards.

1.5 Getting started with e-waste measurement

Countries are at different stages in producing statistics, including those on e-waste. Recognising this, minimum reporting recommendations are laid out in Box 10 of these guidelines for countries starting out in measuring e-waste. These recommendations focus on a minimum set of products to report e-waste statistics on. These have been shortlisted based on criteria including market share and presence across different markets, being associated with high risk to human health and the environment through containing environmentally toxic compounds and representing potential large opportunities for recovery activities by holding large concentrations of valuable resources. In addition, core indicators to focus on for countries at early stages of e-waste measurement are recommended. These are EEE POM, e-waste generated, e-waste formally collected and the formal e-waste collection rate.

To support countries at various stages of producing e-waste statistics, between 2021 and 2023, UNITAR and ITU developed self-paced e-learning courses on SDGs and waste statistics: Addressing the e-waste challenge through data and statistics (ITU Academy). These courses provide an overview of the importance of collecting and monitoring SDG environment-related indicators and waste statistics, in addition to methodological guidance. UNITAR has also developed toolkits to calculate relevant indicators, such as EEE POM and e-waste generation at the national level: Toolkits - Scycle Academy for Circular Economy (ACE) (academy-ce.info). Box 1 further details UNITAR training materials that are available to help data compilers produce statistics on e-waste.

Box 1. UNITAR training materials on measuring e-waste

UNITAR plays an active role in building capacity across countries in the compilation of e-waste statistics. This includes by having developed a range of tools and training material to help measure e-waste, providing wider support as needed, and through projects such as regional e-waste monitors. As part of this capacity-building role, UNITAR has developed an e-waste statistics toolkit comprised of four Excel files and accompanying manuals to assist countries in producing national-level statistics for key e-waste indicators. The tools input to one another in the process of producing final indicators and cover:

- The calculation of EEE POM for UNU-KEYs with sufficient trade and production data
- The calculation of EEE POM of solar photovoltaic (PV) panels
- The calculation of e-waste generated using outputs from the EEE POM toolkits
- The extrapolation of data to 2050 to support scenario analysis and set e-waste collection targets over time. These extend the framework to capture embedded and recovered resources and environmental impacts.

The toolkits can be found at the website: Home - Scycle Academy for Circular Economy (ACE) under the section Toolkits - Scycle Academy for Circular Economy (ACE)

The tools can be pre-filled by UNITAR with internally validated data. This includes EEE POM calculated with the apparent consumption methodology and the latest available and most representative lifetimes. A detailed outline of the steps followed to perform the calculations can be found in Box 3 of these guidelines, "Worked example: steps to calculate EEE POM and e-waste generated." As well as drawing on a pre-populated toolkit, countries can update the data used in the tool on POM for past years and/or the lifetime data based on local context and evidence to support such updates.

The e-waste calculation tools for the EU Member States are publicly available online (European Commission, 2018),[10] while for other countries in the world, these tools can be requested by contacting the corresponding author within the UNITAR-SCYCLE Programme for this document.

[10] *https://environment.ec.europa.eu/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee/implementation-weee-directive_en*

Chapter 2.
Classifying e-waste

This section proposes characteristics of an effective product classification to base e-waste statistics on, introduces the UNU-KEYs designed to meet these criteria, and outlines changes brought in with its latest revision (the UNU-KEYs-v.2). It also introduces statistical classifications used to describe adjacent areas and explains how these link to the UNU-KEYs.

2.1 Criteria for e-waste classification

With a wide variety of electronic goods coming onto the market each year and already in circulation, an essential first step in constructing statistics on e-waste is to group those products into a set of categories to which data inputs, such as on trade flows and lifetimes, can be mapped. As well as having this statistical purpose as part of the measurement framework outlined in these guidelines, a well-constructed product classification can support the tractability of e-waste statistics to a variety of users, from the interested public to businesses and policymakers.

Although multiple classifications can be used to describe EEE and e-waste, there are also several characteristics or criteria that a classification should ideally meet to effectively harmonise e-waste measurement and enable the production of internationally comparable statistics and indicators.

First, categories as part of a classification system should not be defined too specifically around products that do not pose a threat to the environment, contain valuable materials, or have a large market share. This is to avoid having too many irrelevant codes, which can impose an unnecessary administrative burden in data collection and reduce the informativeness of derived statistics. Second, and related to the abovementioned point, large or environmentally relevant e-waste products should be separately demarcated within the classification system to support ongoing monitoring and assessment of "hotspots" of hazardous or valuable materials and help pinpoint areas for improvement.

An effective e-waste classification should avoid excessive aggregation as well as unnecessary product specificity. Categories should be defined at an appropriate level of detail that reflects environmental relevance, while minimising ambiguity in product assignment.

Third, the classification system should not use categories that are too aggregated, as doing so can limit the ability of users to pinpoint areas for improvement and leave room for ambiguity in allocating products to each group between countries. Inconsistencies in reporting affect data quality and can hamper the usability of results for cross-country comparison, international benchmarking, and the production of regional and global aggregates.

Fourth, a robust classification system for e-waste statistics should categorise products by similar function, lifetime distribution, comparable material composition (both in terms of hazardous substances and valuable materials), and related end-of-life attributes. This can help improve the accuracy of quantitative assessment linking these data inputs, as is done as part of the measurement framework outlined here.

2.2 The UNU-KEYs

By grouping individual products with similar functions, lifetimes, and material characteristics, the UNU-KEYs provide a practical and consistent basis for compiling e-waste statistics.

The UNU-KEYs are a classification system developed by UNU to categorise electronic products while fulfilling the criteria outlined in section 2.1 (Wang et al., 2012a, 2012b). Version 1 of the classification system was created in 2012 and provided the basis for the first edition of the *E-waste Statistics* guidelines. The resulting UNU-KEYs were intended to encompass all possible EEE (about 900 products clustered into 660 main product types) (Huisman et al., 2012).
By fulfilling the criteria outlined for an effective e-waste classification, including offering a high level of product detail and grouping similar products across key vectors such as weight and lifetimes, the UNU-KEYs provide a particularly useful basis for compiling e-waste statistics.

Intended from the outset to link to other classification systems used in measuring e-waste, the first two digits of the UNU-KEYs follow the 10-category classification used in the original WEEE Directive (2002/96/EC), and which is still in use in a few selected other countries. The UNU-KEYs now also link to the 6-category classification outlined in the 2012 recast WEEE Directive (2012/19/EC) to be used in reporting by EU Member States from 2019, in addition to the common methodology for calculating WEEE collection targets under Article 7 (European Commission, 2017/2018) (see Table 2 for the correlations between these). This edition of the guidelines captures the more recent split of PV panels from wider large equipment and refers to this as the EU-6PV.

The UNU-KEYs classification also explicitly connects to other widely used national classification systems used to describe related areas, many of which input to the measurement framework laid out in these guidelines-such as the HS and Standard International Trade Classification (SITC) used for classifying traded products. A correspondence table that translates the UNU-KEY categories to the HS classification is provided in Annex 3 of this document. Countries which use their own trade classifications often publish correlation tables between these and the HS.

The UNU-KEYs can also be connected to product classifications for describing goods produced in a domestic territory such as the Central Product Classification (CPC)[11] and Classification of Products by Activity (CPA) and PRODCOM classification used in the EU. By extension, a connection can also be made to classifications used for describing production activities such as the NACE classification. In the absence of registers used for enforcing e-waste-related regulations (that generally collect data on EEE POM as well as collection and some end-of-life treatments such as recycling), the explicit linkages to other classifications through the correlation tables supplied in these guidelines permit countries to produce EEE POM figures, which can then serve as an alternative data source for estimating e-waste generation.

2.3 Statistical uses of the UNU-KEYs

The UNU-KEYs classification system has several intended statistical uses. First, the UNU-KEYs support interoperability between other classification systems, particularly helping to move between the 6 and 10 categories used as part of reporting under the EU WEEE Directive (see Table 2). Second, by linking to available product classifications such as HS codes for describing trade (see Annex 3), the system can be used to integrate data from relevant areas such as trade and domestic production to calculate key indicators and inputs to the measurement framework, such as EEE POM, in a uniform way. The UNU-KEYs can also be used to map other national classifications into the e-waste statistical framework - see Section 2.7.

The UNU-KEYs enable the consistent integration of diverse data sources into the e-waste measurement framework, supporting comparable and coherent statistical outputs.

Third, key inputs to the measurement framework such as average weights provided in these guidelines and related UNITAR resources are published at the detail of the UNU-KEYs. These are intended to help convert, for example, unit-level data to the equivalent mass of products (indicative average product weights are shown in Annex 6). Additionally, and as the lifetime distributions of the products making up each UNU-KEY are relatively homogeneous, the lifetime parameters presented in Annex 5 can be used in conjunction with POM data to determine e-waste generated with a good degree of accuracy.

Since allocation of products to the UNU-KEYs is done in a way to ensure that the material composition of products within a UNU-KEY is also broadly homogeneous, the classification can robustly support material flow and stock analysis used to trace raw materials making up the assemblies and sub-assemblies comprising EEE and e-waste.[12] This can further support linked impact and economic analyses, such as the assessment of the value of e-waste.

[11] *https://unstats.un.org/unsd/classifications/Econ/cpc*

[12] *A commonality across EEE products is their use of electronic circuits, semiconductors, and printed boards, which are critical to their functioning. Between EEE products, electronics can nevertheless vary significantly in their material composition. Parts can be composed of ferrous metals such as iron and steel; non-ferrous metals such as aluminium, copper, and gold; critical raw materials such as rare earth metals; and hazardous substances such as lead and mercury. This is in addition to plastics resins, biomass-based products, and non-metallic minerals. Annex 7 provides estimates of the material makeup of EEE products classified by EU-6 category.*

2.4 Rationale for introducing and the main changes with the UNU-KEYs-v.2

The market for electronic products continues to expand in both diversity and scale. As a result, any classification system intended to comprehensively capture EEE products and meet broader criteria for effective electronics and e-waste classification (as outlined in Section 2.1) must evolve too.

The UNU-KEYs-v.2 update responds to technological change and evolving product markets, ensuring that the classification remains analytically robust, coherent, and fit for purpose.

Several revisions to the UNU-KEYs classification have been made as part of this third edition of the guidelines. This has been done to capture emerging technologies and novel EEE products entering global markets, as well as to incorporate newly introduced trade and production codes delineating these in statistical systems. Adjustments have been made to also improve the allocation of products across the UNU-KEYs to ensure each continues to contain goods with similar attributes. The classification has been simplified in some areas through merging UNU-KEYs in cases where categories are low-volume and there is limited additional value in tracking these separately.

As part of this revision, several new UNU-KEYs have been introduced. These include for products not previously captured under the UNU-KEYs-v.1 (e.g. electric vehicle charging points), as well as for products previously captured, but that are to be separated into their own UNU-KEY, such as e-bikes. The UNU-KEYs descriptions have been refined in several cases to help communicate more clearly what they represent. With these revisions, all original functions of the UNU-KEYs remain, or have been enhanced. The updated UNU-KEYs classification reflecting these changes is referred to as the UNU-KEYs-v.2. A summary of the main changes proposed to be made to the UNU-KEYs-v.1 is presented in Table 1.

Table 1. The main changes between the UNU-KEYs-v.1 and UNU-KEYs-v.2

Change type	Affected UNU-KEYs in v.1	Affected UNU-KEYs in v.2	Description of change and rationale
• New UNU-KEY	**n/a**	**0409** - E-cigarettes and other electronic vaporising devices	A new code 0409, covering disposable vapes, vape pens and vape mods
• New UNU-KEY • Reallocation of product from existing UNU-KEY • Update of existing UNU-KEY definition	**0703** - Leisure equipment (e.g. sports equipment, electric bikes, juke boxes)	**0703** - Leisure equipment (e.g. sports equipment, juke boxes) excl. electric bikes **0704** - E-bikes	A new code 0704, covering e-bikes previously captured under UNU-KEY 0703 and update of 0703 definition to explicitly omit these[13]
• New UNU-KEY	**n/a**	**0705** - Charging stations	A new code 0705, covering electric vehicle charging stations not previously captured under the UNU-KEYs
• New UNU-KEY • Reallocation of product from existing UNU-KEY	**0302** - Desktop PCs (excl. monitors, accessories)	**0302** - Desktop PCs (excl. monitors, accessories) **0310** - Servers	A new code 0310, consisting of servers previously covered under 0302
• Merge of existing UNU-KEYs	**0406** - Cameras (e.g. camcorders, photo & digital still cameras)	**0401** - Small Consumer Electronics (e.g. headphones, cameras, remote controls)	Merging of the contents of UNU-KEY 0406 into 0401, including an updated definition
• Update of existing UNU-KEY definition	**0305** - Telecom-munication equipment (e.g. cordless phones, answering machines)	**0305** - Telecom-munications equipment excl. mobile phones	Definition of 0305 updated to reflect its inclusion of telecommunications infrastructure
• Update of existing UNU-KEY definition	**0105** - Dryers (wash dryers, centrifuges)	**0105** - Dryers (incl. centrifuges)	"Wash dryers" removed to ease comprehension vis-à-vis 0104
• Update of existing UNU-KEY definition	**0108** - Fridges (incl. combi-fridges)	**0108** - Refrigerators (incl. combi-refrigerators)	Changed "Fridges" to "Refrigerators"
• Update of existing UNU-KEY definition	**0307** - Professional IT equipment (e.g. servers, routers, data storage, copiers)	**0307** - Other IT equipment (e.g. data storage, copiers)	Removed reference to servers, now captured under 0310

[13] *Note: There is not yet a global HS code specific to e-bikes as the nearest HS code (871160), includes e-scooters and motorbikes. However, there is in place a relevant CN code (87116010) which can be used as part of EU calculations. If a HS code is introduced specific to e-bikes in the future, this can be used as a basis to track e-bikes outside of the EU. Countries may also have data that can be used to populate this UNU-KEY based on their own trade classifications.*

The revisions to the UNU-KEYs have been informed by analyses as part of the 2024 *Global E-waste Monitor*, in particular for electronic vapes. In addition, further analysis to identify which UNU-KEYs may require updating and to populate product weights and lifetime parameters for newly proposed UNU-KEYs. The updated classification was tested through e-waste calculations conducted at multiple scales - globally (by country), within the EU, and across detailed pilot studies in Kenya, Jamaica, and Thailand - to assess how the changes could affect results in different contexts. The testing showed that changes introduced with the UNU-KEYs-v.2 led to comparable outcomes at the national, regional, and global level as with the UNU-KEYs-v.1, with figures for EEE POM and E-WG marginally higher primarily due to the broader scope of the UNU-KEYs-v.2.

Countries establishing e-waste statistics for the first time are encouraged to use the UNU-KEYs-v.2, while those already using the UNU-KEYs-v.1 can transition to the updated version with broadly comparable results.

The main benefits of introducing the UNU-KEYs-v.2. is to help to account more effectively in statistics for products experiencing significant growth, that pose specific risks to the environment and e-waste management concerns, and which can offer particular opportunities for the circular economy. Countries that are embarking on the production of e-waste statistics for the first time are encouraged to use the UNU-KEYs-v.2. Countries that have statistical routines already established using the UNU-KEYs-v.1 may still continue using the UNU-KEYs-v.1 if they wish, whilst having slightly different but broadly comparable results. Descriptions of each UNU-KEY under v.2 and how they correlate to the EU-6PV and EU-10 categories are presented in Table 2. A correlation table between v.1 and v.2 of the UNU-KEYs classification is shown in Annex 2 of this document.

2.5 Links between the UNU-KEYs and the EU-WEEE Directive

The "WEEE Directive" (2012/19/EU), which entered into force in 2012, applies to EU Member States. The WEEE Directive is intended to limit the generation of e-waste, improve its end-of-life treatment, and drive resource efficiency across the product life cycle (EC, 2024). As part of monitoring and reporting under the regulations, a 10-category breakdown of EEE/e-waste had been used until the 2018 reference year:

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment and photovoltaic panels
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
10. Automatic dispensers

As set out in Annex III of Directive 2012/19/EU, from reference year 2019, six product categories have been recommended for use for monitoring and reporting purposes. EU Member States can adopt more detailed classifications if they wish. Directive (EU) 2024/884[14] states that no later than December 2026, the European Commission shall consider evidence on the need to introduce a new EEE category for PV and split these from the existing EEE category 4, "large equipment" to create a new category, "large equipment (photovoltaic panels incl. inverters).":

1. Temperature exchange equipment
2. Screens, monitors, and equipment containing screens having a surface greater than 100 cm
3. Lamps
4. Large equipment (any external dimension more than 50 cm)
   - Large equipment (excl. photovoltaic panels)
   - Large equipment (photovoltaic panels incl. inverters)
5. Small equipment (no external dimension more than 50 cm)
6. Small IT and telecommunication equipment (no external dimension more than 50 cm)

The correlations between the UNU-KEYs and both EU categories are shown in Table 2. Reflecting the potential introduction of a category for PVs under the current EU-6-based legislation and ongoing monitoring of this category by Eurostat, column 3 is presented with PV separated from large equipment (and referred to as EU-6PV).

[14] *https://eur-lex.europa.eu/eli/dir/2024/884/oj*

Table 2. UNU-KEYs v.2 descriptions and correlations to the EU-6PV and EU-10 classifications

UNU-KEY	UNU-KEY Description	EU-6PV	EU-10
0001	Central Heating (household-installed)	Large equipment (excl. photovoltaic panels)	Large household appliances
0002	Photovoltaic Panels (incl. inverters)	Photovoltaic panels (incl. inverters)	Consumer equipment
0101	Professional Heating & Ventilation (excl. cooling equipment)	Large equipment (excl. photovoltaic panels)	Large household appliances
0102	Dishwashers	Large equipment (excl. photovoltaic panels)	Large household appliances
0103	Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)	Large equipment (excl. photovoltaic panels)	Large household appliances
0104	Washing Machines (incl. combined dryers)	Large equipment (excl. photovoltaic panels)	Large household appliances
0105	Dryers (incl. centrifuges)	Large equipment (excl. photovoltaic panels)	Large household appliances
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	Large equipment (excl. photovoltaic panels)	Large household appliances
0108	Refrigerators (incl. combi-refrigerators)	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, hair dryers, 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)	Small IT	IT and telecommunications equipment
0305	Telecommunications equipment excl. mobile phones	Small IT	IT and telecommunications equipment
0306	Mobile Phones (incl. smartphones, pagers)	Small IT	IT and telecommunications equipment
0307	Other IT equipment (e.g. data storage, copiers)	Large equipment (excl. photovoltaic panels)	IT and telecommunications equipment
0308	Cathode Ray Tube Monitors	Screens and monitors	IT and telecommunications equipment
0309	Flat-Panel Display Monitors (LCD, LED)	Screens and monitors	IT and telecommunications equipment

UNU-KEY	UNU-KEY Description	EU-6PV	EU-10
0310	Servers	Small IT	IT and telecommunications equipment
0401	Small Consumer Electronics (e.g. headphones, cameras, 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, Blu-Ray, set-top boxes) and projectors	Small equipment	Consumer equipment
0405	Speakers	Small equipment	Consumer equipment
0407	Cathode Ray Tube Televisions (TVs)	Screens and monitors	Consumer equipment
0408	Flat-Panel Display Televisions (TVs) (LCD, LED, Plasma)	Screens and monitors	Consumer equipment
0409	E-cigarettes and other electronic vaporising devices	Small equipment	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	Small household appliances
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 (excl. photovoltaic panels)	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, juke boxes) excl. electric bikes	Large equipment (excl. photovoltaic panels)	Toys
0704	E-bikes	Large equipment (excl. photovoltaic panels)	Toys
0705	Charging stations	Large equipment (excl. photovoltaic panels)	Not in scope
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 (excl. photovoltaic panels)	Medical devices
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	Small equipment	Monitoring and control instruments
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	Large equipment (excl. photovoltaic panels)	Monitoring and control instruments
1001	Non-cooled Dispensers (e.g. for vending, hot drinks, tickets, money)	Large equipment (excl. photovoltaic panels)	Automatic dispensers
1002	Cooled Dispensers (e.g. for vending, cold drinks)	Temperature exchange equipment	Automatic dispensers

2.6 Links between the UNU-KEYs and other international classifications

2.6.1 International trade statistics

Most countries worldwide and all member countries of the World Customs Organisation, compile international merchandise trade statistics using a multipurpose international product nomenclature called the Harmonized Commodity Description and Coding System. This goods classification developed by the World Customs Organisation, intended to standardise the specification of goods, is generally referred to as the "Harmonized System," or "HS" for short. The HS correlates to the UN's SITC (currently, Rev. 4), which is also used for describing traded products though does so mainly for analytical purposes. It further forms the basis of the more detailed Combined Nomenclature (CN) classification used by Eurostat and EU states for categorising trade flows through EU countries.

Under the latest major revision of the HS classification (which occur approximately every five years), the HS 22, there are currently around 7,700 six-digit HS codes capturing all traded commodities and arranged in four hierarchical levels. Of those, there are approximately 270 codes which can be regarded as EEE final goods. A list of HS codes correlating to the UNU-KEYs is provided in Annex 3 of these guidelines. The HS classification is used by supranational bodies for publishing international trade statistics such as by the UNSD in the UN Comtrade database. Countries and regions implementing their own trade classifications often anchor these to the HS or publish correlation tables between these and the HS.

2.6.2 National production statistics

The UNU-KEYs can be linked to national production classifications such as the CPC, CPA, and PRODCOM, enabling the use of domestic production statistics within the e-waste measurement framework.

Different classifications are used across countries and regions for categorising goods produced in an economic territory. The primary statistical application of the CPC (currently Version 2.1) maintained by the UN is to serve as an international standard for assembling and tabulating data requiring product detail, including but not limited to industrial production statistics, consumption and price statistics (UNECE and OECD, 2024). The CPA is the equivalent classification required for use in the EU, while typically adding a further (sixth) digit of detail. Extending the CPA while covering only goods produced under Sections B, C and E of the (also linked) NACE Rev. 2 activity classification[15], the more detailed PRODCOM classification (adopted primarily across EU countries), is used to describe sales of manufactured products in monetary and volume terms. The classification draws on up to eight-digit numerical codes (often referred to as 'PCC' codes)[16], the first four of which refer to NACE classes and the next two digits refer to CPA subcategories. These also correlate closely to the HS and CN classifications for describing trade, with each 8-digit PRODCOM code covering one or more CN code.

[15] *The 4-digit International Standard Industrial Classification of All Economic Activities (Rev.4) was developed by the UNSD to describe production activities including, but not limited to, manufacturing and calculated generally in monetary terms. This links to the NACE classification developed by Eurostat for classifying economic activities, NAICS used in the U.S., and other related classifications used for the same purpose.*

[16] *Further national detail is added by some countries to bring these to 10-digits (or more).*

2.6.3 The European List of Waste

There is no global classification system of waste (UNECE, 2021). Nonetheless, what appears to be the most widely used waste classification system at present is the European Waste Classification for Statistics (EWC-Stat) developed for statistical usage. Each EWC-Stat category is an aggregate of categories making up the non-statistical European "List of Waste" classification established by Commission Decision 2000/532/EC. The LoW provides a 6-digit hierarchical legal classification system for classifying solid wastes. It is used mainly for administrative purposes, including permits, waste transfer, and consignment notes to ensure proper waste management.

Many European countries, as well as some Caucasus and Central Asian countries, use the LoW as a framework to collect and publish waste statistics. Following amendments in 2015, the LoW now defines more than 900 waste types at a 6-digit level. These are structured into 20 chapters, mainly according to the industrial or business process from which the waste originates, though also in some cases, by type. The approach to allocating wastes to the LoW categories is outlined in the introduction of Decision 2000/532/EC. Across the classification system, a split is made between hazardous and non-hazardous wastes, designated by a reporter based primarily on the composition of a waste.

Thirteen LoW codes explicitly relate to e-waste and all map to a single EWC-Stat category.

Of the full list of LoW codes, 13 codes explicitly refer to e-waste, including specific sub-types such as "single-use cameras." This list encompasses both hazardous and non-hazardous waste codes, as outlined in Table 3. Parts or components that can be generated during the treatment of e-waste, such as metal scrap, plastics, and glass are captured under other codes which are not listed in this table. The same applies to mixed waste codes, such as "mixed municipal waste" (20 03 01), that may contain e-waste. These mixed codes frequently represent a significant tonnage of waste in a given country.

For reporting statistics on waste at an EU-level, the EWC-Stat (Rev. 4) classification aggregates the LoW codes into approximately 50 level 2 headings (and approximately 80 level 3 headings) based primarily on their substance. All 13 of the LoW codes outlined relate to one EWC-Stat level-2 heading, namely EWC-Stat 08.2, "Discarded electrical and electronic equipment."

Table 3. European List of Waste (LoW) and EWC-Stat codes that refer to e-waste

LoW Code	Description of LoW	EWC-Stat (Rev. 4) 08.2
HAZARDOUS		Discarded electrical and electronic equipment
09 01 11	Single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03	
16 02 09	Transformers and capacitors containing PCBs	
16 02 10	Discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02.09	
16 02 11	Discarded equipment containing chlorofluorocarbons, HCFC, HFC	
16 02 12	Discarded equipment containing free asbestos	
16 02 13	Discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12	
20 01 21	Fluorescent tubes and other mercury-containing waste	
20 01 23	Discarded equipment containing chlorofluorocarbons	
20 01 35	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	

2.6.4 Classification of Electrical and Electronic Wastes under the Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) provides an internationally agreed-upon classification system for hazardous wastes, helping to support the monitoring and control of the transboundary movement of e-waste (Basel Convention Secretariat, 2019). Having entered into force in 1992, there are currently 191 Parties to the Basel Convention.

Effective on 1 January 2025, the Basel Convention adopted a series of amendments to the Convention, including a new definition of Electrical and Electronic Waste. This new definition lists under the Basel Convention both hazardous and non-hazardous electrical and electronic waste. It uses the code A1181 in Annex VIII to the Basel Convention for hazardous electrical and electronic waste and the code Y49 in Annex II to the Convention for non-hazardous electrical and electronic waste. It includes three categories: a) e-waste, b) waste components of e-waste, and c) waste arising from the processing of e-waste, including its components. In comparison to the prior definition and classification of e-waste under the Basel Convention's, the new classification no longer includes the mention of scrap. With this decision, the Basel Convention prior informed consent procedure will apply to nearly all electrical and electronic waste's transboundary movements among its Parties, further aligning its coverage with the UNU-KEYs. National reporting data by Parties to the Basel Convention can offer a source of data to analyse flows and quantities of controlled transboundary movements of e-waste.

2.6.5 Framework for the Development of Environment Statistics

The Framework for the Development of Environment Statistics (FDES) has been designed as a flexible multipurpose conceptual and statistical framework to support countries in the production of environmental statistics. As a framework, it defines a scope for environmental statistics while giving an organising structure to guide data collection and compilation at the national level. First published by the UNSD in 1984, its latest revision is the FDES 2013. Component 3 of the framework - "Residuals" and of that, Sub-component 3.3: the "Generation and Management of Waste" - captures statistics on the amount and characteristics of waste (including e-waste) that have been generated through production and consumption processes in an economy. Under the framework, waste is defined as discarded material for which the owner or user has no further use. The FDES structure is constructed to link to statistical classifications used in economic and social domains such as the ISIC for classifying production activities as well as other related frameworks, such as the System of Environmental-Economic Accounting (SEEA).

2.6.6 System of Environmental Economic Accounting

Prior to the adoption of the System of Environmental Economic Accounting Central Framework (SEEA-CF), the System of National Accounts[17] provided limited guidance on how to reflect, in national accounts, damages to the environment from economic activity, or the value that the environment provides to the economy (LaNotte and Rhodes, 2020). The SEEA framework attempts to fill this gap, applying the accounting concepts, structures, boundaries and principles of the System of National Accounts to environmental information in support of paired economic-environmental analysis.

Solid waste accounts organise information on waste generation and management to support integrated economic-environmental analysis.

Chapter 3.6.5 of the SEEA-CF elaborates on solid waste accounts as a way to organise information on the generation of solid waste and its subsequent management (UN, 2017)[18]. These accounts take the form of a physical supply and use table, which consists of a 'supply table' showing sources of solid waste generation across the economy and imports, and a 'use table' which covers the collection and treatment of solid waste residuals. These 'uses' include through activities within domestic waste collection, treatment and disposal industries and related activities in other industries, as well as exports and releases to the environment, such as via landfilling.

The SEEA guidelines present an indicative categorisation of solid waste types for compiling solid waste accounts based on the EWC-Stat classification. There, e-waste is captured as a subset of the category EWC-Stat 08.2 "discarded electrical and electronic equipment." The solid waste accounts nevertheless represent a flexible framework, and data compilers may adapt this classification to incorporate a more detailed or alternative breakdown of waste types and flows.

Regarding how data generated through the framework outlined in these guidelines can contribute to a solid waste account, on the 'supply' side and as well as giving insight into the total quantity of 'e-waste generated' due to consumption within a national territory, the indicator 'e-waste imported' can be incorporated directly into the physical supply and use table. Unlike SEEA, the methods outlined in these guidelines do not characterise waste generated according to its domestic origin, whether by institutional or industrial units. Nevertheless, such a breakdown could be possible through further modelling by data compilers.

On the 'use' side, data derived from the measurement framework outlined here, particularly on e-waste collected, recycled, entering the waste bin (which typically goes to landfill or incineration), and exported can help populate a physical use table for e-waste in the solid waste accounts. Further breakdowns such as of the quantities of waste entering either landfill or incineration, may be possible to estimate using wider waste statistics available in a country.[19]

[17] *The System of National Accounts is an internationally agreed-upon set of recommendations on how to compile macroeconomic statistics spanning production, income, consumption, accumulation, and wealth. It was introduced by the UN in the 1950s to support the international comparability of statistics collected across countries regarding their economies. The current international standard is the SNA08 and, in Europe, specifically, the European System of National Accounts 2010 (ESA 2010).*

[18] *It distinguishes between residual flows (where the unit discarding the material receives no payment for it), product flows of solid waste (where the discarder receives a payment for the waste, but the value of the material is small), and flows of products (where the discarded materials are sold as second-hand products).*

[19] *For further information on linking waste statistics to waste accounts, see documentation of the following Eurostat project: https://circabc.europa.eu/ui/group/b01d2930-990e-44fb-9121-a9a6b00a1283/library/681ad2db-5e74-4e61-8a08-f10177256915*

2.6.7 UNECE and OECD Waste and Circular Economy Statistics

The UNECE Waste Statistics Framework was published in 2021 to support countries in developing or reviewing national work plans on waste statistics and has been endorsed by national statistical offices in more than 60 countries (UNECE, 2021).[20] One objective of the framework is to provide a foundation for the integration of specific waste streams, such as e-waste, into official statistics. Prepared jointly by UNECE and the OECD, *The Guidelines for Measuring Circular Economy (Part A: Conceptual Framework*, Indicators and Measurement Framework), published in 2024, aims to further support the development of internationally comparable statistics on the circular economy, including by outlining common definitions and key areas to measure (UNECE and OECD, 2024). The Guidelines draw on the UNECE Waste Statistics Framework (UNECE, 2021), on earlier publications by the OECD on measuring material flows and resource productivity (OECD, 2008), and on the work carried out by OECD in cooperation with UNECE on *Monitoring progress towards a resource-efficient and circular economy* (OECD, 2024).

In line with the Bellagio Declaration (EPA Network, 2021), the conceptual framework underpinning the 2024 guidelines centres around four themes: the material life cycle and value chain, including information on material flows; interactions between the economy and the environment; socioeconomic opportunities from a just transition; and responses and actions, particularly government action. Across these, the guidance proposes a tiered indicator framework consisting of 19 core indicators and additional complementary and contextual indicators. EEE flows and e-waste are captured across several of these, such as under theme 2.1 - "Waste generation trends by source, and by waste or material type."

2.6.8 United Nations Framework Classification for Resources

The United Nations Framework Classification for Resources is a global, principles-based framework for classifying and communicating the maturity level of energy, mineral, and raw material resource-based projects (UNECE, 2019). This includes for anthropogenic resources derived from residues and wastes. The framework is intended to help address challenges and opportunities in the resource sectors, which include enhancing resource security, promoting resource efficiency, reducing waste, and increasing transparency through standardising the classification of resources.

The framework describes the status of commercial viability of resource projects based on three criteria: socioeconomic viability, technical feasibility, and the degree of confidence in the quantity and quality of the resource. While generic, the framework provides specifications for applying the system to different resource types and contexts (UNECE, 2022a). Nevertheless, guidance on applying the framework to secondary raw materials such as e-waste is more limited at present.

[20] *Since 2016, the UNECE has provided secretariat functions to the Task Force on Waste Statistics established by the Conference of European Statisticians. The main objective of the task group has been to develop a conceptual framework on waste statistics capable of meeting new demands for data in the context of growing aspirations across countries for more "circular" economies.*

As part of the EU-funded FutuRaM project, a range of case studies are being developed which are expected to help establish procedures for better defining, evaluating and categorising secondary raw material resources projects in order that they can be classified and reported following the framework (FutuRaM, 2024).

2.7 Links between the UNU-KEYs and national e-waste categories

National e-waste categories can be mapped to one or more UNU-KEYs, allowing country-specific classifications to be aligned with internationally comparable e-waste statistics.

Countries that have e-waste legislation in place may already have a national classification of e-waste in use. However, the scope of this legislation can differ by country, and in some instances, not all UNU-KEYs fall within this. Furthermore, groupings of products can be different from the harmonised categories presented in these guidelines (e.g. UNU-KEYs, EU 6-PV, and EU 10) and are frequently less granular than the UNU-KEYs. It is possible to convert national clusters of e-waste categories into the internationally recognized e-waste classifications by linking individual categories to single or multiple UNU-KEYs. An example of this is shown in Table 4. Once this correlation is made, it is possible to link the UNU-KEYS to the 6/7 and 10 e-waste categories used in the EU based on the correlations in Table 2.

As one example, until 2014 as part of its Extended Producer Responsibility (EPR) scheme on EEE/e-waste, China applied a more limited scope than the full list of UNU-KEYs and one that included refrigerators (UNU-KEY 0108), TVs (an aggregate of UNU-KEYs 0308, 0309, 0407 and 0408), washing machines (UNU-KEY 0104), air conditioners (an aggregate of UNU-KEY 0111 and 0113), and computers (CNBS, 2012). Since 2014, coverage has been expanded to include printers and copy machines, fax machines, electric (and gas) water heaters, kitchen ventilators, mobile phones, and telephones. Another example is from Japan, where the adopted classification uses an aggregate "TVs for household use," consisting of the UNU-KEYs 0407 and 0408, and with the same for the category "Refrigerators (for household use)," which is an aggregate of UNU-KEY 0108 and 0109.

Table 4. Example of correlations between the Japanese national clustering of EEE products and the UNU-KEYs

National clustering	UNU-KEYs linked
TVs (for household use)	0407, 0408
Air conditioners (for household use)	0111
Refrigerators (for household use)	0108, 0109

2.8 Correlations between the classifications

Links between the classifications presented in Section 2 of these guidelines are summarized in Table 5. The HS, CN, and PCC codes describe products with the greatest amount of detail, with each UNU-KEY typically correlated to several of these. The UNU-KEYs can, in turn, be related to the 6 or 10 categories in the WEEE Directives. Historically, it has been difficult to relate the LoW codes to the HS codes.

A preliminary correlation table between CN and waste codes was published by the European Commission in the Commission Implementing Regulation (EU) 2016/1245 (European Commission, 2016). Recent developments under the Basel Convention include its expanded definition of e-waste to cover final products, parts/components, and pre-processed waste and scrap.

Table 5. Overview of correlations between classifications to gather or disseminate data for e-waste statistics

	UNU-KEYs	HS, CN, CPC, and PCC codes	European List of Waste (LoW) and EWC-Stat	Basel Codes	FDES, SEEA	EU WEEE Directive, 6/7, categories
HS, CN, CPC and PCC codes	Each HS, CN, or PCC code uniquely links to the UNU-KEYs for EEE. CPC codes can link to multiple UNU-KEYs. HS 8549 covering e-waste (see Box 8) and CN sub-headings are correlated to the UNU-KEYs only at the level of total transboundary e-waste imports/exports. CPC and PCC codes do not cover e-waste.					
EU LoW and EWC-Stat	The UNU-KEYs in most cases are not correlated to individual LoW codes (except for 0502/0503) but can be correlated at an aggregate level, while an aggregate of all UNU-KEYs also links to one EWC-Stat category (08.2).	An aggregate of e-waste-related LoW codes and EWC-Stat 08.2 can correlate to an aggregate of e-waste related HS/CN codes.				
Basel Codes	The UNU-KEYs are product-focused, while Basel codes are hazard-focused. Mapping requires assessing the materials within each UNU-KEY product to assign portions of its e-waste to A1181 or Y49.	Link to the new electrical and electronic waste entries and a number of HS codes associated with specific e-waste streams.	Relevant LoW codes classified as hazardous correlate to A1181, those classified as non-hazardous correlate to Y49.			
FDES, SEEA	An aggregate of all UNU-KEYs can be linked to one EWC-Stat (08.2), used as a basis for SEEA waste accounts.	An aggregate of e-waste-related HS and CN codes can correlate to one EWC-Stat (08.2).	Correlated at a total level through a singular EWC-Stat (08.2).	Correlated through a singular EWC-Stat (08.2)		
EU WEEE Directive, 6/7 categories	Each UNU-KEY can be correlated to one of the 6/7 categories (Table 2).	Can be linked through the UNU-KEYs.	Correlated at a total level across relevant LoW codes (see section 2.6.3) or EWC-Stat 08.2 to the total across the 6/7 categories.	Correlated only at the total level.	Correlated only at the total level.	
EU WEEE Directive, 10 categories	Each UNU-KEY can be correlated to one of the 10 categories (Table 2).	Can be linked through the UNU-KEYs.	Correlated only at the total level.	Not directly correlated.	Correlated only at the total level.	Can be linked using the UNU-KEYS.

Chapter 3.
The measurement framework for e-waste statistics

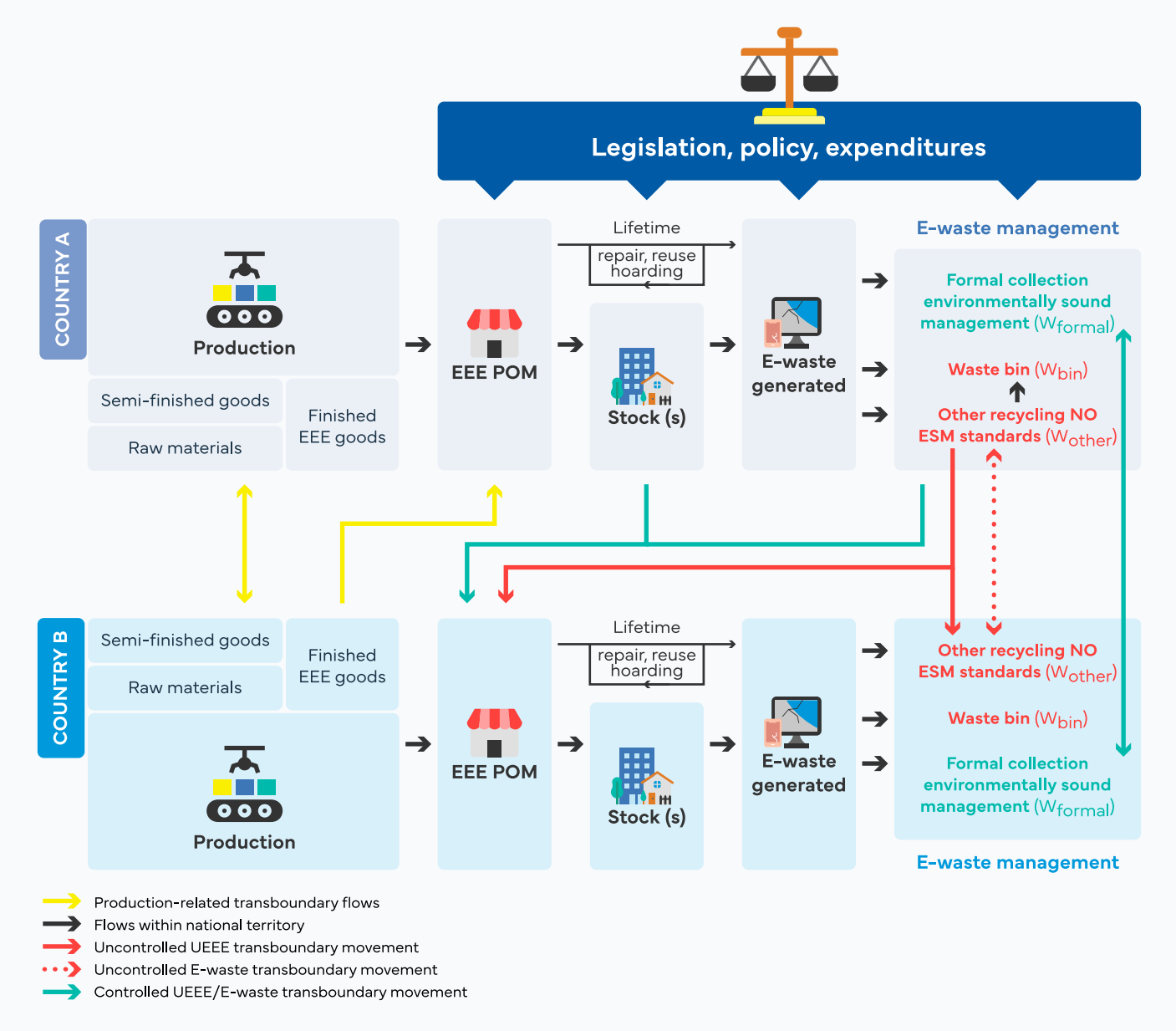
This section lays out the conceptual basis for the e-waste statistics framework. It defines the system boundary and key variables making up the measurement framework and explains how these variables relate to one another through mathematical equations. Examples are given of how the measurement framework can be applied, and these are expanded on in the 'National and regional case examples of e-waste measurement' in Section 6.

3.1 E-waste measurement framework overview

Harmonised concepts and terminology are the bedrock on which to build statistics. Alongside the product classification outlined in Section 2, these guidelines also define a consistent set of stages and variables along the EEE/e-waste life cycle that are (recommended to be) populated as part of the measurement framework.

Figure 1 shows how these different stages relate to one another, covering all key points along the product/material life cycle, from production and trade to consumption, the stock of EEE products in an economy, e-waste generated, and end-of-life treatment. Transboundary flows of e-waste and UEEE are represented. Responses and actions in the form of legislation, policies, and expenditures by a government are a key dynamic driving the system, and these are explicitly captured in the framework and now measured (Baldé and Bel, 2022).

Figure 1. Overview of the measurement framework for e-waste statistics



As in the real world, the measurement framework defined in these guidelines is constructed in such a way that the stages and variables along the EEE/e-waste product life cycle relate to one another. In the framework, this is achieved through a set of mathematical equations that capture input-output dynamics and mass-balances.

The measurement framework is flexible, insofar as it can be applied across different system boundaries - from the national or regional level to the global level, as well as across different historic time periods. Too, as part of forward-looking scenario analyses. While the framework laid out here focuses primarily on quantifying material flows and stocks (alongside regulation), it can and has been extended to cover pollution releases to the environment and economic values (e.g. Baldé, Panchal and Forti, 2022).

3.2 Key variables making up the measurement framework

3.2.1 Production, trade, and EEE POM

EEE POM represents the quantity of final EEE products that enter the market in a geographical area each year. This can consist of a wide variety of products, ranging from small IT equipment to temperature exchange equipment.[21] EEE is often a highly transboundary product group across its stages of production, from raw material extraction through to component manufacture and final product assembly. "**Trade**" in final EEE goods is therefore an important input for estimating EEE POM when using the "apparent consumption" method.[22] As well, production data can be used as an input to estimate the "apparent consumption" of EEE goods in a given time period, which is equivalent to "**domestic production**" plus net trade (i.e. imports - exports). Such a measure broadly corresponds to the scope of POM reported through dedicated registers under national EPR schemes, such as defined under the WEEE Directive.

3.2.2 Lifetime and stocks

After equipment has been placed on the market in a territory and then sold to a consumer/user, it stays in the possession of private (households or businesses) or government institutional units for a period of time until it is disposed of.[23] This period includes any exchange of second-hand equipment between institutional units within the country, including through activities such as repair, resale/donation (prior to products entering the managed waste system), or refurbishment.

Product lifetimes describe the period EEE remains in use or storage within the economy and are a key input for estimating when placed-on-the-market products become e-waste.

Disposal, when occurring, may result from product failure or replacement for other reasons, such as economic or psychological "obsolescence." The period of time that EEE products remain in the economy is referred to within the measurement framework as the product "**lifetime**", and sometimes also referred to as "residence time." More specifically, the product lifetime covers the period of time that products stay in households, businesses, and the public and third sector until they are disposed of. It differs from the term ''service time'', as the "residence time" includes both the time a product is in use (or service) as well as in "hibernation" (Murakami et al., 2010 in Wang et al., 2013). It is incorporated into the framework as a retirement distribution as part of a multivariate Input-Output Analysis method to estimate e-waste generated.

[21] *Crudely, the distinction between EEE POM and sales (realised final demand) is inventories each year.*
[22] *In practice, due to, e.g., gaps in classification schemes, alternative estimation methods for POM can in some cases be required (see Box 2).*
[23] *Asset service lifetimes are an input to the System of National Accounts, including as part of calculating the stock of non-financial assets within national balance sheets as well as measures of net fixed capital formation.*

Also a direct function of the lifetime, the equipment in households, businesses and the public sector as built up through the quantity of EEE POM over time and net of disposals/e-waste, is referred to under the measurement framework as the "**stock**." It can also be considered the 'urban mine', reflecting the latent resource potential of EEE products when coming to their end-of-life.[24] In an average home in the European Union, we can find 74 EEE items (excluding lamps and luminaires), which represent a total mass of 90 Mt (including lamps and luminaires) in EU households (Baldé et al., 2022c).

EEE in the stock can be either functioning or non-functioning. It may also be either in use or out of use (otherwise referred to as "dormant" or "hibernating"). For example, Thièbaud et al. (2018) found that the hibernating stock of EEE devices in Switzerland accounted for about 25% in mass of the total stock in 2014 (Thièbaud et al., 2018). Product dormancy can arise due to a number of reasons, such as users wanting to retain a back-up device or out of concern, for e.g. data security. It can lead to a lag in the release of products from the stock, but it does not affect all EEE products equally. For example, large products with significant storage requirements, such as washing machines often see more highly correlated sales and disposals at the household level (Stowell and Yumashev et al., 2020). Such distinctions and data gathering can be made as part of household and business surveys, as shown in Annex 1, Table 16.

When a second-hand functioning product is exported, the lifetime in that country comes to an end, and the product enters the market again in another country where the lifetime can be continued as part of that country's stock.

3.2.3 E-waste generated, collected and treatment

"E-waste generated" represents the domestic outflow from the stock before collection, treatment, export, or disposal.

After a period of use, which varies significantly across product types and user behaviours, EEE eventually reaches its end of life and becomes waste. In the context of this framework, "**e-waste generated**" refers to the quantity of e-waste arising within a territory before any collection, treatment, export or disposal occurs, and excludes imports of used or waste equipment originating from other countries. E-waste generated therefore represents the total domestic outflow from the in-use stock.

The quantity of e-waste generated in a given year corresponds to the sum of all historic POM cohorts multiplied by the probability that those products exit the stock in that period. This approach captures the probabilistic nature of lifetimes, including variations caused by repair, reuse, storage, hoarding, or premature obsolescence.

[24] *For example, gold and silver concentrations within printed circuit boards can be as high as ten times those seen in their respective ores (Wäger, Hschier, and Eugster, 2011 in Liu et al., 2019).lifetimes are an input to the System of National Accounts, including as part of calculating the stock of non-financial assets within national balance sheets as well as measures of net fixed capital formation.*

Once generated, e-waste can follow several collection and treatment routes. The collection route of e-waste generated is critical, as it determines the environmental and human health impacts as well as the potential for material recovery through circular economy activities such as formal recycling and preparation for reuse. Collection routes typically include formal EPR-compliant systems, informal channels, waste bins or mixed waste streams, second-hand or reuse markets, and potential (legal or illegal) cross-border movements. The implications and outcomes of these pathways are examined in the following sections.

Formal collection refers to e-waste collection and treatment activities conducted under national e-waste legislation, typically within producer responsibility or designated take-back systems.

3.2.3.1 Formal collection

"Formal collection" activities are usually governed under national e-waste legislation and involve e-waste being collected by designated organisations, producers, and/or the government (Baldé et al., 2022c). This can happen via retailer take-back mechanisms, municipal collection points, and/or pick-up services. The final destination for e-waste collected via formal routes is generally a state-of-the-art treatment facility that can recover valuable material parts in an environmentally sound way and dispose of hazardous parts correctly. Requirements on such facilities may be defined in terms of technology standards or permit-based requirements such as using the "best available technology" or "best available technique". Alternatively, through bans on certain types of processing or performance standards such as in relation to environmental emissions.

Recycling rates within formal systems vary significantly by product category, component, and material, driven by technical recoverability and the value of component and material parts (see Box 5). Recovered secondary raw materials may re-enter EEE manufacturing supply chains or be used in other industrial applications as part of the circular economy.

3.2.3.2 Other recycling

"Other recycling" refers to e-waste recycling and associated collection activities that occur outside the official take-back or producer-responsibility system. The nature of these flows varies significantly across countries, depending on the maturity of national waste management frameworks, infrastructure, and enforcement capacity (UNECE, 2022b).

In countries that have developed waste management laws, e-waste is collected by individual waste dealers or companies and then traded through channels including scrap dealers, waste brokers, intermediaries, and cross-border traders. Possible destinations for e-waste in this scenario include selective recycling of valuable materials in e-waste without specifically treating the hazardous substances. This could be done by mixing of the metallic parts with metal recycling, or plastic components with plastic recycling, and exports to developing countries. Under this scenario, e-waste is often not treated in a specialised environmentally sound recycling facility for e-waste management.

By contrast, in most countries in the Global South, "other recycling" activities are more heavily embedded in the informal sector, involving large numbers of self-employed collectors, traders, refurbishers, and small recycling enterprises. These actors often work door-to-door to purchase e-waste from consumers at home and then sell it to be refurbished or recycled, or as 'waste pickers'. Electronic products in this case are mostly recycled through "backyard recycling" or environmentally substandard methods. These treatment routes may involve manual disassembly but often can also include open burning and the use of chemical processing such as acid baths to strip away valuable material parts. These practices can be associated with high levels of pollution, given numerous toxic compounds such as cadmium, lead, persistent organic pollutants, brominated flame retardants, and mercury often found in EEE products. As well as potentially severe damage to the environment, there can also be negative impacts for human health, with children and pregnant women especially at risk (WHO, 2023).

3.2.3.3 Waste bin

E-waste, especially small EEE, can also end up in waste bins. In this scenario, users directly dispose of e-waste in normal dustbins mixed with other types of waste. Consequently, the discarded e-waste is then treated with the regular mixed or residual waste. This waste is most likely incinerated or landfilled depending on the waste management infrastructure in a country. This can include uncontrolled waste burning and informal landfilling. These are not regarded as appropriate techniques for treating e-waste because both can negatively impact the environment and lead to resource loss. Furthermore, such disposal can pose a hazard to waste workers, as seen with fires at waste processing facilities resulting from e-vapes disposed of in this way.

Transboundary movements capture e-waste and UEEE that cross national borders for treatment, reuse, or disposal.

3.2.3.4 Transboundary movement of UEEE and e-waste

As well as being treated domestically, e-waste and UEEE are sometimes shipped to other countries. These import and export flows should ideally be documented as part of a comprehensive measurement framework. A 'transboundary movement' refers to instances of goods moving from an area under the national jurisdiction of one State, to or through an area under the national jurisdiction of another State, or to or through an area not under the national jurisdiction of any State, provided at least two States are involved in the movement (Basel Convention, n.d.).

Trade flows in e-waste or UEEE can be classified as either controlled or uncontrolled (Baldé et al., 2022a). Controlled trade flows are those reported as movements of hazardous waste with prior informed consent under the Basel Convention. Uncontrolled flows may consist of e-waste mixed in with other legal shipments, including UEEE, for disguising purposes. Licit and illicit methods may overlap, such that it can be difficult to determine whether shipments of used electronics are waste or second-hand products, and therefore whether a transboundary movement is legal or illegal under the 2019 Ban Amendment to the Basel Convention. Several developments have been made to quantify the transboundary movement of UEEE and e-waste; these are further outlined under Section 4.8.

3.2.4 E-waste legislation

E-waste legislation provides the legal basis for controlling e-waste flows and for generating reliable data to support e-waste statistics and monitoring.

Governments around the world are at different stages in applying enforceable and implementable instruments governing environmentally sound e-waste management, both legally and non-legally binding. Having a policy or legal instrument governing the management of e-waste has been shown to be a key enabler for transitioning to a circular economy for electronics.[25] Notably, data collected by the ITU and UNITAR shows that countries with such an instrument in place have on average a formal e-waste collection and recycling rate of 25%, whereas for the majority of those without, this rate is on average 0% (Baldé and Bel, 2022). E-waste management systems based on functioning EPR schemes that involve the use of registers to track performance can also help improve data availability and quality.

As well as the global e-waste recycling rate, the ITU tracks the number of countries covered by e-waste policy, regulation, or legislation. It also provides technical assistance to governments to develop such instruments. The 2022 report, *Consultation on the Methodology for Measuring the Global Progress of E-waste Legislation*, lays out a proposal for a methodology and indicator to measure current development in introducing e-waste legislation across nations (Baldé and Bel, 2022). More information on the method for assessing e-waste legislation can be found in Section 4.9.

[25] *Relevant legislation may be levied along the product life cycle, including at the production stage, such as using standards to drive improved design for durability and repairability. Alternatively, at the consumption stage approaches to regulation may include "green public procurement" or product labelling to enable more informed purchase decisions.*

3.3 Mathematical equations underpinning the framework

When a country has no data available on **EEE POM** from a dedicated register or wishes to construct an adjacent measure as a point of comparison, it can alternatively make estimates of the weight of EEE POM using the "apparent consumption method." The mathematical formula for this method is outlined in Eq. [1], with EEE POM in a given year t equal to the sum of domestic production of EEE final goods and imports of EEE, minus EEE exports (i.e. net imports) in that year.

[1] $$\mathrm{POM}(t) = \mathrm{Domestic\ production}(t) + \mathrm{Imports}(t) - \mathrm{Exports}(t)$$

Where data on domestic production is not available, POM can be calculated as a function of net imports alone i.e., imports subtract exports.[26] As the reliability of data inputs can significantly affect results, steps should be taken to carefully prepare data from these sources. This can involve filling data gaps or otherwise cleansing unrealistic data (See Section 4.1.2 for further detail on recommended steps) (Wang et al., 2013). Across either the administrative registers or apparent consumption approach, a sufficiently long time series for EEE POM of 30 years of continuous data or greater is recommended to support robust modelling of derived variables such as e-waste generated. Where this is difficult to produce from observed data, techniques including backcasting can be used (See Box 3 for a case example). Historic data can also be requested from UNITAR SCYCLE. Though trade data is often published in mass and unit terms alongside the monetary value of traded commodities, physical values in domestic production data (where available) for EEE finished goods are generally presented in unit terms alone. It is therefore recommended when making calculations of apparent consumption using this approach, that average per-unit weights such as presented in Annex 6 of these guidelines (which also account for trends in weights over time) are used to convert POM calculated in unit terms into equivalent tonnages.

[26] Tariff subheadings denoting imported goods as 'completely knocked down' (CKD) may also offer a proxy for domestic production in countries given final assembly of these goods can be undertaken domestically.

Box 2. Method to calculate EEE POM for solar PV panels

The World Customs Organisation revises the HS classification approximately every five years, having done so most recently through the introduction of the 2022 edition (HS22). This brought the number of commodity codes to 7,710, up from 7,437 under HS17 (UNCTAD, 2023). Since the introduction of HS22, the 6-digit HS code '854143' - 'Electrical apparatus; photosensitive semiconductor devices, photovoltaic (PV) cells assembled in modules or made up into panels' is being used to represent assembled PV panels in trade data. While data for this code may be used going forward to estimate trade and apparent consumption of solar PV panels, as outturn data for this code has only been published by reporters since 2022, the following method remains relevant for producing historic estimates of PV Panel POM and calculating e-waste generated.

Because assembled PV panels have not been assigned a specific HS code in the past, this has made it difficult to identify them in trade data. Because of this, an alternative approach has been developed to assist data compilers in estimating PV Panels (UNU-KEY 0002) POM figures as set out in the UNITAR EEE POM PV Panel Calculator Manual (Panchal and Baldé, 2021). The method introduced in the manual also has wider potential applications, such as helping link future renewable energy targets to EEE POM of PV panels and through doing so, making projections of future potential e-waste generation resulting from the renewable energy transition under different scenarios.

As detailed in the manual, data inputs to this method are: 1) the installed capacity of PV panels in megawatt (MW) per year and 2) MW to kg conversion factors. The former is often readily available from national statistical offices or other government institutes. In the absence of this, the IRENA database maintained by the International Energy Agency can provide a source (https://www.irena.org/Data).

Conversion factors are supplied in the manual (mass/MW conversion factor) but can be customised by the user. Using these inputs within the spreadsheet tool published alongside the manual, the user can:

- Calculate net changes in installed capacity over time, including converted into weight terms and estimate the addition to the stock of PV panels from this
- Convert the EEE POM in MW terms to tonnages using mass/MW conversion factors. These can be specific to the year of manufacture and even to the country. In case no country-specific data is available, a set of conversions is supplied in the manual (Table 6)
- Derive e-waste generated automatically based on the same approach as other UNU-KEYs, i.e. by using the Weibull distribution parameters to proxy the disposal rate for POM in a given year and calculate e-waste generation as the sum of historic POM years integrated by this distribution.

Table 6. Data to convert installed capacity in MW to kilogram

Year	Kg per Mw	Kg per panel
2012	88,000	15.0
2013	86,000	15.6
2014	82,000	16.2
2015	80,000	16.8
2016	76,000	18.1
2017	76,000	16.6
2018	71,000	18.3
2019	70,000	21.6
2020	66,000	22.0
2021	65,000	22.3
2022	64,000	22.3
2023	64,000	22.8
2024	59,949	28.8

As part of the e-waste statistics measurement framework, the product "**lifetime**", $L^{(p)}(t, n)$, captures the lifetime distribution of EEE sold in historical year t and can be used to calculate e-waste generation, the stock, and net changes in the stock. When represented as a hazard function, the lifetime reflects the probability of a product being discarded in each evaluation year n following it entering the stock in each historic year t.

Product lifetimes can be modelled using various statistical distributions. The Weibull distribution[27] is widely considered to be the most suitable for describing discard behaviour for EEE, having been widely applied in the EU and in the scientific literature (Wang, 2014). The Weibull function is defined by a time-varying shape or alpha parameter $\alpha(t)$ and a scale or beta parameter $\beta(t)$ as described in Eq. [2]:

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

Due to social, technical, and economic developments, a product's lifetime may be time-dependent. For instance, cathode ray tube monitors rapidly became outdated due to technological developments in flatscreen monitors, which likely heightened the stock attrition rate for cathode ray tube monitors. Alternatively, reduced rates of technological advancement between product generations can limit incentives for replacement and lead to longer average lifetimes. This variation can impact the accuracy of measurement as part of the e-waste framework. When changing significantly over time, lifetime distributions should ideally be modelled for each sales year separately.

For more stable products, a time-independent lifetime distribution can sufficiently describe actual disposal behaviour, as in those cases, the variations of the shape and scale parameter over time are minor and can be neglected. For these products, the distribution of a product lifetime can be simplified to the equation as described in Eq. [3]:

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

Point measures of central tendency, which are useful for communicating statistics to wider users, can also be derived from the Weibull distribution. As a widely used measure, the mean can be calculated from Weibull distribution parameters following the 2-parameter specification using Eq. [4], where μ is the mean and Γ is the gamma function:

[4] $$\mu = \beta\,\Gamma\left(1+\frac{1}{\alpha}\right)$$

Another commonly used measure, the median of a two-parameter Weibull distribution can alternatively be calculated using Eq. [5], where M is the median and ln is the natural logarithm:

[5] $$M = \beta\,(\ln 2)^{1/\alpha}$$

[27] The Weibull distribution refers to "a continuous probability distribution that... can be described as modelling the population given a variable and time-dependent failure rate" (Huisman et al., 2017, p.22).

Using POM data in conjunction with the lifetime distribution, the quantity of **e-waste generated** in a given evaluation year n is calculated based on the quantity of EEE POM from all historical years while accounting for their respective lifetimes. The method is represented in Eq. [6], where POM (t) is the quantity of EEE POM in any historical year prior to the evaluation year n; $t0$ is the initial year that a product was sold, and $L(p)$ (t, n) is the discard-based lifetime profile for the cohort of products sold in historical year t.

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

The **stock** of EEE, in a given evaluation year $S(n)$ can then be calculated as the sum of POM in historical years, $POM\ (t)$, minus the sum of e-waste generated in the historical years (t) as shown in Eq. [7], where $t0$ is the initial year that a product was sold.

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

The year-on-year net change in stock between periods equals the difference between the POM and e-waste in a given evaluation year.

As outlined in Section 3.2.3, e-waste generated can be disposed of in different ways: it can be collected in a formal system $(\mathbf{W}_{formal})$; with other recycling streams $(\mathbf{W}_{other})$; or can be discarded in normal waste bins $(\mathbf{W}_{bin})$. $\mathbf{W}_{gap}$ is the quantity of e-waste generated for which the treatment method is unknown and can be derived based on the mass balance principle. The relationship between e-waste generated, its treatment routes and $\mathbf{W}_{gap}$ is described by Eq. [8]:

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

In these guidelines, countries are also recommended to report on where the treatment of domestically generated e-waste takes place, which generally requires estimating the **transboundary movement** of e-waste. For example, formally collected quantities might be subject to further treatment domestically or exported as outlined in Eq. [9].

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

Chapter 4.
Data sources and calculation steps

This section outlines data inputs and calculation steps for populating key variables making up the e-waste measurement framework.

4.1 EEE placed on the market (EEE POM)

Estimates of EEE POM can be constructed via two main approaches. The first involves using data from dedicated administrative registers such as those used in the monitoring and enforcement of EPR schemes. The second involves using the apparent consumption approach which draws on data on trade, and where available, production. In particularly data poor environments, it may also be possible to estimate EEE POM using surveys, however there are few examples of this having been done in practice.

4.1.1 Compliance registers

Compliance registers provide a direct administrative source for estimating EEE placed on the market, but coverage, detail, and data reliability vary by country and scheme design.

First, EEE POM can be estimated using data generated under national EEE/e-waste administrative registers. These registers are generally set up to monitor and enforce compliance with EPR schemes. EPR schemes are in place in a growing number of countries, including all EU Member States, several states of the United States of America, Canada, the United Kingdom of Great Britain and Northern Ireland, China, Japan, the Republic of Korea, multiple Latin American countries (e.g. Chile, Mexico, Brazil, Argentina, and Colombia) and South Africa. Data from such registries are often made publicly available, have the potential to be timely[28] and are often collected/published directly in tonnage terms. In some cases, data captured through registers may also offer an institutional breakdown, such as between EEE POM for household or non-household end uses.

Several factors must nevertheless be kept in mind when using data from such administrative registers. First, the reliability of the data should be considered. There can be an incentive for data reporters to underreport EEE POM in order to reduce scheme liabilities which can lead to figures being an underestimate without adjustment. Non-compliance can affect values in a similar way, as can any reporting thresholds in place. Combined, there is a general tendency for registers to suggest lower POM values than is actually the case or otherwise shown by the apparent consumption method. Further affecting figures derived via this route, the coverage of registers can vary by country aligned to the scope of associated regulation and, in some cases, only offers a partial coverage of the UNU-KEYs. For example, registers may capture data on consumer electronic only and not on relevant industrial equipment. In addition, the level of detail that EEE/e-waste registers are presented against is often relatively low compared to, e.g., trade data. As highlighted in section 2, this can cloak potentially high levels of heterogeneity in material makeup, lifetimes, and environmental impact across product categories.

[28] *In the sense of being published with a small lag period and regular timestep.*

4.1.2 Apparent consumption method

The second main approach to estimating EEE POM is using the "apparent consumption method." This method is compliant with the Common Methodology approach defined in Article 7 of the EU-WEEE Directive (European Commission, 2017). It requires data on trade in final EEE goods and, where available, their domestic production as well.
A worked example of the approach is shown in Box 3, while scripts for its application written in the statistical programming language R are provided at the following open source GitHub repository (Van Straalen et al., 2017). Excel-based resources are further linked to in Box 1.

The apparent consumption method estimates EEE placed on the market using trade data and domestic production.

Calculating EEE POM based on the "apparent consumption" approach involves several steps. First, identifying trade and production codes for final EEE products in scope. In support of this, a correlation table between the UNU-KEYs and HS codes for describing trade is included in Annex 3. Reflecting the relatively high level of detail that trade statistics are reported against (whether at the six-digit HS level or eight-digit or greater CN-level), most UNU-KEYs are an aggregate of several HS codes, and this is often the same for production codes - e.g. PRODCOM. It should be noted that not all UNU-KEYs have been separably identifiable in published trade classifications in the past, such as for solar PV panels. When this is the case, it has required the use of alternative methods to fill the gaps (see Box 2).

Secondly, data for these codes must be extracted. While trade data, specifically, often benefits from high completeness across value, unit, and mass terms, data suppression in input sources can, if not resolved, lead to data gaps via this approach. This affects domestic production data particularly, which is often published under an active suppression approach, where certain data points are withheld to protect confidentiality of firms. Suppressed values should therefore ideally be estimated for accurate calculations, and a statistical routine to do so is outlined in the GitHub repository.[29]

The reliability of trade and production data should also be considered, and possible issues should be mitigated against. Trade data can be impacted by outliers,[30] missing values, and bilateral asymmetries,[31] as well as by underlying differences between countries in the scope of reported data, including due to varying cut-off thresholds for reporting (Jiang et al., 2022).[32] Furthermore, domestic production statistics are generally compiled based on surveys of manufacturers, making figures subject to sampling errors. Volume-based statistics, whether in trade or domestic production statistics, can often be associated with especially high levels of estimation. Outlier identification and treatment protocols can help correct for some of these effects, and methods to do so are also provided in the GitHub repository.

[29] *This uses a ratio calculated between units exported in trade data (generally not suppressed) and units produced for years where data is available to estimate values in years where production data is suppressed but trade data is otherwise available.*
[30] *Data points which differ significantly from other observations.*
[31] *Referring to instances of discrepancies in reported bilateral trade flows between trading partners.*
[32] *Outliers impact commodities under HS chapters 85, 84, 62, 61, and 90 most significantly (Jiang et al., 2022).*

To ensure consistent reporting units across the lifecycle of electronics, from the estimation of EEE quantities to resulting e-waste and its management, unit-level trade and domestic production data should be converted into mass terms. Annex 6 of the guidelines outlines indicative per-unit weights for each UNU-KEY that have been constructed through sampling and detailed studies. Box 3 presents a worked example of the steps used to calculate EEE POM and, in turn, e-waste generated as part of the Global E-waste Monitor.

Box 3. Worked example: steps to calculate EEE POM and e-waste generated. (Baldé et al., 2024)

In the Global E-waste Monitor 2024, the amount of e-waste generated is calculated using both empirical data from the apparent consumption method for calculating EEE POM and a sales-lifespan/lifetime model for estimating e-waste generation. Data inputs used in this report were obtained and processed following the steps set out below.

Step 1.

The relevant codes describing EEE in the HS classification were selected.

Step 2.

For the EU, international trade data was extracted from Eurostat at the level of six-digit CN codes. Domestic production data were also extracted from Eurostat, in the PRODCOM classification. For the other countries, statistical data on units imported and exported were extracted from the UN Comtrade database. This was done for 193 countries and approximately 220 8-digit HS codes for the years 1995-2022. For countries other than the 27 EU Member States, data on domestic production were retrieved from the UNSD Industrial Commodity Statistics Database, while for China and Viet Nam, data on domestic production was retrieved from national registries. For some countries, no data on production was available, and this gap was corrected for through outlier detection routines. For the business-as-usual scenario, countries were then classified into 5 groups according to their purchasing power parity (PPP).[33] This procedure was repeated for each year to capture changes in the PPP of countries over the years. This process was useful to make statistics comparable between countries and to calculate trends between groups.

- Group 1: highest PPP (higher than USD 32,992 per capita in 2017 prices)
- Group 2: high PPP (USD 32,992 - 14,471 per capita in 2017)
- Group 3: medium PPP (USD 14,470 - 6,271 per capita in 2017)
- Group 4: low PPP (USD 6,270 - 1,960 per capita in 2017)
- Group 5: lowest PPP (less than USD 1,960 per capita in 2017)

Step 3.

Unit-level data was converted into weight using the average weight data per appliance type published in the E-waste Statistics Guidelines Edition 2.

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

Step 4.
The POM weight was calculated for the 54 UNU-KEYS by using the apparent consumption approach: POM = Domestic Production + Import - Export (this equation applies to the EU Member States). When data on domestic production were not available, the following approach was used: POM = Import - Export. Undercounting as a result of no domestic production data was subsequently corrected for in the outlier detection routine in step 6.

Step 5.
The numbers presented in this report for UNU-KEY 0002 (PV panels) use the annual installed capacity of panels expressed in megawatts as a basis for the calculation of the quantity of panels POM. This is estimated as the annual change in installed capacity in the year. The source used to calculate the historical annual installed capacity of PV panels, and its future projection was data from the International Renewable Energy Agency. By applying annual conversion factors (kg PV panels/megawatts installed) obtained from the PV Cycle Association, it was possible to estimate the annual quantity of panels POM expressed in kilograms.

Step 6.
The POM data was automatically corrected for outliers, in order to detect and replace 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). The entries detected were replaced with more realistic sales values either from the time series of the origin country or from comparable countries. These statistical routines resulted in a harmonized dataset with a similar scope and consistent sales for a country based on its own trade statistics.

Step 7.
Manual corrections were performed based on the analysis of the automatic corrections, in order to correct unreliable data using knowledge of the market. For instance, cathode-ray tube televisions have not been sold in recent years. In addition, official POM country data calculated following the same methodology and provided by Argentina, Belarus, Bolivia (Plurinational State of), Bosnia and Herzegovina, Costa Rica, Ecuador, El Salvador, Guatemala, Kazakhstan, North Macedonia, Republic of Moldova and Uruguay were inserted in the datasets.

Step 8.
The POM time series was extended. Past POM was calculated back to 1980 based on trends in the available data and the appliance date of market entry. Future POM was predicted to 2030 using sophisticated extrapolation methods. The principle considers the ratio between the POM and PPP per county and uses that ratio to estimate POM with the forecast PPP from the Shared Socioeconomic Pathways database.

Step 9.
The amount of e-waste generated by country was determined using the POM and lifetime distributions. Lifetime data were obtained from the EU Member States using the Weibull distribution. Ideally, the lifetime of each product is determined empirically per product and per type. At this stage, only harmonized European residence times of EEE were available from extensive studies performed for the EU. Due to the absence of data for non-EU countries, it was assumed that the residence times per product in the EU were approximately applicable for non-EU countries as well with slight adjustments.

4.2 EEE lifetimes (L)

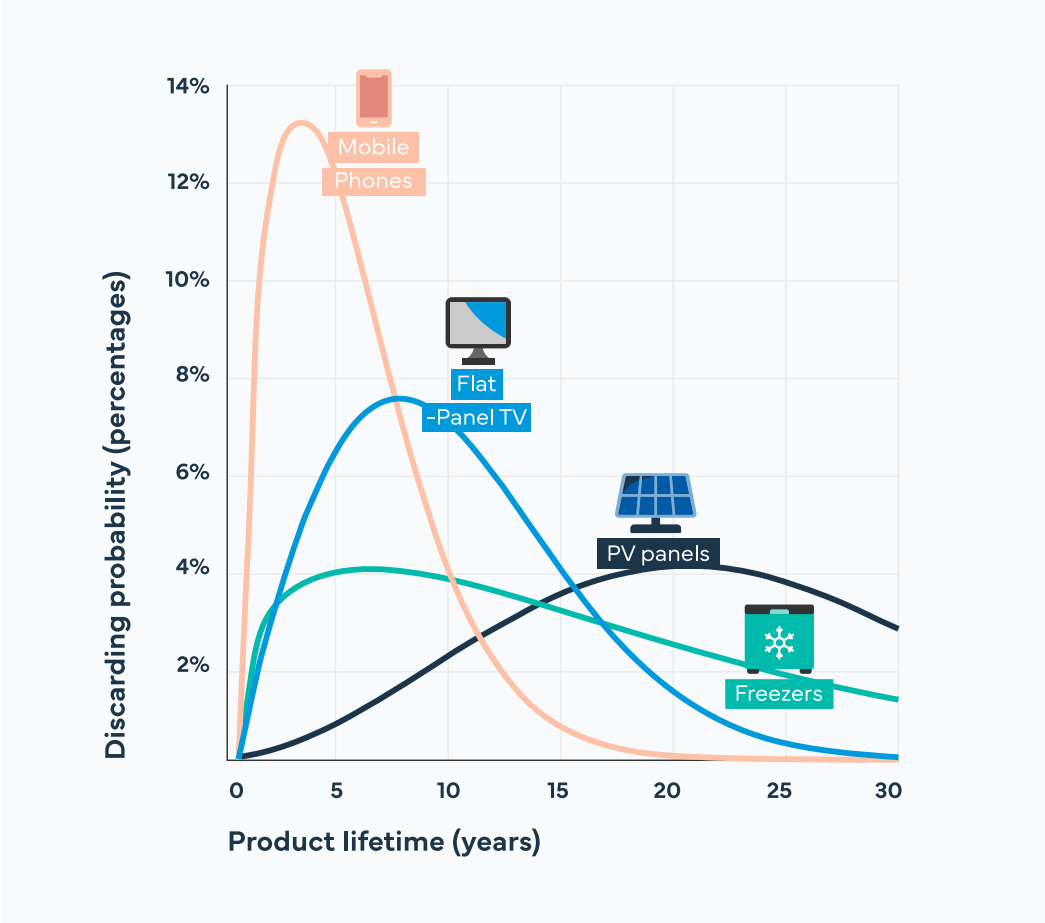
There is frequently no, or limited, official data collected on product lifetimes by governments. At the same time, indicators such as mean time to failure (for non-repairable products) and mean time between failure (for repairable products) are regularly used in industry as part of reliability testing, while data on product lifetimes can be found in the scientific literature, wider studies[34] and even through emerging citizen science initiatives (see Box 4).

Available data on product lifetimes frequently varies in its definition, presentation, and estimation methods employed (Oguchi et al., 2010). While in some cases, point estimates such as the mean or median are made available, in other studies, ranges or confidence intervals are provided (e.g. Rincon-Aznar, Riley and Young, 2017). For others, lifetime distributions are specified, including as parameters of statistical distributions. For this purpose, the Normal, Log-Normal, and Weibull distributions are frequently used. Raw data may also be available from which to construct these.

These various formats can input to material stock and flow analysis in different ways (Fishman et al., 2014). Point estimates can be directly incorporated into a "simultaneous exit" model, which assumes that all products are retired from the stock at the same age. While the use of point estimates in this way can simplify models, it also overlooks variability in product lifetimes. Ranges, and particularly those presented as confidence intervals, provide a direct basis for estimating an upper and lower bound for levels of variables such as e-waste generated over time. Data in the format of a distribution is particularly helpful, providing more realistic insight into the probability of a product being discarded in each period following the year it is placed on the market. Figure 2 provides a graphical illustration of different lifetime probability distributions per type of product in the EU.

[34] *Such as those collated in this article by the EEA: https://www.eea.europa.eu/en/analysis/publications/product-lifespans-monitoring-trends*

Figure 2. Lifetime/discard probability distributions for selected UNU-KEYs



The lifetime of EEE products may vary not only by product, but also by country and over time. Annex 5 presents lifetime distribution parameters calculated for EU and non-EU countries expressed using a two-parameter Weibull distribution specification. For non-EU countries, this includes lifetime parameters derived from studies in Kenya, Lebanon, and Nigeria (Odeyingbo, Baldé and Forti, 2022; Baldé et al., 2022b; ITU and UNITAR, 2023).[35]

While lifetimes can vary by country, the variation for the lifetimes between EU countries, for example, has been found to be small for most products (Van Straalen et al., 2017; Magalini et al., 2014). A sensitivity analysis carried out across EU countries found that the margin of error for estimates of e-waste generated related to plausible ranges in lifetimes was approximately 10% per country on average (Magalini et al., 2014). As the amount of e-waste generated is far more sensitive to levels of POM than lifetime, the Weibull parameters in Annex 5 provide a good starting point for proxying the lifetime distribution of EEE products in the absence of country-specific data.

[35] *These parameters are intended to represent the domestic lifetime of products, i.e. the time interval from acquisition by the first owner to being discarded by the final owner within the same country. This may be lower than the global residence time of an EEE product, which will be the sum of the lifetime of a product across multiple countries in instances of international trade in UEEE (Murakami et al., 2010).*

Using country-specific product lifetimes can improve the reliability of e-waste generation estimates.

Statistics producers may nonetheless wish to determine lifetimes per product that are specific to their own country. Additional research on both product lifetimes and up-to-date POM data at the country level can further improve the reliability of calculations and indicators as part of the measurement framework. The product lifetime can be constructed in various ways, and this is done most precisely if solved numerically using Eq. [6] and Eq. [7] as described in Section 3.3, and which involves iterative modelling of product entry and exit rates (Wang et al., 2013). To get realistic outcomes, one would need high-quality data, including a time series of EEE POM and at least one measurement of the stock *(S)*.

Alternatively, the age distribution for products at their point of discard can also be used to retrieve the lifetime for a specific year as shown in Eq. [10], 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, and e-waste generated *(t, n)* is the amount of e-waste in evaluation year *n* generated by the POM of products in year *t*.

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

The lifetime of EEE products in the stock *(S)* can also be obtained from household surveys (see Annex 1). This type of data can provide extra information on the lifetime distribution in different historic years as presented in Eq. [11], where *S (t,n)* and *S (m,n)* are the quantity or percentage of products still in stock that were originally sold in years *t* and *m*, respectively (i.e. the remaining rate).

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

Another simplified method to monitor the lifetime of products using household survey data is to assume that the shape *(α)* parameter in the Weibull function is exchangeable between countries and that only the scale *(β)* parameter differs. Using a transferred shape parameter (such as that provided in Annex 5), one can then calculate the scale parameter based on Eq. [12].

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

Lifetime parameters derived for EU and non-EU countries are listed in Annex 5. The methodology for calculating these lifetime profiles is compliant with e-waste regulations enforced in the EU.

Box 4. Data on product lifetimes from repair events collated by the Open Repair Alliance

Several studies have pointed to shortening lifetimes of EEE products. For example, a 2017 report from the German Environmental Agency found that between 2000 and 2010, the lifetimes of consumer electronics such as LCD monitors and televisions decreased by 17%, while for IT products such as desktops, laptops, and mobile phones, this had fallen by 10% (Prakash et al., 2020). Conversely, there is some evidence of a recent reverse to these trends in some countries, such as a reduced upgrade frequency for certain products such as mobile phones with high saturation and relatively low innovation rates between models (Kantar, 2017).

Alongside a formal/informal market repair economy for EEE products in many countries, community pop-up repair events have been documented as taking place (Open Repair Alliance, 2023). The Open Repair Alliance works to improve the collection, sharing, and aggregation of data across such community repair events. A core part of this is encouraging the use of its Open Repair Data Standard which helps define key information to collect on repair activities and standardises categories for responses to be mapped to.

As of January 2025, the Open Repair Alliance database captures standardised data from repair events across 31 countries for the period 2012-24. Observations in the database - corresponding to a repair attempt - captures whether that attempt has been successful or not, the type of product subject to a repair attempt and its brand, and the estimated age of the product at the time of (attempted) repair. It should be kept in mind that the database only represents one approach to repairing products (in the community setting, as compared with e.g., professional repair services) and reflects a subset of the population who are committed to trying to repair products.

In 2022, the Open Repair Alliance published an initial correlation table for linking the Open Repair Data Standard classification for products to the UNU-KEYs (Open Repair Alliance, 2022). This has since been further built upon to develop a more granular mapping between the Open Repair Data Standard product categories and the UNU-KEYs accounting for differences in use of the Open Repair Data Standard categories across reporting organisations and countries (Open Repair Alliance, 2024).

4.3 EEE stocks (S)

Under the framework presented in these guidelines, the quantity of EEE stocks — referring to equipment in households, businesses (as fixed capital), and the public sector — can be estimated based on trends in product placements (EEE POM) on one hand, and disposals (e-waste generated) over time on the other. Both functioning and non-functioning appliances are counted as part of the stock under the methodology. Observed data collected on EEE stocks in a country can input to the harmonised framework in different ways. This includes through validating input data on quantities of EEE POM and product lifetimes or calibrating those inputs. For example, calibration of product lifetimes can be done through iterative adjustments to lifetime parameters to better match modelled and observed stock levels over a given period.

Bespoke surveys can also be undertaken to assess quantities of EEE in the stock. Annex 1 of these guidelines presents illustrative survey questions that can be used for this purpose including possible weaknesses of this approach to consider and mitigate against. Conducted surveys should adopt a sampling approach which provides a representative picture across demographic, geographic and socio-economic dimensions to increase accuracy when extrapolating survey findings to the wider population, and to be able to report survey statistics such as confidence intervals to communicate uncertainty in findings.

While data on the quantity of EEE stocks might not be available for all UNU-KEYs given their wide coverage, some information may be available on stock levels for a subset of UNU-KEYs in adjacent ICT and environmental statistics. For example, in many countries, national statistical institutes survey households about household possession and penetration rates of several types of EEE and, in particular, ICT products.

Another data source, albeit a less reliable one, is the number of subscriptions. In that case, one subscription might be interpreted as corresponding to a stock level of at least one appliance. Weaknesses with this approach include that a narrow subset of the UNU-KEYs may be associated with subscriptions, and that there might be appliances with two subscriptions or in-scope appliances without a subscription in the stock. These factors can mean subscription counts don't directly correlate with device ownership and care should be taken in their interpretation.[36]

4.4 E-waste generated (WG)

E-waste generation can be quantified in a number of ways (Wang et al., 2013). As part of the framework outlined in these guidelines, it is recommended that e-waste generation in a given year is modelled using empirical data on EEE products entering the stock in each historic year, multiplied by the lifetime distribution probability for those products. Required data inputs for this approach are the quantity of EEE placed on the market and product lifetimes, with sections 4.1 and 4.2 further detailing data sources and recommended statistical routines to populate these input variables. Strengths of this approach includes more realistically capturing the delayed effect of waste generation for durable goods such as EEE after they are placed on the market in addition to the ability to readily generate timeseries data on e-waste generation.

Another approach to estimate e-waste generation involves summing the quantities of e-waste obtained across collection channels, treatment facilities, and disposal sites. Due to difficulties in comprehensively capturing all relevant flows that e-waste generated may be found in and including e-waste entering mixed residual waste streams, these figures are likely to represent an underestimate and should be interpreted as a lower bound. In addition, figures should be adjusted to account for imports of e-waste generated in other countries so as to estimate the supply of domestically generated e-waste only.

[36] *Estimates of the stock of EEE may be available from statistics tracking national energy use and emissions. For example, as part of estimating electricity consumption across the economy, the government department tasked with decarbonisation strategy and analysis in the United Kingdom of Great Britain and Northern Ireland, DESNZ, produces data tables showing the stock of certain domestic and non-domestic appliances. These figures are calculated based on ad-hoc surveys with results extrapolated to the population for a given year, and the stock in subsequent years modelled based on trends over time (DESNZ, 2023).*

As with quantifying stocks of EEE, bespoke surveys can also be used to estimate quantities of e-waste generation. These have been applied across a range of cases, with example questions from surveys implemented across different countries presented in Annex 1. Relevant questions involve asking respondents regarding the number of different types of EEE products discarded in a prior period - typically 12 or 24 months.

As e-waste can arise through the activities of actors across the economy, including not only households but also businesses, and government, a representative sample across these groups would be required to produce robust figures for e-waste generated across a whole economy using a survey approach. In practice however, surveys often elicit information from one group of actors such as households, and even then, typically of subset of EEE products, meaning they are likely to provide only a partial picture of e-waste generation.

Where surveys are undertaken, a probability sampling approach providing a representative picture and with a minimum sample size to reach a desired level of accuracy is needed to robustly extrapolate figures to the population. While surveys, once scaled to the population, may give insight into e-waste generation in a single period, figures can also be extrapolated to future years or interpolated between survey years in instances of them being undertaken more than one. Such extrapolation can account for exogenous factors such as demographic trends in population and economic trends such as in gross disposable household income. Through a hybrid approach, surveys on disposals can also be used to validate and calibrate inputs to the e-waste framework such as the quantity of EEE entering the market and product lifetimes.

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

Within the measurement framework, e-waste generated is modelled as a function of EEE placed on the market and product lifetimes.

"Formal e-waste collection" refers to the amounts of e-waste that is collected and recycled in compliance with e-waste management laws and environmental standards in a country. As part of the e-waste statistics framework, the formal collection of e-waste is not modelled, but rather needs to be measured using appropriate data-gathering methods (Baldé et al., 2022c). Accurately measuring formal e-waste collection is crucial for assessing recycling rates, understanding the scale of resource recovery (potential), and determining compliance with environmental standards.

All actors involved in the formal e-waste management system in a country are potential sources for such data. This includes authorised collectors and manufacturers with take-back programmes, and regulatory bodies. Data on e-waste formally collected can also be gathered 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.[37] It is further possible to gather data on the quantities of e-waste that enter treatment facilities operating in an environmentally sound manner. In such instances, e-waste imported for recycling should be subtracted from these amounts to avoid double counting and accurately reflect collection of a country's e-waste generation.

[37] *Under the Basel Convention, any exports of e-waste for overseas treatment must adhere to international standards for environmentally sound management and as of January 1, 2025, require prior written consent of the importing country and any transit nations.*

If information from the above-mentioned sources is lacking, then households, businesses and government bodies who dispose of waste can be surveyed through the use of questions on disposal behaviour such as those presented in Annex 1. Figure 3 illustrates key points at which data on e-waste formally collected and recycled can be measured and possible data sources across each.

Figure 3. Formal collection and treatment - points of measurement and data sources.

4.5.1 E-waste disposals: household, business and government statistics

The collection of quantitative data on disposals via surveys of household, business or government bodies presents one route to compile statistics on the formal collection and recycling of e-waste.[38] These surveys can be a valuable tool for understanding the generation and disposal practices of e-waste because they capture information directly from consumers who are the last owners of e-waste products. Nevertheless, to ensure statistical reliability, effective survey design and implementation is important, and any survey should involve a representative sample of a given population to which values will be extrapolated.[39]

[38] *These questions should be designed to quantify the number and types of e-waste discarded, the duration of product use (lifetime), and the method of disposal.*
[39] *This includes across urban and rural areas, while the sample size should be calculated to account for the population distribution and expected e-waste generation.*

Surveys can be used to elicit information on formal collection using questions such as on the quantity of different types of e-waste disposed of via different routes (W_{formal}, W_{bin}, or W_{other}). Such surveyed information is usually reported as the number of units. Converting the number of units to weight allows the quantity of e-waste collected to be compared more readily to other variables in the framework, which are also presented in weight terms. Illustrative questions on disposal behaviours for inclusion in surveys that can be further tailored to individual countries can be found in Annex 1.[40] Outside of surveys and particularly for the government who in many countries can be a significant source of e-waste generation, data may also be available through administrative record-keeping.

4.5.2 E-waste collection points

Collection points established by municipalities (e.g., local recycling centres) or private companies (e.g., electronics retailers or dedicated e-waste drop-off sites) are common in many countries. Obsolete electric or electronic appliances can either be brought to a collection point by an owner or can be collected as 'bulky waste' door to door, with the latter more typical for large household items such as appliances. Municipalities and private companies may register the e-waste collected. If this e-waste is recycled, it can be reported here.

E-waste collection points provide an operational source of data on collected e-waste, capturing flows managed through formal municipal and private collection systems.

Collection points established by retailers may also present a possible source of data, with the return of broken or obsolete appliances to electronics stores being an increasingly widespread practice - often driven by legal requirements. E-waste collected through these collection points must be managed correctly in certified treatment facilities (meaning facilities that meet national or international standards for environmentally sound recycling and disposal) to be considered part of the formal collection system.

Mechanisms for e-waste collection, including related data collection, can vary by country. As one example, in the Netherlands (Kingdom of the), the National (W) EEE Register is mandated by law to compile e-waste statistics. This body collects data from producer responsibility organisations i.e. organizations that ensure producers meet their obligations for the recycling and treatment of end-of-life products. Additionally, the National (W)EEE Register gathers statistics on the export of EEE for reuse, tracking the movement of e-waste beyond domestic borders. PROs are the main data provider to this Dutch body, while the National (W)EEE Register also collects its own statistics on the exportation of EEE for reuse. In other countries, a "clearinghouse" mechanism may be in place, where various stakeholders-such as EEE producers with end-of-life treatment obligations, waste collectors, and recyclers-report their collection data to a central body. This clearinghouse may be managed by a government agency or require upward reporting to relevant statistical bodies to ensure accurate and consistent data reporting. Data collected through this clearinghouse mechanism is typically reported to national statistical bodies or environmental agencies, which may validate and compile the data for use in national inventories and e-waste management reports.

[40] *It should be noted that household surveys may be subject to response bias, where certain groups of people are more or less likely to respond to surveys or to accurately report their disposal habits. Additionally, recall bias may affect responses regarding the lifespan of products.*

4.5.3 Questionnaires to treatment facilities

E-waste collected can also be estimated using data from treatment facilities, often gathered through regular reporting or mandatory monitoring systems that track the quantities of e-waste entering these facilities. Comprehensive registers maintained by government agencies or regulatory bodies are essential for collecting facility-related information, such as the types and quantities of e-waste treated.

A disadvantage of focusing measurement at the point of waste treatment is that the constitution of e-waste may change during processing (e.g., it may be dismantled into components), which can make it difficult to link the treated e-waste back to its original form or accurately report the quantities in terms of the original product types. Another challenge is that it may be difficult to trace which treated e-waste was imported for recycling or which domestically generated e-waste was exported for treatment. This can result in data discrepancies, especially if cross-border e-waste movements are not adequately tracked alongside. Since the goal is to estimate how domestically generated e-waste is managed, imports need to be deducted from figures derived via this route.

4.5.4 Other data sources

On the basis of legal provisions, data on the quantity of e-waste formally collected can be recorded by competent authorities for licensing, monitoring, and enforcement purposes.[41] This is mostly the case for countries that have introduced EPR schemes covering EEE/e-waste (Baldé et al., 2017).[42] Examples of such component authorities include environmental regulatory bodies, local municipalities, or specific government departments overseeing waste management. These authorities may collect data from a number of regulated actors, which include retailers who operate take-back programmes, municipal collection points serving as centralised locations for public droop-offs, and/or pick-up services.

Other possible data sources include registers from waste management companies responsible for the collection, transportation, or treatment of e-waste, as well as reports from NGOs or other environmental surveys in the country. A number of public and industrial associations at the national level compile may statistics for their own use on the management of e-waste streams. Sectoral data of this kind can be incorporated into national statistics on e-waste treatment through collaboration between governmental agencies and industry associations.

Where such data is used, it is advisable to take steps to ensure that it meets the quality criteria defined in national e-waste legislation, such as accuracy, timeliness, and completeness of the data. Scientific literature may also offer a source for statistics or assumptions on the collection and recycling of e-waste, as research in this field is making significant progress worldwide. Nevertheless, such studies are typically undertaken on an ad-hoc basis.

[41] *A distinction can be made between data collected or recorded by competent authorities based on legal provisions for enforcement and reporting purposes and other data collected on a voluntary, economic, or other basis by the private or public sector, including data collected by business associations for their own operational or strategic insights.*

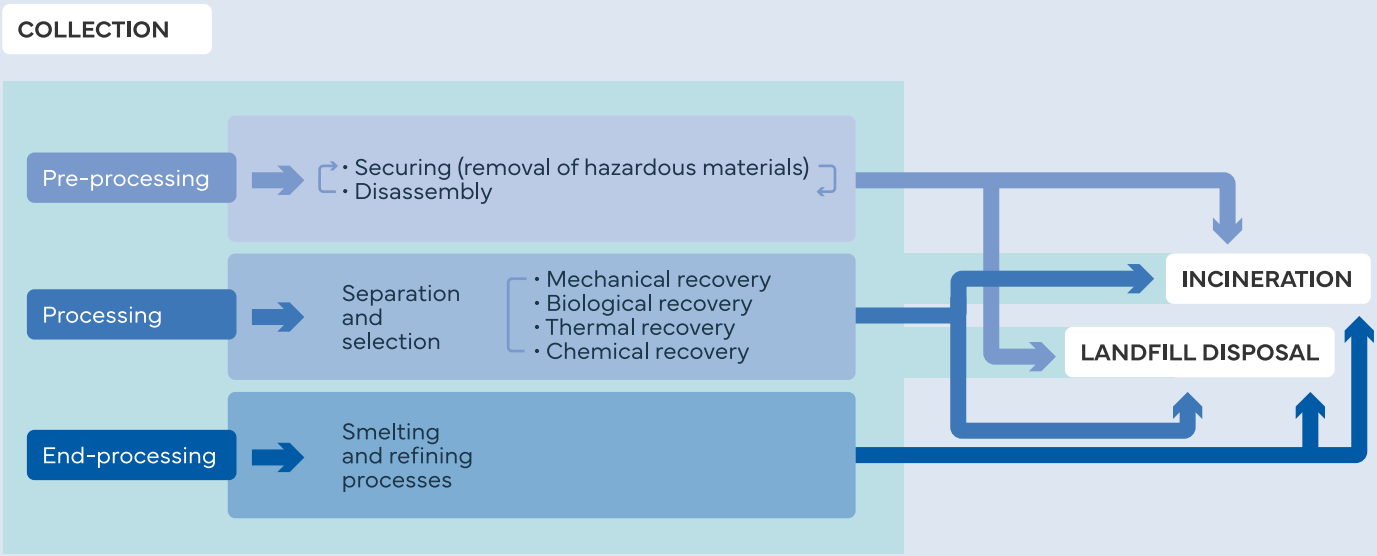
[42] *Even if there is no EPR scheme for e-waste in a country, it should be noted that e-waste may still be recycled in an environmentally sound manner in line with international standards such as those stipulated under the Basel Convention. For example, it can be sent to treatment facilities that are certified to recycle e-waste.*

Box 5. Method to quantify the recovery of secondary raw materials from e-waste management

Quantifying secondary raw materials from e-waste management is crucial for tracking process efficiency and mapping waste flows in a circular economy. However, empirical data on secondary material recovery is often limited. methodology has been developed by UNITAR and in the FutuRaM project[43] for estimating secondary raw materials recovery from e-waste management through the use of waste transfer coefficients (TC). A transfer coefficient represents the fraction of a material/component that is successfully recovered at a given stage of processing. This method is agnostic in relation to the level of granularity used in the product classification; for example, it works with both the EU-6 and UNU-KEYs classifications.

When calculating secondary raw materials derived through e-waste management activities, it is important to understand, first, the different stages of the e-waste management system across which TCs can be derived (see Figure 4). Generally, e-waste treatment and recycling involve three phases: pre-processing, processing, and disposal (Bonoli, 2015). Once e-waste is collected, it is transported to a treatment or recycling facility where it can be processed in various ways. The chosen methods depend on factors such as available technology, the type of waste, and the economic feasibility of recovering certain materials.

Figure 4. Generic e-waste management system
The green section of the diagram represents the focus area for measurement



[43] https://futuram.eu/

- **Pre-processing** is typically done manually and includes a pre-treatment phase to ensure different material fractions are directed to the appropriate recycling processes. This involves removing components that might pose safety risks during further processing. Products are disassembled into main components such as cables, batteries, plastic casings, concrete, printed circuit boards, and toner cartridges. Hazardous materials, such as refrigerants and substances in fluorescent lamps and cathode ray tubes, are safely removed before further processing (Bonoli, 2015 in Baldé et al., 2022b).
- **Processing** involves separation and selection of materials through size reduction (e.g. shredding and/or crushing). This step might need to be repeated to achieve the required output size. E-waste generally undergoes a mechanical separation to isolate metal fractions (e.g. aluminium, iron, copper) from plastic fractions. Magnetic separation efficiently separates ferrous from non-ferrous metals and other materials such as plastic or glass. Gravity separation helps distinguish heavy materials from lighter ones based on density differences (Baldé et al., 2022b). Subsequently, various recovery methods can be applied, including mechanical, biological, thermal, and chemical recovery.
- **End-processing** involves smelting (in the case of mechanical recoveries) and refining, usually performed by specialised industries. If e-waste fractions cannot be recycled due to hazardous content, they are either disposed of in a landfill, incinerated, or used for waste-to-energy purposes.

A TC can be calculated at each of the treatment steps described. The coefficient represents the function belonging to a process: *Flow2 = TC_function (flow1)*, so the mathematical definition will become: $TC_{1\text{-}2}$ = $FractionMass_2$/$FractionMass_1$, where flow represents the fraction mass such as component, material, and element in e-waste.

- Flow1 corresponds to the Mass (kg): e.g. component a (%), element a (%)
- Flow2 corresponds to Mass = MassF1* $TC_{1\text{-}2}$: e.g. component a (%)
- Flow3 corresponds to Mass = MassF1* $TC_{1\text{-}3}$: e.g. element a (%)
- and therefore, $TC_{1\text{-}2}$ = $FractionMass_2$/$FractionMass_1$.

In line with a mass balance approach, consequently, the TC can be calculated from the mass of a component/material/element in the output fraction from a specific step of the treatment process (e.g., mechanical recovery or smelting) over composition of the same component/material/element in the input fraction before the treatment occurs.

4.6 Other recycling of e-waste (W_{other})

"Other recycling" of e-waste comprises e-waste recycling activities that are performed outside of the official take-back system. The management of e-waste as part of "other recycling" can vary significantly between countries that have formal waste management laws and practices, versus countries that do not, and we consider each of these cases below.

In countries that have developed waste management laws and practices, the "other recycling" channel comprises e-waste that has been collected and treated but that is not registered as e-waste. This may arise due to a lack of dedicated e-waste recycling infrastructure, or e-waste being disposed of outside of formal e-waste collection systems.

E-waste handled via this route can still be treated within the formal recycling sector, such as through channels linked to scrap metal or plastic scrap dealers. Quantifying the amount of e-waste treated via those routes can be a complicated undertaking,[44] but may be achieved through compositional estimates of how much e-waste is mixed in with the other waste (see Box 6).

[44] This includes as e-waste fractions may be mixed with wastes of other origins, for example, catalysts to make an optimal mix for resource recovery.

Box 6. Steps taken to calculate e-waste in scrap in Belgium

Several studies have pointed to e-waste being present in the scrap metal waste stream in Belgium (Huisman, Baldé and Wielenga, 2013). This phenomenon has also been registered across multiple other countries in the EU and further afield (Baldé et al., 2020). The rationale for research in this area has been to better understand the scale of e-waste flows which are not collected by the formal schemes in Belgium, and how they could be diverted from the metal scrap flow to improve collection rates.

The metal and scrap market where e-waste has been documented in Belgium, mainly consists of door-to-door collectors and local scrap dealers involved in sorting and dismantling e-waste on one hand, and national recyclers involved in shredding and separation activities on the other. To estimate the quantity of e-waste in metal scrap in Belgium, Recupel (the national producer responsibility organisation) developed an approach made up of the following steps:

1. **Determine the scope of metal scrap**
   First, the type of metal scrap likely to contain e-waste was determined. Previous studies have shown that in Belgium, e-waste is generally found in the light metal scrap waste stream rather than in heavy iron scrap such as generated from steel production.

2. **Quantify the total weight of metal scrap**
   This involved first identifying the total number of light iron shredding installations in Belgium (n = 20). Average tonnages of 'shredder input material' across 7 of the 20 installations were calculated. This was extrapolated to the total population of shredders to estimate overall tonnages treated ('internal treatment'). An adjustment for international trade flows was made through adding the quantity of scrap exported and subtracting imported scrap from internal treatment estimates.

3. **Estimate the percentage of e-waste in a ton of scrap**
   A sampling analysis was commissioned by Recupel to identify the percentage of e-waste in Belgian light iron scrap. Sampling was undertaken at 3 sites geographically dispersed through Belgium to ensure representativeness. For the same reason, sampling across different waste origins was performed. Across the samples taken, an estimated 3.03% mass of metal scrap was found to consist of e-waste, which was then classified against the EU-6 e-waste categories.

4. **Calculate the overall weight of e-waste in metal scrap**
   To estimate the total amount of e-waste in scrap, the amount of shredder input material calculated at step 2 was multiplied by the average percentage of e-waste in each ton of scrap calculated at step three. The resulting figure of total e-waste in metal scrap in Belgium for 2020 was 40,596 tonnes. This was primarily made up of large equipment (excluding photovoltaic panels) (19,131 tonnes, 47%), temperature exchange equipment (10,181 tonnes, 25%) and small equipment (8,625 tonnes, 21%). In addition, smaller tonnages of small IT and telecommunication equipment (2,464 tonnes, 6%) and screens and monitors (195 tonnes, 0.5%) were reported.

Challenges identified in calculating the quantity of e-waste in scrap, included limited incentives or requirements for reporting metal scrap processed by shredding facilities, gaps in understanding of the activities of non-licensed stakeholders, and limits to compositional sampling, including the difficulty of identifying e-waste components from dismantled appliances.

The International Labour Organization (ILO) defines informality as encompassing economic activities, enterprises, and workers that operate outside formal regulation and protection frameworks (2015). In many low- and middle-income countries, the informal sector plays a major role in waste collection and recycling, with around 80 per cent of all jobs in recycling worldwide being informal (Hinchliffe et al., 2020; ILO, 2025). Incentivized by the potential to recover valuable components and materials, informal actors are particularly well represented in the management of e-waste, including collection, waste-picking, sorting, small-scale dismantling, and the resale of secondary materials (Williams et al., 2008).

The informal sector is diverse, ranging from organized cooperatives to individual waste pickers. While some entities may engage in successful collaboration with municipalities, others can remain excluded from institutional recognition and support (Medina, 2007; UN-HABITAT, 2010). This, coupled with the often transient and unregulated nature of informal waste management operations, can make it challenging to obtain reliable data on informal e-waste management.

Data on informal e-waste management can be generated using direct measurement, indirect estimation, or hybrid approaches drawing on multiple data sources.

Methods for quantifying e-waste management in the informal sector may employ direct measurement, indirect estimation, or hybrid approaches. Direct measurement typically involves surveys of households and businesses to capture disposal practices, or interviews with informal collectors, waste pickers, and scrap dealers to estimate e-waste throughput. Collaborations with municipalities, waste picker cooperatives, or treatment facilities can also yield aggregated data.

Indirect, top-down approaches can estimate informal-sector handling as a residual-by subtracting quantities managed by the formal sector from estimates of total e-waste generation. Several innovative approaches have also emerged in this area (see Box 7). Triangulating between different data sources and methodologies can help improve accuracy. Advancing methodologies for collecting and analysing data on e-waste flows outside formal take-back systems remains essential to reducing uncertainties in e-waste statistics.

Box 7. Incorporating the informal sector in the Global South using standardised digital reporting

Workers in the informal sector can be resistant to formalisation and inclusion efforts by governments out of concern for loss of livelihood. This contributes to making these activities often particularly difficult to track, including as part of statistics on e-waste management. Efforts to document e-waste management activities in the informal sectors of India, Mexico and Zambia, led by Minimise, a German company focused on scaling e-waste recycling activities in the Global South by tracing e-waste flows, have shown promise.

In three projects ran by Minimise, local informal collectors were provided fair compensation to collect e-waste and supply this to formal treatment facilities rather than undertaking their own treatment. These facilities then documented the entire e-waste treatment process, including sorting, dismantling, depollution, and resource recovery using software developed by Minimise. From the data, Minimise produces "proof-of-recycling" notes which they sell to electronics manufacturers and retailers as a voluntary mechanism for extended producer responsibility.

As part of data standardisation at the sorting stage, the UNU-KEYs are used to classify the types of electronic devices which enter the formal treatment facilities as waste. Combined with the weighing and counting of devices, "real-time" insight into e-waste flows for a specific facility can be obtained. During dismantling, treatment facilities document sorted outputs using a consistent material documentation framework structured around 9 material groups:

1. Ferrous metals
2. Non-ferrous metals
3. Plastics (for homogeneously sorted plastic types)
4. Components (for circuit boards, motors, etc.)
5. Mixed recyclates (for metals mixed with other materials)
6. Batteries
7. Other materials (for any other homogeneously sorted material)
8. Hazardous materials
9. Waste (for any leftover)

Finally, recipients for output materials are documented. Using the software, the full journey of resources in e-waste, from collection to recycling and/or (hazardous) waste disposal can be tracked. Following verification of 'proof-files', the e-waste recirculation data is made publicly available on https://registry.minimise.today/. This data can serve as an input to decision-making and statistics on e-waste management. As one example, Minimise is coordinating with UNITAR to relay information collected to databases maintained on the weight and composition of electronic products across different countries. This can help improve the timeliness of key data and capture regional differences, where present.

4.7 E-waste in the waste bin (W_{bin})

Households, businesses, and other actors may dispose of e-waste directly in the mixed residual waste, i.e. the "waste bin." This almost always represents a suboptimal disposal route for e-waste and typically results in e-waste being sent to landfill or incineration, where it may be burned to recover energy or disposed of without energy recovery. These treatment routes can contribute to environmental pollution and the loss of valuable materials. Typically, a higher share of small appliances is discarded in this manner due particularly to their size, however, these usually also contains the highest concentration of valuable materials.[45] Currently, data availability on e-waste in mixed residual waste is fairly poor in most countries.

E-waste disposed of in mixed municipal waste can be estimated using waste composition analyses integrated with data from other waste streams.

The quantity of e-waste in non-separately collected waste streams can be estimated based on waste composition analyses, which are sometimes undertaken by national governments or municipalities. These can also be integrated with more regularly published official statistics on total tonnages collected and treated via different routes and from different sectors of the economy. These compositional studies should ideally be performed regularly to monitor the trends of e-waste that ends up in mixed waste and this data can inform waste management policies, guide the development of targeted collection programs, and help track progress toward reducing improper disposal of e-waste. If all other routes are quantified, e-waste in the waste bin can also be estimated as the residual between these and e-waste generation.

4.8 UEEE/E-waste imported or exported

The transboundary movement of UEEE/e-waste is not easy to quantify as there is no comprehensive global registry of both controlled and uncontrolled transboundary UEEE and e-waste movements. This is compounded by the fact that not all shipments are properly documented, and discrepancies can often arise between what is declared as used equipment and what is actually waste. We consider potential data sources relevant to each type of transboundary flow here.

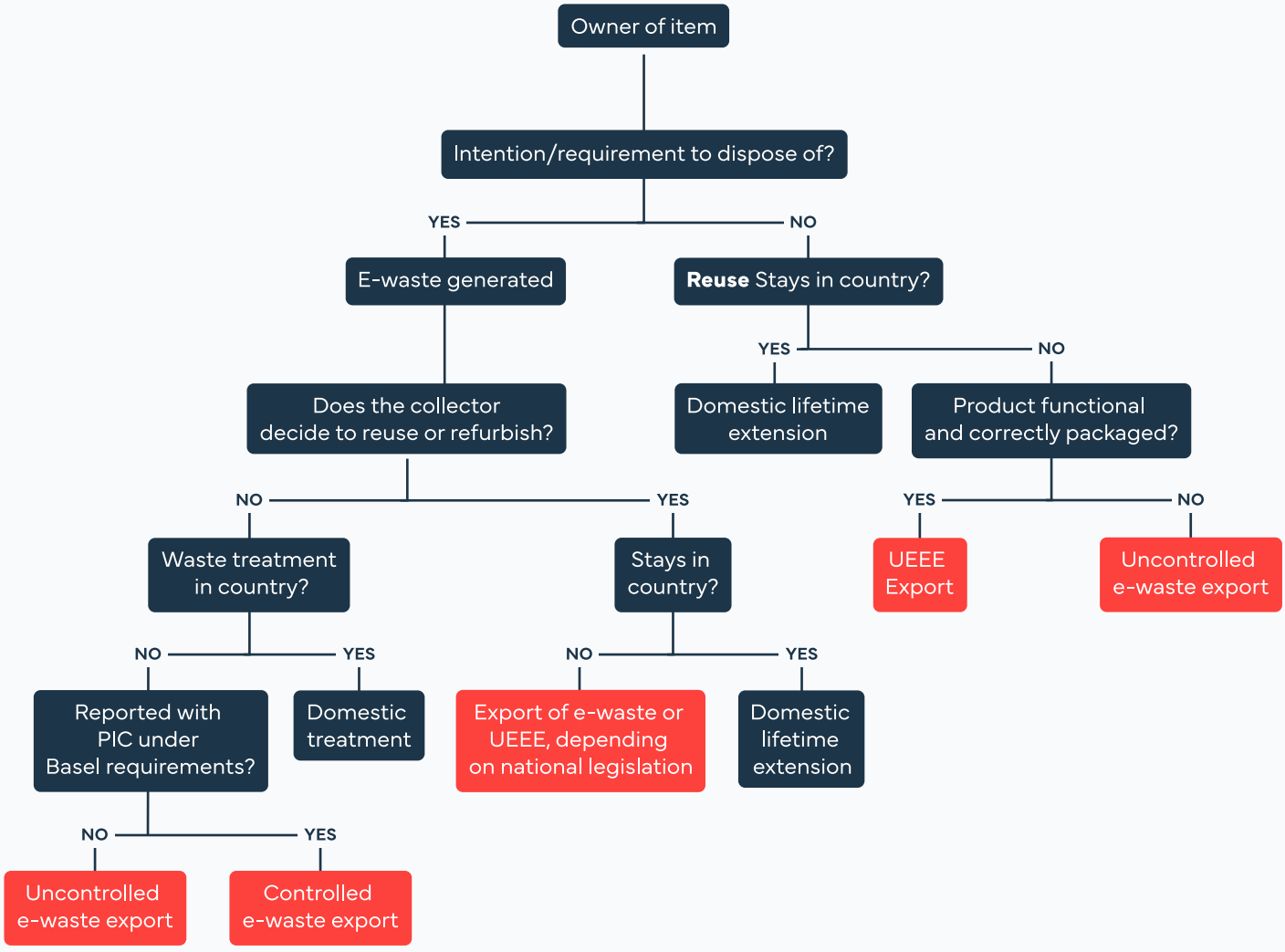
Figure 5 illustrates which transboundary movements of UEEE/e-waste should ideally be measured as part of the e-waste statistics framework. Based on the definition of waste (see Glossary of terms), if a consumer intends or is required to dispose of an item, this is considered part of e-waste generated. The disposed-of item is then collected by formal or informal collectors, who have the option to resell or refurbish it. If an item is sought to be resold or refurbished, the collector can sell it to a purchaser in another country. This can be considered "export of UEEE" if this complies with national legislation of the export, import, and transit states, as well as international regulations such as the Basel Convention which governs the transboundary movement of hazardous waste.

[45] *http://www.prosumproject.eu*

An important criterion for distinguishing between used and waste EEE in transboundary movements is whether the item has been properly tested for functionality and packaged to prevent damage during transport. This distinction is crucial because improperly functioning or poorly packaged items might be considered e-waste under international regulations and subject to stricter controls. If the collector or refurbisher sells it as a second-hand item, but it is not functioning or it is not packaged to avoid breakage during transport, this may be considered an illegal transboundary movement of electrical and electronic waste.

Figure 5. Behaviour related to the export of UEEE and e-waste

Boxes highlighted in red are key points for measuring transboundary UEEE and e-waste movement in the framework. PIC refers to the Prior Informed Consent procedure under the Basel Convention.



4.8.1 Controlled transboundary flows

Controlled transboundary flows refer to cross-border movements of material reported as hazardous waste or shipped as separated components.

"Controlled" transboundary flows here refer to the movement of material reported as hazardous waste (according to the Basel Convention's control regime) or to material shipped as separated components-specifically, printed circuit boards-to specialised end-processors (Baldé et al., 2022). Parties to the Basel Convention are required to report on transboundary movements of imported and exported electrical and electronic waste in the scope of the Convention on an ongoing basis.[46] National reporting data by Parties to the Basel Convention as mandated under Article 13 can therefore offer a source of some data to analyse flows and quantities of controlled transboundary movements of e-waste.

Though the distinction between UEEE and e-waste is legislated on a country-by-country basis through national laws, the non-binding Basel Convention Technical Guidelines on the transboundary movements of electrical and electronic waste and used electrical and electronic equipment (in particular regarding the distinction between waste and non-waste under the Basel Convention) include criteria for distinguishing between e-waste and trade in UEEE.[47] Among these criteria, the guidelines include that the transboundary movement of UEEE for recycling may be classified or considered as waste in the exporting, transit, and destination States. For this reason, transboundary movements of UEEE are recommended to also be monitored by countries.

Nonetheless, due to incomplete reporting by many parties, data generated under the Basel Convention often falls short of a comprehensive picture of transboundary UEEE and e-waste flows. Other attempts have been made to measure these flows, including through the use of: EPR registers (European Commission, 2014), trade codes (differentiating UEEE and e-waste from new commodities using price-difference analysis) (Baldé et al., 2016), GPS technology (BAN, 2016), the use of battery waste codes as a proxy for e-waste flows (Lepawsky et al., 2010), the "Person in the Port" approach (Odeyingbo et al., 2017), and business statistics (via surveys). The methodologies used in those studies each have limitations which need to be accounted for and improved on to yield reliable statistics. Thus, greater national and international efforts are critical to develop a common and harmonised methodology to measure such transboundary flows.

HS trade codes, including newly introduced e-waste codes, can be used to quantify controlled transboundary e-waste flows.

An important development in this area since the release of the second edition of these guidelines, has been the introduction of new HS codes for e-waste. These are further described in Box 8 and may include both hazardous and non-hazardous e-waste. These codes are additional to relevant HS codes that have been in place since earlier editions of the HS classification such as 711299 (waste and precious metal scrap or of metal clad with precious metals) which capture flows of waste components such as printed circuit boards.

It is important to note that the coverage of these trade codes may overlap with transboundary movement of electrical and electronic wastes data reported under the Basel Convention, and hence, if both datasets are available, they are not necessarily additive and an analysis of national reported data under the Basel Convention is also needed to avoid double counting.

[46] *Data reported to the Secretariat of the Basel Convention can be accessed at: http://basel.int/Countries/NationalReporting/DataVisualizationTool/tabid/3216/Default.aspx.*
[47] *https://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/Default.aspx.*

Further alignment between data reported under these HS codes and Basel-reported data on transboundary electrical and electronic wastes flows is expected following the 2025 Basel Convention amendments, which introduced new codes (effective 1 January 2025) and requires countries to report on movements of both hazardous and non-hazardous electrical and electronic wastes.

Box 8. HS codes relevant to monitoring e-waste trade flows

Since 2022, countries have begun using the new 4-digit HS code heading administered by the World Customs Organization specifically for e-waste (HS 8549 - Electrical and electronic waste and scrap). The 4-digit code is further subdivided into the following 6-digit HS codes related to e-waste, based primarily on the material/component makeup of traded items:

- 854921 - Electrical and electronic waste and scrap, of a kind used principally for the recovery of precious metal, containing primary cells, primary batteries, electric accumulators, mercury-switches, glass from cathode-ray tubes or other activated glass, or electrical or electronic components containing cadmium, mercury, lead or polychlorinated biphenyls “PCBs”
- 854929 - Waste and scrap, of a kind used primarily for the recovery of precious metals, n.e.c. in item no. 854921
- 854931 - Waste and scrap of electrical and electronic assemblies and printed circuit boards, containing primary cells, primary batteries, electric accumulators, mercury-switches, glass from cathode-ray tubes or other activated glass, or electrical or electronic components containing cadmium, mercury, lead or polychlorinated biphenyls “PCBs” (excl. for the recovery of precious metal)
- 854939 - Waste and scrap; electrical and electronic assemblies and printed circuit boards, other than those used primarily for the recovery of precious metal, n.e.c. in item no. 854931
- 854991 - Waste and scrap, n.e.c. in heading no. 8549
- 854999 - Waste and scrap, n.e.c. in item no. 8549.91

As they refer to components present in many types of e-waste, the HS codes at the 6-digit level can’t be mapped to any particular UNU-KEYs, nor to any grouping of them. As such, integrating this data source at the level of total aggregates when quantifying imports and exports at the country level is recommended as the best way to integrate this data into the measurement framework.

In some countries, trade statistics distinguish products based on their condition, offering additional insight into trade flows of used electrical and electronic equipment and e-waste. Thailand is one such example, employing an 11-digit commodity coding system for international merchandise trade statistics. The structure of these codes is as follows:

- **First 6 digits:** Correspond to the HS codes defined by the World Customs Organization.
- **Digits 7-8:** Reflect the Association of Southeast Asian Nations Harmonized Tariff Nomenclature codes, used across member states.
- **Digits 9-11:** Represent national statistical codes defined by the Thai Customs Department for the purpose of trade statistics, regulatory controls (e.g., import/export licenses), and policy and economic analysis.

The Thai national statistical codes enable a further level of disaggregation in statistics on internationally traded goods, including whether electronic items are new, used, or waste. For example, smartphones classified under HS 8517.13.00 can include three-digit suffixes shown in Table 7 to indicate product condition.

Table 7. National statistical code suffixes used in Thailand's international merchandise statistics

Code	Description
000	General product (new)
800	Used (second-hand)
899	E-waste (as defined under the Basel Convention)
999	Completely Knocked Down (CKD) units, imported as disassembled parts for local assembly

In countries where trade statistics include such detail in the classifications used, these offer an additional basis for measuring and monitoring trade in used equipment and e-waste.

4.8.2 Uncontrolled transboundary flows

Uncontrolled flows refer to the transboundary movement of UEEE and illegal e-waste shipments.

Uncontrolled flows refer to the transboundary movement of UEEE and illegal e-waste shipments. An approach to help estimate uncontrolled transboundary movements involves an analysis of the monetary value of trade flows for relevant products. This approach was used in the *Global Transboundary E-waste Flows Monitor* beginning with that published in 2022 (Baldé et al., 2022a). The Monitor draws on the framework on e-waste statistics outlined here, to capture controlled and uncontrolled transboundary movement of e-waste with a particular focus on temperature exchange equipment, screens and monitors, large equipment, and small IT equipment.

In the study, a method based on price was used to demarcate new-EEE from UEEE. This starts from a constructed harmonised dataset and involved calculating the median price per HS code, with trade flows for which the price of an individual record is below 30 percent of the median price taken to refer to second-hand goods or e-waste. For small IT, 10% of the median was used. The approach was found to be robust for many but not all of the UNU KEYs, with particular issues for very cheap goods or counterfeit goods. Shipment of e-waste mixed with other waste streams; for example, e-waste classified as metal scrap was not assessed in the study. One issue here is the quality of the source trade data, which can limit application of the method.

Another promising approach to track the import and export of e-waste (including that uncontrolled) is the "Person in the Port" methodology. This involves a researcher being physically located in a receiving (or exporting) port and sampling a number of different types of cargo to build up a representative picture of the percentage of different types of cargo containing UEEE and e-waste (Odeyingbo et al., 2017). This percentage can then be combined with import statistics to extrapolate the findings to the population of all shipments.

See Section 6.11, "Nigeria: Calculating imports of e-waste and used equipment", for further details on this approach.

The "Person in the Port" methodology has been demonstrated to be the most accurate for quantifying such shipments at the national level, though it also resource intensive. The approach has since been modified and applied in the United Republic of Tanzania alongside functionality testing of products in the receiving port to assess if traded goods were broken or still functioning (NBS and UNU, 2019). This helps categorise products into UEEE or e-waste to inform whether the export was legal under the Basel Convention and according to national legislation in which the project was implemented.

4.9 Assessing e-waste legislation

The 2022 publication, *Consultation on the Methodology for Measuring the Global Progress of E-waste Legislation* lays out a proposal for a methodology and indicator to measure current developments in the introduction of e-waste legislation across nations (Baldé and Bel, 2022). The methodology and indicator are intended for use in tracking progress against ITU Target 3.3 and benchmarking and communicating best practices to national policymakers and intergovernmental bodies.

4.9.1 Criteria for indicators on e-waste legislation

Indicators on e-waste legislation should be practical, measurable, internationally comparable, and aligned with global tracking frameworks.

It is crucial that the criteria for developing e-waste legislation indicators align with the goals of tracking progress towards international targets, such as ITU Target 3.3, while also ensuring that they are practical, measurable, and relevant for policymakers and stakeholders. The methodology defined by UNITAR and ITU is informed by the following criteria: availability of data, characteristics of the indicator, and indicator relevance. These are further defined below.

Data Availability

- Data or information is currently available for >90% of countries.
- Data or information is available from, or provided by, a regularly updated data source (registry, on-going reporting, etc.) and should not place additional burden on countries.

Indicator Characteristics

- It is directly related to the performance of e-waste management legislation.
- It is measurable and comparable across countries.
- It can be aggregated from national level to regional or global totals.
- It can be easily interpreted and communicated to various users and audiences.
- It is transparent in terms of the methodology and data used to make calculations, which can be verified by third parties.
- The method has been reviewed by international experts.

Indicator Relevance

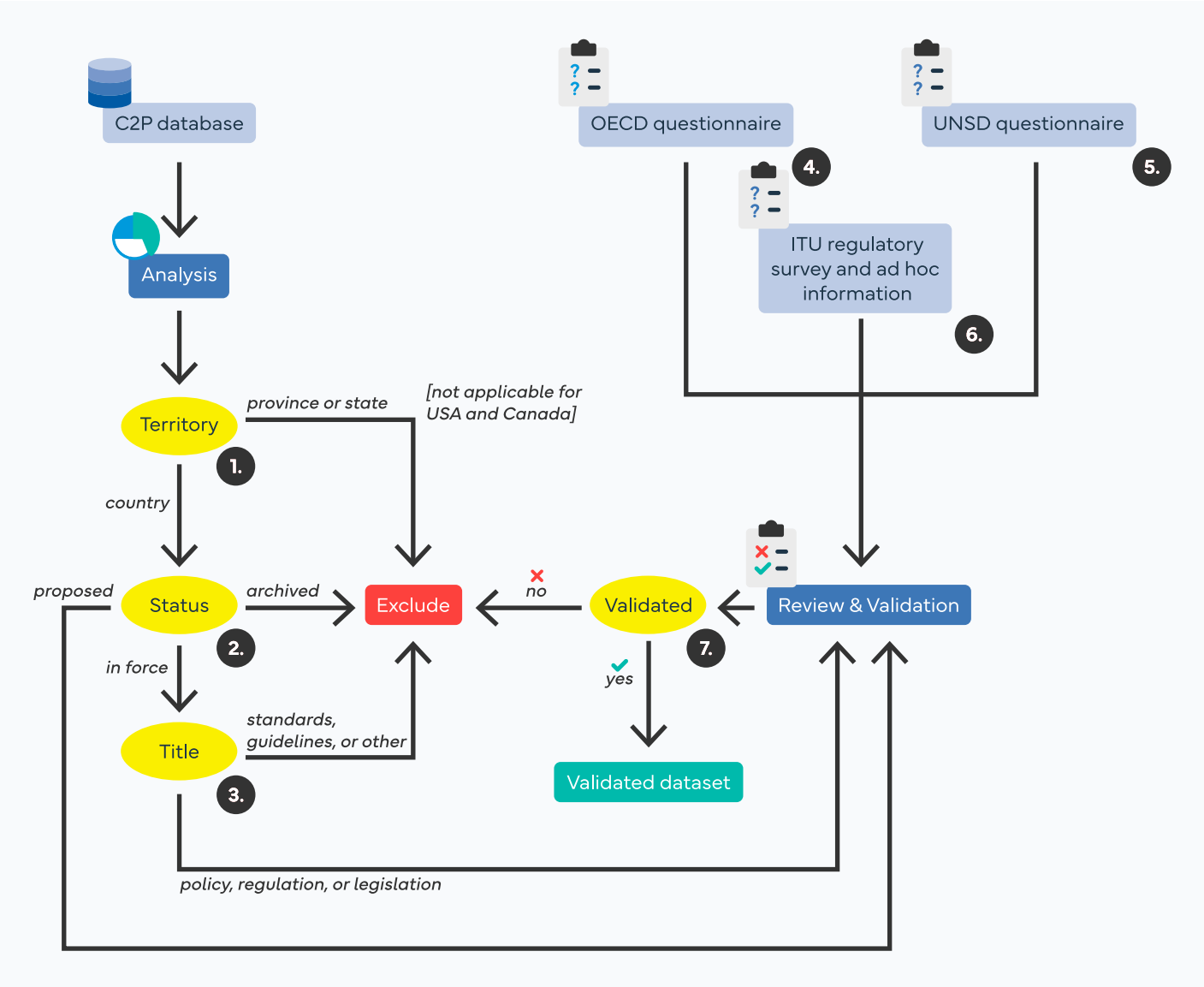
- The direction or messages derived from the indicator are easily interpretable.
- There is a relevant benchmark among countries.
- The indicator does not overlap and is conceptually consistent with existing frameworks (e.g. SDG 12, e-waste statistics framework, etc.).

4.9.2 Methodology

The methodology follows a two-stage process that begins with data gathering and analysis and ends with the validation and calculation of the global headline indicator on e-waste legislation. The stages are essential for ensuring that the data used is reliable, comprehensive, and accurately reflects the state of e-waste legislation in each country.

In the first stage, data is gathered, analysed, reviewed, and validated. The review and validation involve a robust process of critically reviewing and comparing the analysed records against information gathered from all data sources. The outcome of the raw data analysis, review, and validation with the methodology will lead to a consolidated database in which data is stored for each country. This can then be used to calculate the global headline indicator on e-waste legislation. The data gathering, analysis, review, and validation are illustrated in Figure 6 and described in the following section.

Figure 6. Methodological approach to data selection and indicator calculation for measuring e-waste legislation



4.9.2.1 Data gathering, analysis, and validation for e-waste legislation

Data is gathered from the Compliance to Product (C2P2) dataset, which is a compliance knowledge management system for regulations, standards, and management globally for various product and waste streams, including e-waste. The C2P dataset includes detailed information on legislative measures (including policies, regulations, legislation, and other measures, such as guidelines and standards) at national and state- or province-level as well as other details such as status, dates, and the web reference. The subsequent analysis stage involves a systematic review of each record in the dataset, with the stepwise approach described below. The stepwise approach outlined below is part of the overall data gathering and review phase. Each step serves to refine the dataset, ensuring that only valid, current, and relevant legislative records are included in the final indicator calculation.

Step 1. - As the first step, the geographical scope of the recorded measure is checked in the Territory Covered column. Only those implemented at the national level are included in the next step, and others that are at state or province levels are excluded. For the United States of America and Canada, a State/provincial level analysis is undertaken.

Step 2. - In the second step, the "Status" of the measure in the record is analysed. Only the records with an "In force" status are included in the following steps; those with "Archived" status are excluded. In the case of measures with a "Proposed" status, these are not immediately excluded. Instead, they are included in the Review & Validation stage, where they are evaluated based on their potential to influence the future number of countries covered by e-waste legislation.

Step 3. - In the final step, the record is analysed to determine the type of the measure. If the measure qualifies as a policy, a regulation, or a legislation concerning e-waste, WEEE, specific categories, or products within the definition of e-waste, it is considered for the Review & Validation stage. Other measures - including recycling standards, certification programmes, and technical guidelines, as well as those that do not cover e-waste within their scope - are excluded.

Step 4. - After the C2P dataset has been analysed, the intermediate outcomes are further validated based on the information gathered from other data sources, such as the outcomes of questionnaires received from the UNSD, the OECD, and the ITU (through its annual World Telecommunication/ICT Regulatory Survey). The goal of this stage is twofold: to validate outcomes of the analysis of the C2P dataset or to correct outcomes, as the analysis of the C2P dataset could be challenging due to a lack of clarity that may arise due to the translation of the title of the recorded measures. In this step, the record is validated against the responses received from countries for the OECD questionnaire and the ITU Regulatory Survey.

The OECD questionnaire has been co-developed by the UNITAR SCYCLE team as part of the international initiative to document e-waste-related information and sent by the OECD to its member countries. The questionnaire includes a specific question on existing national e-waste legislation, another on its content and scope, and another on the custodian entity, among other questions. These details are compared with the outcome of the Analysis for each OECD country.

Likewise, the ITU Regulatory Survey is used to compare to the outcome of the Analysis. This survey covers a wide range of ICT policy and regulatory issues and helps track the latest ICT trends and evolutions, including some key aspects of the regulatory environment of e-waste management. The survey also includes a specific question on existing national e-waste legislation.

Step 5. - The previous step validates the records only for OECD countries. For non-OECD countries, the records are reviewed in this step and validated based on the responses received through a similar questionnaire survey conducted by the UNSD. As with the OECD questionnaire and the environmental part of the ITU survey, the UNSD/UNEP questionnaire is developed for documenting e-waste-related information for non-OECD countries.

Step 6. - In this step, the records are compared against other ad hoc sources and from the review of existing literature and previous studies. These sources include country workshops conducted by the UNITAR SCYCLE team as part of the capacity-building initiatives under the Global e-waste Statistics Partnership. They also include information drawn from ITU's national e-waste policy and regulatory development technical assistance, which is provided directly to national governments.

Step 7. - Once each record is carefully reviewed against these three sets of supplementary information, the final decision is made on whether to include them to calculate the indicator. If validated, the record is included in the calculation of the indicator; otherwise, it will be excluded.

The outcome of the data-gathering analysis, review, and validation steps is a consolidated database in which per-country data on e-waste legislation is stored. Section 5.1.10 outlines the proposed global headline indicators for monitoring e-waste legislation derived from this database.

4.10 Summary table of data sources to populate the measurement framework

Table 8 presents a summary of the key variables in the e-waste statistics framework and potential data sources to populate these. The sources are tentatively listed by order of preference for each variable.

Table 8. Summary of parameters in the e-waste statistics framework and potential data sources

Variable and definition	Potential data inputs and/or calculation
EEE POM - the 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.	• National e-waste registry • Apparent consumption method • Household and business surveys
Lifetime - the period of time equipment stays in households or businesses before being disposed of or being exchanged as second-hand equipment.	• Input/output analysis • Household and business surveys • Citizen science data collection

Variable and definition	Potential data inputs and/or calculation
Stock - the functioning and non-functional equipment in households, businesses, and the public sector.	• Calculated by subtracting cumulative e-waste generation from cumulative EEE POM • Household and business surveys • Proxy data, e.g. subscriptions
E-waste generated - the quantity of discarded electrical and electronic equipment (e-waste) due to consumption within national territory in a given reporting year and prior to any collection, reuse, treatment, or export.	• Calculated from POM and lifetime data
Formal collection of e-waste (W_{formal}) i.e. the formal collection of e-waste represents e-waste collected as e-waste and regulated by environmental protection laws specifically designed for e-waste. This includes e-waste that is collected, later exported, and treated according to national standards in another country.	• E-waste collected and managed under e-waste compliance register (for instance, collected through an EPR scheme) • E-waste separately collected at municipalities, retailers, and collection points • E-waste entering certified treatment facilities, waste trading companies, etc.
Other recycling (W_{other}) involves recycling of e-waste with other waste streams - for instance, metal scrap.	• Can be obtained from estimating e-waste parts in the other waste collection
E-waste in the waste bin (W_{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.	• Can be available from a sorting analysis of the residual waste in a country in conjunction with data on quantities of residual waste
E-waste and UEEE imported/exported - comprised of the e-waste and/or UEEE that is imported or exported from one national territory to another.	• Country registers • Trade data • Data from GPS tracking • Surveys of exporter or importer • Person in the Port approach • Basel Convention national reported data

The sources listed against each variable can vary in product coverage and detail, timeliness, and reliability among other dimensions. Validation and triangulation between sources can be useful to tease out any quality issues. In some cases, data from different sources can be integrated with one another to achieve better coverage and accuracy, including via application of material flow principles. Two examples of key points in the measurement framework to implement this are:

- Estimates of the stock calculated using EEE POM and lifetime figures per UNU-KEY (or an aggregate) can be compared with estimates of the total of stock of EEE in households, businesses and the public sector as derived through surveys or other approaches which can help calibrate EEE POM and lifetime input parameters that can be then used as part of the framework to construct a more robust time-series of the EEE stock and e-waste generated.
- Comparison of figures calculated for e-waste generated with total measured e-waste flows (W_{formal}, W_{other}, W_{bin}). This can help validate modelled e-waste generated figures, estimate the 'W_{gap}', and calibrate input data to estimate e-waste generated.

Where country-specific data is unavailable, selected input parameters may be transferred between countries with similar consumption and replacement patterns.

4.10.1 Transferring inputs between countries

When a country lacks data in certain areas of the framework, certain parameters can be estimated using data from other countries to fill the gaps. For instance, if a country has data on the possession of cell phones and a time series of EEE Placed on the Market data, while another country only has information on cell phone disposal, data from the first country could help estimate trends in the second country. A statistical analysis on data used in the *Global E-waste Monitor* found that the PPP of a country frequently correlates with consumption characteristics, market saturation, or discard behaviour (Baldé et al., 2017). This is likely because higher PPP can indicate greater access to consumer goods and higher turnover rates of electronic products. It was also found that product lifetimes for electronics can be comparable and therefore interchangeable between countries with similar PPP, as consumers in such countries tend to follow similar consumption and replacement patterns, accounting for economic and wider conditions (Magalini et al., 2014).

Box 9. Extending the e-waste statistics measurement framework to account for substances of concern

A. Measuring mercury-added products in e-waste in the context of the Minamata Convention

The adoption of the Minamata Convention on Mercury in 2013 (and effective from 2017) is a demonstration of the important role multilateral treaties can play in responding to global environmental and human health threats. The Convention contains provisions that relate to the entire life cycle of mercury, including controls and reductions across a range of products, processes, and industries in which mercury is used, released, or emitted.

E-waste encompasses several mercury-added products. In a quantitative analysis undertaken by Baldé et al. (2018), those mercury-added products were categorised using the UNU-KEYs for subsequent analysis along the electronics life cycle, from being placed on market to e-waste generation.

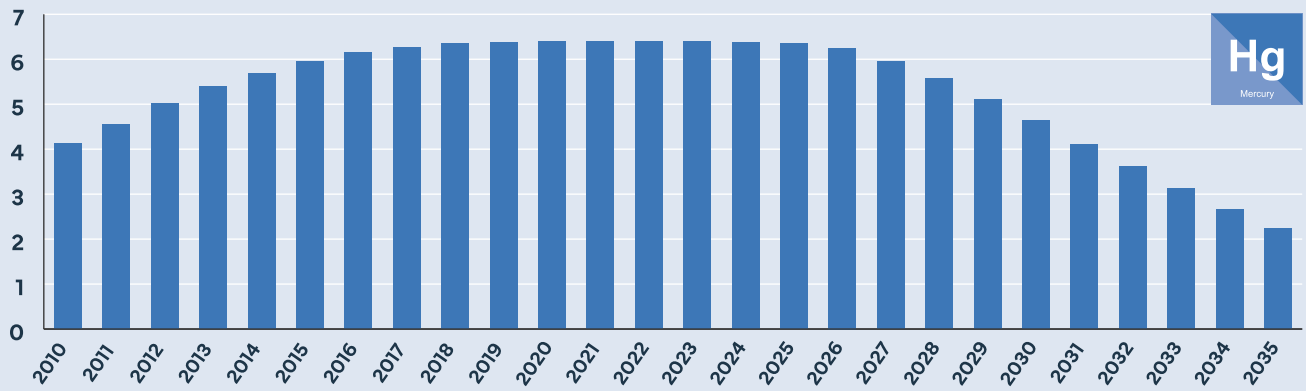
The concentration of mercury was analysed per UNU-KEY, and the following list of UNU-KEYs was selected that were particularly high in mercury content prior to the phase-out of its use:

- UNU-KEY 0302 Desktop PCs (excl. monitors, accessories)
- 0303 Laptops (incl. tablets)
- 0306 Mobile Phones (incl. smartphones, pagers)
- 0309 Flat-Panel Display Monitors (LCD, LED)
- 0408 Flat-Panel Display TVs (LCD, LED, Plasma)
- 0502 Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
- 0503 Straight Tube Fluorescent Lamps
- 0504 Special Lamps (e.g. professional mercury and high- and low-pressure sodium)

While the phase-out date for banning the manufacturing, import, or export of mercury-added products was set at year 2020, certain countries have already asked for an extension, for both part of and for the entire range of relevant products. Thus, for the purpose of this report, 2025 was considered as the average year by which countries will not be producing/exporting/importing mercury-added products anymore. The phasing-out of mercury from e-waste while accounting for product lifetimes was assessed (Figure 7).

→

Figure 7. Global mercury-added product waste - time series (Mt). (Baldé et al., 2018)



B. Improving data and inventories of Persistent Organic Pollutants in EEE and e-waste

With numerous toxic substances potentially found in EEE goods, e-waste can pose a significant environmental and human health hazard, particularly where not treated via environmentally sound management practices.[48] Almost all types of EEE contain hazardous substances, such as heavy metals (such as mercury, lead, cadmium, arsenic, or antimony) and persistent organic pollutants (POPs), such as polychlorinated biphenyls and Brominated flame retardants. POPs are sometimes used as an additive in the manufacture of EEE, primarily in plastic components. These can also be produced unintentionally from precursors where e-waste is treated via substandard means such as open burning. There is also some evidence of the transfer of POPs through mechanical recycling of e-waste, e.g. as highlighted in China by Li et al. (2020). POPs pose a particular hazard, as they are not only toxic, but too resistant to environmental degradation. As a result, there is growing evidence of heightened accumulation of POPs in the environment and bioaccumulation in the bodies of humans, other animals, and technospheric stocks (Wagner et al., 2022). International treaties and, in particular, the Stockholm Convention seek to tackle this growing risk.

Improved data and comprehensive inventories of the concentration of POPs along the EEE/e-waste life cycle have an important role in improved regulation to better control POP-containing products and minimise exposure (GGKP, 2024a). The 2022 *Regional E-Waste Monitor for Latin-America* applied and extended the measurement framework outlined in these guidelines to estimate brominated flame retardants in EEE POM and e-waste generated across 13 countries in Latin America (Wagner et al., 2022). To do so, it drew on a UNU/UNITAR internal product/component composition database to estimate plastic fractions in EEE/e-waste flows alongside information collated as part of the UNDP project *Reducing the release of unintentional POPs and mercury from hospital waste management, e-waste, scrap metal processing and biomass burning* and a wider literature review, to estimate brominated flame retardant concentrations in EEE/e-waste-containing plastics.

There is also a toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention on Persistent Organic Pollutants. The *Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs* is intended to assist parties in establishing release inventories of unintentional POPs that are consistent in format and content, ensuring that it is possible to compare results, identify priorities, mark progress and follow changes over time at the country level, as well as regional and global levels. More information can be found here: https://toolkit.pops.int/.

[48] *This is in addition to exposure risks in the use phase of products.*

Chapter 5.
Reporting e-waste statistics and indicators

This section outlines key indicators that can be derived from the e-waste measurement framework and that can be reported by countries as part of national statistics on e-waste. It highlights a subset of indicators recommended to be reported as a minimum in Box 10 for countries embarking on measuring e-waste for the first time. Newly developed indicators for assessing e-waste legislation are also outlined.

5.1 Key indicators to report

After data has been collected and processed in line with the methodological steps outlined in these guidelines, it can be compiled into a set of indicators or metrics to report on the most critical dimensions of performance of the EEE and e-waste system in a country. A set of indicators is proposed for reporting that gives an overview of the size of a country's market for EEE products, e-waste generated, formal collection of e-waste, and key treatment routes. Taken together, these can help track changes over time and benchmark country performance.

The advised unit for publishing indicators is presented for each indicator below. The majority of the indicators are recommended to be reported with tonnages as the unit of measure. These can also be presented on a per-capita basis, i.e. normalised to the number of inhabitants in a country, which is particularly useful for cross country comparison purposes. Such presentation can also increase the tractability of indicators to users such as the general public. In some cases, a rate is recommended to be calculated, such as for the formal collection of e-waste.

5.1.1 EEE POM

The quantity of EEE supplied as final goods for distribution, consumption, or use on the market of an economic territory in the course of a commercial activity, whether in return for payment or free of charge.
Recommended unit(s): Metric tonnes, kg/per capita

5.1.2 E-waste generated

The quantity of discarded EEE (e-waste), resulting from consumption within an economic territory, prior to any collection, reuse, treatment, or export.
Recommended unit(s): Metric tonnes, kg/per capita

5.1.3 E-waste formally collected

The quantity of e-waste in an economic territory collected and managed under a formal take-back system in accordance with environmental protection laws. This includes e-waste that is collected and later exported to another country where it is treated according to equivalent national standards.
Recommended unit(s): Metric tonnes, kg/per capita

5.1.3.1 Formal e-waste collection rate

The proportion of e-waste generated in an economic territory, that is then collected and treated via formal routes. This includes e-waste that is collected and later exported to another country where it is treated according to equivalent national standards. If e-waste is collected through official take-back systems, it can be assumed that e-waste collected equals e-waste recycled.[49]

This rate can be calculated as: (formal collection of e-waste/e-waste generated)*100
Recommended unit(s): Percentage (%)

5.1.4 Other recycling of e-waste

The quantity of e-waste generated in an economic territory that is recycled outside of formal e-waste collection routes e.g. as metal scrap.[50]
Recommended unit(s): Metric tonnes, kg/per capita

5.1.5 E-waste in the waste bin

The quantity of e-waste that ends up in non-separately-collected waste streams, typically resulting in final disposal via landfill or incineration. This may be household waste or mixed bulk waste.
Recommended unit(s): Metric tonnes, kg/per capita

5.1.6 E-waste exported

The quantity of e-waste generated within an economic territory that then leaves the country to an overseas destination. This should be reported excluding international trade flows in UEEE. An optional disaggregation could be made into "controlled" and "uncontrolled" exports.
Recommended unit(s): Metric tonnes, kg/per capita

5.1.7 E-waste imported

The quantity of e-waste generated outside an economic territory that has been brought into the country from abroad. This should be reported excluding international trade flows in UEEE. An optional disaggregation could be made into "controlled" and "uncontrolled" imports.
Recommended unit(s): Metric tonnes, kg/per capita

5.1.8 UEEE exported

The quantity of UEEE (i.e. second-hand EEE intended for reuse in good working order or could be with minor repair or refurbishment) generated within an economic territory that then leaves the country to an overseas destination. An optional disaggregation could be made into "controlled" and "uncontrolled" exports.
Recommended unit(s): Metric tonnes, kg/per capita

[49] *This assumption is typically based on regulatory oversight and compliance standards. In practice, there might be losses taking place during the treatment phase, and data may be available to qualify this assumption.*
[50] *This type of recycling does not always meet the same efficiency and environmental standards as formal e-waste recycling.*

5.1.9 UEEE imported

The quantity of UEEE generated outside an economic territory that has been brought into the country from abroad. An optional disaggregation could be made into "controlled" and "uncontrolled" exports.
Recommended unit(s): Metric tonnes, kg/per capita

5.1.10 Headline indicators for tracking e-waste legislation

Following the steps outlined under Section 3.2.4, "E-waste Legislation," in these guidelines, global headline indicators can be calculated using the validated dataset produced through the methodology described. Two headline indicators can be constructed from the database:

- The total number of countries with national e-waste legislation in place (unit: number of countries).
- Share of the global population covered under national e-waste legislation (unit: percentage).

Indicator "The total number of countries with national e-waste legislation in place" is calculated by adding up all countries in the consolidated dataset that are marked with a "Yes" for having "e-waste legislation," including either "National E-waste policy," "National E-waste Legislation," or "National E-waste Regulation." Countries having only e-waste strategies are excluded from the indicator calculation. Each country is weighted equally, and this calculation leads to a number. For instance, globally, 81 countries are covered by national e-waste legislation.

Indicator "Share of the global population covered under national e-waste legislation" is calculated by multiplying the countries marked as under indicator 1 with their population and dividing that by the global population. This is multiplied by 100 to derive a percentage.

Alternatively, similar regional indicators covering several countries, a political union such as the EU, or a continent, such as the African continent, or a sub-region such as Central Asia, can be constructed from the same datasets.

Applicability- The headline global indicator reflects the legislative process of a region or the entire world. It does not reflect legislative progress at national levels, which limits its applicability for individual countries to improve specific aspects of their legislative initiatives, particularly from an implementation and enforcement perspective.

It would be important to further develop the methodology to increase its level of detail vis-à-vis the measurement of the performance of national legally binding e-waste instruments. A national indicator in this sense would require a significant level of investment and time, but it would result in a better understanding of the challenges faced by governments when it comes to the implementation and enforcement of e-waste legislation and regulation. Furthermore, it would be important to establish a measurement framework for the influence of the presence of EPR in the provisions of e-waste legislation on the performance of a country's e-waste management system, especially on the formal documented collection and recycling rate.

5.2 Reporting matrix

Table 9 shows an example reporting matrix for the indicators recommended to be populated as outputs of the measurement framework defined in these guidelines. Data presented in line with this reporting matrix can provide sufficient insight to perform international comparisons, locate data gaps, and undertake imputations, where required. Such a matrix is flexible and reported totals can be broken down by different granularities of product groups - whether the six (seven with a PV split) EU e-waste categories, or at the more detailed level of the UNU-KEYs.

Table 9. Example reporting matrix for e-waste statistics

Indicator	E-waste category	Unit[51]	2022	2023	2024
EEE Placed on the Market	Total	1000 t.			
	Total	kg/per capita			
of which:	...	1000t.			
	Temperature exchange equipment	1000t.			
	Screens and monitors	1000t.			
	Lamps	1000t.			
	Large equipment (excl. photovoltaic panels)	1000t.			
	a. Large equipment (photovoltaic panels incl. inverters).	1000t.			
	Small equipment	1000t.			
	Small IT and telecommunication equipment	1000t.			
E-waste generated	Total	7000t.			
of which:	...	1000t.			
	Temperature exchange equipment	1000t.			
	...	1000t.			
	Small IT and telecommunication equipment	1000t.			

[51] *Solid waste is commonly presented in thousands of tonnes, except for hazardous waste, which is usually collected in tonnes.*

Indicator	E-waste category	Unit[51]	2022	2023	2024
E-waste formally collected	Total	1000t.			
of which:	...	1000t.			
	Temperature exchange equipment	1000t.			
	...	1000t.			
	Small IT and telecommunication equipment	1000t.			
Formal e-waste collection rate	Overall	%			
of which:	...	%			
	Temperature exchange equipment	%			
	...	%			
	Small IT and telecommunication equipment	%			
Other recycling of e-waste	Total	1000t.			
of which:	Temperature exchange equipment	1000t.			
	...	1000t.			
	Small IT and telecommunication equipment	1000t.			
E-waste in waste bin	Total	1000t.			
of which:	Temperature exchange equipment	1000t.			
	...	1000t.			
	Small IT and telecommunication equipment	1000t.			
E-waste exported	Total	1000t.			
of which:	Temperature exchange equipment	1000t.			
	...	1000t.			
	Small IT and telecommunication equipment	1000t.			

Indicator	E-waste category	Unit[51]	2022	2023	2024
E-waste imported	Total	1000t.			
of which:	Temperature exchange equipment	1000t.			
	...	1000t.			
	Small IT and telecommunication equipment	1000t.			
UEEE exported	Total	1000t.			
of which:	Temperature exchange equipment	1000t.			
	...	1000t.			
	Small IT and telecommunication equipment	1000t.			
UEEE imported	Total	1000t.			
of which:	Temperature exchange equipment	1000t.			
	...	1000t.			
	Small IT and telecommunication equipment	1000t.			
E-waste legislation	National e-waste legislation in place	Yes/No			
	Population covered under national e-waste legislation	Millions			

When publishing any indicators and statistics generated, consideration may be given to the needs of data users. Data published with high-quality metadata,[52] including the use of controlled terminologies with external links to definitions such as those included in the glossary of these guidelines, and explicit reference of use licenses, can support the findability, accessibility, interoperability, and reusability of generated data (Wilkinson et al., 2016). Documentation of the methods adopted, and any estimation required, can further support the trustworthiness of statistics produced and help users understand possible limitations of the data (Wang et al., 2013).

For policy users, having up-to-date data can ensure relevance and help with timely decision-making. As such, data should be made available as quickly and regularly as needed, and is possible, to generate and preserve value for such users (Open Data Charter, 2015). Other considerations may be given to the format of published data, with a machine-readable data structure and file format such as Comma-Separated Values (alongside a human-readable format) potentially supporting wider uses of outputs and ease of upwards integration of reported results.

[52] *Metadata can be defined as structured information detailing properties or otherwise making it easier to retrieve, use or manage an information resource.*

5.3 International reporting of e-waste data

As well as publishing these indicators as part of national statistics, several routes exist for countries to report internationally:

- For countries making up the OECD and who do not report to Eurostat, data on EEE POM, e-waste generated, e-waste collected, and e-waste recycled can be reported on an annual basis as part of the OECD State of the Environment Questionnaire. The OECD also collect data on e-waste reused and remanufactured, where available. This data is made publicly available by the OECD on the OECD Data Explorer and the OECD Environment at a Glance indicators platform.
- For EU Member States, data on e-waste is reported by national statistical offices as part of monitoring compliance with Directive 2012/19/EU, under which targets for e-waste collection, reuse, recycling and/or recovery are stipulated.[53] Data required to be reported by EU Member States includes on EEE POM, e-waste collected, and e-waste received for reuse, recycling and recovery. Data on e-waste generated can be reported on a voluntary basis. More information on permitted calculation methods for reporting against the EU collection and treatment targets can be found in Section 6.2. Data on e-waste generation and treatment routes can also input to country submissions under the EU Waste Statistics Regulation for the EWC-Stat "Discarded electrical and electronic equipment." (08.2) and "waste containing PCB" (07.7). Eurostat makes reported data available on the Eurostat Data Browser.
- For countries not covered under Eurostat and OECD reporting, the biennial UNSD/UNEP Questionnaire on Environment Statistics includes questions on e-waste generated and e-waste collected. The questionnaires used in the current and previous collection rounds can be found here, while data released as of 2024 can be found here for e-waste generated and here for e-waste collected. Reported data on e-waste through this questionnaire helps track global progress against relevant SDG targets. In particular, SDG Indicator 12.4.2: (a) Hazardous waste generated per capita; and (b) proportion of hazardous waste treated, by type of treatment;[54] and SDG Indicator 12.5.1: National recycling rate, tons of material recycled.
- For Parties to the Basel Convention (as provided for under Articles 13 and 16), data on imports and exports of e-waste should be submitted annually through national reports made to the Basel Convention Secretariat by country focal points. See the Basel Convention website for more information on national reporting and published national reports.
- For Parties to the Stockholm Convention, national reporting on the production, use, and release of POPs in line with Article 15 may include information on POPs present in electronic equipment containing these substances in stocks or waste. The quantity of unintentionally released POPs by e-waste treatment like open burning or cable smouldering should be included there. In addition to national reporting, such information can be included in the preparation or updating of National Implementation Plans, particularly within national source inventories. Guidance and submitted NIPs are available on the Stockholm Convention website.

[53] *There is a mandatory target in place across EU Member States since 2019 that requires either 65% of equipment be sold in the three preceding years or that 85% of e-waste generated in the same year be collected and recycled.*

[54] *"Although e-waste can be either hazardous or non-hazardous, depending on the content of hazardous substances within the specific EEE, based on the precautionary principle…e-waste [is included] in the 12.4.2 indicator on hazardous waste. In the case of reliable data on separately collected/treated/disposed of e-waste without hazardous substances content, these quantities can be excepted from the calculation of the indicator." (UNEP, 2021, p. 67).*

- The assessment of e-waste statistics, management infrastructure, legislation, and key stakeholders-along with policy recommendations, is published in the Global, Regional, and National E-waste Monitor series (https://ewastemonitor.info/), through which countries are invited to report on these aspects. Data is also available through maps and country sheets on the Global E-waste Statistics Partnership website (https://globalewaste.org/).

Box 10. Recommended core indicators and products for reporting on e-waste statistics

Countries are at different stages when it comes to monitoring and reporting on e-waste. The following core indicators and minimum products are recommended for countries starting out in the measurement of e-waste.

Recommended indicators

The following core indicators for reporting on e-waste should be prioritised by countries at early stages of e-waste measurement:

1. EEE POM
2. E-waste generated
3. E-waste formally collected
4. Formal e-waste collection rate

Those indicators can be calculating using the methods outlined in these guidelines.

Recommended products

It is important for countries to adopt and implement harmonised classifications and methodologies to ensure a sustainable mechanism that collects and validates statistics on EEE, UEEE, and e-waste. In practice, there may be difficulties encountered in trying to collect the relevant information to construct the indicators presented in these guidelines with coverage for all UNU-KEYs.

Challenges may include a lack of data from informal e-waste channels or the inability to track the full lifecycle of products. Therefore, the relevant bodies responsible for, or tasked with, collecting data on e-waste and associated flows can consider starting with a minimum set of UNU-KEYs to report on. A minimum recommended set of UNU-KEYs have been selected for this purpose based on the following criteria:

- That the product comprises a significant share of the total market size in terms of weight such as washing machines and refrigerators;
- The product contains environmentally toxic components, such as POPs. Examples of these products include refrigerators and air conditioners;
- 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.

Based on those criteria, countries beginning to compile e-waste statistics should, at a minimum, aim to do so for the following UNU-KEYs:

- Washing Machines (incl. combined dryers) (UNU KEY: 0104)
- Refrigerators (incl. combi-refrigerators) (0108)
- Freezers (0109)
- Air Conditioners (household installed and portable) (0111)
- Cathode ray tube monitors and televisions (0308 and 0407)
- Laptops (incl. tablets) (0303)
- Mobile Phones (incl. smartphones, pagers) (0306)
- Flat-panel display monitors (0309) and televisions (0408)
- Kitchen equipment (e.g. large furnaces, ovens, cooking equipment) (0103)
- Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers) (0601)

In countries where reporting and statistical systems are more developed; it may be feasible to expand the number of products tracked and to track other indicators presented in this section from the outset. For example, countries with more developed systems may more readily track indicators such as E-waste in the waste bin and UEEE exported/imported.

Chapter 6.
National and regional case examples of e-waste measurement

This section showcases examples of countries and regional bodies worldwide that have undertaken measurement of e-waste based on the methodology outlined in the E-Waste Statistics guidelines series.

6.1 East Africa: E-waste generation and household and business surveys

Countries in East Africa have taken various steps to address the issues of e-waste management. The region is covered by the Regional E-waste Management Strategy 2022-2027 developed by the East African Communications Organisation. Countries in the region are gradually developing and approving e-waste policies and regulations to overcome issues such as low rates of formal collection and recycling. As e-waste policies develop, the need for accurate and comprehensive data and statistics becomes even more critical for informed decision-making including planning investments and monitoring progress.

Having in place a regional strategy for East Africa has given a solid foundation to work from when harmonising methods for collecting e-waste data and statistics, including through household and business surveys as piloted in this study. A baseline picture covering EEE POM and e-waste generated has been established for the region to help inform future policy. These statistics have been produced by country representatives using a range of national and business statistics, with surveys of households and businesses issued to fill data gaps.

6.1.1 EEE POM and e-waste generation

Use of the UNITAR EEE POM and e-waste generated tools by representatives of countries participating in the project revealed that:

- EEE POM in East Africa rose from 80 kt in 2000 to 170 kt in 2021, outpacing population growth across the same period.
- The increase of EEE POM has led to higher levels of e-waste generated in the region -having grown from 10 kt in 2000 to 128 kt in 2021.

The rapid rise in EEE POM indicates the increasing consumption of electronics, which in turn, generates pressure on e-waste collection systems. This trend suggests that East Africa will require expanded formal recycling capacity and stronger take-back mechanisms to manage future volumes.

6.1.2 Household and business statistics

The second approach collected data in Burundi and Kenya using household and business surveys. The household surveys conducted in Burundi and Kenya revealed:

- That the highest EEE possession rates were for the UNU-KEY 0306 mobile phones - with more than 95% of respondents in Kenyan and Burundi households interviewed possessing at least one mobile phone.
- The surveys also elicited responses regarding the most common disposal routes for EEE. In Kenya, for example, refrigerators are usually brought to an e-waste collection centre or a county-designated drop-off point (20% of the total) or alternatively picked up from households by the companies that sold the product (30%). The latter disposal route is less common for small household equipment in Kenya, as most is disposed of together with mixed residual solid waste (31%) or sold to a refurbishment or repair shop (34%) (see Table 10).

This study provides a general insight (including as a baseline for further detailed research) into the methodology deployed and results found from pilot household and business surveys undertaken in Kenya and Burundi.

Table 10. Disposal routes for products with the highest possession rate in high-income Kenyan households (2022)

Disposal route	Refrigerators	Laptops	Flat-Panel Display TVs	Small household equipment	Mobile phones
Picked up from home by the company that sold me the product	30%	7%	11%	0%	5%
Collected by door-to-door worker	10%	5%	4%	10%	7%
Sold online	10%	7%	5%	0%	3%
Sold to a refurbishment or repair shop	15%	51%	33%	33%	34%
Disposed of in the mixed municipal solid waste bin	0%	7%	12%	31%	15%
County picked up from home	0%	2%	0%	4%	2%
Brought to an e-waste collection centre or County designated drop off point	20%	0%	2%	2%	4%
Picked up by an e-waste collection centre	0%	2%	2%	2%	1%
Donated	5%	9%	18%	2%	11%
Other	10%	9%	14%	16%	18%

6.1.3 E-waste management in East Africa

The rapid increase of e-waste generated represents a challenge in a region where the availability of e-waste recycling infrastructure is limited. The region currently has only one formal e-waste recycling facility, located in Rwanda, with a capacity of approximately 7 kt per year. E-waste that is not formally collected and recycled is mainly managed by the informal sector even when collected by companies or at designated collection points. This means that, even after collection by formal entities, much of the e-waste ends up being processed informally, which poses risks to both the environment and human health, and in particular, women and girls as they represent approximately 30% of the waste picker workforce at dumpsites in Africa (BRS MEAS, n.d.). Informal processing persists due to factors such as profitability from material recovery, low enforcement capacity, and lack of formal collection points accessible to households.

6.2 EU: Measuring targets and the production of statistics through articles 7, 11, and 16 in the EU-WEEE Directive

The EU has legislated e-waste or Waste Electrical and Electronic Equipment (WEEE) management since 2002 through Directive 2002/96/EC[55] and Directive 2012/19/EU (the "WEEE Directive"). The latter is presently in force in EU Member States, with the WEEE Directive serving as a regulatory framework based on extended producer responsibility principles. There are three articles in the Directive that are particularly relevant to the production of statistics on e-waste in the EU: Articles 7, Article 11, and Article 16. These three articles (on collection rates, recovery targets, and reporting obligations) form the core statistical framework of the Directive, as they determine what data Member States must collect, how it must be calculated, and how compliance is measured.

Article 7 defines the minimum collection rate that each Member State should reach by certain dates. The Directive details two methods for calculating the collection rate for this purpose. The "WEEE Generated method" is calculated as the mass of WEEE collected divided by the mass of WEEE Generated in the same year. The "EEE POM method" is calculated based on the mass of WEEE Collected, divided by the EEE POM of the three years preceding the year of evaluation. The European Commission issued a Commission Implementing Decision (2019) further delineating rules for the calculation, verification, and reporting of data and streamlining the process.[56] For the WEEE Generated method, the target Member States have been required to achieve since 2019 is an 85% rate of collection, and for the EEE POM method, the target is 65%. The coexistence of two calculation methods was intended to give flexibility to Member States with different data quality levels. In practice, many rely on the EEE POM method because historic sales data is easier to obtain than accurate estimations of WEEE Generated.

Collection rates have an important role in providing a baseline for the development of WEEE management infrastructure in EU Member States. Article 7 of the WEEE Directive states that the minimum collection rate to be achieved annually by a Member State shall be either 65% of the average weight of EEE POM in the three preceding years or 85% of WEEE Generated on the territory of a Member State (Baldé et al., 2020). In practice, Member States have the most experience using the 65% collection target based on EEE POM, largely because it is more straightforward and uses readily available data. However, there are some shortcomings in the EEE POM calculation methodology that may be relevant for countries. This reliance on POM-based calculation can lead to misleading results for example high sales in previous years may artificially inflate collection targets, while economic downturns may artificially lower them, neither of which reflects the actual amount of waste arising.

[55] *No longer in force since 2014.*

[56] *Commission Implementing Decision (EU) 2019/2193 of 17 December 2019 lays rules for the calculation, verification and reporting of data and establishing data formats for the purposes of Directive 2012/19/EU of the European Parliament and of the Council on waste electrical and electronic equipment (WEEE) (notified under document C(2019) 8995).*

The most relevant shortcoming of the EEE POM target methodology is that the EEE POM is, conceptually, not directly related to the amount of e-waste that can be collected in a country. A product purchase will not necessarily result in a product discard. Moreover, the POM methodology is very sensitive for fluctuations in consumption of EEE and even more sensitive to fluctuations in PV panels that are placed on the market. The advantage of the WEEE Generated-based target is that, with representative national data, it should more accurately reflect the amount of e-waste arising that can thus be collected. However, the uncertainties for WEEE Generated may be significant if product lifespans are not accurate or realistic for the country or if POM data is not accurate enough. Since 2019, most countries in the EU have failed to meet the target based on either method.

In Article 11, the recovery targets of collected e-waste are described to ensure that collected e-waste undergoes proper handling and depollution of hazardous substances, and it is subject to methods that maximise the recovery of secondary raw materials. These targets are shown in Table 11 for each e-waste category (EU-6).

Table 11. Required recycling and recovery rates by EU-6 category as per Article 11 of the WEEE Directive

Category	Recycled + reuse	Recovered
1,4	80%	85%
2	70%	80%
5,6	55%	75%
3	80%	-

The CENELEC 50625 standard series describe minimum treatment requirements for e-waste and add detail to the WEEE Directive requirements on treatment and depollution. Standard EN CENELEC 50625-1 defines the methodology for calculating recycling and recovery rates of e-waste. The WEEE Forum Reporting Tool (WF-RepTool),[57] designed and developed by the WEEE Forum, put into practice by at least twenty producer responsibility organisations and multiple recyclers and processors, offers a practical solution aligned with the standard methodology. Using harmonised tools such as the WF-RepTool helps ensure consistency across recyclers and reduces discrepancies in how recovery rates are calculated. In practice, several Member States require recyclers to report treatment outcomes through tools aligned with the CENELEC methodology.

[57] *https://www.wf-reptool.org/*

Article 16, “Registration, information and reporting of Member States” covers annual reporting requirements on the collection, recycling, and recovery rates achieved. This may be organised through national registries, reporting directly to the government, or reporting by individually compliant producers or collective responsibility organisations. The underlying company data is also used to allocate funds based on the quantity of products placed on the market to finance e-waste collection and recycling as one of the mandatory features in the extended producer responsibility legislation. The aggregated national level data serves as the basis for calculating e-waste indicators - particularly national collection rates and recycling as well as reuse and recovery rates at the e-waste category level (EU-6). Member States regularly report on the collection and recycling and recovery rates achieved (See Table 12).

To reduce environmental impacts and ensure efficient use of resources, national e-waste legislation must address the challenge of adequate treatment and depollution. This includes establishing clear targets, implementation of monitoring and enforcement mechanisms, and promotion of treatment standards applicable to the recycling sector. At present, there is a pervasive lack of clarity among Member States regarding the methodology used to calculate recycling and recovery rates under Article 11, which is leading to differences in implementation (Seyring et al., 2015; European Commission, 2017). For example, Member States apply different assumptions for material composition and moisture content when calculating recycling rates, leading to inconsistent results. Some also diverge in how they classify ‘reuse’ within recovery calculations, creating discrepancies in reported performance. To ensure consistency and transparency, a harmonised approach taken across all Member States is critical.

Recycling and recovery targets are, currently, predominantly weight-based. However, ongoing discussions are concentrating on the establishment of targets focusing on specific types of secondary raw materials and critical raw materials that may otherwise be a lesser focus given the outsize influence of higher mass fractions such as steel or plastic. Promoted by the circular economy strategy, an increasing number of Member States are also discussing and setting targets for reuse.

Table 12. kg per capita per annum of e-waste recycled, recovered, and reused (Eurostat) (: = not available, s= Eurostat estimate)

Time	2018	2019	2020	2021	2022
GEO (Labels)					
European Union - 27 countries (from 2020)	8.04	9	9.66	10.22	10 s
Belgium	10	10.41	11.41	11.88	11.4
Bulgaria	6.78	8.65	9.91	12.8	13.49
Czechia	7.61	9.09	9.97	12.24	13.31
Denmark	11.1	11.77	12.93	11.84	11.07
Germany	10.01	11.09	12.25	11.84	10.56
Estonia	7.23	7.68	8.68	8.59	7.29
Ireland	11.38	11.63	11.79	13.07	11.86
Greece	4.7	5.33	5.07	5.2	5.57
Spain	6.4	6.65	7.45	6.81	6.54
France	10.05	10.83	11.22	13.05	12.52
Croatia	9.49	9.42	9.93	8.46	7.37
Italy	6.16	6.6	7.23	7.76	8.07
Cyprus	3.45	3.97	5.2	3.23	3.55
Latvia	4.25	5.01	5.13	7.22	8.9
Lithuania	4.44	5.09	5.13	6.18	6.69
Luxembourg	9.5	9.32	9.66	10.01	8.36
Hungary	6.05	7.32	7.94	7.45	8.25
Malta	4.83	5.09	4.05	4.62	4.37
Netherlands (Kingdom of the)	9.64	9.31	11.24	10.44	10.16
Austria	12.22	14.07	14.81	14.68	14.43
Poland	5.94	9.67	9.71	11.89	12.84
Portugal	6.48	4.34	4.24	5.16	5.35
Romania	2.87	4.05	3.96	6.71	:
Slovenia	6.17	6.49	6.41	7.06	6.64
Slovakia	5.24	6.53	7.93	8.89	9.48
Finland	11.44	12.71	15.19	14.08	13.42
Sweden	13.04	14.83	13.56	12.34	:
Iceland	14.13	13.83	7.65	:	:
Liechtenstein	11.14	9.36	13.37	12.12	11.34
Norway	17.26	18.91	20.32	19.1	18.07

6.3 Bosnia and Herzegovina: Producing e-waste statistics

6.3.1 Waste statistics

Through the establishment of the Bosnia and Herzegovina Environmental Strategy and Action Plan 2030+, the competent institutions in Bosnia and Herzegovina received an Environmental Strategy and an Action Plan with strategic and thematic goals along with feasible, clearly defined, and adopted measures. The content of the Bosnia and Herzegovina Environmental Strategy and Action Plan 2030+ refers to seven EU areas of the environmental acquis, including the thematic area of waste.

The Bosnia and Herzegovina Environmental Strategy and Action Plan 2030+ strategy ensures a coordinated approach to solving priority issues and uniform harmonisation with EU legal regulations, which is of particular importance in the context of the Circular Economy and the Green Agenda for the Western Balkans. By signing the Sofia Declaration in 2020, Bosnia and Herzegovina began working on sustainable production, waste reduction, sorting, and recycling for reuse, in accordance with the Green Agenda.

The Agency for Statistics Bosnia and Herzegovina is continuously working on improving the quality of statistical data on waste, as well as providing data in accordance with new requirements. Waste statistical surveys have been prepared in accordance with the provisions of EU regulations in the field of waste and prescribed methodological recommendations from Eurostat.

6.3.2 ITU-UNEP-UNITAR's E-Waste Monitor for the Western Balkans

The ITU Regional Office for Europe and the Telecommunication Development Bureau, the UNEP Regional Office for Europe, the Program Office in Vienna, and the UNITAR-SCYCLE Program joined forces in 2022-23 as part of the regional project titled ITU-UNEP-UNITAR E-Waste Monitor for the Western Balkans.

The objective of this project was to support national-level data producers in the region in producing official statistics on e-waste and facilitate the production of globally harmonised statistics in the area. The project provided technical training to national experts, enabling them to replicate the methodology independently and integrate e-waste indicators into national statistical workflows. In general, the project contributed to building the foundation for green and sustainable digitisation processes and contributed to the achievement of SDGs. This is, particularly, for SDG 12, "Ensure sustainable consumption and production patterns," where e-waste has a sub-indicator according to SDG 12.4.2, "Hazardous waste management," as well as SDG 12.5.1 "National recycling rate."

The Agency for Statistics of Bosnia and Herzegovina used a common methodology and tool for calculating the mass of EEE POM and e-waste generated (E-WG) (Manual for the use of the WEEE calculation tool, 2017). Based on tools and methodology developed by UNITAR, the Agency for Statistics Bosnia and Herzegovina managed to compile the e-waste statistics indicators from 2010 until 2021 at the level of both the UNU-KEYs and the EU-6 classification system. Using the same methodology as EU Member States significantly improves the comparability of Bosnia and Herzegovina's statistics with Eurostat datasets, which is essential for EU accession monitoring and benchmarking.

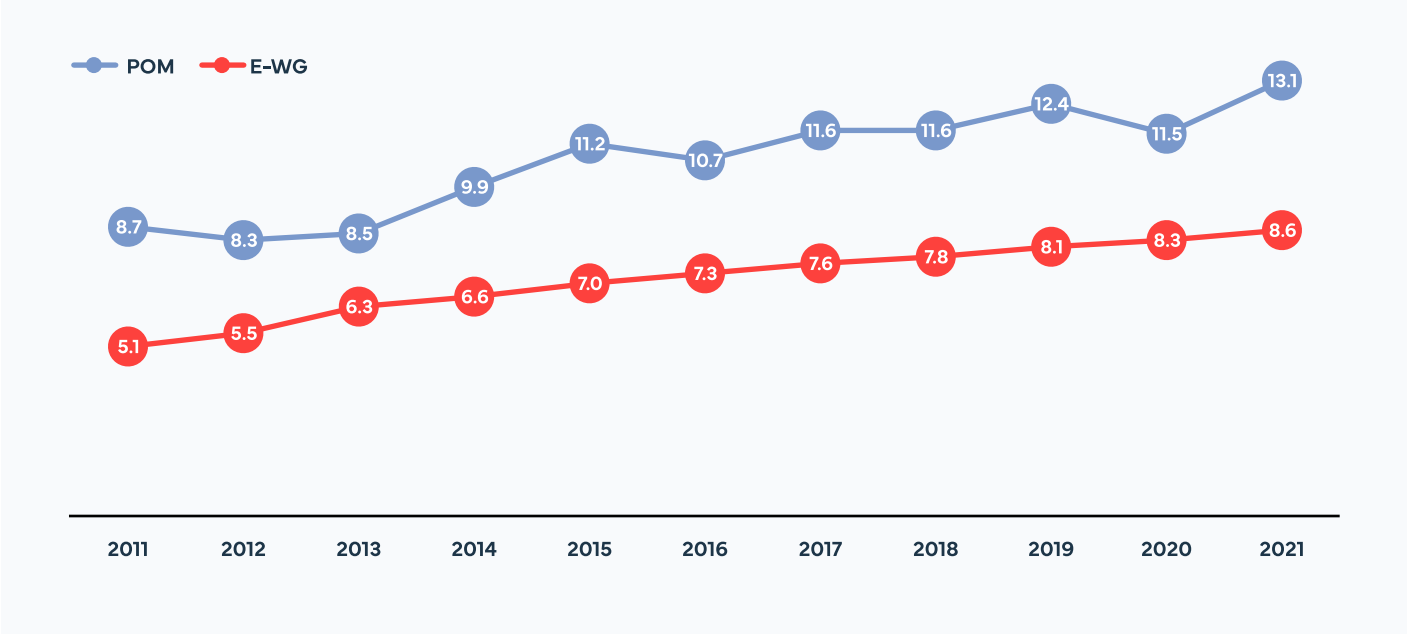
6.3.3 International Reporting Requirements

Based on the tools and methodology developed by UNITAR, the following indicators have been constructed for Bosnia and Herzegovina (Figure 8):

- Total EEE POM (unit kg/per capita) - representing the size of the national e-goods market.
- Total E-waste generated (unit kg/per capita) - representing the size of the national e-waste market.

These indicators provide the baseline required for future national targets on collection and recycling and allow Bosnia and Herzegovina to comply with international reporting requirements, including SDG 12.4.2 and Eurostat's WEEE questionnaires.

Figure 8. EEE POM and e-waste generated (E-WG) in Bosnia and Herzegovina, 2011-2021, kg per capita



Implementation of the method shows that the annual quantity, per capita, of EEE POM is increasing in Bosnia and Herzegovina, standing approximately 50% higher in 2021 than in 2011. In addition, the average annual quantity of e-waste generated, per capita, has also grown across this period, being almost 70% greater in 2021 as compared with the equivalent figure for 2011.

The Agency for Statistics of Bosnia and Herzegovina has prepared the transmission of available data to Eurostat through Questionnaire WASTE_WEEEDAT_A. It is based on data collected within the framework of Directive 2012/19/EU on waste electrical and electronic equipment (WEEE Directive). This marks an important milestone, as it is the first time Bosnia and Herzegovina can report harmonised e-waste data comparable with EU Member States, improving transparency and supporting the country's EU integration efforts.

6.4 South Africa: Attempts to initiate a measurement framework

Prior to 2020, South Africa did not have in place any dedicated national e-waste legislation. In 2020, the Waste Electronic and Electrical Equipment Extended Producer Responsibility Regulations were introduced. These regulations place a legal requirement on all EEE producers to participate in an extended producer responsibility scheme with penalties for non-compliance and performance targets. Additionally, a draft *WEEE National Management Policy* was published in 2024. As part of these regulations, e-waste in South Africa is classified into seven groups of specific product types and one group of mixed e-waste that includes products not elsewhere classified (see Table 13).

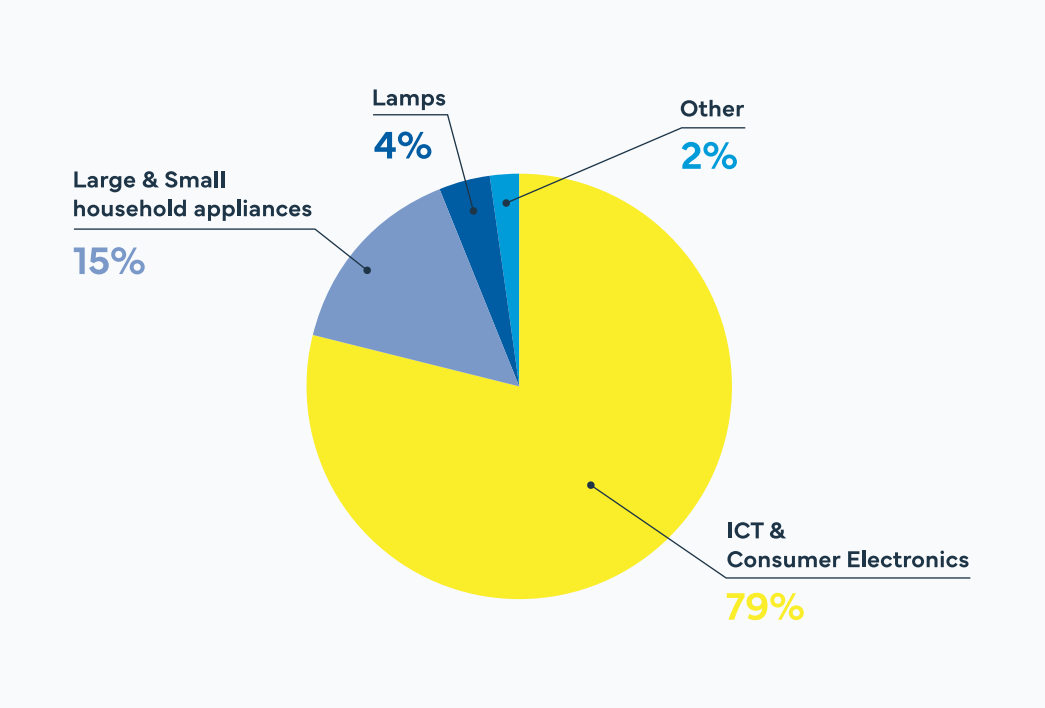
Table 13. Categorisation of e-waste in South Africa (Lydall et al., 2017)

Product category	Illustrative products within the category
Large household appliances	Washing machines, refrigerators, dryers, air conditioners
Small household appliances	Vacuum cleaners, coffee machines, toasters, irons
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
Light sources and lighting equipment	Fluorescent tubes and lamps, sodium lamps
Electrical and electronic tools	Drills, electric saws, sewing machines, lawnmowers, large stationary tools, machines
Security and healthcare equipment	Surveillance & control equipment and medical instruments & equipment
Mixed waste electrical & electronic equipment	Various e-waste

The 2017 Waste Research Development and Innovation Roadmap Research Report (Lydall et al., 2017) points out that South Africa lacks a harmonised framework to measure e-waste flows. Aggregated POM 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 parts are sold to (Lydall et al., 2017). As a result, in South Africa, EEE POM data, e-waste generation, and recycling volumes are not readily available from national statistical bodies. The absence of reliable POM and recycling statistics limits the ability of government and producer responsibility organisations to set realistic collection targets, plan infrastructure needs, or track the performance of the newly implemented EPR system.

From the report, Figure 9 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 items (e.g., cables). In aggregate, 17.7 kt tonnes of e-waste was handled by 23 treatment firms. Of this waste, 79% were ICT and consumer electronics, and 15% were large and small household appliances. These figures likely represent only a portion of South Africa's actual e-waste flows, as the sample excluded informal collectors and several formal recyclers that did not report. Therefore, the total national e-waste handled is expected to be significantly higher than the 17.7 kt recorded.

Figure 9. Volumes of e-waste handled across sample (17.7 kt) - by e-waste categories. (Lydall et al., 2017)



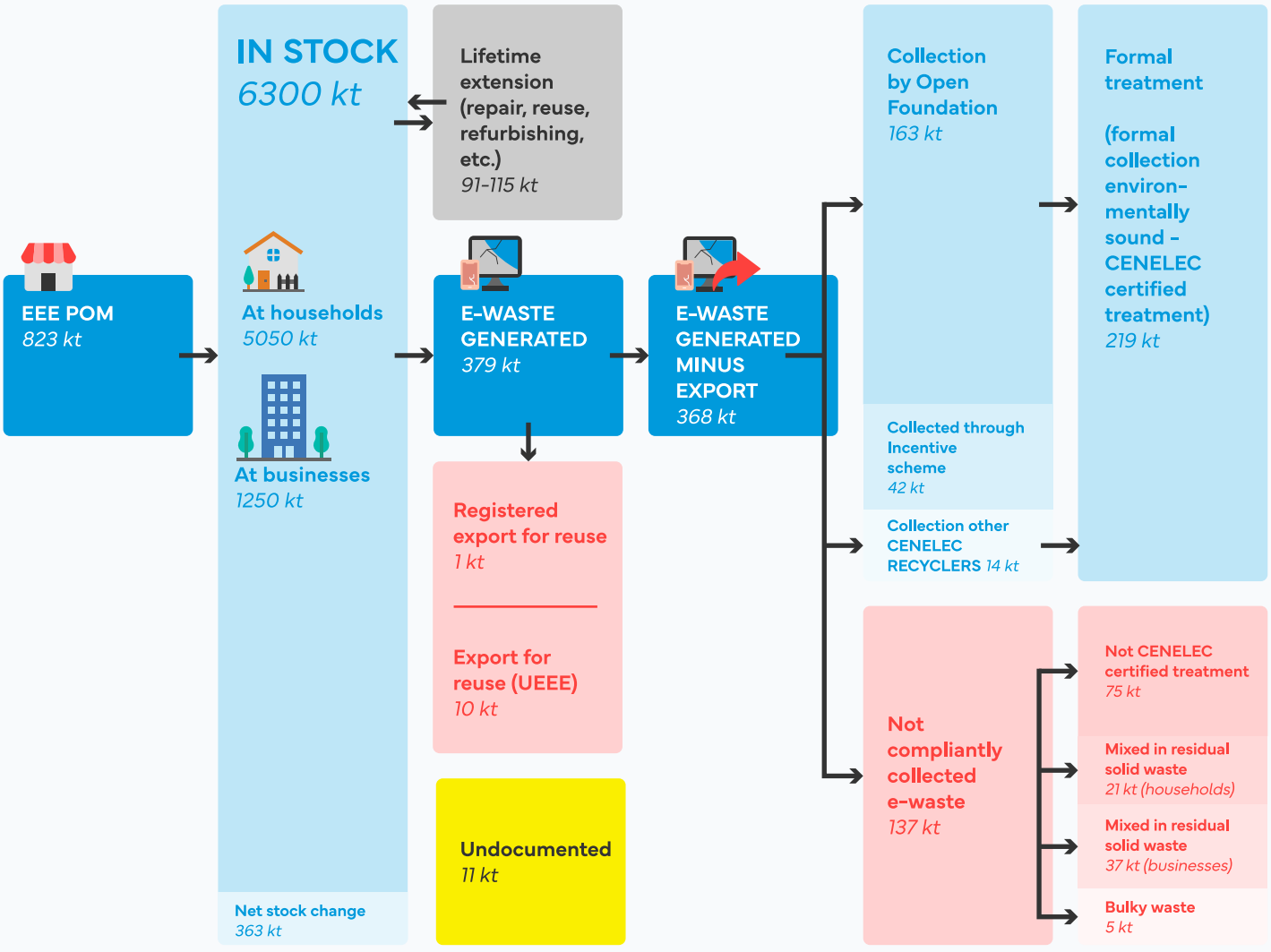
Data for South Africa on EEE POM, e-waste generated, and e-waste formally collected is being collected as part of the *Global E-waste Monitor* (Baldé et al., 2024). See the South Africa country profile on the global e-waste statistics website for more details.

6.5 Netherlands (Kingdom of the): Mapping EEE/e-waste flows

In transposing the WEEE Directive, the Netherlands (Kingdom of the) has opted for a "Universal Binding Declaration", meaning that Stichting OPEN is the only body in the Netherlands (Kingdom of the) with the role of implementing the extended producer responsibility mechanism. Because of this position, OPEN collates and holds a significant quantity of data. This allows the foundation to properly monitor all flows, draw up reports, and investigate areas of leakage flows and/or illegal flows, including free-riders. In collaboration with the Dutch government, the challenge in the coming years is anticipated to be to close these gaps and leakages by implementing good policy, effective campaigns, and proper enforcement.

Stichting OPEN has provided insight into EEE and e-waste flows across the Netherlands (Kingdom of the) based on the model shown in Figure 10. In this model, all data points are explained and substantiated with tools, studies, and domestic data. In the coming years, the focus of the OPEN Foundation will be on filling in the blind spots in the model. Key stages are described further below.

Figure 10. Model of e-waste flows in the Netherlands (Kingdom of the), with tonnage values for 2023



EEE POM: EEE POM in the Netherlands (Kingdom of the) is registered with the OPEN Foundation by means of assignments. This represented approximately 823 kt in 2023. A large part of the EEE POM is caused by market entry of new products, such as PV panels, air conditioners, and heat pumps.

Stock of EEE: The Open Foundation periodically conducts research into the EEE stock in the country. This is done through qualitative research and by using the datasets to create a mass balance. The stock of EEE is calculated to be 6,300 kt, of which 5,050 kt is with households and 1,250 kt is with businesses and the public sector. The total EEE stock hoarded in households is estimated to be 600 kt. How much is hoarded in businesses and the public sector is unknown.

E-waste generated: E-waste generated is calculated using the official tool developed by UNITAR. The tool makes use of all POM data and available life cycles. This was calculated to be 379 kt in 2023.

Export for reuse of UEEE (registered and not registered): There is a separate registry on exports for reuse of UEEE in the Netherlands (Kingdom of the). The entries from the registry indicate that 1 kt is registered. This is assumed to be an undercount and Stichting OPEN estimates the unregistered volume to be 10 kt. In the coming years, the Open Foundation will conduct new studies to verify these figures for the Netherlands (Kingdom of the).

E-waste compliantly collected (W_{Formal}): the amount of compliant collected and managed e-waste is 219 kt. This is further split into the source: collected by Stichting OPEN (163 kt), collected through an ad hoc incentive scheme (42 kt), and 14 kt collected by CENELEC-certified e-waste recyclers outside of the Stichting OPEN scheme.

E-waste non-compliantly collected (W_{other} and W_{bin}): the amount of e-waste that is not collected through the complaint schemes is calculated to be 137 kt. 21 kt has been found in the residual waste (W_{bin}) of households, 37 kt in the residual waste of businesses, and 5 kt with the bulky waste. It is estimated that 75 kt is treated not non-CENELEC-compliant ways, such as by being mixed in with metal or plastic scrap (W_{other}).

The remainder of the e-waste (11 kt) could not be documented or estimated.

Usage of the model and e-waste available for collection
The model developed provides a good picture of total flows of e-waste in the Netherlands (Kingdom of the) and is expected to be annually updated and improved. This allows OPEN foundation with the evaluation and assessment of campaigns; with the underlying data, it is possible to assess more comprehensive e-waste collection and treatment performance in the Netherlands (Kingdom of the) and effectively increase the compliant management of e-waste.

The model is also useful for the evaluation of e-waste collection targets. It was also found that the current collection target based on collecting 65% of EEE POM in three preceding years gives an unrealistic target due to the high volume of new products, such as solar panels, heat pumps, air conditioners, and electric bicycles coming onto the market and not directly generating waste.

The OPEN Foundation has been exploring possible new visions for a collection target. While focusing on minimising leakage flows and maximising collection, a new target is expected to provide a better picture of overall performance compared to the existing collection target. A potential suitable metric is the "E-waste available for collection", an estimate of the quantity of available e-waste that could be collected in a year. The methodology could be based on end-of-life calculations per product category (default timelines) and could include complementary flows based on evidence. The model could be based on e-waste generated flow data.

6.6 Malaysia: Defining UEEE, e-waste inventories and waste surveys

In Malaysia, e-waste (though not UEEE) is categorised as a Scheduled Waste under code SW 110 of the Environmental Quality (Scheduled Wastes) Regulations, 2005. The Environmental Quality (Prescribed Premises) (Treatment Disposal Facilities for Scheduled Wastes) Regulations, 1989 sets controls on the collection, treatment, recycling, and disposal of e-waste in the country.

In 2010, the Malaysian Department of Environment issued the second release of the *Guidelines for the Classification of Used Electrical and Electronic Equipment in Malaysia*. This publication focused on assisting all parties involved in e-waste management, with identifying and classifying used EEE or components. Clear definitions were crucial for customs officers, recyclers, and importers to distinguish between reusable products and waste. The guidelines defined UEEE or components as e-waste if the items met one or more criteria, including having a defect that materially affected their functionality or physical damage that impaired their functionality or safety (PGE, 2009). EEE considered e-waste in Malaysia as part of those guidelines are listed in Table 14.

Table 14. EEE products and components in the scope of the Malaysian guidelines

Used televisions	Used cathode ray tubes
Used air-conditioner units	Used electric cables
Used computers	Used mobile phones
Used refrigerators	Used motherboards
Used washing machines	Used hard disk drives
Used video recorders	Used printed circuit boards
Used telephones	Used lead frames
Used photocopy machines	Used patterned wafers
Used fax machines	Used ink cartridges
Used microwaves/ovens	Used or rejected or waste of integrated circuits
Used radios	Used audio amplifiers
Used printers	Used electrical and electronic equipment/products 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.

In Malaysia, while the export and import of e-waste or UEEE is not banned, it is restricted. Exporters or importers are required to obtain a written approval from the Director General prior to any shipment, with potential criminal charges for contravening this requirement. Certain factors limit this in practice, such as a lack of adequate information and limited of awareness of relevant entities and importers (UNEP, 2016). These compliance challenges contributed to unrecorded transboundary movements, meaning that a portion of UEEE entering or leaving the country is not captured in official statistics.

The Malaysian government has since issued further guidance defining permitted criteria to determine whether transboundary flows can be counted as UEEE and input legally to domestic activities such as direct reuse, reuse, repair, and refurbishment (PGE, 2017). This includes consideration of the age of equipment, management of hazardous waste, and operational information (PGE, 2017).

In 2016, a total of 129 e-waste facilities were recorded as being present in Malaysia, consisting of 97 partial recovery e-waste facilities (physical or manual segregation of e-waste for further processing) and 32 full recovery e-waste facilities, which can process the e-waste to recover precious metals (UNEP, 2016). Further work has been done by the Malaysian government to inventory collection centres, collection points, and recovery facilities, with 135 collection centres, 122 collection points and 64 recovery facilities reported on the 'list of collectors and recovery facilities' as of December 2024.[58] The increase in collection centres and recovery facilities reflects growing formalisation efforts. However, the capacity and treatment quality vary widely between facilities, and many still lack reporting obligations, which limits the reliability of national e-waste flow data.

Malaysia's Department of Environment cooperated with the Japan International Cooperation Agency (JICA) Technical Expert to undertake the Project for Development of Mechanism for Household E-waste Management in Malaysia. The purpose of the project was to implement a legal structure and organisational 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 Regulations in 2018. Items covered under the projects are television sets, personal computers, mobile phones, refrigerators, air conditioners, and washing machines.

In 2009, the Department of Environment 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 UEEE and e-waste. 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 e-waste is managed. Unfortunately, the figures presented in this study were unrealistically high and not representative of the actual e-waste generated in the country. This is because the sample was not nationally representative, the survey over-relied on self-reported disposal frequencies, and the methodology did not account for stockpiling behaviours common in Malaysia. A more recent estimate by UNITAR provided an e-waste-arising estimate of approximately 411 kt of e-waste generated in 2016 in Malaysia (Baldé et al., 2024).

[58] *https://ewaste.doe.gov.my/index.php/about/list-of-collectors/*

6.7 Belarus: Codifying an e-waste generation measurement approach

Belarus has a population of more than 9 million people and a significant domestic industry in the manufacture of EEE. Replacing an earlier system of fixed environmental tax payments, Belarus has had an EPR scheme for EEE/e-waste in place since 2012. This is alongside national e-waste collection targets (requiring 30% of EEE POM is collected) and a range of standards governing e-waste management activities. As well, Belarus is party to international agreements relevant to the management of e-waste - the Basel, Rotterdam, Stockholm, and Minamata Conventions.

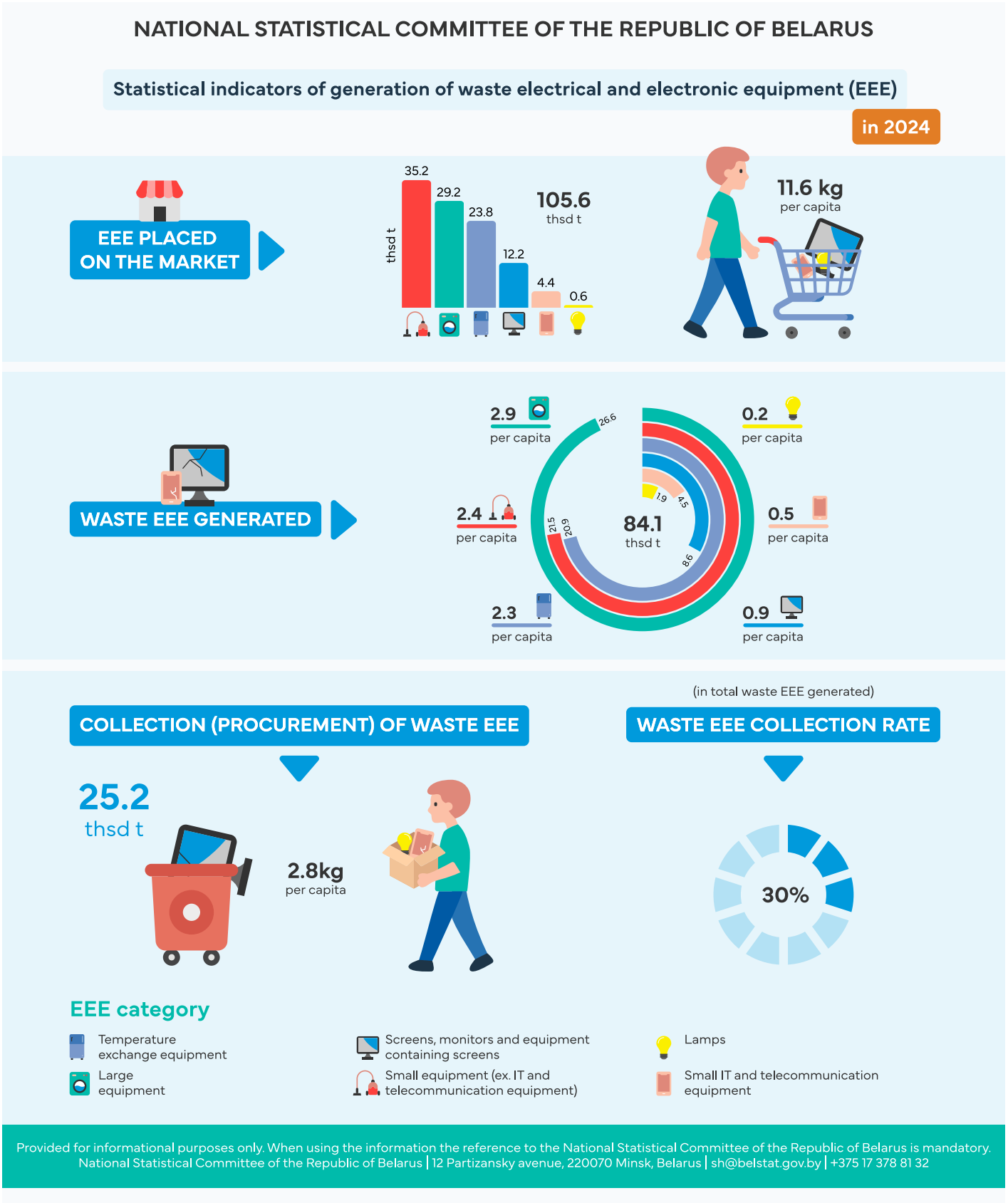
In Belarus, statistics on industrial waste are produced by the Ministry of Natural Resources and Environment Protection, while the Ministry of Housing and Utilities produces statistics on municipal waste and secondary raw materials, including e-waste. The National Statistical Committee Belstat coordinates statistical activity in Belarus, including the underlying methodology of indicators and dissemination of information. Dissemination is done primarily through the publication of annual statistical reviews and publications on specific indicator groups such as green growth. Belstat is also responsible for reporting SDG indicators and achievements at an international level.

In 2022, the National Statistical Committee of the Republic of Belarus approved the use of an official methodology for calculating statistics on e-waste generation, put into effect starting from the calculation of statistical indicators characterising the generation of e-waste for 2020 (Belstat, 2022a). Methodological guidance issued by Belstat alongside the published notice of approval sets out relevant definitions and procedures for calculating indicators including on e-waste generation, EEE sales, and e-waste collection in tonnage and per capita terms. The methodological guidance has been produced in accordance with the 2nd edition of UNU/UNITAR's global *E-waste Statistics* guidelines (Belstat, 2022b).

The adoption of an official methodology is a major milestone, as it formalises how Belarus measures e-waste and ensures that national statistics can now be compared with international datasets, including those produced under the Global E-waste Monitor. Areas of alignment include the use of the UNU-KEYs for calculating e-waste generation, published correlations to trade codes (further correlated to the Statistical classifier CK 25.006-2015 on "Industrial products" (SKPP), and technical parameters on product lifetimes and weights. Outputs of the process are to be published at the level of the EU-6 classification defined in Annex III of the EU Directive 2012/19/EU.

Belarus was estimated to have generated 84.1 kt of e-waste in 2024, with 30% of this being collected, meeting the national 30% target. The outcomes are summarized in the following infographic in Figure 11.

Figure 11. Key e-waste statistics in Belarus 2024. (Source: National Statistical Committee of the Republic of Belarus)[59]



[59] *https://www.belstat.gov.by/en/ofitsialnaya-statistika/macroeconomy-and-environment/okruzhayuschaya-sreda/statistical-indicators-of-generation-of-waste-electrical-and-electronic-equipment-/?sfnsn=wa*

6.8 United Republic of Tanzania: Strengthening the compilation of e-waste statistics

E-waste is a growing environmental and public health issue, not only at the global scale but also in low- and middle-income countries (NBS and UNU, 2019). The United Republic of Tanzania is experiencing a rapid growth in its IT sector (TCRA, 2025) that has contributed to a growing quantity of e-waste generated (NBS and UNU, 2019). The United Republic of Tanzania is also a destination for transboundary flows of UEEE but has in place limited infrastructure for the environmentally sound management of e-waste at present.

Only a few countries in Africa have enacted e-waste-specific policies and legislation, and there is currently no legislation specific to e-waste management in the United Republic of Tanzania. E-waste is managed more broadly under the solid waste and hazardous regulations forming part of the 2004 Environmental Management Act. The United Republic of Tanzania is also party to a number of international and regional multilateral environmental agreements, including the Basel Convention and Bamako Convention covering the transboundary movement of hazardous wastes.

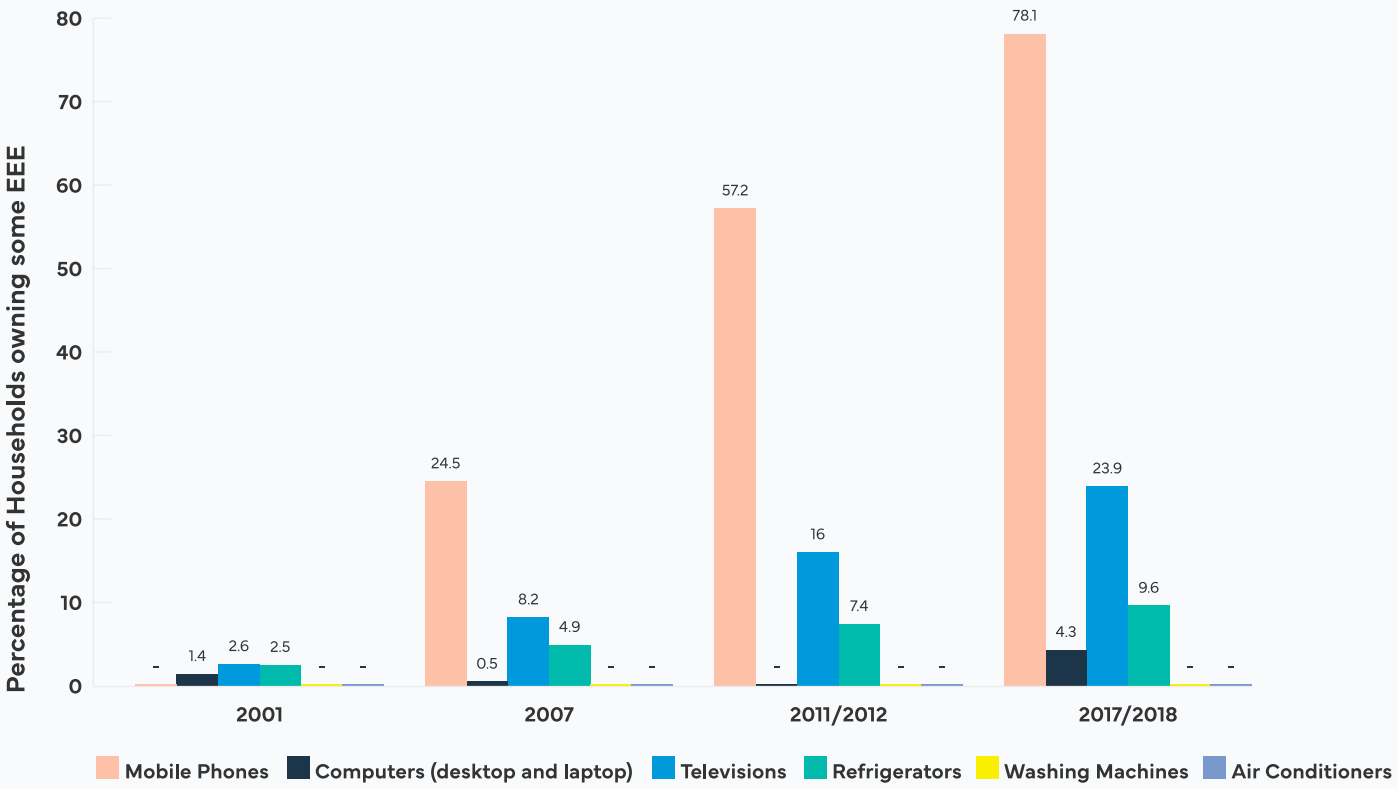
To strengthen the compilation of e-waste statistics in The United Republic of Tanzania, UNU provided training and Technical Support to the United Republic of Tanzania's National Bureau of Statistics through several events between October 2017 and May 2019. Training and production of the first round of statistics drew on the use of the following tools:

- The global *E-waste Statistics* guidelines document on classification, reporting, and indicators, published in 2015
- The EEE POM Tool - which helps a user prepare, adjust, and convert the available country data on POM
- The "UNU E-waste calculation tool" for the calculation of the weight of EEE POM, imported, exported, collected, and recycled

A key outcome of this cooperation was a joint UNU-TZA report - the 2019 *National E-Waste Statistics Report, Tanzania Mainland* which presented estimates for key indicators on EEE/e-waste for The United Republic of Tanzania for the first time (NBS and UNU, 2019). While challenges included a lack of reliable data, the report found an increasing and accelerating trend of EEE POM and e-waste generated (see Figure 13).

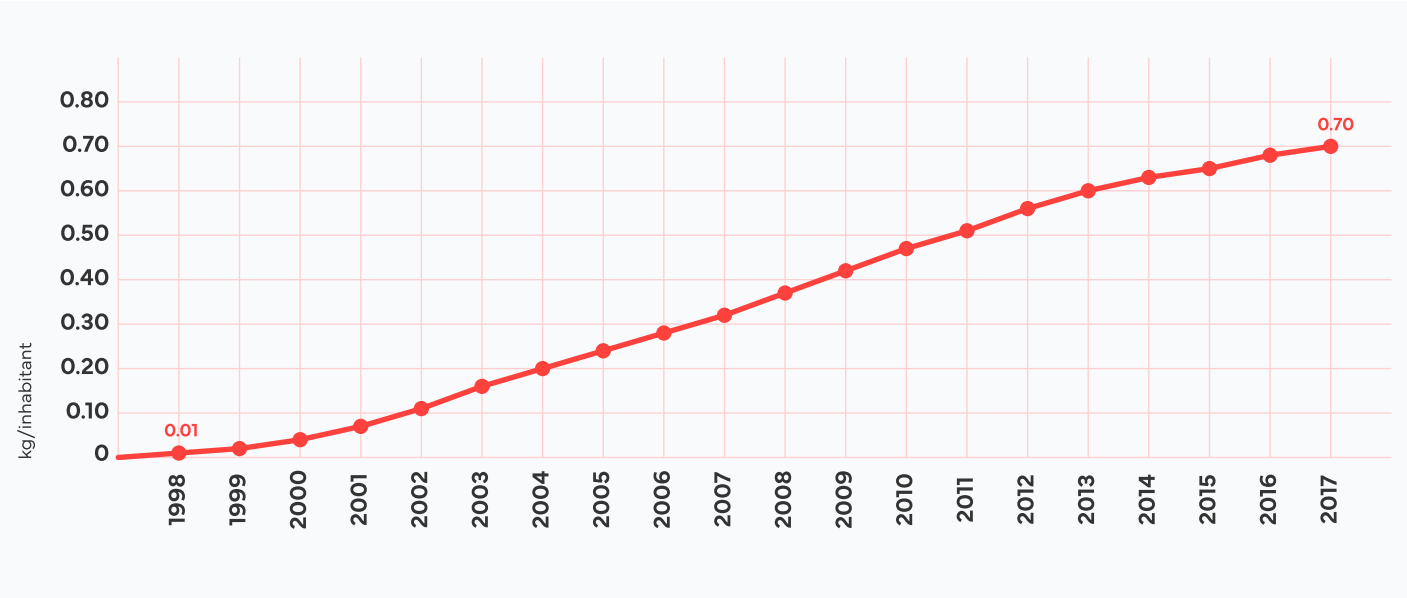
Proxy data from the Household Budget Surveys conducted by the National Bureau of Statistics showed high penetration rates for mobile phones in households (with nearly eight in ten households owning one in 2017/18) and growing rates of ownership across other categories such as televisions and refrigerators (Figure 12).

Figure 12. Percentage of households in the United Republic of Tanzania that own some type of EEE product, 2001, 2007, 2011/12, 2017/18 (NBS and UNU, 2019)



The study also highlighted increasing levels of e-waste generation, made up particularly of large equipment, small equipment, and temperature exchange equipment, which also dominated imports. On average, e-waste generated per inhabitant was found to have steadily increased from 0.01 kilogram per capita in 1998 to 0.70 kg per capita in 2017 (Figure 13).

Figure 13. E-Waste generated per Inhabitant (kg/inhabitant) in the United Republic of Tanzania Mainland, 1998-2017 (NBS and UNU, 2019)



To tackle e-waste in The United Republic of Tanzania going forward, the study outlined three key recommendations centring on capacity, awareness, and improved data:

- To increase capacity across the government to tackle e-waste, including through the development of specific legislation and policy for e-waste management. This could include mandatory reporting of EEE POM by importers, requirements for formal recyclers to submit annual returns, and the designation of approved collection centres.
- To build awareness across bodies involved in government and the general public of the effects of e-waste on the environment and human health through routes such as workshops and campaigns as a means to enable improved waste treatment.
- To enhance data availability on certain flows such as domestic production and flows of e-waste. This includes through designing and disseminating questionnaires to capture further information from households and businesses, improved data collection by local government at the point of waste disposal, and recycling and working to minimise under- and misreporting of EEE and illegal EEE transactions.

The study also highlighted the potential value of using country-specific data such as on product lifetimes and import sources.

6.9 Lebanon: The National E-waste Monitor

An output of a joint UNITAR and UNDP project, the National E-waste Monitor for Lebanon (2022) presents for the first time, a comprehensive assessment of electronics flows, stock levels, and waste generation in Lebanon, including estimates for EEE POM and e-waste collected for environmentally sound management (Baldé, Panchal and Forti, 2022). The report generated estimates for EEE POM, the national stock of EEE products, and waste generation, including waste collected for environmentally sound management alongside flows across alternative disposal routes (Baldé, Panchal and Forti, 2022).

Particular methodological developments in the report included integrating household statistics into the framework which provided a basis to validate and calibrate inputs to modelling e-waste. The study further presents novel statistics on household disposal behaviour in Lebanon in addition to e-waste collection and recycling for environmentally sound management. The study also applied a methodology developed for the *Global E-Waste Monitor 2020* (Forti et al., 2020) to calculate hazardous and raw materials embedded in e-waste.

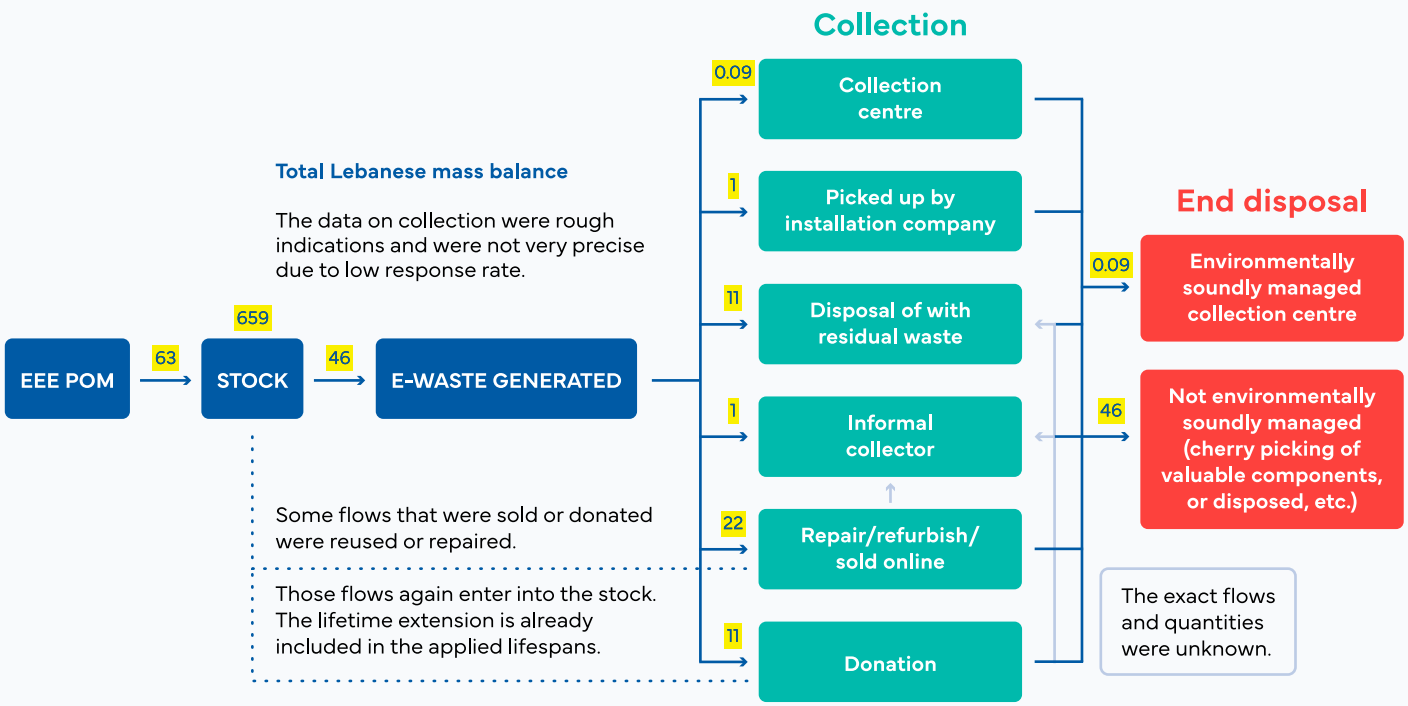
Currently, e-waste is managed under a general hazardous waste decree, though it is recognized that further actions, including an EPR scheme, are needed for more targeted management. A national strategy published in 2019 includes some targets for e-waste, while the country is in the process of establishing an EPR scheme for electronics. The statistical data generated will support national planning for e-waste management, inform infrastructure development for e-waste collection and recycling, and guide international reporting, particularly for SDG 12 (indicators 12.4.2 on hazardous waste management and 12.5.1 on national recycling rates).

The study applied the internationally accepted framework for calculating e-waste generation developed by UNITAR. EEE POM was calculated for each UNU-KEY based on an apparent consumption method, back-casting to 1980 and forecasting to 2021 using linear regression to produce a complete time-series. Lifetime distribution parameters used in calculating stocks and waste generation were refined through modelling. Household stocks for 25 UNU-KEYs were estimated through a representative survey of 1,280 households across six governorates in the region undertaken in 2021. The outcomes of the survey were extrapolated to represent the entire population of Lebanon, including refugees. E-waste generation estimates were improved and validated using these surveyed figures, applied through iterative adjustments to the POM and product lifetime inputs for several UNU-KEYs.

The study found that 63 kt of EEE was placed on the market in Lebanon in 2021 (Figure 1). The largest category of EEE POM in 2021 was large equipment (representing 42.3%, by mass), which added to a stock of 659 kt. In the same year, 46 kt of e-waste was discarded, or 7.2 kg/inhabitant. As part of the study, e-waste was found to frequently end up in non-separated residual solid waste or was collected by the informal sector.

Only 0.09 kt, or 0.2%, of e-waste generated in 2021 was documented as being formally collected, dismantled, and managed in an environmentally sound manner (Figure 14). The low formal collection rate reflects limited availability of designated drop-off points, absence of producer obligations, and the dominance of informal collectors. It is likely that the vast majority of e-waste ends up in landfill or open dumpsites. This corroborates the wider findings picture for the region, as in the *Arab Regional E-waste Monitor* (Iattoni et al., 2021).

Figure 14. Mass balance of e-waste in Lebanon in 2021 - unit kt. (Baldé, Panchal and Forti, 2022)



The household survey undertaken as part of the project highlighted repair as the primary intended action across households for products no longer functioning (which can serve to further extend product lifetimes), with stated disposal routes by households assumed to be the same for businesses. A mass-balance approach was used alongside the survey to populate disposal routes by UNU-KEY.

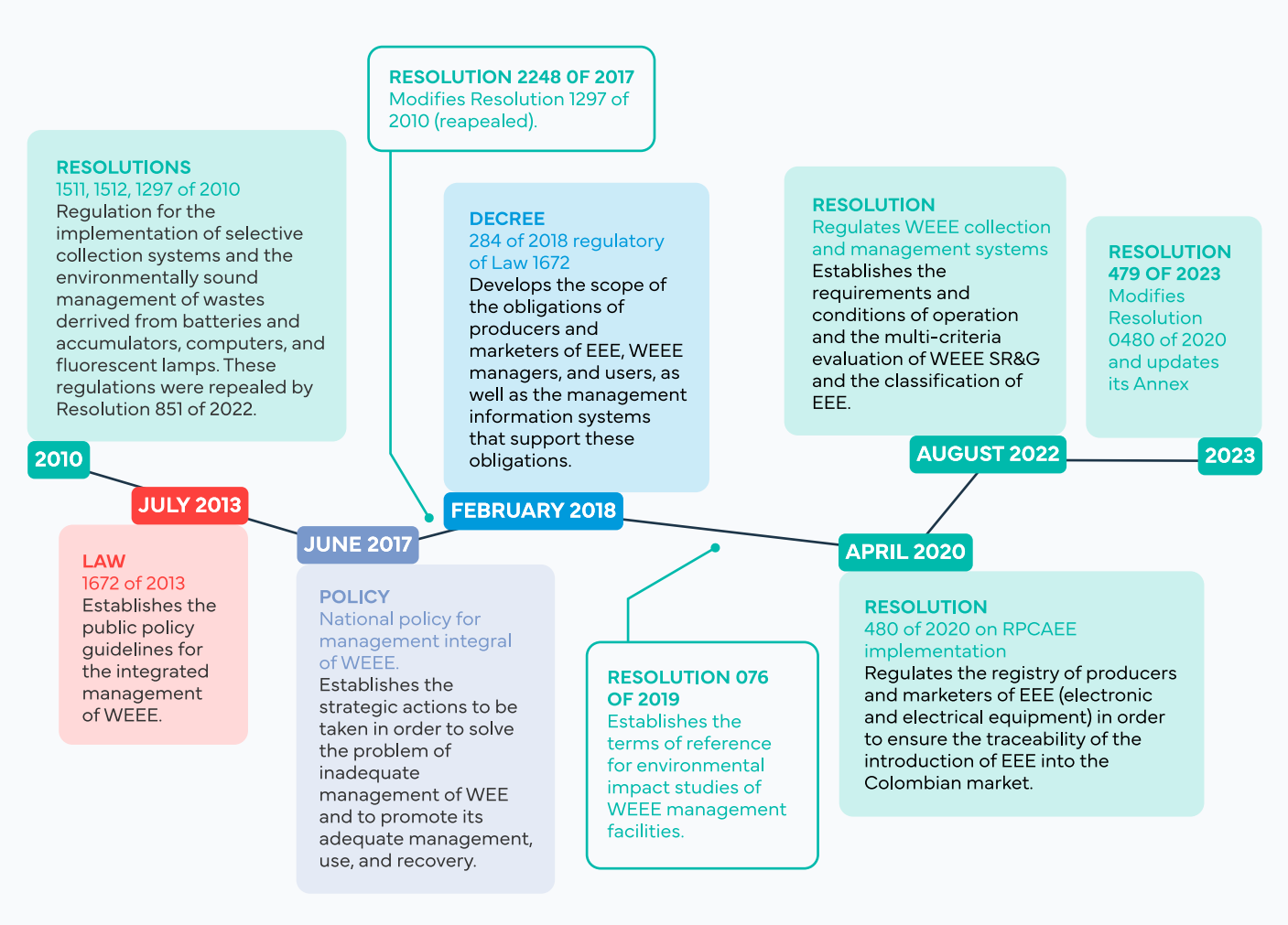
The report made the following recommendations to improve statistics on, and the treatment of, e-waste in Lebanon:

- Establish a clear legal framework for e-waste collection and recycling, including establish a clear legal framework for e-waste collection and recycling, introducing EPR to ensure that producers finance the collection and dismantling of e-waste, and strengthen monitoring, statistics, and compliance mechanisms across the country to ensure a level playing field for all.
- Expand and improve collection systems, including establishing accessible collection points, supporting formal take-back schemes, and integrating informal collectors to increase the share of e-waste captured through formal channels.
- Develop national recycling capacity and data systems by investing in environmentally sound treatment facilities, raising public awareness of the benefits of proper disposal and recycling, and strengthening the technical skills and networks of e-waste managers and public authorities.

6.10 Colombia: Tracking E-waste Management

Colombia has been a forerunner in Latin America in developing a sound environmental policy and a specific regulatory framework to address the growing problem of inadequate management and disposal of e-waste. Figure 15 shows the timeline for developing extended producer responsibility (EPR) regulations for e-waste in Colombia.

Figure 15. Development of policy and regulation for comprehensive e-waste management in Colombia. (Colombia Technical Guide for The Integral Management of WEEE 2023)

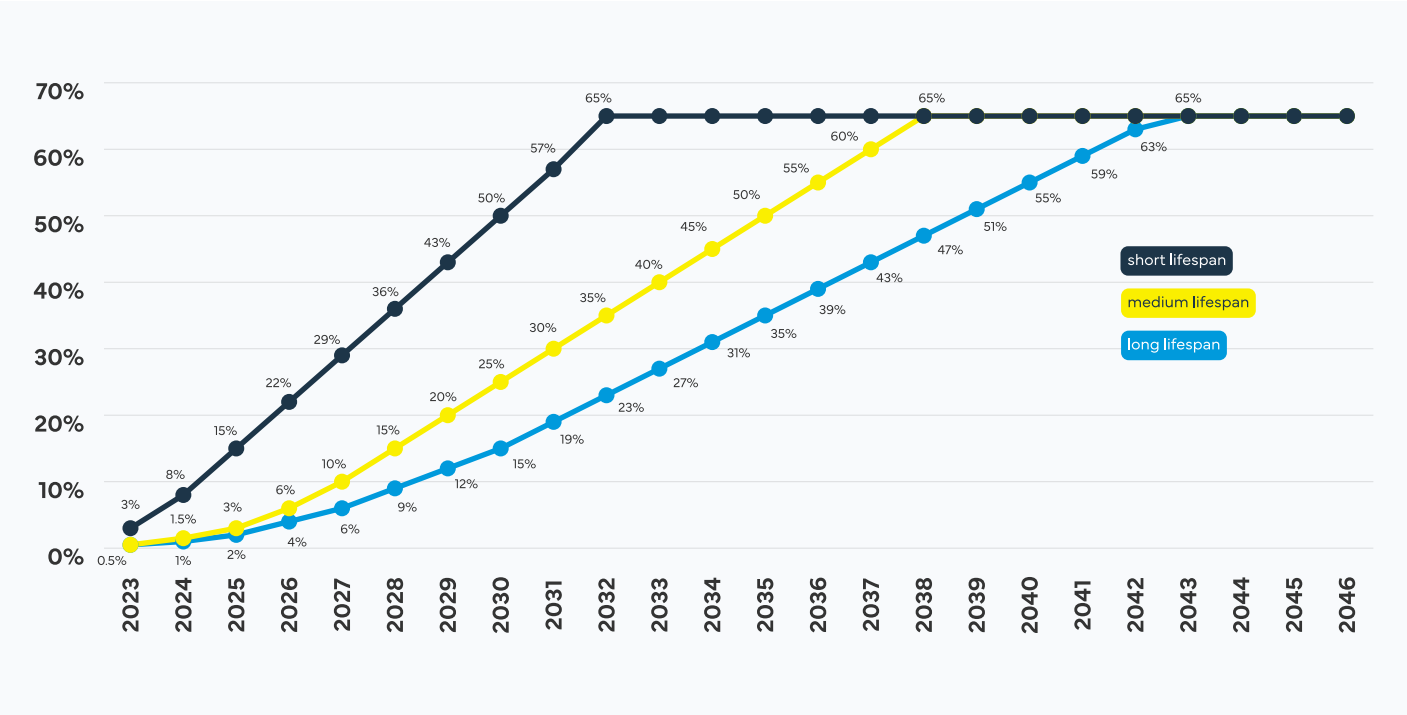


The first e-waste regulations were issued in 2010. These required importers and national producers of computers, printers, batteries, accumulators, and fluorescent lamps to take responsibility for the associated waste generated in the country. This has resulted in the collection and treatment of 42,140 tonnes of e-waste between 2012 and 2022.

Subsequently, the Congress of the Republic promulgated the Law 1672 in 2013, which establishes the "Guidelines for the Adoption of a Public Policy for Comprehensive Management of WEEE," further formalising producer obligations and broadening the scope of covered products. The application of the EPR principle requires importers and national producers of EEE to implement and finance, either directly or through third parties and whether individually or collectively, systems for the collection and environmentally sound management of waste corresponding to the EEE they have placed on the market.

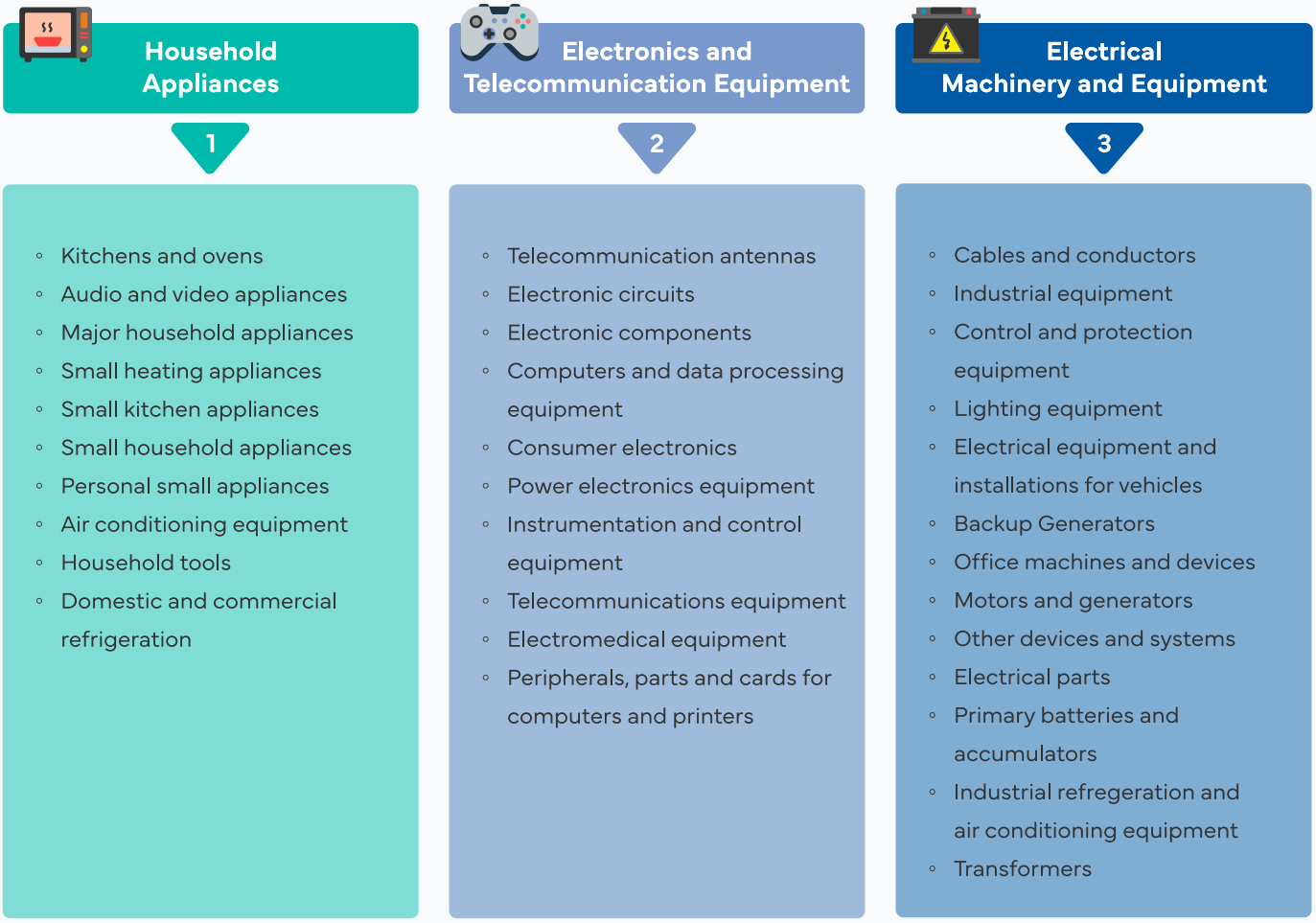
In 2022, the Ministry of Environment and Sustainable Development issued Resolution 851 of 2022, which set out the guidelines and requirements that these systems must comply with for mass-consumption EEE marketed in the country. Resolution 851 sets progressive national targets for the collection and management of e-waste for all previously unregulated EEE, considering the anticipated lifetimes of the equipment according to three major groups: short, medium, and long lifetimes. Targets on the collection and management of e-waste (as shown in Figure 16) have been set which require 65% of EEE POM is collected and managed, with the timeframe to achieve this varying by product type. This percentage is required to be met by 2033 for short life products, by 2038 for medium life products, and by 2044 for long life products to allow producers to gradually scale collection and treatment capacity in line with waste arising. For this purpose, a list of EEE was classified and categorised into three categories and 33 subcategories, with around 620 EEE products identified by 10-digit tariff subheadings according to the HS.

Figure 16. Targets for the collection and management of e-waste, distinguished by anticipated lifetime of product (short, medium, and long) (Resolution 851 of 2022) (Minambiente Colombia, 2022)



The classification of EEE/e-waste shown in Figure 17 has been developed based on the characterisation of the country's production chains, grouping EEE according to their functionality, size, composition, and common end-of-life characteristics. This is done in the same way as the UNU-KEYs against which, each EEE category is correlated. Aligning Colombia's classification with the UNU-KEYs has enabled harmonised international reporting and facilitates comparisons with other countries.

Figure 17. Classification of EEE/e-waste in Colombia (Colombia Technical Guide for The Integral Management of WEEE 2023)



As part of producing statistics on e-waste in Colombia, e-waste generation is estimated based on a calculation of apparent consumption and the sales-lifetime model. This involves applying the Weibull probability distribution for each EEE in the way outlined in these guidelines. Lifetime parameters from the second edition of the E-waste Statistics guidelines have been used, specifically those for countries outside the EU. The generation of e-waste in 2024 was estimated at 210 to 250 kt based on this approach.

By adopting these methods, better traceability of the flows of EEE/e-waste in Colombia has been achieved. Compliance with targets on the collection and proper treatment of e-waste is monitored on an ongoing basis by the government. The Ministry provides the regulations, studies, technical guides and other documents related to the management of e-waste in Colombia at the following link: https://quimicos.minambiente.gov.co/raee.

6.11 Nigeria: Calculating imports of e-waste and used equipment

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

The Person in the Port method was applied in Nigeria as part of a project spanning 2015-2016 which sought to obtain a realistic picture of qualities, quantities, origin, types, and functionality of imported UEEE and e-waste.

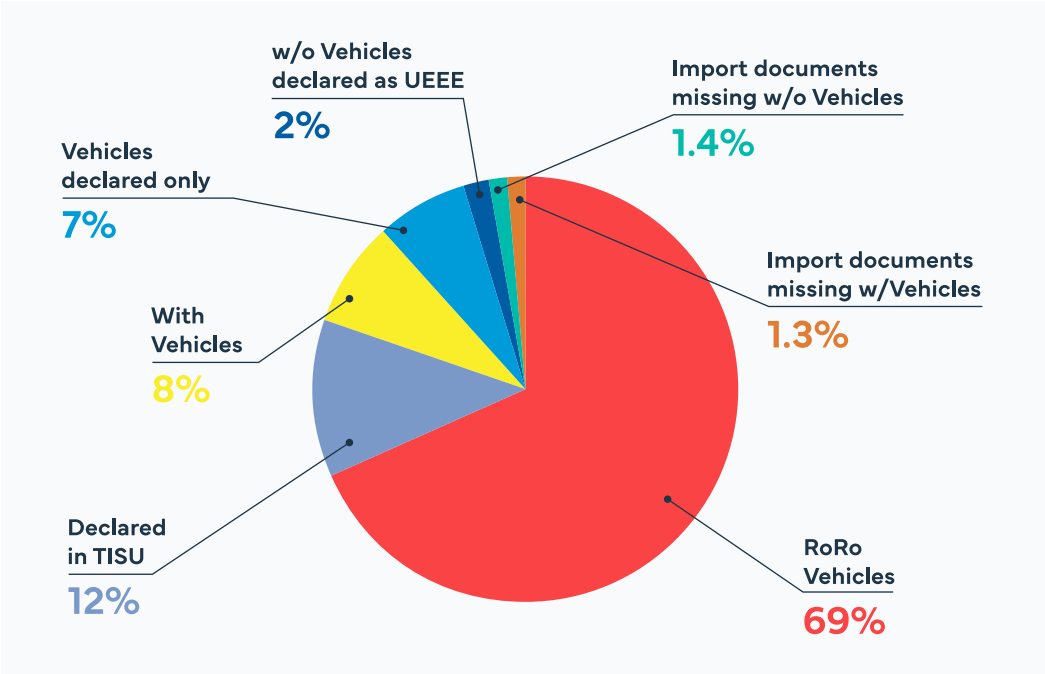
Across two phases of the project, 201 containers reported to be carrying UEEE were inspected at the Tin Can Island Port Complex and the Lagos Port Complex Apapa in Lagos. These locations were considered to be the main hubs of UEEE imports into Nigeria. Of the 201 inspected container with UEEE, around 9% had missing documentation or could not be related to the inspected containers. During inspections, the person in the port inspected the numbers, types, and weight of UEEE, its condition, country of origin and the availability of testing certificates. In addition, 2,184 randomly selected non-containerised vehicles were inspected for UEEE notwithstanding that most were declared as 'vehicles only' in the customs declarations.

Additionally, 3,622 import documents of containers with UEEE were reviewed. Data from the inspections was used to quantify goods in containers not declared as UEEE in import documents, but as "terms indicating suspected UEEE". These were mainly household goods and personal effects. The quantity of goods classified as "terms indicating suspected UEEE" based on importation documents, were converted into estimates of UEEE according to the percentages of "terms indicating suspected UEEE" declared in inspected containers that were actually found to be UEEE during the inspections. The inspection data in conjunction with importation documents were used to calculate the total annual volumes of UEEE imports in the documented imports, as well as the types of UEEE, their origin, etc. Some inspected containers could not be identified in the import documentation. The percentage of these inspected containers missing in the import documentation was used to adjust the calculated import volumes calculated so as to account for this gap.

Overall, based on the data from inspections and review of import documents, around 60 kt of UEEE were estimated to be imported annually in 2015 and 2016, respectively. Almost 70% - 41.5 kt - of the UEEE reaching Lagos each year was estimated to arrive inside vehicles (Roll-on, Roll-off, RoRo)[60] destined for Nigeria's second-hand auto market. This highlighted an import route for UEEE imports that had previously not been thoroughly assessed. Another 18,300 tonnes each year was estimated to arrive in shipping containers. Figure 18 illustrates the share of total UEEE imported across import routes.

[60] *A shipping mode in which the cargo is driven on and off the vessel. In RoRo, the ships are designed to carry wheeled cargo, such as automobiles, trucks, semi-trailer trucks, trailers, tractors, buses, which are driven on and off the ship on their own wheels, or oversized cargo loaded on special flatbeds, trailers or using platform vehicles, such as self-propelled modular transporters.*

Figure 18. Modes of UEEE importation into Nigeria at main trade hubs (Odeyingbo et al., 2017)



Most of the UEEE imported in containers was clean and undamaged but improperly packaged and some had cut cables. Basic testing showed, depending on the type of UEEE, that imported UEEE is functional to varying degrees - approximately 19% on average. Thus, every year, Nigeria may have imported around 15.7 kt 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 particularly to UEEE imports in containers with vehicles, and even more so for Roll-on/Roll-off imported vehicles.

The Person in the Port 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 study highlighted a continuing "severe problem" of non-compliance with international and national rules governing shipments of UEEE. 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 mechanisms, in particular, could be strengthened for Roll-on/Roll-off imported vehicles, which have been shown to be a key UEEE import route in Nigeria (and this may also be true for other developing countries).

The methodology developed in this project shows potential in being able to 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 would, however, reduce the required efforts for the assessment and evaluation of import documentation. This highlights that effective cooperation with the main stakeholders along these transport routes - such as customs and port authorities, as well as of enforcement agencies - is important for the success of such projects.

6.12 Nigeria: Improving mapping of Persistent Organic Pollutants (POPs) in e-waste for Stockholm Convention national source inventories

6.12.1 Background

This case study presents the first comprehensive estimate of POPs in WEEE plastics for a low-income country, using data for Nigeria (Babayemi et al. 2025). This work is important for global monitoring of POPs by helping to fill a geographic data gap that currently limits accurate global assessments under the Stockholm Convention. This estimate is also important for Nigeria because the country receives large volumes of second-hand electronics whose plastic components often contain POPs, yet national inventories historically lacked quantitative data on these substances.

Conducted under the UNEP-led and GEF-funded global project on updating National Implementation Plans for the Stockholm Convention, the study supports global efforts to improve hazardous chemical management through knowledge generation and evidence-based policy guidance. The study was compiled as sectoral case study of POPs in EEE/e-waste (see GGKP 2024c) with the aim to disseminate practical tools and support stakeholder coordination in addressing POPs in electronic waste (GGKP 2024c).

Nigeria is one of Africa's largest importers of EEE and has historically been a destination for significant volumes of used electronics and e-waste -often undocumented or illegally imported.

POPs such as Polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD), Dechlorane Plus, and chlorinated paraffins (short-chain chlorinated paraffins (SCCPs) and medium-chain chlorinated paraffins (MCCPs)) are widely present as flame retardants and additives in EEE and WEEE plastics (see Annex 8). These substances are toxic, persistent, and can be released into the environment through informal recycling practices, such as open burning, leading to multiple health risks to waste collectors, recyclers and surrounding communities, particularly to children and elderly women exposed to such toxins (BRS MEAS, n.d.). Impact factors have been compiled by the Stockholm Convention inventory guidance for PBDEs (UNEP, 2021b) and the Sectoral Guidance for POPs inventories (GGKP, 2024a) (see Annex 8) and were used for the country estimate.

6.12.2 Key findings

Key findings of the Nigerian case study were:

- Official Import Volumes (1990-2022) - Based on UN Comtrade data, Nigeria imported cumulatively 4.6 Mt EEE between 1990 and 2022. The cumulative embedded plastic content is estimated to be 1.4 Mt. These imports represent a major share of Nigeria's total electronics consumption and a substantial contributor to the national stock of POPs.
- Adjusted Estimates Including Informal Imports - During 2000-2010, Nigeria received large volumes of undocumented WEEE. Factoring in these imports adds an estimated 7.7 Mt, bringing the total volume of EEE and WEEE imports to 12 Mt, and plastics to 3.6 kt-more than double the official estimate.

- POPs Content in EEE Plastics - Using impact factors derived from prior studies, the estimated quantities of POPs in officially recorded and adjusted imports are compiled in Table 15.

PBDEs are identified as the most relevant POP due to their high former use volumes and presence. Furthermore, they have the potential to form the highly toxic brominated dioxins and furans (Polybrominated dibenzo-p-dioxins/ Polybrominated dibenzofurans) present in EEE/e-waste plastic containing PBDEs (Weber and Kuch 2003; Sindiku et al. 2015) and currently evaluated as POPs by the POPs Review Committee. The vast majority of these imported plastics, particularly those containing POPs, are not managed through formal systems.

Table 15. Estimated POPs imported in EEE and WEEE to Nigeria (1990-2022) (Babayemi et al., 2025; GGKP 2024c)

Substance	Official Data (t)	Overall Estimate (t)
Decabromodiphenyl ether (DecaBDE)	**3897**	**8511**
hexabromodiphenyl ether and heptabromodiphenyl ether (HexaBDE and HeptaBDE)	**454**	**1043**
HBCD	**57**	**154**
SCCPs	**33**	**91**
MCCPs	**133**	**364**
Dechlorane Plus	**54**	**146**

Hazardous fractions are often dumped or burned, creating severe risks for human health and the environment. Currently, Nigeria lacks the infrastructure to monitor, separate, or safely dispose of POP-containing plastics from imported or discarded EEE. These risks are exacerbated by common practices such as open burning at informal dumpsites and backyard cable burning, which release POPs directly into surrounding communities.

6.12.3 Data Limitations

The study (GGKP, 2024c; Babayemi et al., 2025) had some limitation in data coverage:

- Only 28 of the 54 UNU-KEY product groups were analysed.
- Domestically assembled EEE products were excluded which were considered minor.
- Some years have incomplete data coverage.
- Informal and unreported cross-border trade within West Africa is not reflected in official statistics.

These limitations mean that the findings represent a low estimate, likely underrepresenting the full scale of the imported total POPs amount.

Chapter 7. Conclusion

This third edition of the global E-waste Statistics guidelines publication has been published with the goal of helping countries produce internationally comparable statistics on e-waste and, in doing so, support national and international policy-making. A harmonised classification, measurement framework, and indicators as laid out, are a key step toward reaching an integrated and comparable global measurement framework for e-waste.

The guidelines define a measurement framework that seeks to capture the most important dynamics of flows and stocks of EEE and e-waste. The framework is centred around a product classification, the "UNU-KEYs," that is designed to encompass all possible EEE. Updates to the UNU-KEYs classification to produce the UNU-KEYs-v.2 are outlined. The classification connects outwardly to other classifications describing adjacent areas, including areas such as trade, production, and transboundary e-waste flows, allowing the framework to be populated with relevant data while also increasing interoperability in the system of classifications used to describe EEE/e-waste flows.

Key points of measurement laid out in the measurement framework are EEE POM, product lifetimes, and the stock, e-waste generated, e-waste formal collected, and other disposal routes. The framework distinguishes between e-waste that is formally collected, recycled by other methods, discarded in the waste bin, and imported and exported. The guidelines detail potential data inputs for populating the measurement framework defined, including some of their strengths and weaknesses. It outlined how key parameters are interlinked through mathematical equations and calculation steps.

These guidelines recommend core indicators for use in summarising the statistical outputs from the measurement framework and reporting on critical areas of performance, including legislation. These are: EEE POM, E-waste generated, E-waste formally collected, and the collection rate. Minimum requirements for reporting for countries at different stages of statistical production are defined, including both minimum recommended products to track and core variables to estimate.

The document showcases examples of countries and regions utilising the approaches defined through the guidelines series to gather data on EEE/e-waste flows and inform and monitor policy and legislation to drive change. These real-world examples demonstrate the feasibility and benefits of the methodology. Refreshed technical parameters are included in the annexes, which include correlations between the UNU-KEYs-v.2 and HS codes, lifetime profiles expressed as distribution parameters, per UNU-KEY weights and material composition breakdowns of products. Updated examples of questions that can be included in surveys on EEE/e-waste are also provided. Links are included throughout the document to wider resources and tools to support countries in producing statistics on e-waste.

Chapter 8.
Glossary of terms

Term	Definition	Source
Apparent consumption	An approach to calculating the quantity of electrical and electronic equipment placed on a nation's market using statistics on domestic production and trade through the formula: apparent consumption = production + imports - exports.	
Businesses	Refers to an institutional unit in its capacity as a producer of goods and services.	UNSD
Circular economy	An economy where the value of materials in the economy is maximised and maintained for as long as possible; the input of materials and their consumption is minimised; and the generation of waste is prevented and negative environmental impacts reduced throughout the life cycle of materials.	OECD expert group and UNECE Task Force in UNECE and OECD, 2024
Disposal	Any operation, the main purpose of which, is not the recovery of materials or energy even if the operation has as a secondary consequence the reclamation of substances or energy.	EU Waste Framework Directive
Electrical and Electronic Equipment	Includes a wide range of products with circuitry or electrical components with a power or battery supply.	Step Initiative, 2014
Environmentally sound management	The management of waste undertaken in a manner which will protect human health and the environment against the adverse effects which may result from such wastes.	Basel Convention (1989)
E-waste	Electronic waste, otherwise referred to as e-scrap, end-of-life electronics, discarded electrical equipment, or Waste Electrical and Electronic Equipment (WEEE). Defined as "a term used to cover items of all types of electrical and electronic equipment (EEE) and its parts that have been discarded by the owner as waste without the intention of re-use."	Step Initiative, 2014

Term	Definition	Source
E-waste generated	Discarded electrical or electronic products following consumption within a national territory, prior to any collection, reuse, treatment, or export.	
E-waste collected (formal)	E-waste collected and regulated by environmental protection laws specifically designed for e-waste. This includes e-waste that is collected, exported, and treated according to national standards in another country.	
E-waste in waste bins	The amount of e-waste that ends up in non-separately collected waste. This can be household waste or mixed bulky waste.	
Formal sector	Where activities usually under the requirement of national e-waste legislation take place, in which e-waste is collected by designated organizations, producers, and/or the government.	
Goods	Physical objects for which a demand exists, over which ownership rights can be established and whose ownership can be transferred from one institutional unit to another by engaging in transactions on markets; they are in demand because they may be used to satisfy the needs or wants of households or the community or used to produce other goods or services.	SNA, 2008
Government	Otherwise referred to as the public sector. The totality of institutional units which, in addition to fulfilling their political responsibilities and their role of economic regulation, produce principally non-market services (and some goods) for individual or collection consumption and redistribution income and wealth.	
Gross domestic product (GDP)	GDP 'combines into a single figure... [the monetary value of] the [market] output...carried out by all the firms, non-profit institutions, government bodies and households in a given territory during a given period, provided that the production takes place within the country's economic territory' (OECD, 2014, p.15).	OECD, 2014
Hibernation	Otherwise referred to as dead storage, the period of time products are in the stock while not in active use.	
Households	Based on the arrangements made by persons, individually or in groups, for providing themselves with essentials for living	OECD, 2014
Incineration	The controlled combustion of waste with or without energy recovery	UNECE
Industry	Establishments engaged in the same kind of economic activity	SNA, 2008
Informal waste handling	The collection, transportation, treatment and disposal of waste by the informal sector outside of official take-back systems.	UNECE Task Force
Institutional units	Economic entities 'capable of owning assets, incurring liabilities and engaging in economic activities and in transactions with other entities'	OECD, 2014

Term	Definition	Source
Landfilling	Final placement of waste into or onto the land in a controlled or uncontrolled way. The definition covers both landfilling in internal sites (i.e., where a generator of waste is carrying out its own waste disposal at the place of generation) and in external sites.	UNECE
Legislation	Legally binding laws, generally set by a governing body such as a parliament and interpreted by the judicial branch.	
Lifetime	The period that products stay in households, businesses, and the public and voluntary sector until they are disposed of, including any exchange of second-hand equipment.	Forti, Baldé and Kuehr (2018)
Other recycling	Recycling of e-waste with other waste streams-e.g. mixed with metal waste or mixed with plastic waste, generally not following formal e-waste management standards	
Physical input-output tables	Physical input-output tables (PIOT) describe the flows of material and energy within the economic system and between the economic system and the natural environment	Eurostat, 2001
Placed on the Market (POM)	The 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. Also referred to as "put on the market."	
Recovery	A sub-category of waste management, any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy	EU Waste Framework Directive
Recycling	Any activity by which materials are recovered from a waste stream for the purpose of providing material inputs for use in another production process (other than processes designed for energy recovery, the reprocessing into fuels or material for backfilling)	UNECE, 2021
Reuse	Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived	EU Waste Framework Directive
Secondary raw materials	Materials that have been previously used and have been recovered or prepared for reuse. This includes materials in products that have been reused, refurbished, or repaired; components that have been remanufactured; and materials that have been recycled.	UNECE and OECD, 2024
Stock	The quantity of equipment (functioning and non-functioning) in households, businesses, and the public sector.	

Term	Definition	Source
System of National Accounts	The internationally agreed upon standard set of recommendations on how to compile measures of economic activity, particularly geared towards the development of aggregates	UN STATS
Transboundary movement of e-waste	Any movement of e-waste from an area under the national jurisdiction of one State to or through an area under the national jurisdiction of another State, or to or through an area not under the national jurisdiction of any State, provided at least two States are involved in the movement.	Basel Convention
Used Electrical and Electronic Equipment (UEEE)	Second-hand products that are intended for reuse and are in good working order or could be with minor repair or refurbishment.	
Waste	Any material which the holder discards or intends or is required to discard (UNECE, 2021 - based on definitions of waste in the Basel Convention and EU Waste Framework Directive)	UNECE, 2021 - based on definitions of waste in the Basel Convention and EU Waste Framework Directive
Waste collection	The gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport	EU Waste Framework Directive
Waste generated	The amount of waste generated before any collection or treatment	
Waste management	Activities carried out by economic units, both public and private, for the purpose of the collection, transportation, and treatment of waste, including final disposal and after-care of disposal sites	UNECE, 2021; Eurostat, 2021
Waste treatment	Recovery of disposal operations which change the physical, chemical, or biological character or composition of waste to render it non-hazardous, safer for transport, amenable for recovery or storage, or to reduce it in volume. A particular waste may undergo more than one treatment process.	EU Waste Framework Directive; Eurostat, 2021

Annexes

Annex 1. Illustrative survey questions on EEE stocks, e-waste generation, and disposal behaviour

Surveys of households, businesses, and other institutional actors, such as the government, can input to the e-waste statistics framework laid out in these guidelines in several ways. First, by helping to validate and highlight potential inaccuracies in input data, such as on quantities of EEE POM and product lifetimes. Beyond this, survey results can offer a basis against which to calibrate those data inputs. For example, surveys capturing information on current electronic stocks extrapolated to the wider population, offer a means to calibrate product lifetimes (see Section 4.3 for more information on this application). In some data-poor contexts, inference from surveys may even be the sole source of information available on electronic flows and stocks.

Surveys can nevertheless suffer from several potential weaknesses that need to be considered and, where possible, mitigated against. A key weakness in relation to questions on electronics is that the accuracy of survey results can be negatively impacted by the memory bias of respondents. As well, low response rates to a survey or individual question items have the potential to increase nonresponse error and reduce certainty in results. Administering surveys using a robust sampling method to ensure representativeness can also come with significant cost and complexity. Where surveys on e-waste are undertaken, the harmonisation of survey questions across countries and regions plays an essential role in aiding international comparisons. Therefore, when selecting survey questions relating to EEE and e-waste, practitioners should consider aligning these with international guidance as detailed by the ITU in its *Report of the EGH Subgroup on Measuring E-Waste* (ITU, 2023). This alignment can include:

- **The use of a common reference period.** A balance between a shorter reference period during which few products may be discarded but a respondent's recall is strongest, and a longer period associated with the inverse, is needed. It is recommended that survey questions adopt a common reference point no shorter than 12 months but no longer than 24 months.
- **The use of a common product classification.** Survey questions should use the equipment classification laid out in Section 2 of these guidelines - the UNU-KEYs. This can include a subset, where applicable.
- **An address of questions at an individual rather than household level.** Many devices are now individually owned as opposed to household owned. Consequently, surveys should typically be administered to individuals, with questions formulated to ask respondents to think of products they own themselves as well as those shared within their household.

The remainder of this annex outlines examples of survey questions that can be used to elicit information on electronic product stocks and possession, e-waste generation, and disposal behaviour. Questions covering purchase behaviours, such as whether EEE products are purchased new or second-hand, as well as questions on the age of products at their time of disposal, can provide further information to input to the e-waste statistics framework, but are not covered here.

Example survey questions - 2022 East Africa survey

Table 16 presents example questions from a 2022 survey administered by the ITU and UNITAR in partnership with the East African Communications Organisation (ITU and UNITAR, 2023). With households and businesses as the target population of interest, the survey aimed to enhance the quality and harmonisation, collection, and interpretation of e-waste data in the East African states of Burundi, Kenya, Rwanda, South Sudan, United Republic of Tanzania, and Uganda.

The survey included questions relating to 18 of the UNU-KEYs and was implemented through a stratified sampling and mixed mode data collection approach (ITU and UNITAR, 2023). Questions asked included ones on the number of products in households and businesses, with a further breakdown by functioning/non-functioning products, disposal quantities, and routes of disposal. These questions were presented in a matrix format alongside equipment categories to derive responses by UNU-KEY.

Table 16. Questions included in a survey of households and businesses as part of the East African Communications Organisation Regional E-waste Data Harmonization project (ITU and UNITAR, 2023)

No	Question
1.	Which of the following electrical/electronic products exist in your household/business?
2.	Of the following electrical/electronic products, how many of these are in your possession and functioning? (units)
3.	Of the following electrical/electronic products, how many of these are in your possession but not functioning? (units)
4.	For each of the following electrical/electronic products, how many have you discarded in the past 24 months?
5.	For those products discarded in the past 24 months, what was the disposal route? • Picked up from home by the company that sold me the product • Collected by door-to-door worker • Sold online • Sold to a refurbishment or repair shop • Disposed of in the mixed municipal solid waste bin • County picked up from home • Brought to an e-waste collection centre or county-designated drop-off point • Picked up by an e-waste collection centre • Donated • Other

Example survey questions - ITU Expert Group on ICT Household Indicators 2023 recommendations

Table 17 presents questions included in guidance published by the ITU's Expert Group on ICT Household Indicators relating to the design of surveys for use in monitoring e-waste generation, disposal behaviour, and lifetimes (ITU, 2023). The guidance harmonises survey questions developed by the East African Communications Organisation project, Eurostat, and a previous e-waste questionnaire independently drafted by the subgroup. These questions focus on general categories of disposal route, while allowing sub-categories to vary based on the local context.

Table 17. Harmonised survey questions on e-waste generation and disposal behaviour (ITU, 2023)

Question	Response options
Have you or someone in your household discarded or thrown away any [equipment category] that you owned or shared with others in your household in the last 12 months?	a. Yes b. No
Referring to the most recent [equipment category] discarded or thrown away, what was the mode of discard?	a. Discarded or thrown away in electronic waste collection/recycling b. Returned to the company that sold me the product c. Sold or gave it away d. Discarded or thrown away but not in electronic waste collection/recycling e. Cannot remember
Was the most recently discarded or thrown away [equipment category] purchased used or second-hand? That is, did it have a previous owner?	a. Yes b. No
How many years did you own or possess this [equipment category] before it was discarded or thrown away?	Number of years
What was the main reason you discarded it or threw it away?	a. It was broken b. It was no longer performing as well as desired c. It lacked needed features d. I no longer needed it e. Other

Example survey questions - 2021 Lebanon survey

Taken from a survey of households in Lebanon, conducted in 2021, that covered 25 UNU-KEYs, Table 18 highlights options presented to respondents on disposal routes for discarded products (Baldé, Panchal and Forti, 2022). These are cross tabulated with several illustrative equipment categories of focus in the survey. Note that relevant categories of disposal route may vary depending on country-specific contexts.

Table 18. Disposal routes included in a survey of household disposal behaviour in Lebanon alongside example product categories (Baldé, Panchal and Forti, 2022)

PRODUCT	Dispose of with regular unsorted household waste	Take to a collection or drop-off point (including return to retailer/ manufacturer)	Store at home	Repair	Donation	Sell it	Exchange
Washing Machines (incl. combined dryers)							
Microwaves (incl. combined, excl. grills)							
Vacuum Cleaners (excl. professional)							
Desktop PCs (excl. monitors, accessories)							

Annex 2. UNU-KEYs-v.1 - UNU-KEYs-v.2 correlation table

Table 19 shows the relationship between Version 1 (v.1) and Version 2 (v.2) of the UNU-KEYs. Column 3 (comment) uses:

1. An "ex" as notation to indicate that the v.2 UNU-KEY includes only part of the adjacent v.1 UNU-KEY;
2. A "n" to indicate a new entry with v.2 of the UNU-KEYs encompassing products not previously covered in v.1; and
3. A "w" to indicate the UNU-KEYs-v.2 code encompassing the entirety of the adjacent UNU-KEY under v.1.

Table 19. Correlation table between UNU-KEYs-v.1 and UNU-KEYs-v.2

UNU KEY v.1	UNU KEY v.2	Comment
0001	0001	
0002	0002	
0101	0101	
0102	0102	
0103	0103	
0104	0104	
0105	0105	
0106	0106	
0108	0108	
0109	0109	
0111	0111	
0112	0112	
0113	0113	
0114	0114	
0201	0201	
0202	0202	
0203	0203	
0204	0204	
0205	0205	
0301	0307	ex
0301	0301	ex
0302	0302	
0302	0310	ex
0303	0303	
0304	0304	
0305	0305	
0306	0306	
0307	0307	
0308	0308	
0309	0309	
0401	0401	
0402	0402	
0403	0403	
0404	0404	
0405	0405	
0406	0401	w
0407	0407	
0408	0408	
	0409	n
0501	0501	
0502	0502	
0503	0503	
0504	0504	
0505	0505	
0506	0506	
0507	0507	
0601	0601	
0602	0602	
0701	0701	
0702	0702	
0703	0704	ex
0703	0703	
	0705	n
0801	0801	
0802	0802	
0901	0901	
0902	0902	
1001	1001	
1002	1002	

Annex 3. UNU-KEYs - HS correlation table

Table 20 presents correlations between the UNU-KEYs-v.2 and the HS22 classification used for describing international trade flows. This updates an equivalent table present in the second edition of the guidelines while accounting for: the addition of new UNU-KEYs, correlations across years in the HS classification, and alignment with the "open scope" approach taken in applying the WEEE Directive across EU countries since 2018.

Table 20. Correlation table between the UNU-KEYs and HS codes

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0001	Central Heating (household-installed)	840310	Boilers; central heating boilers (excluding those of heading no. 8402)
0002	Photovoltaic Panels (incl. inverters)	854143	Electrical apparatus; photosensitive semiconductor devices, photovoltaic cells assembled in modules or made up into panels
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	Dishwashers	842211	Dish washing machines; of the household type
0102	Dishwashers	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 (incl. centrifuges)	842112	Centrifuges; clothes-dryers
0105	Dryers (incl. centrifuges)	845121	Drying machines; of a dry linen capacity not exceeding 10kg
0105	Dryers (incl. 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

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
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	Refrigerators (incl. combi-refrigerators)	841810	Refrigerators and freezers; combined refrigerator-freezers, fitted with separate external doors, electric or other
0108	Refrigerators (incl. combi-refrigerators)	841821	Refrigerators; for household use, compression-type, electric or other
0108	Refrigerators (incl. combi-refrigerators)	841829	Refrigerators; household, electric or not, other than compression-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, of a kind designed to be fixed to a window, wall, ceiling or floor, self-contained or "split-system"
0111	Air Conditioners (household installed and portable)	841581	Air conditioning machines; containing a motor driven fan, other than window or wall types, incorporating a refrigerating unit and a valve for reversal of the cooling/heat cycle (reversible heat pumps)
0111	Air Conditioners (household installed and portable)	841582	Air conditioning machines; containing a motor driven fan, other than window or wall types, incorporating a refrigerating unit
0112	Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)	841861	Heat pumps; other than air conditioning machines of heading no. 8415
0112	Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)	841869	Refrigerating or freezing equipment; n.e.c. in heading no. 8418
0113	Professional Cooling equipment (e.g. large air conditioners, cooling displays)	841583	Air conditioning machines; containing a motor driven fan, other than window or wall types, not incorporating a refrigerating unit
0113	Professional Cooling equipment (e.g. large air conditioners, cooling displays)	841850	Furniture incorporating refrigerating or freezing equipment; for storage and display, n.e.c. in item no. 8418.1, 8418.2, 8418.3 or 8418.4 (chests, cabinets, display counters, 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

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	850980	Electro-mechanical domestic appliances; with self-contained electric motor, other than vacuum cleaners of heading 85.08, n.e.c. in heading no. 8509
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; electrically operated, with or without a stop-watch, with case of precious metal or of metal clad with precious metal, with mechanical display only
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910119	Wrist-watches; electrically operated, with or without a stop-watch, with case of precious metal or metal clad with precious metal, without mechanical display
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910191	Pocket-watches and other watches, including stop-watches; (excluding wrist-watches), with case of precious metal or of metal clad with precious metal, electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910211	Wrist-watches; electrically operated, with or without a stop-watch, (other than those of heading no. 9101) with mechanical display only
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910212	Wrist-watches; electrically operated, with or without a stop-watch, (other than those of heading no. 9101) with opto-electronic display only
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910219	Wrist-watches; electrically operated, with or without a stop-watch, (other than those of heading no. 9101) without mechanical or opto-electronic display
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; (excluding wrist-watches), other than those of heading no. 9101, electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910299	Pocket watches and other watches, including stop-watches; (excluding wrist-watches), other than those of heading no. 9101, other than electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910310	Clocks; with watch movements, electrically operated, excluding clocks of heading no. 9104
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910390	Clocks; with watch movements, other than electrically operated, excluding clocks of heading no. 9104
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910511	Clocks; (excluding those with watch movements and instrument panel clocks), alarm clocks, electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910519	Clocks; (excluding those with watch movements and instrument panel clocks), alarm clocks, other than electrically operated

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910521	Clocks; (excluding those with watch movements and instrument panel clocks), wall clocks, electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910529	Clocks; (excluding those with watch movements and instrument panel clocks), wall clocks, other than electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910591	Clocks; (excluding those with watch movements and instrument panel clocks), (other than alarm or wall clocks), electrically operated
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910599	Clocks; (excluding those with watch movements and instrument panel clocks), other than alarm or wall clocks, other than electrically operated
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, electrically operated, 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, electrically operated, by means of solar cells, with opto-electronic display
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	910819	Watch movements; complete and assembled, electrically operated, by means of solar cells, without mechanical display or device including such or opto-electronic display
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 electrically operated
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)	842310	Weighing machines; personal (including baby scales) and household scales
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.c. 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

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
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
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. toothbrushes, hair dryers, razors)	851010	Shavers; with self-contained electric motor
0205	Personal Care equipment(e.g. toothbrushes, hair dryers, razors)	851020	Hair clippers; with a self-contained electric motor
0205	Personal Care equipment(e.g. toothbrushes, hair dryers, razors)	851030	Hair-removing appliances; with self-contained electric motor
0205	Personal Care equipment(e.g. toothbrushes, hair dryers, razors)	851631	Hair-dressing apparatus; electro-thermic hair dryers
0205	Personal Care equipment(e.g. toothbrushes, hair dryers, razors)	851632	Hair-dressing apparatus; electro-thermic, other than hair dryers
0205	Personal Care equipment(e.g. toothbrushes, hair dryers, razors)	851633	Hand-drying apparatus; electro-thermic
0205	Personal Care equipment(e.g. toothbrushes, 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)	847010	Calculating machines; electronic calculators capable of operation without an external source of electric power and pocket-size data recording, reproducing and displaying machines with calculating functions
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	Units of automatic 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	Units of automatic data processing machines; storage units
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847180	Units of automatic data processing machines; n.e.c. in item no. 8471.50, 8471.60 or 8471.70
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	847190	Magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, not elsewhere specified or included
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	852351	Semiconductor media; solid-state non-volatile storage devices, whether or not recorded, excluding products of Chapter 37

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0302	Desktop PCs (excl. monitors, accessories)	847141	Automatic data processing machines; comprising in the same housing at least a central processing unit and an input and output unit, whether or not combined, n.e.c. in item no. 8471.30
0302	Desktop PCs (excl. monitors, accessories)	847149	Automatic data processing machines; presented in the form of systems, n.e.c. in item no. 8471.30 or 8471.41
0303	Laptops (incl. tablets)	847130	Automatic data processing machines; portable, 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)	844315	Printing machinery; letterpress, other than reel-fed, excluding flexographic printing
0304	Printers (e.g. scanners, multi-functionals)	844319	Printing machinery; used for printing by means of plates, cylinders and other printing components of heading 84.42, n.e.c. in item no. 8443.1
0304	Printers (e.g. scanners, multi-functionals)	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)	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
0304	Printers (e.g. scanners, multi-functionals)	848510	Machines for additive manufacturing; by metal deposit
0304	Printers (e.g. scanners, multi-functionals)	848520	Machines for additive manufacturing; by plastic or rubber deposit
0304	Printers (e.g. scanners, multi-functionals)	848530	Machines for additive manufacturing; by plaster, cement, ceramics or glass deposit
0304	Printers (e.g. scanners, multi-functionals)	848580	Machines for additive manufacturing; by other than metal, plastic, rubber, plaster, cement, ceramics or glass deposits
0305	Telecommunications equipment excl. mobile phones	851711	Line telephone sets with cordless handsets
0305	Telecommunications equipment excl. mobile phones	851718	Telephone sets n.e.c. in item no. 8517.1
0305	Telecommunications equipment excl. mobile phones	851761	Base stations
0305	Telecommunications equipment excl. mobile phones	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

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0305	Telecommunications equipment excl. mobile phones	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	Telecommunications equipment excl. mobile phones	903040	Instruments and apparatus; specially designed for telecommunications (e.g. cross-talk meters, gain measuring instruments, distortion factor meters, psophometers)
0306	Mobile Phones (incl. smartphones, pagers)	851713	Telephone sets; smartphones for cellular or other wireless networks
0306	Mobile Phones (incl. smartphones, pagers)	851714	Telephone sets; other than smartphones, for cellular or other wireless networks
0307	Other IT equipment (e.g. data storage, copiers)	844312	Printing machinery; offset, sheet-fed, office type (sheet size not exceeding 22 x 36cm in the unfolded state)
0307	Other IT equipment (e.g. 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	Other IT equipment (e.g. data storage, copiers)	847050	Cash registers
0307	Other IT equipment (e.g. data storage, copiers)	847090	Machines incorporating a calculating device; n.e.c. in heading no. 8470
0307	Other IT equipment (e.g. data storage, copiers)	847210	Office machines; duplicating machines
0307	Other IT equipment (e.g. data storage, copiers)	847230	Office machines; for sorting or folding mail or for inserting mail in envelopes or bands, machines for opening, closing or sealing mail and machines for affixing or cancelling postage stamps
0308	Cathode Ray Tube Monitors	852842	Monitors; cathode-ray tube, capable of directly connecting to and designed for use with an automatic data processing machine of heading 84.71
0308	Cathode Ray Tube Monitors	852849	Monitors; cathode-ray tube, n.e.c. in subheading 8528.42, whether or not colour
0309	Flat-Panel Display Monitors (LCD, LED)	852852	Monitors; other than cathode-ray tube; capable of directly connecting to and designed for use with an automatic data processing machine of heading 84.71
0309	Flat-Panel Display Monitors (LCD, LED)	852859	Monitors other than cathode-ray tube; n.e.c. in subheading 8528.52, whether or not colour
0309	Flat-Panel Display 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

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0310	Servers	847150	Units of automatic data processing machines; processing units other than those of item no. 8471.41 or 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
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	854370	Electrical machines and apparatus; having individual functions, not specified or included elsewhere in this chapter, n.e.c. in heading no. 8543
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	851810	Microphones and stands therefor
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	851830	Headphones and earphones, whether or not combined with a microphone, and sets consisting of a microphone and one or more loudspeakers
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	852582	Television cameras, digital cameras and video camera recorders; radiation-hardened or radiation-tolerant goods as specified in subheading note 2 to this chapter
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	852583	Television cameras, digital cameras and video camera recorders; night vision goods as specified in subheading note 3 to this chapter
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	852589	Television cameras; n.e.c. in item no 8525.8
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	900661	Photographic flashlight apparatus; discharge lamp (electronic)
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	900669	Photographic flashlight apparatus; n.e.c. in heading no. 9006
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	900710	Cameras, cinematographic; whether or not incorporating sound recording apparatus
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	852692	Radio remote control apparatus
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	852581	Television cameras, digital cameras and video camera recorders; high-speed goods as specified in subheading note 1 to this chapter
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	900640	Cameras, photographic (excluding cinematographic); instant print cameras
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	900659	Cameras, photographic (excluding cinematographic); n.e.c. in heading no 9006
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852712	Radio broadcast receivers capable of operating without an external power source; pocket-size radio cassette-players
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852719	Radio broadcast receivers capable of operating without an external power source; n.e.c. in item no. 8527.1
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

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	852691	Radio navigational aid apparatus
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	901480	Navigational instruments and appliances; for navigation other than aeronautical or space navigation (excluding direction finding compasses)
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	852713	Radio broadcast receivers capable of operating without an external power source; apparatus (other than pocket-size radio cassette-players), combined with sound recording or reproducing apparatus
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	852791	Radio-broadcast receivers n.e.c. in heading no. 8527; combined with sound recording or reproducing apparatus
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	852792	Radio-broadcast receivers n.e.c. in heading no. 8527; not combined with sound recording or reproducing apparatus but combined with a clock
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	847290	Office machines; not elsewhere classified
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)	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)	851989	Sound recording or reproducing apparatus; n.e.c. in heading no 8519
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
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
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	851840	Amplifiers; audio-frequency electric
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	852110	Video recording or reproducing apparatus; magnetic tape-type
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	852190	Video recording or reproducing apparatus; other than magnetic tape-type
0404	Video (e.g. Video recorders, DVD, Blu-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, Blu-Ray, set-top boxes) and projectors	852862	Projectors; capable of directly connecting to and designed for use with an automatic data processing machine of heading 84.71
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	852869	Projectors; n.e.c. in subheading 8528.62, whether or not colour

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0404	Video (e.g. Video recorders, DVD, Blu-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, Blu-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, Blu-Ray, set-top boxes) and projectors	900850	Image projectors, photographic enlargers and reducers, excluding cinematographic
0404	Video (e.g. Video recorders, DVD, Blu-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, Blu-Ray, set-top boxes) and projectors	901050	Photographic laboratory apparatus and equipment; n.e.c. in item no. 9010.10, for photographic (including cinematographic) laboratories; negatoscopes
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	901060	Photographic laboratory apparatus and equipment (including cinematographic); projection screens
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	852550	Transmission apparatus for radio-broadcasting or television, whether or not incorporating sound recording or reproducing apparatus, not incorporating reception apparatus
0405	Speakers	851821	Loudspeakers; single, mounted in their enclosures
0405	Speakers	851822	Loudspeakers; multiple, mounted in the same enclosure
0407	Cathode Ray Tube Televisions (TVs)	852873	Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus; incorporating a monochrome video display or screen
0408	Flat-Panel Display Televisions (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
0409	E-cigarettes and other electronic vaporising devices	854340	Electrical machines and apparatus; electronic cigarettes and similar personal electric vaporising devices
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

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
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	853931	Lamps; discharge, (excluding ultra-violet), fluorescent, hot cathode
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)	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)
0504	Special Lamps (e.g. professional mercury, high- & low-pressure sodium)	853941	Lamps; arc-lamps
0505	LED Lamps (incl. retrofit LED lamps)	853951	Lamps; light-emitting diode (LED) light sources, light-emitting diode (LED) modules
0505	LED Lamps (incl. retrofit LED lamps)	853952	Lamps; light-emitting diode (LED) light sources, light-emitting diode (LED) lamps
0505	LED Lamps (incl. retrofit LED lamps)	854141	Electrical apparatus; photosensitive semiconductor devices, light emitting diodes (LED)
0505	LED Lamps (incl. retrofit LED lamps)	854149	Electrical apparatus; photosensitive semiconductor devices, diodes other than light emitting diodes and photovoltaic cells whether or not assembled in modules or made up into panels
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940519	Chandeliers and electric ceiling or wall light fittings; (excluding those used for lighting public open spaces or thoroughfares), for use other than with light-emitting diode (LED) light sources
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940511	Luminaires and light fittings; chandeliers and electric ceiling or wall light fittings; (excluding those used for lighting public open spaces or thoroughfares), for use solely with light-emitting diode (LED) light sources
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940529	Luminaires and light fittings; electric, table, desk, bedside or floor-standing, for other than use solely with light-emitting diode (LED) light sources
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940521	Luminaires and light fittings; electric, table, desk, bedside or floor-standing, for use solely with light-emitting diode (LED) light sources
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940531	Luminaires and light fittings; electric, lighting strings of a kind used for Christmas trees, for use solely with light-emitting diode (LED) light sources

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	940539	Luminaires and light fittings; electric, lighting strings of a kind used for Christmas trees, for other than use solely with light-emitting diode (LED) light sources
0507	Professional Luminaires (offices, public space, industry)	940549	Luminaires and light fittings; electric, designed for other than use solely with light-emitting diode (LED) light sources
0507	Professional Luminaires (offices, public space, industry)	940541	Luminaires and light fittings; electric, photovoltaic, designed for use solely with light-emitting diode (LED) light sources
0507	Professional Luminaires (offices, public space, industry)	940542	Luminaires and light fittings; electric, designed for use solely with light-emitting diode (LED) light sources
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
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)	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
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	842430	Mechanical appliances; steam or sand blasting machines and similar jet projecting machines
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	903031	Multimeters; for measuring or checking voltage, current, resistance or power (other than those for measuring or checking semiconductor wafer or devices), without a recording device
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	841459	Fans; n.e.c. in item no. 8414.51
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	845929	Machine-tools; for drilling by removing metal, other than numerically controlled
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	846591	Machine-tools; for working wood, cork, bone, hard rubber, hard plastics or similar hard materials; sawing machines

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	841350	Pumps; reciprocating positive displacement pumps, n.e.c. in heading no. 8413, for liquids
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	841370	Pumps; centrifugal, n.e.c. in heading no. 8413, for liquids
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	841381	Pumps and liquid elevators; n.e.c. in heading no. 8413
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
0602	Professional Tools (e.g. for welding, soldering, milling)	851519	Brazing or soldering machines and apparatus; other than soldering irons and guns, whether or not capable of cutting
0602	Professional Tools (e.g. for welding, soldering, milling)	843061	Machinery; for tamping or compacting, not self-propelled
0602	Professional Tools (e.g. for welding, soldering, milling)	845819	Lathes; for removing metal, horizontal, other than numerically controlled
0602	Professional Tools (e.g. for welding, soldering, milling)	846090	Machine-tools; for deburring, grinding, polishing or otherwise finishing metal, sintered metal carbides or cermets by means of grinding stones, abrasives or polishing products, n.e.c. in heading no. 8460
0602	Professional Tools (e.g. for welding, soldering, milling)	846596	Machine-tools; for working wood, cork, bone, hard rubber, hard plastics or similar hard materials; splitting, slicing or paring machines
0602	Professional Tools (e.g. for welding, soldering, milling)	847431	Machines; concrete or mortar mixers
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	880621	Unmanned aircraft; for remote-controlled flight only, for other than for carriage of passengers, with the maximum take-off weight of not more than 250g
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	880622	Unmanned aircraft; for remote-controlled flight only, for other than for carriage of passengers, with the maximum take-off weight of more than 250g but not more than 7kg
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, special tables for casino games, automatic bowling alley equipment, n.e.c. in heading 9504

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	950430	Games; operated by coins, banknotes, bank cards, tokens or by other means of payment, other than billiard articles and accessories, and automatic bowling alley equipment
0702	Game Consoles	950450	Games; video game consoles and machines, other than those of subheading 9504.30
0703	Leisure equipment (e.g. sports equipment, juke boxes) excl. electric bikes	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, juke boxes) excl. electric bikes	871390	Carriages for disabled persons; mechanically propelled
0705	Charging stations	850440	Electrical static converters
0705	Charging stations	853710	Boards, panels, consoles, desks and other bases; for electric control or the distribution of electricity, (other than switching apparatus of heading no. 8517), for a voltage not exceeding 1000 volts
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), n.e.c. in item no. 9018.1
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
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	901820	Medical, surgical instruments and appliances; ultra-violet or infra-red ray apparatus
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	901920	Therapeutic respiration apparatus; ozone, oxygen, aerosol therapy apparatus; artificial respiration or other therapeutic respiration apparatus
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	902212	Apparatus based on the use of x-rays; including radiography or radiotherapy apparatus, whether or not for medical, surgical, dental or veterinary uses, computed tomography apparatus
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	902213	Apparatus based on the use of x-rays; including radiography or radiotherapy apparatus, for dental uses, excluding computed tomography apparatus

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	902214	Apparatus based on the use of x-rays; including radiography or radiotherapy apparatus, for medical, surgical or veterinary uses, not dental uses, excluding computed tomography apparatus
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	902221	Apparatus based on the use of alpha, beta, gamma or other ionising radiations, including radiography or radiotherapy apparatus; for medical, surgical, dental or veterinary uses
0901	Household Monitoring & Control equipment (e.g. 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 (e.g. alarm, heat, smoke, excl. screens)	853180	Signalling apparatus; electric, sound or visual, apparatus n.e.c. in heading no. 8531, excluding those of heading no. 8512 or 8530
0901	Household Monitoring & Control equipment (e.g. 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 (e.g. 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 (e.g. alarm, heat, smoke, excl. screens)	902610	Instruments and apparatus; for measuring or checking the flow or level of liquids
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	902620	Instruments and apparatus; for measuring or checking pressure
0901	Household Monitoring & Control equipment (e.g. 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 (e.g. alarm, heat, smoke, excl. screens)	902710	Instruments and apparatus; gas or smoke analysis apparatus, for physical or chemical analysis
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	903089	Instruments and apparatus; n.e.c. in heading no. 9030, without a recording device
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	903210	Regulating or controlling instruments and apparatus; automatic type, thermostats
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	903032	Multimeters; for measuring or checking voltage, current, resistance or power, with a recording device
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902781	Instruments and apparatus; for physical or chemical analysis, for measuring or checking viscosity, porosity, expansion, surface tension or quantities of heat, sound or light, mass spectrometers

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902789	Instruments and apparatus; for physical or chemical analysis, for measuring or checking viscosity, porosity, expansion, surface tension or quantities of heat, sound or light, exposure meters
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 tachymeters (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.c. 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)	902920	Meters; speed indicators and tachometers; stroboscopes
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	903020	Oscilloscopes and oscillographs
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	903033	Instruments and apparatus; for measuring or checking voltage, current, resistance or power, without a recording device (excluding multimeters)
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	903149	Optical instruments and appliances; for measuring or checking, n.e.c. in chapter 90
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	903180	Instruments, appliances and machines; for measuring or checking n.e.c. in chapter 90
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	901110	Microscopes, compound optical; stereoscopic microscopes
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	901120	Microscopes, compound optical; for photomicrography, cinephotomicrography or microprojection
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	901180	Microscopes, compound optical; (other than stereoscopic and microscopes for photomicrography, cinephotomicrography or microprojection)
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	901210	Microscopes (excluding optical microscopes); diffraction apparatus

UNU-KEY	UNU-KEY Description	HS22 Code	HS Description
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902229	Apparatus based on the use of alpha, beta, gamma or other ionising radiations, including radiography or radiotherapy apparatus; (for other than medical, surgical, dental or veterinary uses)
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902720	Chromatographs and electrophoresis instruments
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902730	Spectrometers, spectrophotometers and spectrographs; using optical radiations (UV, visible, IR)
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	902750	Instruments and apparatus; using optical radiations (UV, visible, IR), (other than spectrometers, spectrophotometers and spectrographs)
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	903010	Instruments and apparatus; for measuring or detecting ionising radiations
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	903039	Instruments and apparatus; for measuring or checking voltage, current, resistance or power, with a recording device (excluding multimeters)
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	903084	Instruments and apparatus; n.e.c. in heading no. 9030, with a recording device
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, (e.g. 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, (e.g. postage stamp, cigarette, food or money-changing machines, excluding beverage-vending machines), incorporating heating or refrigerating devices

Annex 4. UNU-KEYs - CPC correlation

Table 21 presents a correspondence between the UNU-KEYs-v.2 and the CPC (version 2.1) used for the categorisation of goods and services and, in particular, industrial production outputs. In some instances, a single CPC code encompasses products corresponding to multiple UNU-KEYs. These CPC codes are linked to the multiple relevant UNU-KEYs in the correlation table. To prevent double-counting when compiling production data by CPC using this correspondence, it is recommended that production data associated with these CPC codes be allocated across the corresponding UNU-KEYs based on country-specific export data. The recommended procedure is as follows:

1. Identify the CPC code and its corresponding UNU-KEYs in Table 21 (for example, CPC 44816 maps to UNU-KEYs 0201 through to 0205).
2. Using a CPC-HS correlation table, such as that published by the United Nations Statistics Division (UNSD), determine the HS codes correlated to that CPC code.
3. Link the HS codes from Step 2 to their corresponding UNU-KEYs using the UNU-KEY-HS correlation table in Annex 3. Then, based on country export data for those HS, calculate the proportion of total exports attributable to each UNU-KEY linked to the HSs.
4. Apply these proportions by UNU-KEY, to distribute the CPC-level production data proportionally based on export volumes across the relevant UNU-KEYs.

In the event there is a 1 CPC to many UNU-KEY relationship and no export data is held, CPC-level data can be allocated as an equal share across the linked UNU-KEYs.

Table 21. Correlation table between the UNU-KEYs and CPC codes

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0001	Central Heating (household-installed)	44825	Central heating boilers, for producing hot water or low-pressure steam
0002	Photovoltaic Panels (incl. inverters)	47150	Diodes, transistors and similar semi-conductor devices; photosensitive semi-conductor devices; light emitting diodes; mounted piezo-electric crystals
0101	Professional Heating & Ventilation (excl. cooling equipment)	44622	Laundry-type washing machines, each of a dry linen capacity exceeding 10 kg; dry-cleaning machines; drying machines for textile fabrics or articles, each of a dry linen capacity exceeding 10 kg
0101	Professional Heating & Ventilation (excl. cooling equipment)	44629	Other machinery for textile and apparel production n.e.c.
0102	Dishwashers	44812	Dishwashing machines and clothes or linen washing or drying machines, household type, electric or non-electric
0102	Dishwashers	43935	Dishwashing machines, except household type
0103	Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)	44817	Electric instantaneous or storage water heaters and immersion heaters; electric space heating apparatus and soil heating apparatus; ovens; cookers, cooking plates, boiling rings, grillers and roasters
0104	Washing Machines (incl. combined dryers)	44812	Dishwashing machines and clothes or linen washing or drying machines, household type, electric or non-electric
0104	Washing Machines (incl. combined dryers)	44622	Laundry-type washing machines, each of a dry linen capacity exceeding 10 kg; dry-cleaning machines; drying machines for textile fabrics or articles, each of a dry linen capacity exceeding 10 kg
0105	Dryers (incl. centrifuges)	44911	Centrifugal clothes driers
0105	Dryers (incl. centrifuges)	44812	Dishwashing machines and clothes or linen washing or drying machines, household type, electric or non-electric
0105	Dryers (incl. centrifuges)	44622	Laundry-type washing machines, each of a dry linen capacity exceeding 10 kg; dry-cleaning machines; drying machines for textile fabrics or articles, each of a dry linen capacity exceeding 10 kg
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	44815	Fans and ventilating or recycling hoods of the domestic type

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	44817	Electric instantaneous or storage water heaters and immersion heaters; electric space heating apparatus and soil heating apparatus; ovens; cookers, cooking plates, boiling rings, grillers and roasters
0108	Refrigerators (incl. combi-refrigerators)	44811	Refrigerators and freezers, household type, electric or non-electric
0109	Freezers	44811	Refrigerators and freezers, household type, electric or non-electric
0111	Air Conditioners (household installed and portable)	43912	Air-conditioning machines
0112	Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)	43913	Refrigerating and freezing equipment and heat pumps, except household type equipment
0113	Professional Cooling equipment (e.g. large air conditioners, cooling displays)	43913	Refrigerating and freezing equipment and heat pumps, except household type equipment
0114	Microwaves (incl. combined, excl. grills)	44817	Electric instantaneous or storage water heaters and immersion heaters; electric space heating apparatus and soil heating apparatus; ovens; cookers, cooking plates, boiling rings, grillers and roasters
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	44813	Electric blankets
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	44815	Fans and ventilating or recycling hoods of the domestic type
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	44816	Other small electric domestic appliances (including vacuum cleaners, kitchen waste disposers, food mixers, shavers, hair dryers, smoothing irons, coffee makers and toasters)
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	48410	Watches
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	48420	Clocks
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	48430	Time of day recording apparatus, apparatus for measuring, recording or otherwise indicating intervals of time, and time switches, with clock or watch movement or with synchronous motor
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	48440	Watch or clock movements
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	44814	Household sewing machines
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	43922	Weighing machinery (excluding balances of a sensitivity of 5 cg or better)
0202	Equipment for food preparation(e.g. toaster, grills, food processing, frying pans)	44816	Other small electric domestic appliances (including vacuum cleaners, kitchen waste disposers, food mixers, shavers, hair dryers, smoothing irons, coffee makers and toasters)

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0203	Small household equipment for hot water preparation (e.g. coffee, tea, water cookers)	44817	Electric instantaneous or storage water heaters and immersion heaters; electric space heating apparatus and soil heating apparatus; ovens; cookers, cooking plates, boiling rings, grillers and roasters
0203	Small household equipment for hot water preparation (e.g. coffee, tea, water cookers)	44816	Other small electric domestic appliances (including vacuum cleaners, kitchen waste disposers, food mixers, shavers, hair dryers, smoothing irons, coffee makers and toasters)
0204	Vacuum Cleaners (excl. professional)	44816	Other small electric domestic appliances (including vacuum cleaners, kitchen waste disposers, food mixers, shavers, hair dryers, smoothing irons, coffee makers and toasters)
0205	Personal Care equipment(e.g. toothbrushes, hair dryers, razors)	44816	Other small electric domestic appliances (including vacuum cleaners, kitchen waste disposers, food mixers, shavers, hair dryers, smoothing irons, coffee makers and toasters)
0205	Personal Care equipment(e.g. toothbrushes, hair dryers, razors)	48160	Mechano-therapy appliances; massage apparatus; psychological aptitude-testing apparatus; ozone therapy, oxygen therapy, aerosol therapy, artificial respiration or other therapeutic respiration apparatus; other breathing appliances and gas masks (excluding protective masks having neither mechanical parts nor replaceable filters)
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	45130	Electronic calculators and pocket-size data recording, reproducing and displaying machines with calculating functions
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	45261	Input peripherals (keyboard, joystick, mouse etc.)
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	45269	Other input or output peripheral devices
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	45271	Fixed media storage units
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	45272	Removable media storage units
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	45281	Sound, video, network and similar cards for automatic data processing machines
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	45289	Other units of automatic data processing machines
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	47550	Solid-state non-volatile storage devices
0302	Desktop PCs (excl. monitors, accessories)	45230	Automatic data processing machines, comprising in the same housing at least a central processing unit and an input and output unit, whether or not combined
0302	Desktop PCs (excl. monitors, accessories)	45240	Automatic data processing machines presented in the form of systems

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0303	Laptops (incl. tablets)	45220	Portable automatic data processing machines weighing not more than 10 kg, such as laptops, notebooks and sub-notebooks
0304	Printers (e.g. scanners, multi-functionals)	45262	Scanners (except combination of printer, scanner, copier and/or fax)
0304	Printers (e.g. scanners, multi-functionals)	44914	Bookbinding machinery; machinery for type-setting and the like; printing machinery and machines for uses ancillary to printing (except office type sheet-fed offset printing machinery)
0304	Printers (e.g. scanners, multi-functionals)	44629	Other machinery for textile and apparel production n.e.c.
0304	Printers (e.g. scanners, multi-functionals)	45266	Units performing two or more of the following functions: printing, scanning, copying, faxing
0304	Printers (e.g. scanners, multi-functionals)	44917	Stand-alone photocopiers, printers and facsimile machines
0304	Printers (e.g. scanners, multi-functionals)	45263	Inkjet printers used with data processing machines
0304	Printers (e.g. scanners, multi-functionals)	45264	Laser printers used with data processing machines
0304	Printers (e.g. scanners, multi-functionals)	45265	Other printers used with data processing machines
0304	Printers (e.g. scanners, multi-functionals)	44218	Machine-tools n.e.c. for working metal, sintered metal carbides or cermets, without removing material
0304	Printers (e.g. scanners, multi-functionals)	44915	Machinery n.e.c. for working rubber or plastics or for the manufacture of products from these materials
0305	Telecommunications equipment excl. mobile phones	47221	Line telephone sets with cordless handsets
0305	Telecommunications equipment excl. mobile phones	47223	Other telephone sets and apparatus for transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network)
0305	Telecommunications equipment excl. mobile phones	45281	Sound, video, network and similar cards for automatic data processing machines
0305	Telecommunications equipment excl. mobile phones	48244	Instruments and apparatus (except cathode-ray oscilloscopes and oscillographs) for telecommunications
0306	Mobile Phones (incl. smartphones, pagers)	47222	Telephones for cellular networks or for other wireless networks
0307	Other IT equipment (e.g. data storage, copiers)	45150	Office type sheet-fed offset printing machinery
0307	Other IT equipment (e.g. data storage, copiers)	44917	Stand-alone photocopiers, printers and facsimile machines

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0307	Other IT equipment (e.g. data storage, copiers)	45141	Accounting machines, cash registers, postage-franking machines, ticket-issuing machines and similar machines, incorporating a calculating device (except point-of-sale terminals, ATMs and similar machines)
0307	Other IT equipment (e.g. data storage, copiers)	45142	Point-of-sale terminals, ATMs and similar machines
0307	Other IT equipment (e.g. data storage, copiers)	45160	Other office machines
0307	Other IT equipment (e.g. data storage, copiers)	45110	Typewriters and word-processing machines
0308	Cathode Ray Tube Monitors	47315	Monitors and projectors, principally used in an automatic data processing system
0308	Cathode Ray Tube Monitors	47314	Monitors and projectors, not incorporating television reception apparatus and not principally used in an automatic data processing system
0309	Flat-Panel Display Monitors (LCD, LED)	47315	Monitors and projectors, principally used in an automatic data processing system
0309	Flat-Panel Display Monitors (LCD, LED)	47314	Monitors and projectors, not incorporating television reception apparatus and not principally used in an automatic data processing system
0309	Flat-Panel Display Monitors (LCD, LED)	46929	Other electric sound or visual signalling apparatus, except for cycles or motor vehicles, and except electromechanical traffic control equipment for transport facilities
0310	Servers	45250	Other automatic data processing machines whether or not containing in the same housing one or two of the following types of units: storage units, input units, output units
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	47330	Microphones and stands therefor; loudspeakers; headphones, earphones and combined microphone/speaker sets; audio-frequency electric amplifiers; electric sound amplifier sets
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	47213	Television cameras
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	47214	Video camera recorders
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	47215	Digital cameras
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	48329	Other photographic equipment
0401	Small Consumer Electronics (e.g. headphones, cameras, remote controls)	48322	Photographic (including cinematographic) cameras
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	48220	Radar apparatus, radio navigational aid apparatus and radio remote control apparatus

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	47311	Radio broadcast receivers (except of a kind used in motor vehicles), whether or not combined with sound recording or reproducing apparatus or a clock
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	48211	Direction finding compasses; other navigational instruments and appliances
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	47321	Sound recording or reproducing apparatus
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	47330	Microphones and stands therefor; loudspeakers; headphones, earphones and combined microphone/speaker sets; audio-frequency electric amplifiers; electric sound amplifier sets
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	38340	Musical instruments, the sound of which is produced, or must be amplified, electrically
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	47323	Video recording or reproducing apparatus
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	47211	Transmission apparatus incorporating reception apparatus
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	47314	Monitors and projectors, not incorporating television reception apparatus and not principally used in an automatic data processing system
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	47315	Monitors and projectors, principally used in an automatic data processing system
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	47313	Television receivers, whether or not combined with radio-broadcast receivers or sound or video recording or reproducing apparatus
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	48323	Cinematographic projectors
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	48329	Other photographic equipment
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	47212	Transmission apparatus not incorporating reception apparatus
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	44214	Machine-tools for drilling, boring or milling metal
0405	Speakers	47330	Microphones and stands therefor; loudspeakers; headphones, earphones and combined microphone/speaker sets; audio-frequency electric amplifiers; electric sound amplifier sets
0408	Flat-Panel Display Televisions (TVs) (LCD, LED, Plasma)	47313	Television receivers, whether or not combined with radio-broadcast receivers or sound or video recording or reproducing apparatus
0501	Small lighting equipment (excl. LED & incandescent)	46531	Portable electric lamps designed to function by their own source of energy (except those for cycles or motor vehicles); electric ceiling or wall lighting fittings (except those for lighting public open spaces or thorough-fares); electric table, desk, bedside or floor-standing lamps; non-electrical lamps and lighting fittings; illuminated signs, illuminated name-plates and the like

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0502	Compact Fluorescent Lamps (incl. retrofit & non-retrofit)	46510	Electric filament or discharge lamps; arc lamps
0503	Straight Tube Fluorescent Lamps	46510	Electric filament or discharge lamps; arc lamps
0504	Special Lamps (e.g. professional mercury, high- & low-pressure sodium)	46510	Electric filament or discharge lamps; arc lamps
0505	LED Lamps (incl. retrofit LED lamps)	47150	Diodes, transistors and similar semi-conductor devices; photosensitive semi-conductor devices; light emitting diodes; mounted piezo-electric crystals
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	46531	Portable electric lamps designed to function by their own source of energy (except those for cycles or motor vehicles); electric ceiling or wall lighting fittings (except those for lighting public open spaces or thorough-fares); electric table, desk, bedside or floor-standing lamps; non-electrical lamps and lighting fittings; illuminated signs, illuminated name-plates and the like
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	46532	Lighting sets of a kind used for Christmas trees
0507	Professional Luminaires (offices, public space, industry)	46539	Other electric lamps and lighting fittings (including lamps and lighting fittings of a kind used for lighting public open spaces or thorough-fares)
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	44232	Electromechanical tools for working in the hand, with self-contained electric motor
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	43220	Pumps for liquids; liquid elevators
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn mowers)	44121	Mowers for lawns, parks or sportsgrounds
0602	Professional Tools (e.g. for welding, soldering, milling)	44919	Special-purpose machinery n.e.c. (including machinery for isotopic separation, machines for assembling electric lamps in glass envelopes, machines for manufacturing glassware and rope making machines)
0602	Professional Tools (e.g. for welding, soldering, milling)	46939	Other electrical equipment n.e.c. (including electro-magnets; electro-magnetic couplings; clutches and brakes; electro-magnetic lifting heads; electrical particle accelerators; electrical signal generators and apparatus for electro-plating, electrolysis or electrophoresis)
0602	Professional Tools (e.g. for welding, soldering, milling)	44241	Electrical machinery and apparatus for soldering, brazing or welding; electric machines and apparatus for hot spraying of metals or sintered metal carbides
0602	Professional Tools (e.g. for welding, soldering, milling)	43931	Fans, except domestic type; centrifuges, except cream separators and clothes dryers

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0602	Professional Tools (e.g. for welding, soldering, milling)	44222	Machine-tools for working wood, cork, bone, hard rubber, hard plastics or similar hard materials; presses for the manufacture of particle board or fibre building board of wood or other ligneous materials and other machinery for treating wood or cork
0602	Professional Tools (e.g. for welding, soldering, milling)	44121	Mowers for lawns, parks or sportsgrounds
0602	Professional Tools (e.g. for welding, soldering, milling)	44430	Pile-drivers and pile-extractors; snow-ploughs and snow-blowers; other moving, grading, levelling, scraping, excavating, tamping, compacting, extracting or boring machinery, not self-propelled, for earth, minerals or ores; machinery n.e.c. for public works, building or the like
0602	Professional Tools (e.g. for welding, soldering, milling)	44213	Lathes for removing metal
0602	Professional Tools (e.g. for welding, soldering, milling)	44216	Machine-tools for deburring, sharpening, grinding, honing, lapping, polishing or otherwise finishing metal, sintered metal carbides or cermets by means of grinding stones, abrasives or polishing products; machine-tools for planing, shaping, slotting, broaching, gear cutting, gear grinding or gear finishing, sawing, cutting-off and other machine-tools working by removing metal, sintered metal carbides or cermets n.e.c.
0602	Professional Tools (e.g. for welding, soldering, milling)	44440	Machinery for sorting, screening, separating, washing, crushing, grinding, mixing or kneading earth, stone, ores or other mineral substances, in solid form; machinery for agglomerating, shaping or moulding solid mineral fuels, ceramic paste, unhardened cements, plastering materials or other mineral products in powder or paste form; machines for forming foundry moulds of sand
0602	Professional Tools (e.g. for welding, soldering, milling)	44217	Machine-tools for working metal by forging, hammering or die-stamping; machine-tools for working metal by bending, folding, straightening, flattening, shearing, punching or notching; other presses for working metal or metal carbides
0602	Professional Tools (e.g. for welding, soldering, milling)	44211	Machine-tools for working any material by removal of material, by laser or other light or photon beam, ultra-sonic, electro-discharge, electro-chemical, electron beam, ionic beam or plasma arc processes, water-jet cutting machines
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	38510	Dolls' carriages; wheeled toys designed to be ridden by children
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	38520	Dolls representing human beings; toys representing animals or non-human creatures

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	38540	Toy electric trains and tracks, signals and other accessories therefor; reduced-size ("scale") model assembly kits and other construction sets and constructional toys
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	38560	Other toys (including toy musical instruments)
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	38590	Other articles for funfair, table or parlour games (including articles for billiards, pintables, special tables for casino games and automatic bowling alley equipment), except video games of a kind used with a television receiver
0702	Game Consoles	38581	Video game consoles
0702	Game Consoles	38582	Software cartridges for video game consoles
0705	Charging stations	46122	Ballasts for discharge lamps or tubes; static converters; other inductors
0705	Charging stations	46213	Boards, consoles, cabinets and other bases, equipped with electrical switching etc. apparatus, for electric control or the distribution of electricity, for a voltage not exceeding 1000 V
0801	Household Medical equipment(e.g. thermometers, blood pressure meters)	48172	Hearing aids and other appliances which are worn or carried, or implanted in the body, to compensate for a defect or disability
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	48121	Electro-diagnostic apparatus, used in medical, surgical, dental or veterinary sciences
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	48130	Other instruments and appliances (except syringes, needles and the like), used in dental sciences
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	46921	Burglar or fire alarms and similar apparatus
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	46929	Other electric sound or visual signalling apparatus, except for cycles or motor vehicles, and except electromechanical traffic control equipment for transport facilities
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	48251	Hydrometers and similar floating instruments, thermometers, pyrometers, barometers, hygrometers and psychrometers
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	48252	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases, except navigational, hydrological or meteorological instruments and appliances, gas or liquid supply meters and automatic regulating or controlling instruments and apparatus
0901	Household Monitoring & Control equipment (e.g. alarm, heat, smoke, excl. screens)	48249	Instruments and apparatus for measuring or checking electrical quantities n.e.c.

UNU-KEY	UNU-KEY Description	CPC 2.1	CPC Description
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48243	Instruments and apparatus (except cathode-ray oscilloscopes and oscillographs) for measuring or checking voltage, current, resistance or power, without a recording device (except electricity production or supply meters)
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48253	Instruments and apparatus for physical or chemical analysis, for measuring or checking viscosity, porosity, expansion, surface tension or the like, or for measuring or checking quantities of heat, sound or light
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48269	Measuring, checking, regulating or controlling instruments, appliances and machines n.e.c.
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48212	Rangefinders, theodolites and tachymeters (tacheometers) and levels
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48219	Other surveying, hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48262	Machines and appliances for testing the mechanical properties of materials
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48263	Gas, liquid or electricity supply or production meters
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48264	Revolution counters, production counters, taximeters, mileometers, pedometers and the like; speed indicators and tachometers, except hydrographic and meteorological instruments; stroboscopes
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	48242	Cathode-ray oscilloscopes and cathode-ray oscillographs
1001	Non-cooled Dispensers (e.g. for vending, hot drinks, tickets, money)	43934	Automatic goods vending machines
1002	Cooled Dispensers (e.g. for vending, cold drinks)	43934	Automatic goods vending machines

Annex 5. UNU-KEYs lifetime distribution parameters

Table 22 sets out lifetime profiles for the UNU-KEYs in the form of two parameter Weibull distributions (alpha/shape, beta/scale). These can be used as part of the measurement framework laid out in these guidelines to estimate waste generation and the stock of EEE products. Parameters for non-EU countries include data from studies undertaken in Nigeria, Kenya and Lebanon (Table 23). Countries outside out of the EU with a comparable GDP-PPP should use the parameters listed under the EU-27 section.

Table 22. Weibull distribution parameters for the EU-27 (including specific to the Netherlands (Kingdom of the)), and non-EU countries

Region	EU-27		Netherlands (Kingdom of the)		Non-EU Countries	
Year of study	2023		2018			
UNU-KEY	Alpha	Beta	Alpha	Beta	Alpha	Beta
0001	2.00	14.21	2.00	14.21	2.00	14.21
0002	4.25	See table 24	4.25	See table 24	4.25	See table 24
0101	1.92	16.07	1.92	16.07	1.92	16.07
0102	1.79	17.13	1.79	17.13	1.79	17.13
0103	2.00	19.35	2.00	19.35	2.00	19.35
0104	1.85	13.32	1.85	13.32	1.85	17.70
0105	2.58	18.08	2.58	21.00	2.58	19.00
0106	2.00	13.47	2.00	13.47	2.00	13.47
0108	2.20	16.71	2.20	17.13	2.00	15.59
0109	1.28	18.55	1.28	18.55	1.28	18.55
0111	2.00	20.60	2.00	20.60	2.70	20.60
0112	2.36	13.36	2.36	13.36	2.36	13.36
0113	1.60	15.36	1.60	15.36	1.60	15.36
0114	2.07	17.99	2.07	17.99	2.07	17.20
0201	1.22	7.97	1.22	7.97	1.22	7.97
0202	2.02	11.02	2.02	11.02	2.02	11.02
0203	1.18	7.61	1.18	12.71	1.18	12.71
0204	1.22	10.59	1.22	10.59	1.22	7.60
0205	1.20	8.09	1.20	8.09	1.63	8.95
0301	1.30	6.15	1.30	6.15	1.30	6.15
0302	1.80	10.33	1.80	7.50	2.20	14.01
0303	1.94	8.76	1.94	8.76	2.03	9.45
0304	1.88	9.31	1.88	9.31	1.88	9.31
0305	1.32	7.70	1.32	7.70	1.32	7.70
0306	1.52	5.62	1.52	5.62	1.56	8.80
0307	1.46	7.78	1.46	7.78	1.46	7.78

Region	EU-27		Netherlands (Kingdom of the)		Non-EU Countries	
Year of study	2023		2018			
0308	1.40	15.94	1.40	15.94	3.25	16.05
0309	2.30	12.18	2.30	13.00	2.30	12.70
0310	2	7.5	2	7.5	2	7.5
0401	1.30	9.87	1.30	9.87	1.30	9.87
0402	1.50	10.01	1.50	10.01	1.50	10.01
0403	2.30	10.00	2.30	10.00	2.30	10.00
0404	1.14	8.33	1.14	8.33	3.05	13.66
0405	1.13	12.54	1.13	12.54	1.13	12.54
0407	2.49	12.08	2.49	12.08	2.49	12.08
0408	1.88	10.95	2.30	16.00	1.88	11.10
0409	1.2	0.6	1.2	0.6	1.2	0.6
0501	1.42	8.72	1.42	8.72	1.42	8.72
0502	1.60	7.11	1.60	7.11	1.60	7.11
0503	1.75	8.70	1.75	8.70	1.75	5.79
0504	1.60	7.30	1.60	7.30	1.60	6.90
0505	1.36	12.91	1.36	12.91	1.36	4.20
0506	2.34	16.59	2.34	16.59	2.34	15.30
0507	2.00	20.50	2.00	20.50	2.00	12.50
0601	1.77	14.98	1.77	14.98	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
0704	1.2	9	1.2	9	1.2	9
0705	2.49	11.59	2.49	11.59	2.49	11.59
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	15.00	2.00	15.00	2.00	15.00

Table 23. Weibull distribution parameters from studies undertaken in Nigeria, Kenya, and Lebanon (Odeyingbo, Baldé and Forti, 2022; ITU and UNITAR, 2023; Baldé et al., 2022b)

Region	Nigeria		Kenya		Lebanon	
Year of study	2022		2023		2022	
UNU-KEY	Alpha	Beta	Alpha	Beta	Alpha	Beta
0104					1.85	17.7
0105					2.58	19
0108	1.79	14.47	2.2	16.7		
0114					2.07	17.2
0204					1.22	7.6
0205			1.26	12.6	2	5.3
0301						
0302	2.59	14.22			1.8	13.8
0303	2.11	11.7			1.94	7.2
0306			1.56	8.8		
0307						
0308	5.1	17.09			1.4	15
0309					2.3	12.7
0404	3.05	13.66				
0408					1.88	11.1
0505					1.36	4.2
0506					2.34	15.3

A time-dependent varying scale parameter is recommended for modelling waste generation associated with UNU-KEY 0002 (Table 24).

Table 24. Scale parameter of the Weibull Distribution for UNU-KEY 0002

UNU KEY	Year	Beta/scale parameter
0002	1980	23.16
0002	1981	23.40
0002	1982	23.64
0002	1983	23.88
0002	1984	24.12
0002	1985	24.36
0002	1986	24.61
0002	1987	24.85
0002	1988	25.09
0002	1989	25.33
0002	1990	25.57
0002	1991	25.81
0002	1992	26.05
0002	1993	26.29
0002	1994	26.54
0002	1995	26.78
0002	1996	27.02
0002	1997	27.26
0002	1998	27.50
0002	1999	27.74
0002	2000	27.98
0002	2001	28.22
0002	2002	28.46
0002	2003	28.71
0002	2004	28.95
0002	2005	29.43
0002	2006	29.91
0002	2007	30.39
0002	2008	30.88
0002	2009	31.36
0002	2010	31.84
0002	2011	32.33
0002	2012	32.80
0002	2013	33.29
0002	2014	33.78
0002	2015	34.25
0002	2016	34.74
0002	2017	35.56
0002	2018	36.39
0002	2019	37.21
0002	2020	38.05
0002	2021	38.87
0002	2022	39.70
0002	2023	40.53
0002	2024	40.53

Annex 6. UNU-KEYs per-unit weights

Table 25 presents indicative average per-unit weights for the UNU-KEYs. These can be used as part of the measurement framework laid out in these guidelines to convert unit-level data into equivalent mass terms. The figures have been calculated excluding the mass of batteries.

Table 25. Average per-unit weights by UNU KEY, 1995-2024, kg

UNU-KEY	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024
0001	30.85	30.85	30.85	30.85	30.85	33.35	35.85	38.35	40.85	43.9
0002	17	17	17	17	17	22	22.31	22.27	22.77	28.8
0101	124.61	124.61	124.61	124.61	124.61	124.61	124.61	124.61	124.61	124.61
0102	49.35	47.62	45.46	43.3	43.3	42.3	41.3	40.3	39.43	41.45
0103	37.31	37.31	37.31	38.91	38.27	40.2	42.12	45.05	44.99	44.92
0104	69.36	70.26	71.4	72.54	72.54	72.68	68.41	72.21	68.98	74.36
0105	38.27	40.47	43.22	45.98	45.98	45.98	44.96	43.94	43.09	41.87
0106	12.14	12.14	12.14	12.14	12.14	12.3	12.45	12.61	12.76	12.92
0108	33.59	35.64	38.21	40.79	40.79	41.4	42	42.61	43.22	43.82
0109	43.59	43.73	43.91	44.09	44.09	44.63	45.18	45.72	46.27	46.81
0111	26.7	26.7	26.7	26.7	26.7	26.75	25.37	27.74	27.73	25.45
0112	41.7	41.7	41.7	41.7	41.7	49.34	49.51	51.43	51.79	54.9
0113	72	72	72	72	72	72	72	77.86	75.9	83.21
0114	16.34	18.21	20.55	22.9	22.9	23.57	24.24	25.59	24.93	24.3
0201	1.3	1.21	1.1	0.99	0.99	0.99	0.99	0.99	0.99	0.99
0202	1.7	1.7	1.7	1.7	1.5	2.09	1.85	1.73	1.71	1.84
0203	1.7	1.7	1.7	1.7	1.5	1.3	1.3	1.3	1.3	1.3
0204	4.88	5.16	5.52	5.88	5.88	6.7	7.52	7.68	7.85	6.33
0205	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
0301	0.65	0.57	0.48	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0302	10.31	9.87	9.32	8.77	8.77	7.19	7.39	6.94	6.44	6.26
0303	4.43	3.81	2.98	2.28	1.09	1.02	1.07	1.12	1.17	1.35
0304	7	7.94	9.13	10.32	10.32	10.68	11.05	11.41	11.77	12.13
0305	0.82	0.82	0.96	1.04	1.33	1.62	1.68	1.74	1.74	1.74
0306	0.12	0.11	0.1	0.09	0.09	0.09	0.08	0.08	0.08	0.08
0307	40	40	40	40	40	39.75	39.5	39.25	39.25	39.25
0308	14.6	16.71	19.35	22	22	22	22	22	22	22
0309	5	5.14	5.32	5.5	5.5	7.41	8.27	7.71	7.62	8.2
0310						18.92	18.84	18.76	18.68	18.61
0401	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0402	0.4	0.35	0.29	0.23	0.23	0.23	0.23	0.23	0.23	0.23
0403	4.15	4.03	3.88	3.73	3.73	3.73	3.73	3.73	3.73	3.73
0404	2.9	2.9	2.9	2.9	2.1	2.66	2.66	2.66	2.66	2.66

UNU-KEY	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024
0405	3	2.75	2.44	2.14	2.14	2.14	2.14	2.14	2.14	2.14
0407	25	27.34	30.27	33.2	33.2	33.2	33.2	33.2	33.2	33.2
0408	7	9.2	11.95	14.7	10.2	12.04	12.76	13.66	13.95	14.68
0409						0.5	0.5	0.5	0.5	0.5
0501	0.09	0.09	0.09	0.09	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	0.08	0.08	0.08	0.08
0503	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
0504	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
0505	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
0506	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
0507	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67
0601	2.6	2.56	2.52	2.49	2.49	2.49	2.49	2.49	2.49	2.49
0602	23.17	23.17	23.17	23.17	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	0.45	0.45	0.45	0.45
0702	0.48	0.48	0.48	0.48	0.48	0.79	1.1	1.71	1.57	1.62
0703	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37
0704						25	25	25	25	25
0705						7	7	7	7	7
0801	0.18	0.18	0.18	0.18	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	67.04	67.04	67.04	67.04
0901	0.24	0.24	0.24	0.24	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	5.51	5.51	5.51	5.51
1001	44	44	44	44	44	46.2	48.4	50.6	52.8	55.94
1002	92.22	92.22	92.22	92.22	92.22	90.22	88.22	86.22	84.22	84.49

Annex 7. UNU-KEYs material composition

Table 26 presents data on the material composition of e-waste at the EU-6PV level. The figures have been calculated based on the UNITAR SCYCLE material composition database for EEE goods POM further developed through the FutuRaM project (Kippert et al. 2025).[61] This data has then been processed through the UNITAR SCYCLE global stock-and-flow model to calculate material composition at the point of waste generation for the year 2024. The data can be used to convert mass-based estimates at the product level into constituent materials. Potential applications include estimating the recovery of materials across different end-of-life processes and monitoring the monetary value of e-waste.

Table 26. Average material composition by EU-6PV category

		EU-6PV						
Unit mg element / kg waste stream		1	2	3	4a	4b	5	6
Transition Metals	Fe	4.37E+05	2.80E+05	1.04E+05	5.08E+05	2.31E+04	3.52E+05	2.83E+05
	Al	4.40E+04	4.91E+04	2.38E+05	2.14E+04	1.16E+05	7.32E+04	2.02E+04
	Ni	2.32E+04	2.16E+03	1.16E+04	7.78E+03	1.17E+01	5.76E+03	4.32E+03
	Cu	4.46E+04	2.38E+04	3.66E+04	1.98E+04	6.79E+03	4.53E+04	3.66E+04
	Cr	5.23E+04	2.80E+03	1.04E+04	2.28E+04	3.18E+02	8.99E+03	3.38E+03
	Mn	5.10E+03	3.43E+03	1.46E+03	5.29E+03	4.55E+02	3.70E+03	2.84E+03
	Zn	7.62E+03	2.76E+03	2.29E+03	1.65E+03	5.08E+02	5.63E+03	2.88E+03
	Sc				2.47E-02			6.66E-01
	V	1.04E-01	1.25E+00	8.46E-01	1.87E-01	1.03E-02	2.20E-01	2.41E+00
	Co	7.92E+00	2.18E+01	1.48E+04	6.69E-01	3.42E-01	6.29E+00	3.35E+02
	Y		5.09E-02	8.34E+02				
	Zr		2.03E+02					2.42E+01
	Nb		1.42E-01	1.91E+02			6.60E-01	1.27E+00
	Mo	8.97E-03	1.70E+00	5.08E-02	6.59E-03		4.74E-02	9.48E+00
	Ag	1.00E-01	1.11E+02	1.59E+01	1.40E+00	8.92E+00	1.14E+01	1.38E+02
	Au	4.78E-02	2.86E+01	1.21E+01	1.01E-01	1.57E-02	1.55E+00	3.47E+01
	Ta	1.52E-02	3.38E+01	4.66E+00	7.99E-02	1.29E-02	1.23E+00	5.65E+01
	W	4.13E+01	9.19E+00	5.23E+03	6.40E+01	4.44E-01	5.39E+02	5.01E+01
Platinum Group Metals	Pt							4.18E-01
	Pd	1.57E-03	5.13E+00	2.25E+00	6.69E-03		4.25E-01	5.99E+00
	Rh			8.88E-03			1.29E-02	9.41E-01
Post transition Metals	Ga	5.27E-02	2.65E+00	5.58E+00	3.63E-02	1.69E+00	8.42E-02	6.46E+00
	Cd	7.07E-02	8.31E+00	4.22E-02		3.10E+01	1.70E-01	3.49E+00
	In	1.22E-02	2.50E+01	5.43E+00	3.13E-01	6.50E+00	2.94E+00	6.02E+00
	Sn	1.44E+02	1.24E+03	1.58E+03	1.04E+02	8.01E+01	1.35E+03	2.19E+03
	Hg		1.09E-01	2.59E+01	3.12E-05			4.27E-01
	Pb	1.90E+01	4.56E+03	1.16E+03	4.04E+01	2.80E+00	2.50E+02	1.11E+03
	Bi		7.83E+00	1.20E-02			6.62E-01	4.58E+00

[61] *The FutuRaM 'Composition Consolidated Data – WEEE' dataset can be accessed at the following link: https://doi.org/10.5281/zenodo.17789750*

		EU-6PV						
Unit mg element / kg waste stream		1	2	3	4a	4b	5	6
Metalloids	Sb	4.63E+00	2.04E+03	7.06E+01	2.14E+01	4.12E+00	2.21E+01	1.12E+02
	As	4.46E-04	2.45E+00	2.96E-03	1.42E-03	1.16E-04	2.14E-02	5.79E+00
	Ge		1.69E-02					1.39E-01
	Te		1.17E-01	4.60E-03		3.49E+01	6.69E-03	2.48E-01
Alkaline	Be	3.96E-04	5.61E-02		6.92E-04			
	Mg	1.09E+03	4.57E+03	5.77E+03	5.69E+02	1.12E+04	1.72E+03	5.74E+02
	Sr	1.64E+02	1.76E+03	1.41E+01	1.26E+01	5.59E+00	2.14E+02	3.96E+02
Rare Earth Metals	La	8.83E-03	3.48E-03	1.76E+02	4.95E-04	2.76E-04	1.99E-02	8.46E-02
	Ce	3.38E-03	8.67E-03	1.34E+02	2.05E-04	6.19E-05	6.40E-03	1.20E-03
	Pr	3.16E-02	1.82E+00	1.60E-03	2.42E-03	1.73E-03	8.44E-03	7.34E+01
	Nd	1.83E-01	3.71E+02	1.93E+00	2.76E+02	1.07E-02	1.14E+02	3.26E+02
	Sm							1.31E+01
	Eu		2.60E-03	5.81E+01				1.65E-01
	Tb		7.30E-04	5.58E+01				2.46E+00
	Dy	1.40E-03	5.66E-01	7.73E-05	1.87E+01	8.36E-05	2.00E-01	2.68E+01
	Er							1.32E-02
Other (such as plastic, glass etc.)		3.85E+05	6.21E+05	5.66E+05	4.12E+05	8.41E+05	5.01E+05	6.41E+05

Table 27 presents grades of selected metals from low grade or 'basic' mobile phones (UNU-KEY 0306), including dismantled PCB. This data was collected between 2015 and 2023 in Cameroon, Ghana, Rwanda, Uganda and Zambia (Source: Closing the Loop). The table includes a comparison to a typical 'smart' phone across the selected metals (Sources: Babitt, and internal UNITAR data).

Table 27. Composition of selected metals in different types of mobile phones.
(Closing the Loop; Babitt et al., 2020; UNITAR)

Product	Measure	PPM Au	PPM Ag	PPM Pd	PPM Pt	Mass fraction Cu
Basic mobile phones	min-max	39 - 256	411 - 964	1 - 22	2 - 3	0,04 - 0,13
	average	75	503	7	2	0,072
Smart phones	average	185	780	40	1	0,042
PCB	min-max	165 - 231	918 - 995	15 - 17	not sampled	0,21 - 0,23
	average	199	959	16	not sampled	0,22

Annex 8: Persistent Organic Pollutants (POPs) in EEE/E-waste

Quantifying POPs as part of national inventories is complex, as concentrations of POPs in EEE, and by extension, e-waste, can vary by product type, manufacturer, and country and year of manufacture, among other factors. Parties and other stakeholders preparing national inventories of POPs in EEE/e-waste should consult the relevant guidance developed under the Stockholm Convention on Persistent Organic Pollutants, which provide detailed methodologies for screening, sampling, and analysis.[62]

Stockholm Convention guidance emphasises that inventories based solely on desk studies are likely to overestimate POP concentrations, and that concentration data derived from one country or region should not be directly transferred to another unless product supply chains, market characteristics, and regulatory contexts are demonstrably comparable. To support the development of robust national inventories, sampling and analytical verification are essential to calibrate any default values to country-specific conditions. In particular, POP inventories should consider the timing of the phase-out of relevant POPs in major manufacturing countries, as well as the year of entry into force of the corresponding Stockholm Convention amendments for each Party, which determines when listed POPs should no longer be present in newly manufactured equipment.

Considering the provisional low POP content values established under the Basel Convention technical guidelines[63], countries should ensure the environmentally sound disposal of POPs waste. This involves ensuring that the POP content is destroyed or irreversibly transformed so that the waste no longer exhibits the characteristics of POPs, or that waste is otherwise disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option. Efforts to strengthen waste management systems, particularly for e-waste, are critical for supporting the circular economy. Without effective removal of POPs from the recycling stream, higher recycling rates have the potential to lead to continued circulation of these chemicals in new articles.

PBDEs

Estimating POP-PBDEs concentrations as part of a national inventory requires data on the flows and stocks of higher risk EEE/e-waste in mass terms, the polymer content of those products, and the concentration of POP-PBDEs within the polymer share (UNEP, 2021b).

Inventories of 2009 POP-BDEs[64] undertaken in developing countries continue to indicate large stocks of POPs in articles still in use or stockpiled, and significant amounts of POP-BDEs in the waste stream. For most developing countries, past imports were the main source of articles containing 2009 POP-BDEs. While the import of new articles containing 2009 POP-BDEs may be less of a concern in recent years, developing countries continue to receive such articles as second-hand/used goods or as wastes.[65]

[62] *https://www.pops.int/Implementation/NationalImplementationPlans/Guidance/tabid/7730/Default.aspx*
[63] *UNEP/CHW.17/5/Add.1/Rev.1.*
[64] *Hexabromodiphenyl ether and heptabromodiphenyl ether as well as Tetrabromodiphenyl ether and pentabromodiphenyl ether are collectively referred to as 2009 POP-BDEs, from the year of their listing in the Stockholm Convention by decisions SC-4/14 and SC-4/18.*
[65] *UNEP/POPS/COP.12/INF/13.*

Available evidence indicates that elevated POP-PBDEs concentrations are most consistently associated with CRT televisions and monitors (Wäger et al., 2010). Additional product groups reported to present a higher likelihood of POP-PBDEs occurrence include LCD televisions and selected heating and ventilation appliances (Hennebert et al., 2018). Table 28 summarises product categories considered particularly relevant for use in an initial screening assessment (UNEP, 2021b).

Table 28. Relevant UNU-KEYs for a first-generation EEE inventory of PBDEs (UNEP, 2021b)

UNU KEY	UNU-KEY Description	Corresponding HS Codes (H0-H6)
0101	Professional Heating & Ventilation	845110, 845130
0104	Washing Machines (incl. combined dryers)	845011, 845012, 845019, 845020
0106	Household Heating & Ventilation	841460, 851621, 851629
0108	Refrigerators (incl. combi-refrigerators)	841810, 841821, 841822, 841829
0111	Air Conditioners (household installed and portable)	841510, 841581, 841582
0308	Cathode Ray Tube Monitors	852821, 852822, 852841, 852842, 852849
0407	Cathode Ray Tube Televisions (TVs)	852812, 852813, 852873
0303	Laptops (incl. tablets)	847130
0306	Mobile Phones (incl. smartphones, pagers)	851712, 851713, 851714
0309	Flat-Panel Display Monitors (LCD, LED)	852851, 852852, 852859, 853120
0408	Flat-Panel Display Televisions (TVs) (LCD, LED, Plasma)	852872

To estimate the POP-PBDEs content in EEE/e-waste plastics, data on POP-PBDEs concentrations in the total polymer fraction of the relevant EEE/e-waste are required. Table 29 presents ranges in the polymer fraction, by weight, for high-risk product groups, as taken from studies by Wäger et al. (2008) and EFRA (2013) in UNEP (2021b).

Table 29. Total polymer fractions in high-risk EEE/e-waste types. (Wäger et al. 2008; EFRA, 2013 in UNEP, 2021b)

Category[66]	Article	Minimum (%)	Maximum (%)	Mean (%)
3	ICT equipment without monitors	26	58	42
4	Consumer equipment without monitors	21	26	24
3	CRT monitors	13	38	30
4	CRT-TVs	15	38	30
4	LCD-TV (Flat screen)	30	45	37

Note: Printed wiring boards and cables are not included

Available sampling data on POP-PBDEs concentrations are relatively limited and derive from only a small number of studies. Table 30 presents measured concentrations of decaBDE and Σ hexa/heptaBDE in the total polymer fraction, based on samples collected at e-waste recycling facilities in Europe in 2010 (Wäger et al., 2010) and 2018 (Hennebert & Filella, 2018). These have been compiled in the Stockholm Convention POP-PBDEs inventory guidance (UNEP, 2021b) and are also included in the sectoral inventory guidance (GGKP, 2024a). The sampling and analytical procedures applied are described in Wäger et al. (2010). See also Appendix 2 of UNEP/POPS/COP.12/INF/13 for further data on POP-PBDEs concentrations in e-waste (UNEP, 2024).

Table 30: POP-PBDE (hexa/heptaBDE and decaBDE) content in total (mixed) polymer fractions of different WEEE in Europe (Wäger et al. 2010; Hennebert & Filella, 2018 in UNEP, 2021b)

Category[67]	Article	Σ hexa/heptaBDE in plastic fractions (kg/tonne)			decaBDE in plastic fractions (kg/tonne)		
		Min	Max	Mean	Min	Max	Mean
1	Cooling/freezing appliances; washing machines	–	–	<0.05	–	–	<0.05
1	Heating appliances	–	–	<0.05	–	–	0.8
2	Small household appliances	–	–	–	<0.1	0.5	0.17
3	ICT equipment, w/o monitors	0.027	0.22	0.12	0.5	1.4	0.8
3	CRT monitor casings	0.08	5.7	1.37	0.5	7.8	3.2
4	Consumer equipment w/o monitors (1 composite sample)	–	–	0.08	0.7	0.9	0.8
4	TV CRT monitor casings	0.03	1.9	0.47	0.8	7.8	4.4
4	Flat screen TVs (LCD)	0.008	0.010	0.009	1.2	4.3	2.71

[66/67] The category column refers to the 10-category breakdown of EEE/e-waste used under the WEEE Directive until the 2018 reference year.

These impact factors represent only concentrations derived from sampling in specific facilities and product streams. Their applicability beyond the original study contexts can be limited and actual POP levels may be considerably higher or lower depending on:

- The composition of specific plastic fractions in EEE goods,
- The market of origin of the EEE,
- The year of manufacture[68]
- National import patterns and supply chains, and
- Changes in production and regulatory conditions over time.

Given that DecaBDE production in China ceased in 2023 (GGKP, 2024b), when developing a national inventory, POP-PBDEs impact factors should only be applied to EEE produced up to 2023. Equipment manufactured from 2024 onwards should be treated as free of POP-PBDEs, unless sampling analysis indicates otherwise.

HBCD, SCCPs, MCCPs, UV-328 and Dechlorane Plus

In addition to POP-PBDEs, other POPs have been used in plastics in EEE and e-waste, including as flame retardants (e.g. HBCD, Dechlorane Plus), plasticisers (e.g. SCCPs and MCCPs), and ultraviolet stabilisers (UV-328). Table 31 presents indicative concentrations of these selected POPs reported in the plastic fraction of EEE/e-waste, based on studies from Switzerland (Taverna et al., 2017) and Norway (Norwegian Environment Agency, 2021), as compiled in the sectoral POP inventory guidance (GGKP, 2024a).

Table 31. Impact factors of HBCD, SCCPs, MCCPs and Dechlorane Plus in EEE/e-waste plastics (GGKP, 2024a)

POP in plastic in e-waste	Content (kg/t) in the plastic fraction	Source
HBCD	0.042	Taverna et al. 2017
Dechlorane Plus	0.04	Taverna et al. 2017; Norwegian Environment Agency 2021
SCCP	0.025	Norwegian Environment Agency 2021
MCCP	0.1	Norwegian Environment Agency 2021

As with all POP inventories, sampling and laboratory analysis are essential to calibrate desk-based estimates and to support the development of credible national inventories. The data presented in Annex 8 is intended solely for preliminary screening purposes and should not be assumed to represent national conditions in the absence of analytical verification.

[68] *The production and use of DecaBDE decreased since 2008 (UNEP 2021b) and has been substituted frequently by decabromodiphenyl ethane (DBDPE) which was recently classified as Substance of Very High Concern since it is very persistent and bio-accumulative (vPvB) (ECHA 2025). Therefore, for EEE produced after 2008, the PBDE impact factors (Table 30) can be considered an upper estimate and are likely lower.*

Chapter 9. References

Andersson, M., Oxfall, H., Nilsson C. (2019). Mapping and Evaluation of some Restricted Chemical Substances in Recycled Plastics Originating from ELV and WEEE Collected in Europe. RISE report: 2019:28 for Swedish EPA; ISBN: 978-91-88907-54-7.

Babayemi, J.O., Nnorom, I.C., Weber, R. (2025). Comprehensive inventory of imports of electrical and electronic equipment and related plastics and POPs plastic additives into Nigeria in the past 32 years (1990-2022). *Emerging Contaminants* 11, 100423.

Babbitt, C.W., Madaka, H., Althaf, S., Kasulaitis, B., Ryen, E.G. (2020). Disassembly-based bill of materials data for consumer electronic products. *Sci Data* 7, 251.

Baldé, C.P., Kuehr, R., Blumenthal, K., Fondeur Gil, S., Kern, M., Micheli, P., Magpantay, E., Huisman, J. (2015). E-waste statistics: Guidelines on classifications, reporting and indicators. United Nations University, IAS - SCYCLE, Bonn, Germany.

Baldé, C.P., Wang, F., Kuehr, R. (2016). Transboundary movements of used and waste electronic and electrical equipment, United Nations University, ViE - SCYCLE, Bonn, Germany.

Baldé, C.P., Forti V., Gray, V., Kuehr, R., Paul, S. (2017). The Global E-waste Monitor - 2017, United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Vienna.

Baldé, C.P., D'Angelo E., Forti V., Kuehr R., Van den Brink S. (2018). Waste mercury perspective, 2010-2035: from global to regional, United Nations University (UNU), United Nations Industrial Development Organization, Bonn/Vienna.

Baldé, C.P., Wagner, M., Iattoni, G., Kuehr, R. (2020). In-depth Review of the WEEE Collection Rates and Targets in the EU-28, Norway, Switzerland, and Iceland, 2020, United Nations University (UNU) / United Nations Institute for Training and Research (UNITAR) - co-hosting the SCYCLE Programme, Bonn, Germany.

Baldé, C.P., Iattoni, G., Luda, V., Nnorom, I.C., Pecheniuk, O., Kuehr, R. (2021). Regional E-waste Monitor for the CIS + Georgia - 2021, United Nations University (UNU) / United Nations Institute for Training and Research (UNITAR) - co-hosting the SCYCLE Programme, Bonn, Germany.

Baldé, C.P. and Bel, G. (2022). Consultation on the Methodology for Measuring the Global Progress of E-waste Legislation.

Baldé, C.P., D'Angelo, E., Luda, V., Deubzer, O., Kuehr, R. (2022a). Global Transboundary E-waste Flows Monitor - 2022, United Nations Institute for Training and Research (UNITAR), Bonn, Germany.

Baldé C.P., Panchal, R., Forti, V. (2022b). National E-waste Monitor for Lebanon 2022. United Nations Institute for Training and Research (UNITAR), Bonn, Germany.

Baldé, C.P., Iattoni, G., Xu, C., Yamamoto, T. (2022c). Update of WEEE Collection Rates, Targets, Flows, and Hoarding - 2021 in the EU-27, United Kingdom, Norway, Switzerland, and Iceland. SCYCLE Programme, United Nations Institute for Training and Research (UNITAR), Bonn, Germany.

Baldé, C.P., Kuehr, R., Yamamoto, T., McDonald, R., D'Angelo, E., Althaf, S., Bel, G., Deubzer, O., Fernandez-Cubillo, E., Forti, V., Gray, V., Herat, S., Honda, S., Iattoni, G., Khetriwal, D.S., Luda di Cortemiglia, V., Lobuntsova, Y., Nnorom, I., Pralat, N., Wagner, M. (2024). International Telecommunication Union (ITU) and United Nations Institute for Training and Research (UNITAR). Global E-waste Monitor 2024. Geneva/Bonn.

Basel Action Network (BAN) (2016). Scam Recycling: e-Dumping on Asia by US Recyclers.

Basel Convention (n.d.). Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal: Controlling transboundary movements. Retrieved from: https://www.basel.int/Implementation/Controllingtransboundarymovements/Overview/tabid/4325/Default.aspx. (Accessed December 12, 2024).

Belstat (2022a). Resolution for E-Waste Methodology. Retrieved from: https://www.belstat.gov.by/upload-belstat/upload-belstat-word/Methodology/pr_m5_invir_01_06_2022.doc. (Accessed June 5, 2024).

Belstat (2022b). Methodology for calculating Statistical Indicators characterizing the Generation of Waste Electrical and Electronic Equipment. Retrieved from: https://www.belstat.gov.by/upload-belstat/upload-belstat-word/Methodology/m5_invir_01_06_2022.doc. (Accessed June 5, 2024).

Bergdahl, M., Ehling, M., Elvers, E., Földesi, E., Körner, T., Kron, A., Lohauss, P., Mag, K., Morais, V., Nimmergut, A., Sæbø, H., & Timm, U. (2007). Handbook on Data Quality Assessment Methods and Tools. Eurostat, European Commission. Wiesbaden, Germany.

Bonoli, A. (2015). "La gestione dei Rifiuti Elettrici e Elettronici. Universita' degli studi di Bologna, Dipartimento di Ingegneria Civile, Chimica, Ambientale e dei Materiali."

BRS MEAS (n.d.). Gender Heroes in Africa. United Nations Environment Programme. Retrieved from https://www.brsmeas.org/Implementation/Gender/GenderHeroes/GenderHeroesinAfrica/tabid/4762/language/en-GB/Default.aspx. (Accessed December 9, 2025).

Duan, H., Miller, T.R., Gregory, J., Kirchain, R., Linell, J. (2013). Quantitative characterization of transboundary flows of used electronics: a case study of the United States. StEP Initiative.

EPA Network (2021). The Bellagio Declaration. Retrieved from: https://plonesaas.devel4cph.eea.europa.eu/epanet/reports-letters/reports-and-letters/bellagio-declaration.pdf/view. (Accessed December 16, 2024).

European Chemical Agency (ECHA) (2025). Inclusion of substances of very high concern in the Candidate List for eventual inclusion in Annex XIV. D(2025)6375-DC.

European Information Technology Observatory (EITO) (2011). EITO Report including Consumer Electronics. European Information Technology Observatory.

European Commission - DG Environment (2014). Development of Guidance on Extended Producer Responsibility (EPR).

European Commission (EC) (2016). Setting out a preliminary correlation table between codes of the Combined Nomenclature provided for in Council Regulation (EEC) No 2658/87 and entries of waste listed in Annexes III, IV and V to Regulation (EC) No 1013/2006 of the European Parliament and of the Council on shipments of waste implementing Regulation C/2016/4780. Official Journal of the European Union.

European Commission (EC) (2024). Waste from Electrical and Electronic Equipment (WEEE). Retrieved from: https://environment.ec.europa.eu/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en. (Accessed May 19, 2024).

Eurostat. (2001). *Economy wide Material Flow Accounts and Derived Indicators: A Methodological Guide*. Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2018). Economy-wide material flow accounts handbook: 2018 edition. Publications Office of the European Union, Luxembourg.

Fishman, T., Schandl, H., Tanikawa, H., Walker, P., Krausmann, F. (2014). Accounting for the Material Stock of Nations. *Journal of Industrial Ecology*, 18: 407-420.

Forti, V., Baldé, K., Kuehr, R. (2018). E-waste Statistics: *Guidelines on Classifications, Reporting and Indicators, second edition*, Bonn, Germany, United Nations University.

FutuRaM (2024). UNFC - What is the UN Framework Classification for Resources? Retrieved from: https://futuram.eu/what-is-unfc/ (Accessed December 10, 2024).

Green Growth Knowledge Platform (GGKP) (2024a). Sectoral Guidance for Inventories of POPs and Other Chemicals of Concern in Buildings/Construction, Electrical and Electronic Equipment and Vehicles.

Green Growth Knowledge Platform (GGKP) (2024b). Production, use and trade of POPs newly listed in the Stockholm Convention 2009 to 2022.

Green Growth Knowledge Platform (GGKP) (2024c). Inventory of POPs in Electrical and Electronic Equipment (EEE) and Related Waste (WEEE) in Nigeria. Annex of the Sectoral POP inventory guidance (GGKP 2024a)

Hinchliffe, D., Gunsilius, E., Wagner, M., Hemkhaus, M., Batteiger, A., Rabbow, E., Radulovic, V., Cheng, C., de Fautereau, B., Ott, D., Awasthi, A.K., Smith, E. (2020). Case studies and approaches to building Partnerships between the informal and the formal sector for sustainable e-waste management. StEP Initiative.

Hertwich, E., Ali, S., Ciacci, L., Fishman, T., Heeren, N., Masanet, E., Asghari, F., Olivetti, E., Pauliuk, S., Tu, Q., Wolfram, P. (2019). Material efficiency strategies to reducing greenhouse gas emissions associated with buildings, vehicles, and electronics - A review. *Environmental Research Letters*. 14.

Honda, S., Deepali S.K., Kuehr, R. (2016). Regional E-waste Monitor: East and South Asia. United Nations University ViE - SCYCLE, Bonn, Germany. Huisman, J. (2012b). Eco-efficiency evaluation of WEEE take-back systems. In Part 1 in Waste electrical and electronic equipment (WEEE) handbook, Goodship, V.; Stevels, A. (2012b). Eds. Woodhead Publishing Ltd: Cambridge, the United Kingdom.

Huisman, J., van der Maesen, M., Eijsbouts, R.J.J., Wang, F., Baldé, C.P., Wielenga, C. A. (2012). The Dutch WEEE Flows. Bonn, Germany, United Nations University, ISP - SCYCLE.

Huisman, J., Baldé, C.P., Wielenga, K. (2013). (W) EEE Mass balance and market structure in Belgium., United Nations University, FFACT.

Huisman, J., Habib, H., Baldé, K., van Straalen, V., Chancerel, P., Chanson, C., Söderman, M.L., Kushnir, D. (2017). Product Stocks and Flows Deliverable 3.3. ProSUM.

International Labour Organization. (2015). *4.5 Informal economy workers*. Retrieved from https://www.ilo.org/resource/45-informal-economy-workers (Accessed October 29, 2025).

International Labour Organization. (2025, April). *Decent work opportunities and challenges in recycling* (Technical Brief).

International Monetary Fund (IMF) (2017). Retrieved from World Economic and Financial Surveys - World Economic Outlook Database: https://www.imf.org/en/Publications/SPROLLs/world-economic-outlook-databases.

International Telecommunication Union (ITU) (2023). Report of the EGH Subgroup on Measuring E-Waste. https://www.itu.int/itu-d/meetings/statistics/wp-content/uploads/sites/8/2023/09/Report-of-the-EGH-subgroup-on-measuring-e-waste.pdf.

International Telecommunication Union (ITU) and United Nations Institute for Research and Training Sustainable SCYCLE Programme (UNITAR-SCYCLE) (2023). Towards the Harmonization of Data Collection - A Baseline Study for E-waste in Africa. Geneva/ Bonn.

International Organization for Standardization (ISO) (2022). ISO 8000-2(2022): Data quality - Part 2: Vocabulary. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso:8000:-2:ed-5:v1:en (Accessed December 20, 2024).

Jiang, Z., Chen, C., Li, N., Wang, H., Wang, P., Zhang, C., Ma, F., Zhang, Z., Huang, Y., Qi, J., Chen, W.Q. (2022). Advancing UN Comtrade for Physical Trade Flow Analysis: Addressing the Issue of Outliers. *Resources, Conservation and Recycling.* 186.

Kantar Worldpanel (2017). An incredible decade for the smartphone: What's next? The Future of Mobile is in Combining Devices, Content, and Services. Kantar Worldpanel.

Kirby, P., and Lora-Wainwright, A. (2015). Exporting harm, scavenging value: Transnational circuits of e-waste between Japan, China and beyond. *Area.* 47, 40-47.

Kippert, K., Hu, H.-J., Korf, N., Arvidsson, R., Böcher, C., Capelli, M., Forti, V., Iattoni, G., Maisel, F., Monfort Climent, D., Philippe, A., Rösslein, M., Sanz Prada, L., Schubert, M., Tippner, M., Van den Abeele, L., Van Stee, J., & Rotter, V. S. (2025). Methodology paper - Composition data collection and consolidation. Zenodo. https://doi.org/10.5281/zenodo.17176611

La Notte, A., and Rhodes, C. (2020). The theoretical frameworks behind integrated environmental, ecosystem, and economic accounting systems and their classifications, *Environmental Impact Assessment Review*, 80, 106317, JRC116799. Lepawsky, J., and Mcnabb, C. (2010). Mapping international flows of electronic waste. *The Canadian Geographer*, 54, 177-195.

Li, Y., Chang, Q., Luo, Z., Zhang, J., Liu, Y., Duan, H., Li, J. (2020). Transfer of POP-BFRs within e-waste plastics in recycling streams in China. *Science of The Total Environment.* 717 (135003).

Liu, W., Ford, P., Uvegi, H., Margarido, F., Santos, E., Ferrão, P., Olivetti, E. (2019). Economics of materials in mobile phone preprocessing, focus on non-printed circuit board materials. *Waste Management, 87*, 78-85.

Lydall, M., Nyanjowa, W., James, Y. (2017). Mapping South Africa's Waste Electrical and Electronic Equipment (WEEE) Dismantling, Pre-Processing and Processing Technology Landscape, Mintek.

Magalini, F., Huisman, J., Wang, F. (2012). Household WEEE Generated in Italy, analysis on volumes & consumer disposal behavior for Waste Electrical and Electronic Equipment. Ecodom.

Magalini, F., Wang, F., Huisman J., Kuehr, R., Baldé K., v. Straalen, V., Hestin, M., Lecerf L., Sayman, U., Akpulat, O. (2014). Possible measures to be initiated by the commission as required by article 7(4), 7(5), 7(6) and 7(7) of directive 2012/19/eu on waste electrical and electronic equipment (weee).

Medina, M. (2007). *The World's Scavengers: Salvaging for Sustainable Consumption and Production.* Lanham, MD: AltaMira Press (series: Globalization and the Environment).

Murakami, S., Oguchi, M., Tasaki, T., Daigo, I., Hashimoto, S. (2010). Lifespan of Commodities, Part I. *Journal of Industrial Ecology, 14:* 598-612.

National Bureau of Statistics and United Nations University, ViE - SCYCLE (2019). National E-Waste Statistics Report 2019. National Bureau Statistics, Dodoma, Tanzania, United Nations University, ViE - SCYCLE, Bonn, Germany.

Norwegian Environment Agency (2021). Environmental Pollutants in Post-Consumer Plastics. Fraunhofer and Rambol report for the Norwegian Environment Agency, Case Number M-2059j2021.

Odeyingbo, O., Nnorom, I., Deubzer, O. (2017). Person in the Port Project: Assessing Import of Used Electrical and Electronic Equipment into Nigeria. UNU-ViE SCYCLE and BCCC Africa.

Odeyingbo, O., Baldé, C.P., Forti, V. (2022). Effect of a modified lifetime model on e-waste generation in Nigeria under defined reuse options. *African Journal of Environmental Science and Technology, 16(6):* 192-206.

Oguchi, M., Murakami, S., Tasaki, T., Daigo, I., Hashimoto, S. (2010). Lifespan of Commodities, Part II. *Journal of Industrial Ecology, 14:* 613-626.

Open Data Charter (2015). International Open Data Charter. Retrieved from: https://opendatacharter.org/principles/ (Accessed August 10, 2024).

Open Repair Alliance (2022). ORDS product category UNU-KEY map. Retrieved from: https://github.com/openrepair/tools/blob/355f1389f6a27bdbfe9001b39ca0175e93926b11/dat/ords_product_category_unu_key_map.csv. (Accessed December 14, 2024).

Open Repair Alliance (2024). ORDS-Extra. Retrieved from: https://github.com/zenlan/ords-extra/tree/main. (Accessed December 14, 2024).

Organisation for Economic Co-operation and Development (OECD) (2008). Measuring Material Flows and Resource Productivity Volume I. The OECD Guide.

Organisation for Economic Co-operation and Development (OECD) (2014). *Understanding National Accounts: Second Edition.* Paris: OECD Publishing.

Organisation for Economic Co-operation and Development (OECD) (2024). *Monitoring Progress towards a Resource-Efficient and Circular Economy*, OECD Publishing, Paris.

Panchal R. and Baldé C.P. (2021). Electrical and Electronic Equipment Placed on Market Tool for Photo Voltaic Panels Manual. United Nations University and United Nations Institute for Training and Research (UNITAR) - co-hosting the SCYCLE Programme, Bonn, Germany.

PGE (2017). Guidelines for the transboundary movement of used electrical and electronic equipment (UEEE) in Malaysia.

Prakash, S., Dehoust, G., Gsell, M., Schleicher, T. (2020). Influence of the service life of products in terms of their environmental impact: Establishing an information base and developing strategies against "obsolescence." German Environment Agency.

Rincon-Aznar, A., Riley, R., Young, G. (2017). Academic Review of Asset Lives in the UK.

Schluep, M., Hagelueken C., Kuehr, R., Magalini F., Maurer, C., Meskers, C., Muller, E., Wang, F. (2009). Recycling: From e-waste to resource, United Nations Environmental Program (UNEP) and Solving the E-waste Problem Initiative (StEP).

Sindiku, O., Babayemi, J.O., Tysklind, M., Osibanjo, O., Weber, R., Schlummer, M., Lundstedt, S. (2015). Polybrominated Dioxins and Furans (PBDD/Fs) in e-waste plastics in Nigeria. Environ Sci Pollut Res Int. 22, 14462-14470.

Step Initiative (2014). Solving the E-Waste Problem (Step) White Paper, One Global Definition of E-waste. Bonn, Germany.

Stowell, A., Yumashev, D., Schaer, O., Silva, C. (2020). Second-hand EEE flows and the implications for the UK. Lancaster University.

Taverna, R., Gloor, R., Zennegg, M., Birchler, E. (2017). Stoffflüsse im Schweizer Elektronikschrott. Umwelt-Zustand Report for the Swiss Federal Office for the Environment, Vol. 1717, p. 164.

Tanzania Communications Regulatory Authority (TCRA). *Communications Statistics Report* - Quarter Ending September 2025. Dar es Salaam: TCRA.

Thiébaud (-Müller), E., Hilty, L., Schluep, M., Widmer, R., Faulstich, M. (2017). Service Lifetime, Storage Time, and Disposal Pathways of Electronic Equipment: A Swiss Case Study. *Journal of Industrial Ecology.* 22.

UK Department for Energy Security and Net Zero (DESNZ) (2023). ECUK 2023: Electrical products data tables (Excel). Retrieved from: https://www.gov.uk/government/statistics/energy-consumption-in-the-uk-2023. (Accessed July 20, 2024).

United Nations, European Commission, Food and Agricultural Organization of the United Nations, International Monetary Fund, Organization for Economic Co-operation and Development, World Bank. (2017). *System of Environmental-Economic Accounting 2012.* USA: United Nations.

United Nations Conference on Trade and Development (UNCTAD) (2023). Trade in ICT goods statistics: Impacts of the 2022 update to the Harmonized Commodity Description and Coding System. UNCTAD Technical Notes on ICT for Development No. 20.

United Nations Conference on Trade and Development (UNCTAD) (2024). Digital Economy Report. UNCTAD/DER/2024.

United Nations Economic Commission for Europe (UNECE) (2020). United Nations Framework Classification for Resources Update 2019. ECE ENERGY SERIES No. 61.

United Nations Economic Commission for Europe (UNECE) (2021). In-depth Review of Measuring Circular Economy. Economic Commission for Europe Conference of European Statisticians. ECE/CES/2021/8. Geneva, Switzerland.

United Nations Economic Commission for Europe (UNECE) (2022a). Guidance for the Application of the United Nations Framework Classification for Resources (UNFC) for Mineral and Anthropogenic Resources in Europe. UNFC Guidance Europe.

United Nations Economic Commission for Europe (UNECE) (2022b). Conference of European Statisticians Framework on Waste Statistics.

United Nations Economic Commission for Europe (UNECE) and Organisation for Economic Co-operation and Development (OECD) (2024). The Guidelines for Measuring Circular Economy (Part A: Conceptual Framework, Indicators and Measurement Framework).

United Nations Environment Programme (UNEP) (2011). Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers.

United Nations Environment Programme (UNEP) (2021). Global Chemicals and Waste Indicator Review Document. Nairobi.

United Nations Environment Programme (UNEP) (2021). Draft guidance on preparing inventories of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants. Secretariat of the Basel, Rotterdam and Stockholm conventions, United Nations Environment Programme, Geneva.

United Nations Environment Programme (UNEP) (2024). *Report on the evaluation and review of brominated diphenyl ethers pursuant to paragraph 2 of parts IV and V of Annex A to the Stockholm Convention.* Note by the Secretariat. UNEP/POPS/COP.12/INF/13. Geneva.

United Nations Environment Programme (UNEP) International Environmental Technology Centre (2016). *Study on E-Waste Management in ASEAN Countries.*
UN HABITAT (2010). Solid Waste Management in the World's Cities: Water and Sanitation in the World's Cities 2010. London & Washington, DC: Earthscan for United Nations Human Settlements Programme. ISBN 978 1849711708.

Van Straalen V.M., Forti V., Baldé C.P. (2017). Waste over Time - World [computer software]. The Hague, The Netherlands: Statistics Netherlands (CBS). Retrieved from: https://github.com/Statistics-Netherlands/ewaste. (Accessed April 10, 2024).

Vermeșan, H., Tiuc, A. -E., Purcar, M. (2020). Advanced Recovery Techniques for Waste Materials from IT and Telecommunication Equipment Printed Circuit Boards. *Sustainability*, 12(1), 74.

Wäger, P., Schluep, M., Mueller, E. (2010). RoHS substances in mixed plastics from Waste Electrical and Electronic Equipment. St.Gallen / Switzerland: Empa, Swiss Federal Laboratories for Materials Science and Technology.

Wäger, P., Hischier, R., Eugster, M. (2011). Environmental impacts of the Swiss collection and recovery systems for Waste Electrical and Electronic Equipment (WEEE): A follow-up. *The Science of the Total Environment.* 409. 1746-56.

Wagner, M., Baldé, C.P., Luda, V., Nnorom, I.C, Kuehr, R., Iattoni, G. (2022). Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn, Germany.

Wang, F., Huisman J., Meskers C.E., Schluep M., Stevels A., Hagelüken, C. (2012a). The Best-of-2-Worlds philosophy: Developing local dismantling and global infrastructure network for sustainable e-waste treatment in emerging economies. Waste Management 32(11): 2134 - 46.

Wang, F., Huisman, J., Baldé, K., Stevels, A. (2012b). A systematic and compatible classification of WEEE. In Electronics Goes Green, Berlin, Germany.

Wang, F., Huisman, J., Stevels, A.L.N., Baldé, C.P. (2013). Improving estimation of e-waste generation with advanced Input-Output Analysis, Waste Management, 33(11), 2397-2407.

Weber, R., Kuch, B. (2003) Relevance of BFRs and thermal conditions on the formation pathways of brominated and brominated-chlorinated dibenzodioxins and dibenzofurans. Environment International 29, 699-710.

Wielenga, K., Huisman, J. and Baldé, C. P. (2013). (W) EEE Mass balance and market structure in Belgium study for Recupel, Brussels, Belgium, Recupel.

Wang, F. (2014). E-waste: collect more, treat better; Tracking take-back system performance for eco-efficient electronics recycling. PhD Dissertation.

Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data 3,* 160018.

Williams, I. D., Kahhat, R., Allenby, B., Kavazanjian, E., Kim, J., & Xu, M. (2008). Environmental, social, and economic implications of global reuse and recycling of personal computers. *Environmental Science & Technology,* 42(17), 6446 6454.

World Bank (2024). Digital Progress and Trends Report 2023. Washington, DC: World Bank. License: Creative Commons Attribution CC BY 3.0 IGO.

World Health Organisation (WHO) (2023). Electronic waste (e-waste). Retrieved from: https://www.who.int/news-room/fact-sheets/detail/electronic-waste-(e-waste) (Accessed August 23, 2024).

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, UNITAR, the World Bank, the UN Department of Economic and Social Affairs (UN-DESA), the Secretariat of the BRS Conventions, 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 on Measuring ICT for Development Steering Committee is composed of ITU, UNCTAD, and UNECLAC.

The overall objective of the Task Group on Measuring E-Waste is 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 Task Group developed a framework for monitoring e-waste based on internationally defined indicators and helping countries produce reliable and comparable e-waste statistics.

PARTNERSHIP ON
MEASURING ICT
FOR DEVELOPMENT

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e-waste statistics

guidelines on classifications, reporting and indicators

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