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Towards the harmonization of data collection

A baseline study for e-waste in East Africa

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Africa region

Towards the harmonization of data collection

A baseline study for e-waste in East Africa

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Foreword

Great strides have been made in East Africa to improve the management of e-waste and to harmonize approaches to e-waste statistics and data collection. The EACO Regional E-waste Strategy 2022 – 2027 lays out a strategic plan designed to improve the harmonization of efforts to tackle e-waste in the region. In any country or region, monitoring quantities and flows of e-waste is essential for evaluating developments over time, and to set and assess targets towards a sustainable society and circular economy. The deployment of the UNITAR statistical tools that help calculate the amount of equipment being placed on the market and estimate the amount of e-waste being generated, using the UNU-Keys and the standardised six categories of e-waste, can assist countries to develop a baseline for further detailed research and ultimately begin monitoring quantities and flows of e-waste. Household and business surveys can provide additional detail to inform e-waste monitoring activities. The monitoring of e-waste is essential for developing more effective legislation as the amount of e-waste continues to increase globally.

Information and communication technologies (ICTs) are critical development tools. Infrastructure and technological advancement and innovation have created new opportunities for global connectivity. As a result, more people, especially in rural and previously unconnected areas, have access to the Internet. In many areas, mobile-cellular and broadband networks and services have expanded rapidly. Higher levels of disposable income, urbanization, and industrialization in many countries are leading to growing amounts of throw-away ICT devices, and consequently to waste electrical and electronic equipment or e-waste. E-waste refers to electrical or electronic equipment (EEE), which has reached the end of its useful life, including all components, sub-assemblies and consumables that are part of the equipment at the time of discarding. The price of equipment, such as computers, peripheral equipment, TVs, laptops, printers, and mobile handsets is dropping whilst other trends concerning EEE are rising such as multiple device ownership, the electrification of traditionally non-electrical equipment, growth in cloud computing services and data centres, and shorter and shorter replacement cycles for EEE.

Despite huge technological gains, the environmental, social, and economic implications of the global take-make-dispose model are unanswered by many policy-makers, especially in emerging markets. Discarded equipment such as phones, air conditioning units, fans, fridges, PCs, TVs, laptops, and sensors contain substances that pose considerable risks to society and the environment. As most e-waste is neither properly documented nor managed through the appropriate collection or recycling channels, inadequate methods are exacerbating environmental degradation and damage to human health. The development of recycling infrastructure, sound policies, and legal instruments are more efficiently implemented on the basis of sound e-waste data.

Building on the partnership on measuring ICT for development, in 2017, the International Telecommunication Union (ITU) and the United Nations Institute for Training and Research (UNITAR), joined forces to create the Global E-waste Statistics Partnership as a way of addressing the challenges associated with managing e-waste. The partnership helps countries enhance their understanding and interpretation of e-waste data and improve the quality of e-waste statistics by guiding stakeholders and building capacity through e-waste statistics training. All data globally is made publicly available via its open-source global e-waste database,

www.globalewaste.org. Since 2017, the partnership has made substantial efforts by expanding national and regional capacity on e-waste statistics in various countries.

This baseline for e-waste in East Africa, towards the harmonization of data collection, introduces the mixed use of tools and surveys to apply a harmonized approach to collecting data and statistics on e-waste, at the East Africa regional level.

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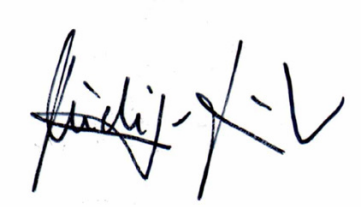

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Abbreviations

Abbreviations	Meaning
CAPI	Computer assisted personal interview
CATI	Computer assisted telephonic interviews
EEE	Electrical and electronic equipment
EACO	East African Communications Organisation
EPR	Extended producer responsibility
EU	European Union
GESP	Global E-waste Statistics Partnership
GLICE	Great Lakes Initiative for Communities Empowerment
HS	Harmonized System
ICT	Information and communication technologies
IT	Information technology
ITU	International Telecommunication Union
kt	Kilotonne
LCD	Liquid crystal display
LED	Light emitting diode
Mt	Megatonnes
NGO	Non-governmental organization
PC	Personal computer
POM	Put-on-the-market
TV	Television
UNITAR	United Nations Institute for Training and Research
WEEE	Waste Electrical and Electronic Equipment

Executive Summary

This collaborative study between the International Telecommunication Union (ITU) and the United Nations Institute for Training and Research Sustainable Cycles Programme (UNITAR-SCYCLE) aims to improve the quality, collection, and interpretation of e-waste data in East Africa. The six countries in focus are Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda.

Countries in East Africa have taken various steps forward to address the issues of e-waste management. The region as a whole is covered by the *Regional E-waste Management Strategy 2022-2027* developed by East African Communications Organisation (EACO). The countries in the region are gradually developing and approving e-waste policies and regulations to overcome issues such as low formal collection and recycling rates.

This policy-level progress has made the need for better data and statistics as important as ever. Moreover, the coverage of the region by a regional strategy has established solid foundations upon which to build when harmonizing the methods used to collect e-waste data and statistics, including through household and business surveys as piloted in this study.

This baseline study uses two approaches to collect data through an internationally adopted methodology: The first approach used calculates data about electrical and electronic equipment (EEE) put on the market (POM) in each country (imports minus exports plus domestic production), and the amount of e-waste being generated. This exercise was performed by country representatives using national data. The second approach collects data through the distribution of household and business surveys in Burundi and Kenya. Both data sets together contribute to greater clarity in comparability among countries in East Africa. In addition to collecting quantitative information about EEE stocks, the household and business surveys help to provide insights into the disposal habits of households and businesses, as well as qualitative information such as consumer behaviour towards environmentally sound management of e-waste.

This study provides a general insight – as a baseline for further detailed research – into the methodology deployed and the results found from pilot household and business surveys undertaken in Kenya and Burundi. These have been complemented by further statistical work using the EEE POM Tool and the E-waste Generated Tool, in collaboration with stakeholders in these two countries and in the other five countries of the region. The EEE POM Tool and the E-waste Generated Tool are Microsoft Excel-based tools that help the responsible waste statistics agencies to estimate the amount of e-waste being generated. The EEE POM Tool helps the user to prepare, adjust and convert the available country data on EEE put on the market (POM) before using that data in the E-waste Generated Tool. It is pre-populated with UNITAR datasets of EEE POM and replaced with national data where available. This data includes a long time-series of EEE import and export data in weight (kilogrammes) or number of units that is aggregated by year and Harmonized System (HS) codes (a standardized numerical method of classifying traded products). If available, domestic production data is also inserted into the tool. The tool converts the inserted import/export data to weight. The E-waste Generated Tool is an integral part of the methodology and is then used to calculate the total quantity of e-waste generated each year in a specific country based on the amount of EEE POM in the preceding years and the corresponding lifespan of a harmonized list of products, called UNU-Keys that

classifies EEE into 54 products. This E-waste Generated Tool will output the results in relation to six e-waste categories. Further information on the tools is provided in section 2.1.4.

The household surveys conducted in Burundi and Kenya revealed that higher possession rates apply to mobile phones; indeed, 96 per cent of the Burundi households interviewed possess at least one mobile phone. This trend is in line with the findings from Kenya household surveys (98%). The surveys also sought responses regarding the most common disposal routes for EEE. Fridges, for example, are usually brought to an e-waste collection centre or to a county designated drop off point (20% of the total) or they are picked up from home by the companies that sold the product to households in Kenya (30%), the latter disposal route is not used in the case of small household equipment as most is disposed together with mixed residual solid waste (31%) or it is sold to a refurbishment or repair shop in Kenya (33%). Compared to the results in Kenya, less equipment in Burundi is picked up from home by the company that sold the product. In addition, there is no evidence of equipment being collected, less seems to be sold online or donated, and more households reported to be unaware of disposal routes or to be still in possession of the product.

The usage of the EEE POM and e-waste generated tools by the representatives of the countries participating in the project revealed that EEE POM in East Africa has been rising rapidly in the past years, hitting 170 kilotonnes (kt) in 2021. The rapid increase of EEE POM has caused an increase of e-waste generated in the region, which reached 128 kt in 2021. The rapid increase of e-waste generated represents a challenge in a region where the availability of e-waste recycling infrastructure is limited. The only formal e-waste recycling facility in the region is located in Rwanda, with a capacity of approximately 7 kt per year, and e-waste that is not formally collected and recycled is mainly managed by the informal sector.

This study sets out a brief evaluation and recommendations. Regular updates of the national e-waste statistics are necessary, this can be achieved by updating the tools with new trade and production data as they become available. Updated e-waste statistics and awareness raising through statistical findings will serve as a useful basis for policy making. Additionally, it is recommended to expand the coverage of household and statistical surveys in future studies because the sample was too limited in this project to extrapolate data at country or regional levels.

With better coverage, data from household or business surveys could be used to complement e-waste statistics, adding to the estimation of EEE stocks and enabling modelling of EEE POM and e-waste generated based on those estimations.

1 Introduction

1.1 What is electrical and electronic equipment and e-waste?

Electrical and electronic equipment (EEE) is a term used to define products that have circuitry or electrical and electronic components that need a power or battery supply in order to perform their functions. EEE includes almost any such products available in households and businesses – including laptops, mobile phones, fridges, washing machines, dishwashers, cooking and kitchen appliances.

E-waste refers to all EEE and its parts that have been discarded by their owner as waste without the intent of reuse.[1] Each type of e-waste has a specific size, hazardous components, and valuable materials that affect the way it must be formally collected, treated, recycled, or disposed of in an environmentally sound manner. E-waste can be categorised in different ways, including by product type or size. The *European Union Directive 2012/19/EU on Waste Electrical and Electronic Equipment*[2] and the *E-waste Statistics: Guidelines for Classification, Reporting and Indicators*[3] use a treatment-oriented categorization, with six main categories as indicated in Figure 1.

Figure 1: Categories of electrical and electronic equipment

	1. Temperature exchange equipment, including fridges, freezers, air conditioners, and heat pumps.
	2. Screens and monitors, comprising liquid crystal display (LCD) and light emitting diode (LED) televisions and monitors, laptops, and tablets.
	3. Lamps, including LED lamps, high-intensity discharge lamps, and compact and straight tube fluorescent lamps.
	4. Large equipment, including products such as dishwashers, washing machines, ovens and central heating systems, large printing systems, and photovoltaic panels.
	5. Small equipment, comprising microwaves, grills and toasters, personal care products, speakers, cameras, audio sets and headphones, toys, household tools, and medical and monitoring systems.
	6. Small IT and Telecommunication equipment, including desktop personal computers, printers, mobile phones, cordless phones, keyboards, routers, and consoles.

[1] Step. (2014). Solving the E-waste Problem (Step) White paper. One Global Definition of E-waste. https://www.stepinitiative.org/files/_documents/whitepapers/StEP_WP_One%20Global%20Definition%20of%20E-waste_20140603_amended.pdf

[2] The European Parliament and the Council of the European Union. (2012). Official Journal of the European Union. Directive 2012/19/EU of 4 July 2012 on waste electrical and electronic equipment (recast). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0019&from=EN

[3] Forti, V., Baldé C.P, and Kuehr, R. (2018). E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. United Nations University, ViE – SCYCLE, Bonn, Germany. https://www.itu.int/en/ITU-D/Climate-Change/Documents/2018/EWaste_Guidelines_final.pdf

Rudimentary treatment of e-waste can result in serious negative environmental impacts and can pose a risk to human health. Many countries have realized the long-term effects that poor e-waste management can have on human health and the environment, as well as the potential economic impact if the value of this waste stream is not retained. As a result, governments around the world are increasing their efforts to collect better data in order to fully assess the magnitude of the e-waste challenge at the national level. At the same time, governments are also developing stronger legal frameworks in order to better regulate the environmentally sound management of this complex waste stream.

Monitoring the global quantities and flows of e-waste is difficult because not all countries are using the internationally adopted measurement methodology. This means that any national monitoring activities are potentially lacking harmonization with other national approaches, which is particularly pronounced at the regional or sub-regional levels such as in East Africa. With increasing economic and technological development, dependence and rapid obsolescence of electronics is increasing. This makes e-waste one of the world's fastest-growing domestic waste stream. Containing rare-earth and other metals, it is also one of the most valuable waste streams per volume.

The East African Communications Organisation (EACO) has developed a *Regional E-waste Management Strategy 2022-2027*.[4] The goal of the strategy is to achieve a sustainable e-waste management system in East Africa's EACO Member States, and a harmonized monitoring framework for e-waste management. The EACO Member States comprise Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda. This baseline study is a deliverable of the East Africa Regional E-waste Data Harmonization project.[5] The overall aim of the technical assistance was to support the relevant strategic actions of the Regional E-waste Management Strategy, notably to track progress and its achievements and to harmonize the collection of e-waste data regionally, eventually helping to sustain a central database within the secretariat of EACO. The overall project and this baseline study were conducted in under the structure of the EACO Working Group 7 on E-waste Management and Green ICTs. Currently, the six Member States of EACO currently do not institutionally collect data and statistics related to e-waste in a harmonized manner across the sub-region and there are differing categorizations of EEE and e-waste in each country. There is no collection of long-time series of e-waste data and no national baseline in each country, nor is there any regional baseline for e-waste generated. Monitoring the quantities and flows of e-waste in the sub-region will be essential to evaluate developments over time and to set and assess targets towards a sustainable society and circular economy – all of which require a regionally harmonized and economically integrated approach by the countries of the East Africa bloc. In an effort to catalyze a regional approach, EACO has recently established a central databank to support the regional ICT policy development agenda and other ICT initiatives through the sharing of regional data and statistics with other stakeholders in East Africa and beyond. EACO also aims to eventually store and track e-waste data and statistics as part of this databank.

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4 East Africa Communications Organisation. (2022). Regional E-waste Management Strategy 2022 – 2027. EACO Working Group 07 on E-waste Management and Green ICTs. https://www.eaco.int/admin/docs/publications/EACO%20Regional%20E-waste%20Management%20Strategy%202022-2027.pdf

5 International Telecommunication Union. (2022). EACO Regional E-waste Data Harmonization. https://www.itu.int/en/ITU-D/Environment/Pages/Spotlight/E-waste-EACO.aspx

1.2 E-waste management in East Africa

Globally, e-waste generation rates are varying geographically. In 2019, Africa generated 2.9 million tonnes (Mt) of e-waste. As in other parts of the world, e-waste generation in the East Africa countries of Burundi, Kenya, Rwanda, South Sudan, Tanzania and Uganda is also increasing. In Africa as a whole, there are several countries covered by an e-waste legislation, policy or regulation.[6] In East Africa, these are Tanzania, Rwanda and Uganda. There is a national e-waste strategy and guidelines in Kenya and a draft regulation. In Uganda there is a national e-waste policy in place and in Rwanda and Tanzania there are regulations and standards in place relating to e-waste. Tanzania has general environmental management regulations in place that refer to certain restrictions on e-waste whilst Rwanda has a regulation in place dedicated to governing e-waste management. Rwanda has a second regulation, in draft form, which is expected to put forward provisions relating to governing EEE being put on the market in the context of the registration of importers with a view to incorporating extended producer responsibility (EPR) in business operator licensing. Thanks to recent support through a project with ITU, the Government of Burundi is also in the approval stages of establishing a national e-waste management policy.

One of the growing topics of discussion in East Africa when it comes to e-waste management is the growth and integration of e-waste collection and recycling infrastructure and networks and the incorporation of the EPR principle into national regulation whereby the 'producers' (e.g. importers, manufacturers, distributors, resellers) are obliged to take physical and/or financial responsibility over the post-consumer phase of the equipment which they put on the market in East African countries.

In recent years, some East Africa countries have begun to establish collection, recycling and repair services. Created in 2010, the Burundi-based Great Lakes Initiative (GLICE) is a non-profit association promoting the reduction of the digital and energy divide while protecting the environment. GLICE Burundi is establishing services for collecting e-waste. In Kenya, the WEEE Centre which was established in 2012 offers training and disposal services for e-waste whilst in Rwanda the Enviroserve Rwanda Green Park is dedicated to e-waste dismantling and recycling. There is minimal harmonization when it comes to the categorisation of EEE across East Africa countries. Appendix B of the 2012 Electronic Waste (E-waste) Management Policy for Uganda categorizes EEE across seven groups whilst Annex A of the Regulation No002 of 26/04/2018 on Governing E-waste Management includes 13 categories of EEE. Identical to those in Rwanda, Schedule 5 of the draft Kenya Environmental Management and Co-ordination (E-waste Management) Regulations, 2013, includes 13 EEE categories.

This baseline study demonstrates a strong level of local ownership of the e-waste challenge, spearheaded at the East Africa regional level by EACO. It also demonstrates a significant level of sustainability in the collaboration among EACO, ITU and the United Nations Institute for Training and Research (UNITAR), as it is a direct follow up to the previous capacity building activities and workshops where assistance has been provided by the partners to help track and monitor e-waste in the region, particularly during a regional workshop in 2019. During the workshop, all six East Africa countries developed a short and succinct roadmap aimed towards collecting e-waste data and statistics, soliciting improvements and conducting this in a harmonized manner.

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[6] Forti, V., Baldé, C., Kuehr, R., Bel, G. (2020). The Global E-waste Monitor 2020. UNU/UNITAR and ITU. https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf

A clear demand has been demonstrated by the national e-waste committee focal points from Kenya, Rwanda, South Sudan, Tanzania and Uganda to develop harmonized household and business surveys, and to integrate these within the international statistical methods and customized e-waste tools developed by UNITAR, to support the development of a regional e-waste inventory to help inform policymakers, producers and e-waste managers.

The region has a great potential to utilize the e-waste sector for economic development as well as minimizing the environmental and health consequences it has on the community. An effective and established e-waste management system generates green jobs, adding to the economic value of the sector. The two conventions regulating e-waste in Africa are the Basel Convention and Bamako Convention. E-waste management in Africa is dominated by thriving informal sector collectors and recyclers in most countries; neither organized take-back systems nor licence provisions for sorting and dismantling e-waste exist. Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda have adopted a regional e-waste strategy to achieve a sustainable e-waste management system. The strategy prioritizes a) strengthening the policy, legal, and regulatory framework for sustainable resourcing of e-waste management, b) putting in place the requisite e-waste management infrastructure, c) establishing mechanisms for comprehensive and sustainable mobilization for e-waste management resources, d) strengthening e-waste coordination structures at regional and national levels, and e) promoting research and innovation in e-waste management. An updated strategy will be adopted in 2023.

Table 1: Overview of the status of e-waste policy and regulation in East Africa

Country	Instrument	Description
Burundi	*La Politique Nationale de Gestion des Déchets d'Equipements Electriques et Electroniques au Burundi.*	A draft national policy on WEEE management is under development since spring 2022. The first part of the policy argues in favor of its utility and explains its methodology. The second part describes the initiatives existing in Burundi linked to e-waste management. The third part traces the main vision and mission and the goals of the policy. These elements are phrased as goals and call for the implementation of an institutional framework around e-waste management within the country. The custodian and implementing authorities are both within the Ministry of Environment of Burundi.

Table 1: Overview of the status of e-waste policy and regulation in East Africa (continued)

Country	Instrument	Description
Kenya	*Environment Management and Co-Ordination (Extended Producer Responsibility) Draft Regulations.*	Under development since 2020, the regulations provide extended producer responsibility for all products and packaging in all phases of their life cycle to enhance environmental sustainability.
	Environment Management and Co-Ordination (E-Waste Management) Draft Regulations.	Under development since 2013, the regulations will provide an appropriate legal and institutional framework and mechanisms for the management of e-waste handling, collection, transportation, recycling and safe disposal.
	National E-waste Draft Strategy, 2019.	The strategy guides stakeholders in the concerted efforts in sustainable management of E-waste in the country and hence build synergy among the various players.
	E-Waste Management Guidelines, 2010.	The guidelines apply to the handling and management of the various categories and elements of e-waste in Kenya. The guidelines provide a clear mechanism for the management of e-waste at various stages in the supply chain, the objective being to ensure the integrity of the environment is assured against the potential impacts of e-waste and its elements.
	National Sustainable Waste Management Policy, 2021.	The policy requests the adoption of 5-year waste management plans and the adoption of green public procurement measures around waste.
Rwanda	*Regulation on Governing E-waste Management in Rwanda, 2018.*	The regulation covers the licensing of e-waste management companies and the EPR obligations of EEE producers.
	National E-waste Policy, 2015.	The policy provides comprehensive guidance for the efficient and effective management of e-waste through appropriate legal, regulatory instruments, which promote green growth and ensure a sustainable economic development for the country.
South Sudan	Not available.	Not available.

Table 1: Overview of the status of e-waste policy and regulation in East Africa (continued)

Country	Instrument	Description
Tanzania	*Solid Waste Management Regulations, 2009.*	The regulations provide the general regulatory framework around solid waste in the country and refer to the principle of EPR.
	Hazardous Waste Control and Management Regulations, 2008.	The regulations apply to all categories of hazardous waste and to the storage and disposal of hazardous waste and their movement into and out of Tanzania and refer to EPR.
	Electronic and Postal Communications (Electronic Communications Equipment Standards and E-waste Management) Regulations, Government Notice No. 919, 2020.	The regulations apply to electronic communications equipment imported or manufactured for use for connection to any electronic communications network for the purpose of receiving or transmitting electronic communication signals.
	Guidelines for Hazardous Waste Management, 2013.	The guidelines cover hazardous waste management hierarchy, a brief overview of hazardous waste management practices in the country, legal framework as well as roles and responsibilities of different stakeholders; guidelines on management of hazardous waste during segregation, storage, packaging, labelling, transportation, treatment and disposal; and administrative procedures for trans-boundary movements of hazardous waste.
Uganda	*National Electronic Waste Management Policy, 2012.*	Presents the vision of Uganda in e-waste. It also elaborates the mission, goal, policy objectives and strategies in considerable detail. It includes an institutional framework, as well as a monitoring and evaluation arrangement for its implementation.
	National E-waste Strategy, 2014.	The strategy provides an all-encompassing plan for implementing the e-waste policy, detailing the costs, time frames, targets, outputs and outcomes, and refers to EPR.

End-of-life options for EEE can include reuse, repair, refurbishing, repurposing of parts into other products, recycling and resource recovery, landfill (both controlled disposal and sanitary engineered landfilling), incineration uncontrolled and indiscriminate dumping and littering. Within Africa, most of these options are utilized - dictated by infrastructure, markets, and value items. The transport of used EEE and e-waste to Africa, has resulted in an informal, yet important industry, with far-reaching consequences. Used EEE, and repairable EEE, have permitted individuals and companies to buy inexpensive and vital electronics or IT equipment, helping socioeconomic development. Informal e-waste recycling provides a major source of livelihood for many communities across the region.

1.3 Scope and objectives

This baseline study is the result of a collaboration between ITU and the UNITAR Sustainable Cycles Programme with EACO. ITU and UNITAR are the founding partners of the Global E-waste Statistics Partnership (GESP), which aims to monitor developments of e-waste over time and to help countries to produce e-waste statistics.[7] The objective of this baseline study is to improve the quality, collection and interpretation of e-waste data using an internationally adopted methodology and to produce survey data to complement the supply data provided by the E-waste Statistics Toolkit, whilst also providing insights into household size, income levels, the product lifetime and how products may be disposed of by households and businesses.

It is expected that this data will help to improve comparability among countries. It is highly desirable to have a sound measurement framework that can integrate existing harmonized data and can serve as the basis for e-waste statistics and e-waste indicators. Measuring e-waste is an important step towards addressing the e-waste challenge since statistics help to evaluate developments over time, set and assess targets, and identify best practices for policies. This study also supports strategic actions of the *EACO Regional E-waste Management Strategy 2022-2027*, notably to track progress and its achievement and to harmonize the collection of e-waste data regionally.

The aim of the surveys was to understand EEE stocks and disposal from households and businesses in the region. The surveys were piloted in Burundi and Kenya with a small sample in accordance with the budget limitations of the project. To implement an effective e-waste management plan, these surveys aimed to collect consumer behaviour towards the environmentally sound management of e-waste. Survey questions paid attention to recipients' behaviour when discarding EEE, the reasons why they would discard this equipment, and their possession of EEE. Stock levels of appliances in households and businesses are generally unavailable, especially when levels are measured in a harmonized manner.

[7] The Global E-waste Statistics Partnership. (2023). About Us. https://globalewaste.org/about-us/

2 Methodology

2.1 Household and business surveys

The surveys were piloted in Kenya and Burundi with the aim to obtain the following information:

- the possession rates of EEE in households and businesses;
- an understanding of consumers' behaviour towards discarding e-waste;
- to identify the main disposal routes for e-waste.

2.1.1 Survey questionnaire design

A standard baseline survey for households and businesses was developed for this study with a period of review and validation with all six countries prior to implementation in Burundi and Kenya. The questions and the product scope were carefully designed to obtain the necessary information to draw the profiles of both countries. A harmonized list, called UNU-Keys classifies EEE into 54 products.[8] The surveys were conducted only on a subset of this full list to reduce the complexity as well as to avoid asking questions concerning items that are unlikely to be owned by either the households or the businesses in question. Therefore, a total of 18 UNU-Keys were selected for the surveys, it should be noted that some of the UNU_KEYS descriptions have been adapted to the context of the countries and therefore they may present small variations compared to those in the E-waste Statistics Guidelines.[9] The survey builds on UNITAR experience in Lebanon where a household survey was conducted in 2021 on 25 UNU_KEYs.[10] Since the 8th Meeting of the ITU Expert Group on ICT Household Indicators (EGH) in September 2020, a sub-group was created to address the measurement of e-waste in households via surveys, where the group has been working to discuss measurement methods and develop an e-waste survey. Based on experience from this baseline study, the GESP have been contributing to the development of the survey based on experience from this East Africa study – the final survey will be presented at the 2023 EGH meeting.

8 Forti, V., Baldé C.P, and Kuehr, R. (2018). E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. United Nations University, ViE – SCYCLE, Bonn, Germany. https://www.itu.int/en/ITU-D/Climate-Change/Documents/2018/EWaste_Guidelines_final.pdf

9 Forti, V., Baldé C.P, and Kuehr, R. (2018). E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. United Nations University, ViE – SCYCLE, Bonn, Germany. https://www.itu.int/en/ITU-D/Climate-Change/Documents/2018/EWaste_Guidelines_final.pdf

10 Baldé C.P., Panchal R., Forti V. (2022). National E-waste Monitor for Lebanon 2022. United Nations Institute for Training and Research (UNITAR), Bonn, Germany. https://ewastemonitor.info/wp-content/uploads/2022/05/Lebanese-National-E-waste-Monitor-220526-UNITAR.pdf

Table 2: The 18 UNU-Keys covered by the household and businesses surveys

0108	Fridges [including combi-fridges]
0109	Freezers
0111	Air conditioners [household installed and portable]
0303	Laptops [including. tablets]
0309	Flat display panel monitors for computers [LCD/LED]
0408	Flat display panel televisions [LCD/LED/plasma]
0103	Kitchen equipment [e.g. large furnaces/ovens/cooking equipment – electrical]
0104	Washing machines [including. combined dryers]
0105	Dryers [wash dryers/centrifuges]
0114	Microwaves [including combined excluding grills]
0202	Equipment for food preparation [e.g. toaster/grills/food processing/frying pans] excluding hot water preparation
0304	Small household equipment for hot water preparation [e.g. coffee/tea/water cookers]
0204	Vacuum cleaners [excluding. professional]
0205	Personal care equipment [e.g. toothbrushes/hair dryers/razors - electrical]
0302	Desktop PCs [excluding. monitors/accessories]
0304	Printers [e.g. scanners/multi functionals/faxes]
0306	Mobile phones [including smartphones/pagers]
0305	Telecommunication equipment [e.g. cordless phones/answering machines]

With reference to the items listed in Table 2, several key questions were posed to survey respondents. Generic demographic information was also gathered at the start of each survey, which can provide useful insights to support data analysis and enables this study to evaluate EEE possession rates and discard behaviour by geographical area, income level (for household surveys only) and business size and type (for business surveys only). All survey respondents were aged 18 and over.

Table 3: Questions used to gather information from households and businesses in Kenya and Burundi on possession rates of EEE and discard behaviour

1.	Which of the following electric/electronic products exist in your household/ business?
2.	Which of the following electric/electronic products in your possession are functioning?
3.	Of the following, how many of these electric/electronic products in your possession are functioning? (Quantity)
4.	Which of the following electric/electronic products in your possession are not functioning?
5.	Of the following, how many of these electric/electronic products in your possession are not functioning? (Quantity)
6.	Which of the following products have you discarded in the past 24 months?
7.	For each of the following products kindly tell me how many you have discarded in the past 24 months?
8.	If you have discarded that product in the past 24 months, what was the disposal route for the number of products discarded?

Table 4: Demographic information collected from the household and business surveys

Household surveys:	age, gender, occupation, income, household size, and location.
Business surveys:	number of employees: micro (0-9 employees), medium (10-49 employees), large (50+ employees), location, and business sector.

2.1.2 Survey sampling design and implementation

The surveys were rolled out in both Burundi and Kenya by GeoPoll[11] which is an experienced provider of mobile-based surveys globally. During the course of September 2022, GeoPoll surveyed 4 major cities in Kenya and three in Burundi. GeoPoll translated the survey questionnaire into local languages and formatted the questions to fit the standardized Computer Assisted Telephonic Interviews (CATI) method in order to serve as the script for call operators. It includes all aspects of the interview, including introduction, screening, questions, answer choices, interviewer instructions, and skip logic.

The surveys were carried out using a mixed mode data collection approach. A quantitative structured questionnaire administered via a CATI platform was used to collect data for households in Kenya and Burundi and for businesses in Kenya. In Burundi, the business survey was conducted using face to face interviews via a computer assisted personal interview (CAPI) method.

[11] GeoPoll (2023). About GeoPoll. https://www.geopoll.com/about/

Table 5: Survey sampling size, collection dates and locations in Burundi and Kenya

Survey	Kenya		Burundi	
	Household (CATI)	Business (CATI)	Household (CATI)	Business (CAPI)
Sample size achieved	507	308	351	117
Data collection dates (2022)	16 to 22 September	12 to 30 September	14 to 30 September	13 to 29 September
Sample locations	Nairobi, Mombasa, Kisumu, Nakuru		Bujumbura, Muyinga, Gitega	
Language	English, Swahili		English, French, Kirundi	

For CATI surveys, enumerators dialled respondents' numbers and conducted the interview via telephone. Mobile numbers obtained by GeoPoll were pre-stratified by gender, age, county and sub-county based on the most recently available national statistics for Burundi and Kenya to ensure the sample was representative of the population in the selected regions. Through CATI, the GeoPoll household survey completion rate is estimated to be at a 15 per cent incidence rate. For each contact in the sample, five call attempts were made in order to consider a contact not being reachable. The GeoPoll indexed user database has been active for several years and was created in partnership with all mobile network operators in countries where it operates.

For the household surveys, the sample was developed using two-stage stratified cluster sampling involving the allocation of primary sampling units and regions using the probability proportion to size (PPS) method and a random selection of mobile phone numbers representative from the GeoPoll database.

For the business surveys conducted in Kenya, a stratified random sampling method was used that consisted of a random sample of telephone numbers and emails from businesses, using an equal probability selection method. Online interviews were conducted when preferred by the respondent and a survey link was shared to complete the interview at their convenience.

The business surveys conducted in Burundi were administered through face-to-face interviews in the selected three regions (in strict observance of COVID-19 health protocols). A simple random sampling method was used to target businesses across the different regions. The target respondent for businesses were mainly the business owners or people in business administrator roles.

Table 6: The proportion of the population surveyed in Burundi and Kenya

Kenya Household Survey (CATI)				Burundi Household Survey (CATI)			
Location	Population proportion (%)	Sample	Achieved	Location	Population proportion (%)	Sample	Achieved
KISUMU	11%	57	57	Bujumbura	55%	193	179
MOMBASA	14%	70	71	Muyinga	26%	89	89
NAIROBI	53%	263	267	Gitega	19%	68	83
NAKURU	22%	110	112	**Total**	**100%**	**350**	**351**
Total	**100%**	**500**	**507**				
Margin of Error: +/- 4.35% at 95% confidence level for the household study.				Margin of Error: +/- 5.23% at 95% confidence level for the household study.			

Kenya Business Survey (CATI)				Burundi Business Survey (CAPI)			
Location	Population proportion (%)	Sample	Achieved	Location	Population proportion (%)	Sample	Achieved
KISUMU	20%	60	67	Bujumbura	40%	40	41
MOMBASA	20%	60	59	Muyinga	30%	30	43
NAKURU	20%	60	60	Gitega	30%	30	33
NAIROBI	40%	120	122	**Total**	**100%**	**100**	**117**
Total	**100%**	**300**	**308**				

2.1.2.1 CAPI and CATI methodology

The CAPI method involves face to face research undertaken where interviewers use software on a computer or tablet to record interview responses, allowing for follow-up questions and visual or audio aids. CAPI can reach any respondent, making it a good solution for low-income or unconnected populations, but it requires trained interviewers to travel to each household, making it time-consuming and costly.

The CATI method involves voice call interviews in which trained interviewers call respondents' phone numbers from a central call centre. CATI interviews are interviewer-administered and can use audio aids as part of a questionnaire design. CATI is faster to administer than CAPI surveys and it comes at a slightly lower cost, as interviewers work from a central location rather than traveling to conduct surveys in person. However, CATI surveys may not reach the lowest-income populations who do not have access to a mobile phone or landline. One of the benefits of the CATI method is its ability to collect detailed data through follow-up questions and probing, secure data storage, and reaching wide segments of the population without having to overcome logistical hurdles associated with in-person research.

The GeoPoll CATI Methodology is supported by three core elements: managed call centres and interviewers, a technology platform and central database, and the CATI Application. These tools supported sample selection and quality assurance. The GeoPoll CATI Tool is device-agnostic and can be accessed online or downloaded to phones or tablets. The tool can house any type of survey question and it provides question-specific instructions and notes to aid operators. It also enables quota management, callback times, and limits operator ability to skip questions. The tool captures analytics covering call duration, non-response, and callbacks. Varying levels of access are provided to enumerators to support secure data collection and privacy management.

2.1.3 Survey training, quality control and data checks

Quality assurance was paramount during the data collection phase. Here is a summary of the main quality assurance and control mechanisms that were implemented by GeoPoll:

- Video checks:
    - Uses video conference software to randomly monitor enumerator performance.
- Progress monitoring:
    - Captures daily reviewed analytics about the duration of time an operator spends on each question, the overall length of a call, and aggregated statistics, such as the number of calls placed in a day, average call length, non-response, and callbacks.
- Automated data quality checks:
    - Evaluates the response given automatically, upon receipt of data from CATI systems to make sure they are within expected parameters.
- Manual data quality checks:
    - Reviews data by checking for unusual survey response patterns, drop-offs for specific questions or potential skews in the data.
- Back checks:
    - Conducts back checks on calls.

Based on the specifications of the survey, GeoPoll identified appropriate call centre operators and conducted training. Training lasted approximately two business days and provided the opportunity to train the interviewers about the purpose of the surveys, to observe mock calls, and to provide detailed feedback prior to full CATI implementation. Training is essential to reducing measurement errors (the difference between the value provided by the respondent and the true value) and reduce phone operator bias (a bias originating from unintentional operator behaviours). In addition, the training process provided a good opportunity to refine the questionnaire.

The following was addressed during training and testing:

- Principles of interviewing, including sampling methods, respondent recruitment and handling, question types, interviewing techniques, performance measurement, optimal call times, and quality.
- Professional and ethics standards, including expected behaviour of operators during phone calls.

- Survey instrument review, including:
    - Reasons why specific questions are included in the survey instrument and how they should be asked.
    - Explanation of the terminology used throughout the questionnaire, including a potential "cheat sheet" provided to operators.
    - Discussion on how to reply to difficult questions posed by respondents, including a sheet with standard answers as a guide to operators.
- Systems training, including how to enter data into the data entry tool and how to manage phone numbers.
- Practice sessions via mock interviews and entering data in the CATI Tool. Hands-on practice will evaluate how each operator understands the questionnaire and identify knowledge and/or skills gaps that need addressed before calls commence.
- Conducting a pilot to pre-test the instrument. After testing with staff, the pilot survey instrument is sent to in-country paid testers to ensure that respondents are able to understand and complete the surveys. Any respondent confusion or question logic issues are then identified and addressed immediately before deploying the survey across the full sampling frame.

Once calls were finished, all data was stored within the GeoPoll CATI Tool with a unique ID. Software tools R and SPSS were then used for quality checks and data transformation from the raw survey data in order to enable results and interpretations from tables and data visualizations.

2.1.4 E-waste measurement tools

The tools developed by the SCYCLE team, formerly part of the United Nations University (UNU), and recently transitioned to the United Nations Institute for Training and Research – UNITAR), consist of:

- an *EEE put on the market (POM) Tool*, which is used to collect, compile and analyse EEE that is put on the market,
- an *E-waste Generated Tool* which uses EEE put on the market data to calculate the amount of e-waste being generated.

Both tools are an integral part of the methodologies used for the calculation of the weight of EEE, POM, and the e-waste being generated. It is based on the same methodologies as developed by the task group of the international, multi-stakeholder initiative called the Partnership for Measuring ICT for Development.[12] The tools are customized for each country and are pre-populated with estimations for EEE put on the market and the amount of e-waste being generated per country. The calculation routines have been developed by the SCYCLE and, the scripts are based on a tool focussing on Europe developed by Statistics Netherlands which have been further developed by SCYCLE for the rest of the world. The methodology used is further described in the E-waste Statistics Guidelines[13].

[12] Forti, V., Baldé C.P, and Kuehr, R. (2018). E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. United Nations University, ViE – SCYCLE, Bonn, Germany. https://www.itu.int/en/ITU-D/Climate-Change/Documents/2018/EWaste_Guidelines_final.pdf

[13] Forti, V., Baldé C.P, and Kuehr, R. (2018). E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. United Nations University, ViE – SCYCLE, Bonn, Germany. https://www.itu.int/en/ITU-D/Climate-Change/Documents/2018/EWaste_Guidelines_final.pdf

In order to support countries to generate their own statistics for EEE put on the market and e-waste being generated, stakeholders can use the tools to calculate their respective country's own "EEE Put on Market". Subsequently, the outcomes from the "EEE Put on Market Tool" can overwrite the estimations with the country data on put on the market for new EEE. The "EEE Put on Market" can be calculated as imports – exports + domestic production. If, however, the country does not have any Domestic Production of EEE, the user can neglect it and consider only the Imports and Exports. Imports and Exports data can be obtained at the National Bureau of Statistics or at any other Trade Authority in the country. Therefore it is important to add the main parameters that are needed for the calculation of EEE POM, namely the EEE imports, exports and domestic production (if available).

When harvesting the data, the following recommendations should be considered:

- obtain data for a long time-series (preferably 20 to 30 years, or at least 10 years);
- data should be aggregated by year (annual data);
- data should be by Harmonized System code (6 digits); and
- data should be collected in weight (kg) or number of units

Once trade data are entered in the EEE POM Tool, if data are provided in number of units, the tool automatically converts the units to weight using the average weight data per appliance that are published in the E-waste Statistics Guidelines (Forti et al., 2018). In addition, the tool automatically calculates the EEE POM by applying the equation: imports minus exports plus domestic production. It further corrects EEE POM negative values by setting them to 0 as negative sales can't be accepted.

The tool restructures the dataset to facilitate the statistical analysis, and validation steps to be carried out by the user. Ideally, the statistical analysis should include:

- corrections for outliers for the EEE POM data;
- corrections to ensure consistency along the timeseries and correct unreliable trends;
- extension of the time series of EEE POM data if it is planned to forecast e-waste being generated for future years.

Once the data analysis for EEE POM is concluded, the user can insert the results into the E-waste generated tool. The tool determines the e-waste generated by linking the EEE POM data to the specific lifetime distributions.

Lifetime data that is pre-filled in the EEE POM Tool, is obtained from the 27 European Union (EU) member States using the Weibull distribution. Ideally, the lifetime of each product should be determined empirically per product and by country. At the time of this study, only harmonized European residence times of EEE were available from extensive studies and due to the absence of data, it was assumed that the higher residence times per product in the EU were approximately applicable for non- EU countries as well.

In some cases, this would lead to an overestimation, as a product could last longer in developing countries than in developed countries because residents of developing countries are more likely to pass on or repair products. However, it can also lead to an underestimation, as the quality of products is often lower in developing countries because reused equipment or more cheaply produced versions that don't last as long might enter the domestic market. But in general, it is assumed that this process leads to relatively accurate estimates. Nevertheless, should lifetime data be available, the user has the possibility to update lifetime data directly in the E-waste

Generated Tool. Once data on EEE put on the market are inserted, the user can calculate the amount of e-waste being generated by clicking on a button in the front sheet.

Ultimately, the E-waste Generated Tool provides a summary of the results of the EEE put on the market and the e-waste being generated by year both in tables and in graphs. Additionally it is possible to visualize the breakdowns per EEE category. For more information about the functionalities of both the EEE POM Tool and the E-waste Generated Tool, please contact the GESP at globalewaste.org.

The results of the E-waste Generated Tool provide an indication of the quantities and type of e-waste that is disposed of every year in the country. This information can be useful to design ad-hoc e-waste management infrastructure including the setting up of collection points, organizing the collection and predicting the potential capacities of e-waste recycling facilities.

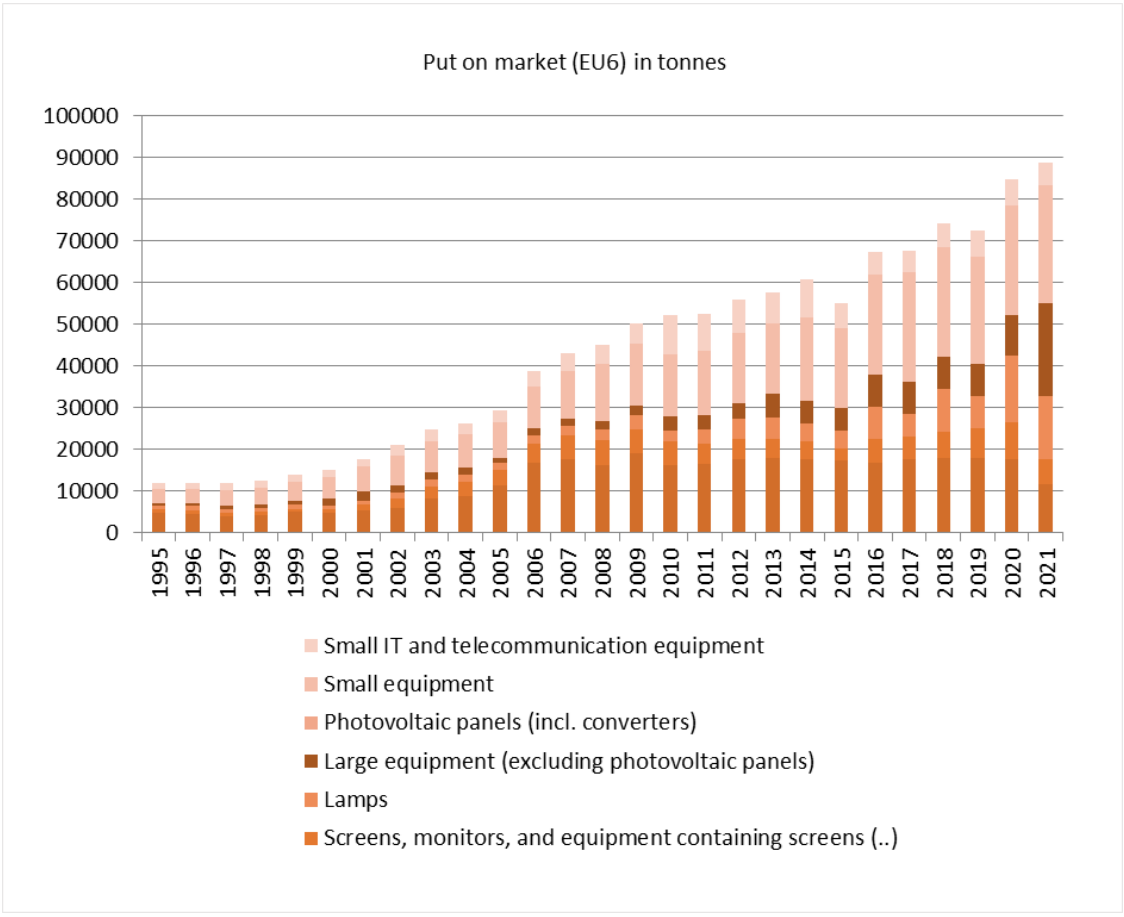
3 Results and discussion

3.1 Results of the EEE POM and e-waste generated tools compared with results of household and business surveys in Kenya

The assessment of the evolution of EEE POM and E-waste Generated over time in Kenya shows that despite a slight decrease in the years 2015 and 2019, sales of new electronics are rapidly increasing. In fact, EEE POM has almost tripled since 2005 when EEE POM accounted for 29.3 kilotonnes (kt). In 2021, it accounted for 88.8 kt. The largest shares comprised small equipment (28 kt), large equipment (22.3 kt), and lamps (15.4 kt). Other categories represent smaller shares: 11.6 kt temperature exchange equipment, 5.9 kt screens and monitors and 5.5 kt small IT and telecommunication equipment.

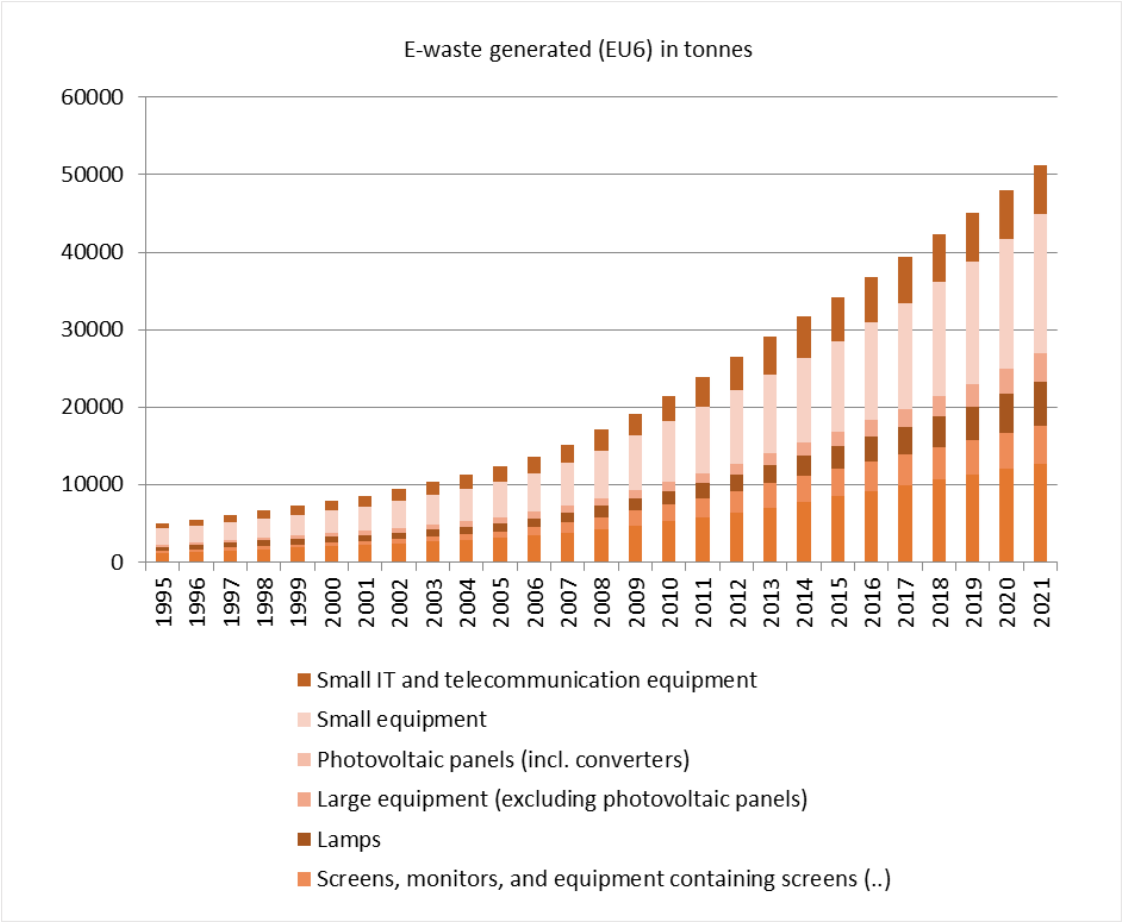
EEE trade data have been provided by the Kenya authorities for the period 2010 to 2021. To be able to capture all e-waste arisings, the time series was extended backwards to 1980 using UNITAR internal estimations. The data analysis also included filling in data gaps by keeping the last available data point constant.

Figure 2: Results of the analysis of EEE POM using the EEE POM Tool



The amount of e-waste being generated in Kenya has also shown a rapid increase notably because of the increase of sales in the past 15 years. The total e-waste generation in Kenya has been estimated to be 51.3 kt in 2021. The largest shares are represented by small equipment (18 kt) and temperature exchange equipment (12.7 kt).

Figure 3: Results of the analysis of e-waste generated using the E-waste Generated Tool



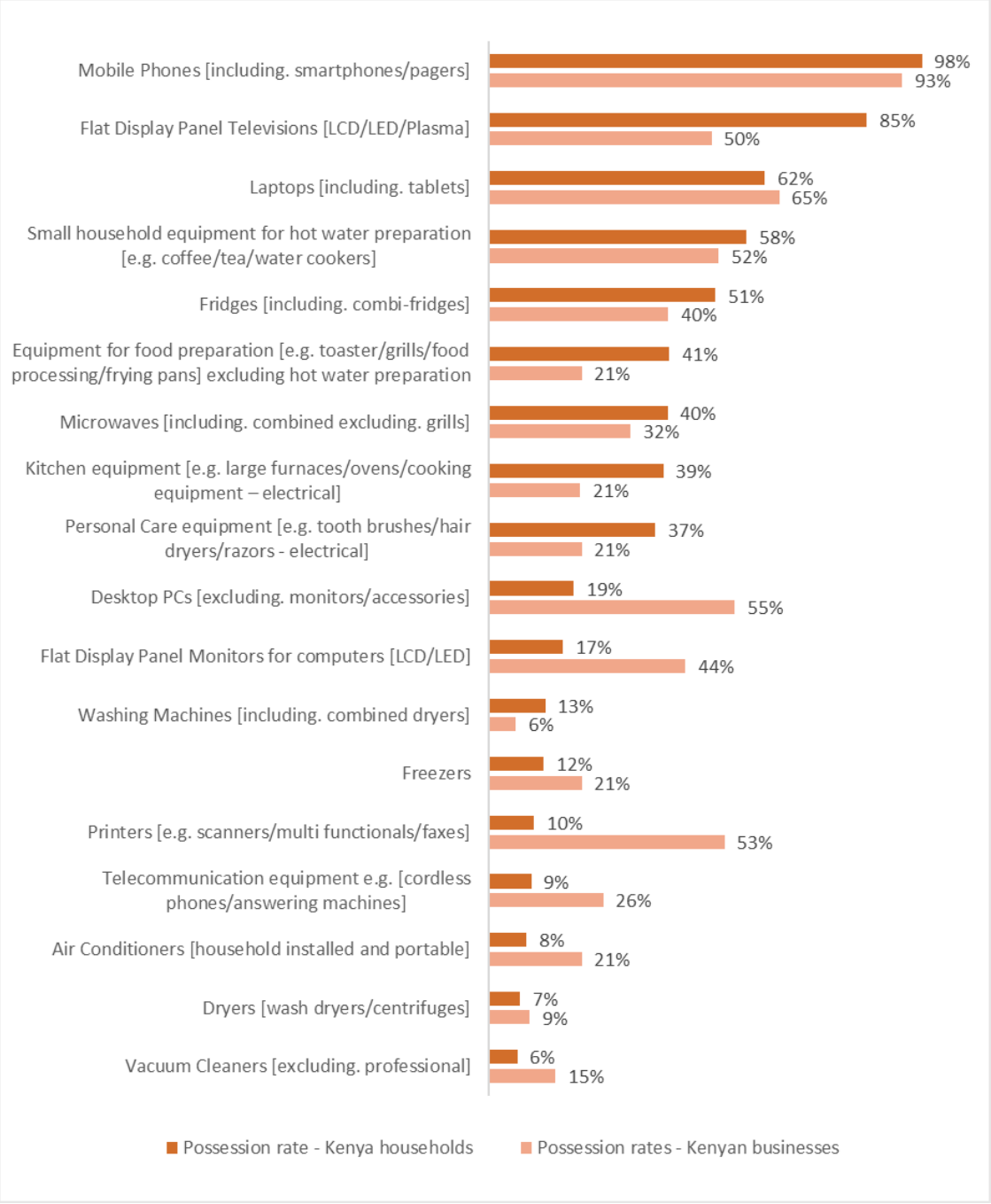
Temperature exchange equipment represents one of the categories contributing the most to the e-waste being generated in Kenya because this category is typically comprising heavy products (e.g. fridges, air conditioner, freezers) and since most places in Kenya experience relatively high temperature during the year, it is expected that the usage of temperature exchange equipment is quite frequent. It could also be inferred that a general rise in income levels means that more households are able to purchase these types of products.

The pilot household and business surveys conducted in Kenya showed that 51 per cent of the households surveyed possessed at least one fridge, 12 per cent at least one freezer and 8 per cent at least one air conditioner, while for businesses the possession rate of at least one item increases to 21 per cent for both freezers and air conditioners. Small equipment is the category contributing the most to the amount of e-waste being generated in Kenya throughout all the years analysed. This trend is also justified by the results of the pilot household and business survey, since at least one small household equipment for water and food preparation is present in more than, respectively, 58 per cent and 41 per cent of the households surveyed. In addition,

personal care equipment has high possession rates in Kenyan households, at 37 per cent. Whilst vacuum cleaners in Kenyan businesses are at a 15 per cent possession rate.

Besides small equipment and temperature exchange equipment, the household surveys conducted in Kenya revealed that there is a high possession rate of mobile phones. Indeed, 98 per cent of the Kenyan households interviewed possess at least one mobile phone. Possession rates were also shown to be high for flat display panel televisions (85%), and laptops (65%). Other items were present in less than half of the households surveyed, this is the case of vacuum cleaners possessed by 6 per cent of the households surveyed, dryers 7 per cent etc. More examples are provided in Figure 4. The business surveys conducted in Kenya similarly indicated a high level of possession for mobile phones and laptops where 93 per cent and 65 per cent, respectively, were present in the businesses surveyed. Desktop personal computers were shown to be present in 55 per cent of the businesses surveyed, printers in 53 per cent. It must be noted the survey covered 507 households in Kenya in the regions of Nairobi, Mombasa, Kisumu, Nakuru, results may be different for rural areas.

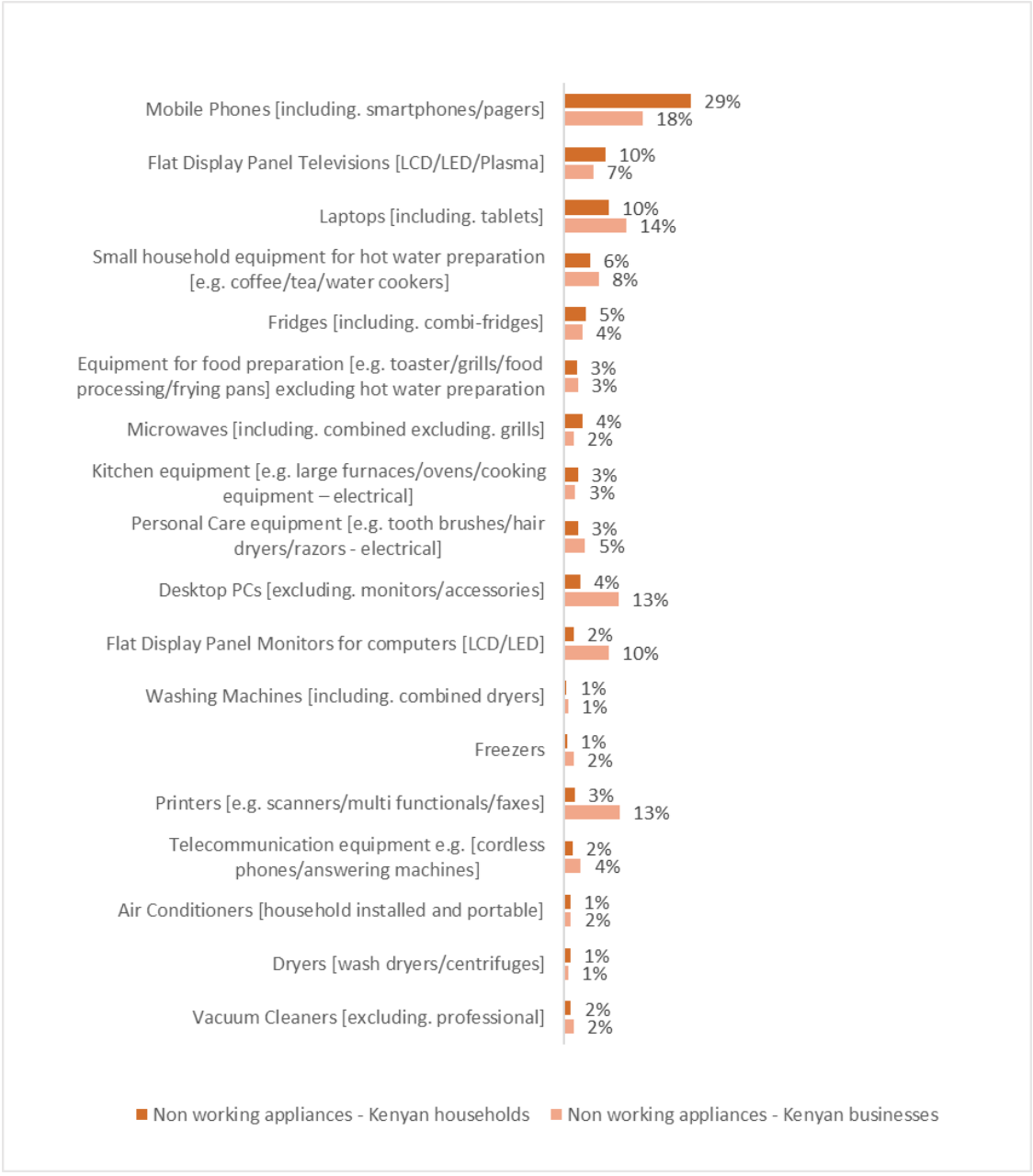
Figure 4: Percentage of households and businesses in Kenya that possess at least one product



The majority of households that reported to possess the items in Figure 4, possess only one item. For example, 97 per cent of the households with a washing machine, possess only one washing machine, 96 per cent of those reporting to possess a microwave, possess only one microwave and 95 per cent one fridge and freezer. For mobile phones, the survey results show that a considerable number of households (35%) own two mobile phones, 27 per cent of households own one, 22 per cent own three, 10 per cent own four and 3 per cent own five mobile phones.

On average, 29 per cent of the surveyed Kenya households possess at least one non-functioning mobile phone, 10 per cent one non-functioning flat display panel television, and one non-functioning laptop. In the case of businesses, the higher percentages of non-functioning appliances apply to mobile phones (18%), laptops (14%), desktop PCs and printers (13% each) and flat display monitors for computers (10%). The discrepancy between households and businesses in Kenya is high in the case of appliances that are most commonly used in the business sector such as monitors, desktop PCs and printers. This is an indication that in many cases non-functioning items are being stored at home for a long time before they are being disposed of.

Figure 5: Percentage of non-functioning equipment possessed by households and businesses in Kenya



The survey addressed the amount of appliances that consumers disposed of in the past 24 months, taking into account September 2022 as a reference (time when the survey was conducted). As shown in Table 7, mobile phones were the appliance that had been disposed of by the majority of households in the 24 months preceding this study. Indeed, the surveys indicated that 212 households, almost half of the 507 surveyed, discarded at least one mobile phone in the previous 24 months. As for businesses, 106 businesses out of the 308 surveyed discarded at least one mobile phone in the same period, this is almost one third.

Table 7: Number of households and businesses in Kenya that have discarded a product in the past 24 months (August 2020 – August 2022)

UNU-Keys	Product description	Number of Kenya households that discarded a product in past 24 months	Number of Kenya businesses that discarded a product in past 24 months
0306	Mobile Phones [including. smartphones/pagers]	212	106
0408	Flat Display Panel Televisions [LCD/LED/Plasma]	57	35
0203	Small household equipment for hot water preparation [e.g. coffee/tea/water cookers]	49	46
0205	Personal Care equipment [e.g. toothbrushes/hair dryers/ razors - electrical]	47	21
0303	Laptops [including. tablets]	43	46
0108	Fridges [including. combi-fridges]	20	15
0202	Equipment for food preparation [e.g. toaster/grills/ food processing/frying pans] excluding hot water preparation	18	12
0103	Kitchen equipment [e.g. large furnaces/ovens/cooking equipment – electrical]	15	10
0114	Microwaves [including. combined excluding. grills]	13	13
0309	Flat Display Panel Monitors for computers [LCD/LED]	12	26
0105	Dryers [wash dryers/centrifuges]	8	7
0304	Printers [e.g. scanners/multi functionals/faxes]	7	40
0104	Washing Machines [including. combined dryers]	6	2

Table 7: Number of households and businesses in Kenya that have discarded a product in the past 24 months (August 2020 – August 2022) (continued)

UNU-Keys	Product description	Number of Kenya households that discarded a product in past 24 months	Number of Kenya businesses that discarded a product in past 24 months
0302	Desktop PCs [excluding. monitors/accessories]	6	52
0305	Telecommunication equipment e.g. [cordless phones/ answering machines]	5	9
0111	Air Conditioners [household installed and portable]	4	10
0204	Vacuum Cleaners [excluding. professional]	3	8
0109	Freezers	3	5

The surveys sought responses regarding the most common disposal routes for EEE. Focusing on the five appliances that are mostly present in households in Kenya, namely mobile phones, flat display panel televisions, laptops, small household appliances and fridges, it is possible to notice differences in the disposal routes that are possibly linked to consumer behaviours as well as with the intrinsic dynamics of e-waste collection in the country.

Fridges, for example, are usually brought to an e-waste collection centre or to a county designated drop off point (20% of the total) or they are picked up from home by the companies that sold the product (30%). The collection by companies disposal route is not used in the case of small household equipment as most is disposed together with mixed residual solid waste (31%) or it is sold to a refurbishment or repair shop (33%). On the other end, the majority of waste laptops are sold to refurbishment or repair shops (51%), this is related to the fact that waste laptops are perceived to contain greater value when it comes to reuse, therefore local refurbishers aim to make an income from refurbishing and selling them as a second-hand products. The same trend can be observed for flat display panel televisions, in fact 33 per cent were reported to be sold to refurbishers or repair shops, however, compared to laptops, a higher percentage appear to be donated (18% of flat display panel TVs vs 9% of laptops). Mobile phones are also often sold to refurbishers or repair shops (34%), this probably applies for relatively new smartphones, older smartphones or mobile phones are instead disposed of in the mixed municipal solid waste bin (15%) and 11 per cent are donated.

Table 8: Disposal routes for products with the highest possession rate in Kenya households

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

3.2 Results of EEE POM and e-waste generated tools compared with results of household and business surveys in Burundi

Burundi EEE POM was estimated to be 1.1 kt in 2021 whilst sales of temperature exchange equipment corresponded to 0.4 kt in the same year and sales of products corresponding to other categories represented lower shares. The size of the Burundi population reflects the size of its EEE POM. It is also important to note that Burundi country data on EEE POM was made available by the authorities for 2010 to 2021 which means that results covering e-waste generated are presented from 2010 onwards. Whilst for Kenya the same time series (2010 to 2021) was extended backwards to 1980 using UNITAR internal estimations, this was not done for Burundi due to some limitations on the availability of estimations since 1980. The estimated e-waste generated in Burundi calculated with country data in 2021 corresponds to a total of 1.8 kt.

Figure 6: Results of the analysis of EEE POM using the EEE POM tool

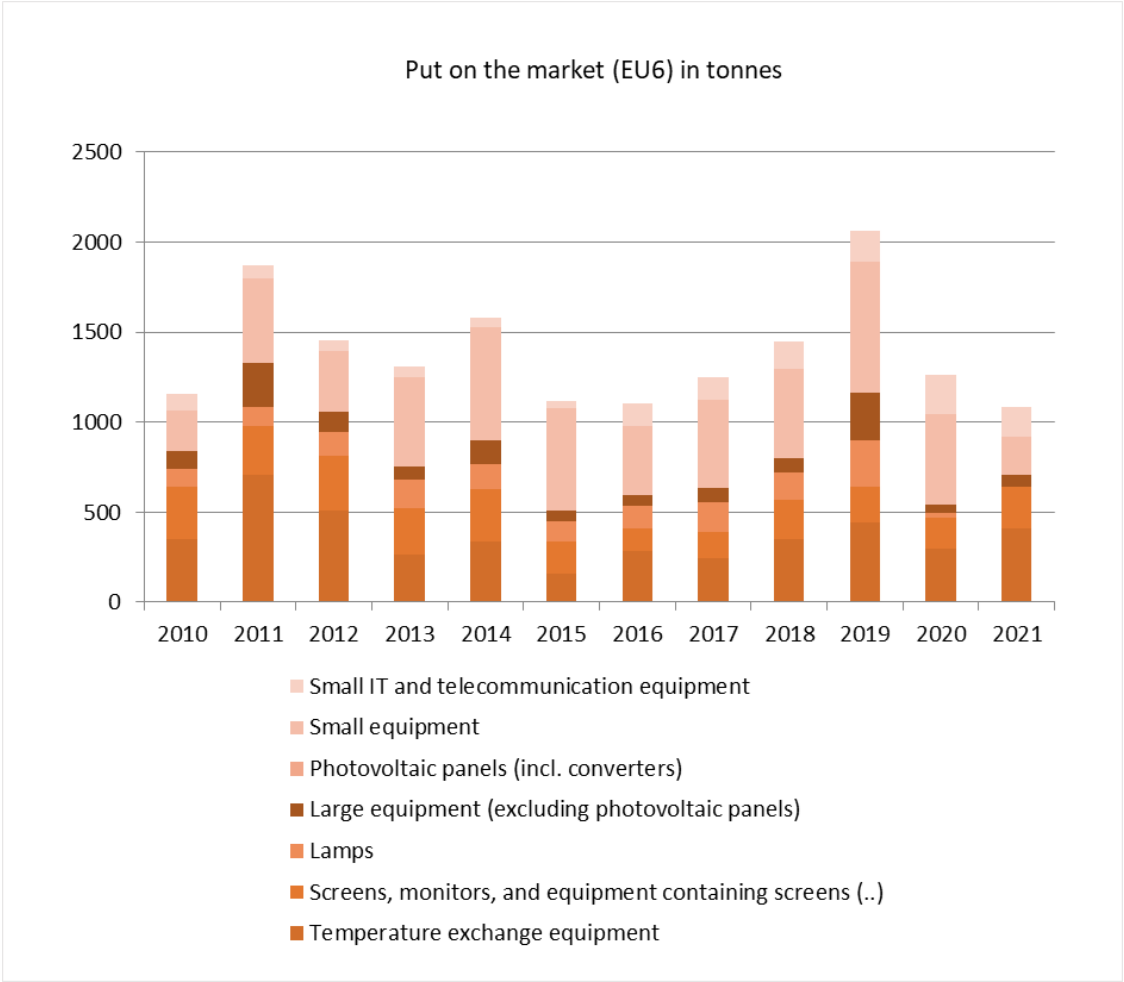
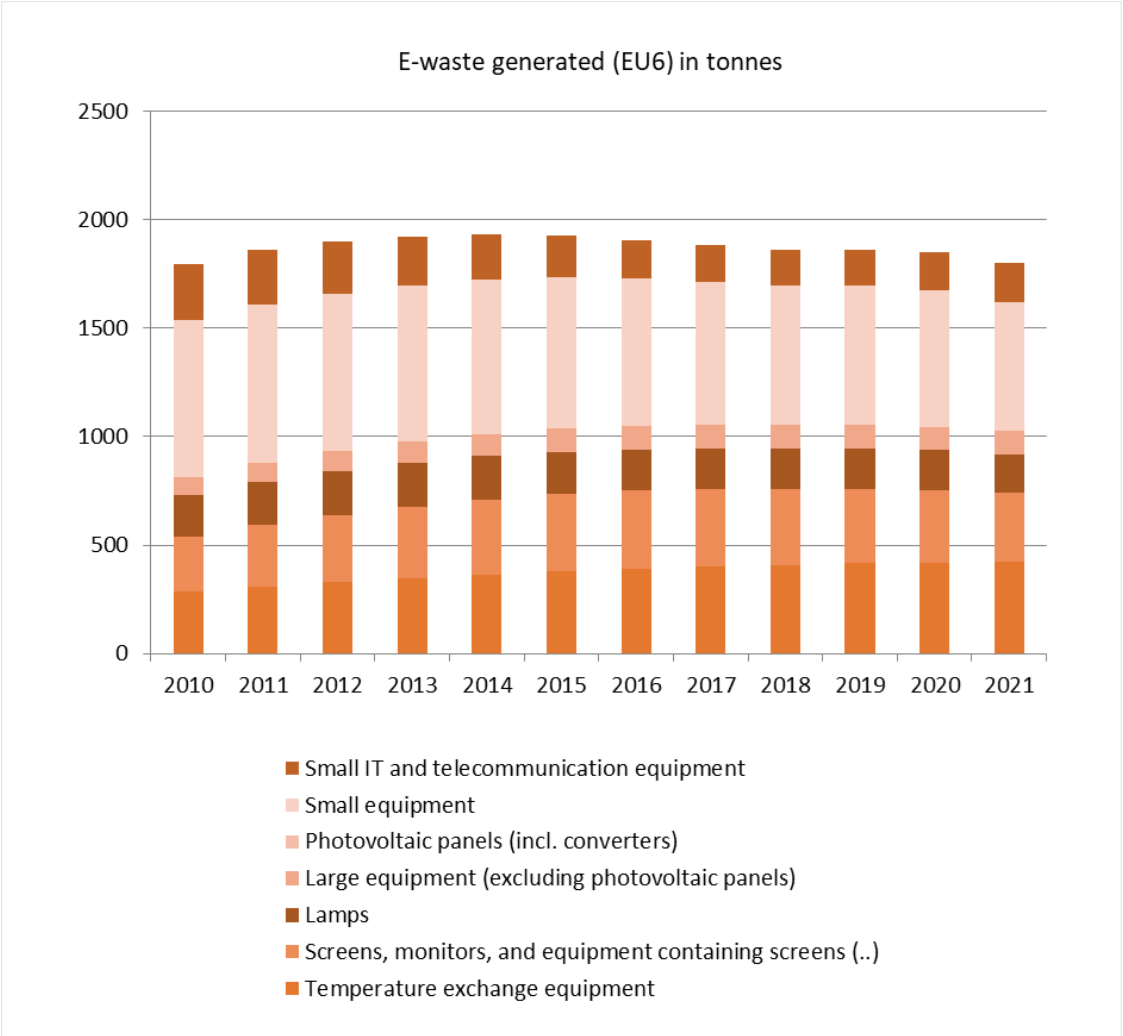


Figure 7: Results of the analysis of e-waste generated using the E-waste Generated tool



Similarly to Kenya, temperature exchange equipment and small equipment represent the categories contributing the most to the e-waste generated in Burundi and the drivers for the e-waste generation of temperature exchange equipment is the heavy average weight of the items, while for small equipment it is the high usage rate.

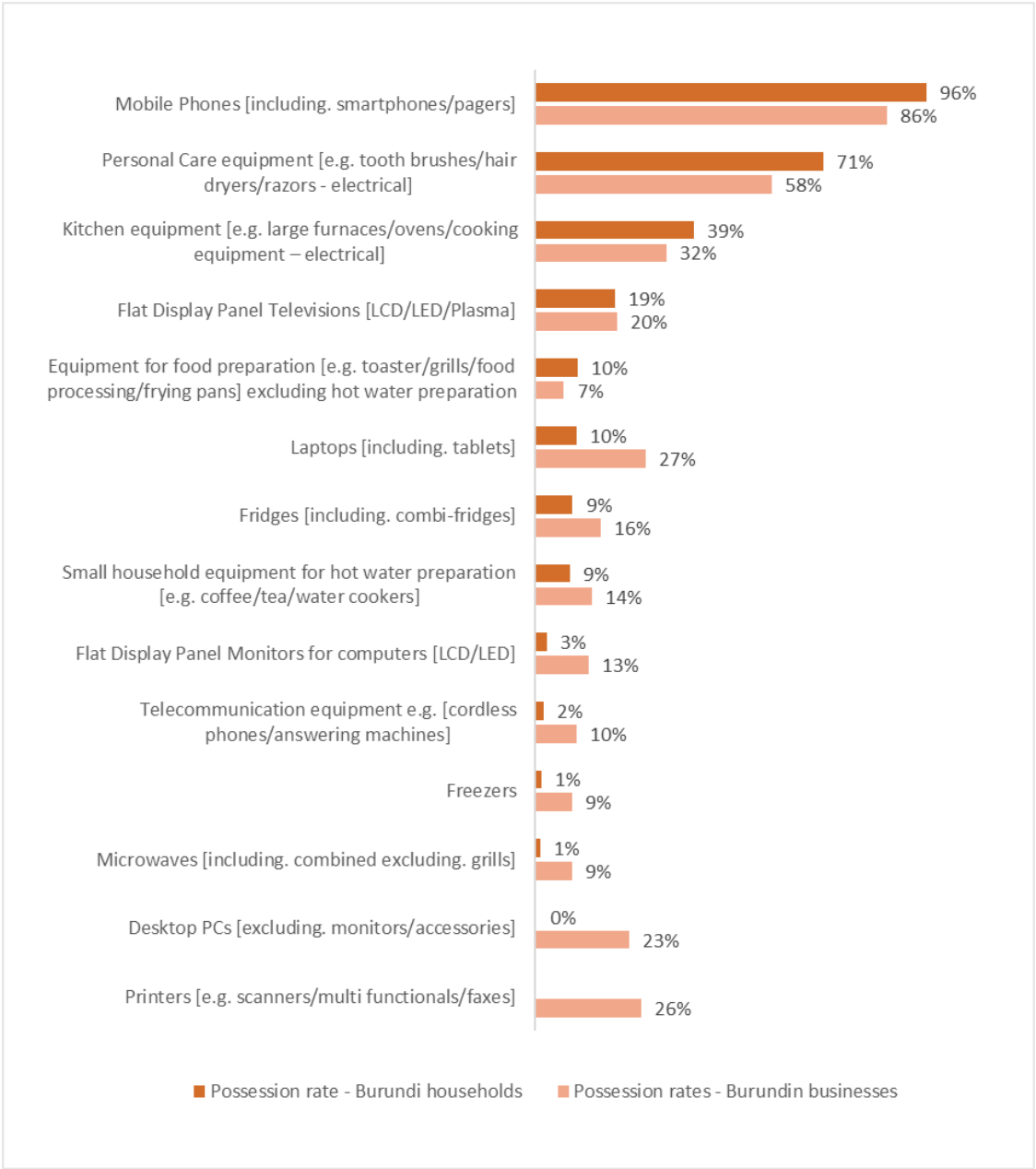
From the results of the E-waste Generated tool, small equipment is the category contributing the most to e-waste generation in Burundi in all years analysed. This trend is also justified by the results of the pilot household and business survey since high possession rates are shown for personal care equipment (71% for households and 58% for businesses) and kitchen equipment (39% for households and 31% for businesses).

Compared to Kenya, considerably fewer of the households surveyed in Burundi possessed at least one fridge (9%), at least one freezer (1%), while air conditioners were not part of the survey. As for businesses, the possession rate of at least one item increases to 16 per cent for fridges and 9 per cent for freezers.

The household surveys conducted in Burundi revealed that higher possession rates apply to mobile phones; indeed, 96 per cent of Burundi households interviewed possess at least one mobile phone. This trend is in line with the findings from Kenya household surveys. Possession

rates are high also for personal care equipment (71%). All other items, including flat display panel televisions, laptops, small household equipment and fridges are present in less than half of the households surveyed depicting a different situation in comparison to Kenya households. In Burundi businesses, mobile phones and personal care equipment are present in 86 per cent and 58 per cent respectively of the total surveyed, while printers are present in 26 per cent of the businesses, laptops in 27 per cent, and desktops in 23 per cent. Overall, possession rates are lower in Burundi for both households and businesses than in Kenya.

Figure 8: Percentage of households and businesses in Burundi that possess at least one product

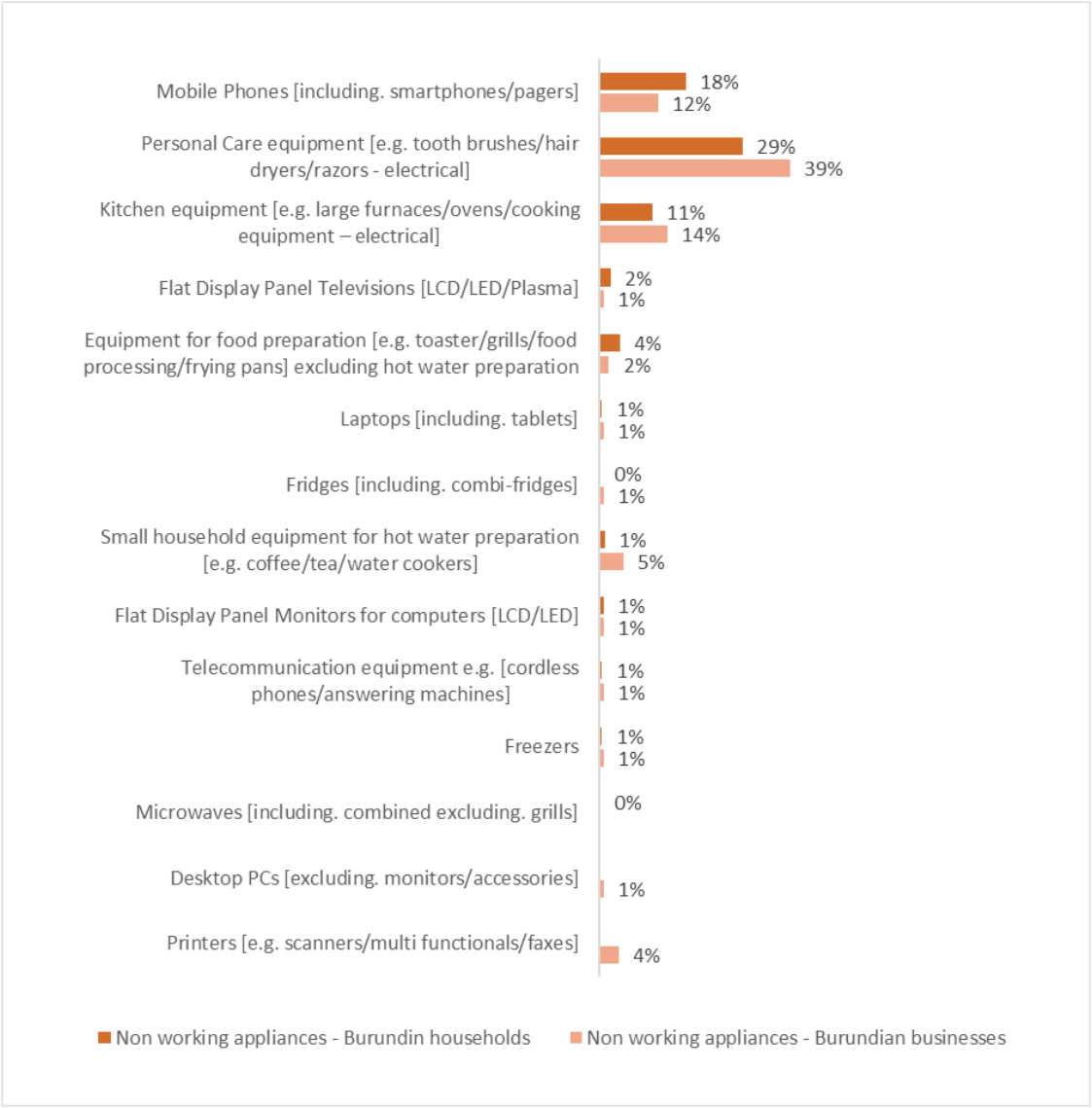


The majority of households that reported to be in possession of the items in Figure 8, possess only one of the items. For example, all households that claimed to possess a laptop, had only one laptop. This ratio was that same for flat display panel televisions, fridges and freezers. For mobile phones, only 48 per cent of households in Burundi that possess a mobile phone, have

only one item, a considerable amount (26%) own two mobile phones, 15 per cent own three, 4 per cent own four, and 3 per cent own five.

On average, 18 per cent of the surveyed households in Burundi possess at least one non-functioning mobile phone (Figure 9), 29 per cent possess one non-functioning personal care equipment, and 11 per cent possess one non-functioning kitchen equipment. In the case of Burundi businesses, the higher percentages of non-functioning appliances apply to mobile phones (12%) and personal care equipment (39%). The discrepancy between households and businesses is high in the case of appliances that are most commonly used in the business sector such as printers. A non-common trend can be observed for non-functioning kitchen equipment and small household equipment for which the percentage is higher in businesses than in households.

Figure 9: Percentage of not working equipment possessed by households and businesses in Kenya



Similar to Kenya, the surveys in Burundi analysed the amount of appliances that consumers disposed of in the 24 months before the survey, also taking into account September 2022 as a reference. The mobile phone is the appliance disposed of by most households in the 24 months preceding this study; indeed the surveys revealed that 201 households (out of 308 surveyed) discarded at least one personal care equipment, this is 65 per cent of the households surveyed. For businesses, the share is lower. Out of the 117 businesses surveyed, 42 discarded at least one personal care equipment, this is 36 per cent of the businesses surveyed. As for mobile phones, 116 households and 18 businesses had discarded at least one mobile phone, this is approximately 38 per cent of the households surveyed and 15 per cent of the businesses surveyed.

Table 9: Number of Burundi households and businesses that discarded a product in the past 24 months (August 2020 – August 2022)

	Number of Burundi households that discarded a product in past 24 months	Number of Burundi businesses that discarded a product in past 24 months
Personal care equipment [e.g. tooth-brushes/hair dryers/razors - electrical]	201	42
Mobile phones [including. smartphones/ pagers]	116	18
Kitchen equipment [e.g. large furnaces/ ovens/cooking equipment – electrical]	82	21
Equipment for food preparation [e.g. toaster/grills/food processing/frying pans] excluding hot water preparation	27	4
Small household equipment for hot water preparation [e.g. coffee/tea/water cookers]	13	2
Flat display panel televisions [LCD/LED/ plasma]	5	1
Laptops [including. tablets]	3	2
Telecommunication equipment e.g. [cord-less phones/answering machines]	2	NA
Flat display panel monitors for computers [LCD/LED]	2	2
Desktop PCs [excluding. monitors/accesso-ries]	1	1
Microwaves [including. combined exclud-ing. grills]	1	1
Freezers	1	NA
Fridges [including. combi-fridges]	1	NA
Printers [e.g. scanners/multi functionals/ faxes]	NA	3

The surveys revealed the most common disposal routes for EEE. Table 10 focuses on the five main household appliances and shows the differences in the disposal routes that are possibly linked to consumer behaviour as well as with the intrinsic dynamics of e-waste collection in Burundi.

Mobile phones for example, are usually sold to a refurbishers or repair shop (21%) or collected informally at home (17%), this is related to the fact that used or waste mobile phones are perceived to have a net value and therefore local refurbishers or informal collectors aim to make an income from refurbishing and selling them as a second-hand products. On the contrary, personal care equipment, kitchen equipment and equipment for food preparation are mostly disposed of with mixed residual solid waste (49%, 51% and 30% respectively). Compared to the Kenya results, less equipment in Burundi is picked up from home by the company that sold the products. In addition, there is no evidence that equipment is being collected by the county, less shares seems to be sold online or donated and higher number of households reported not to be informed about the disposal route or to be still in possession of the product (included in "Other").

Table 10: Disposal routes for products with the highest possession rate in Burundi households

Disposal route	Mobile phones	Personal Care equipment	Flat Display Panel TVs	Kitchen equipment	Equipment for food preparation
Picked up from home by the company that sold me the product	2%	1%	NA	4%	NA
Collected by door-to-door worker	17%	10%	20%	11%	NA
Sold online	3%	NA	NA	NA	NA
Sold to a refurbishment or repair shop	21%	0%	20%	2%	19%
Disposed of in the mixed municipal solid waste bin	13%	49%	20%	51%	30%
Brought to an e-waste collection center or County designated drop off point	7%	19%	NA	14%	4%
Picked up by an e-waste collection center	NA	4%	NA	2%	NA
Donated	10%	NA	NA	1%	7%
Other	27%	15%	40%	14%	41%

3.3 Results of the EEE POM and e-waste generated tools for the remaining countries

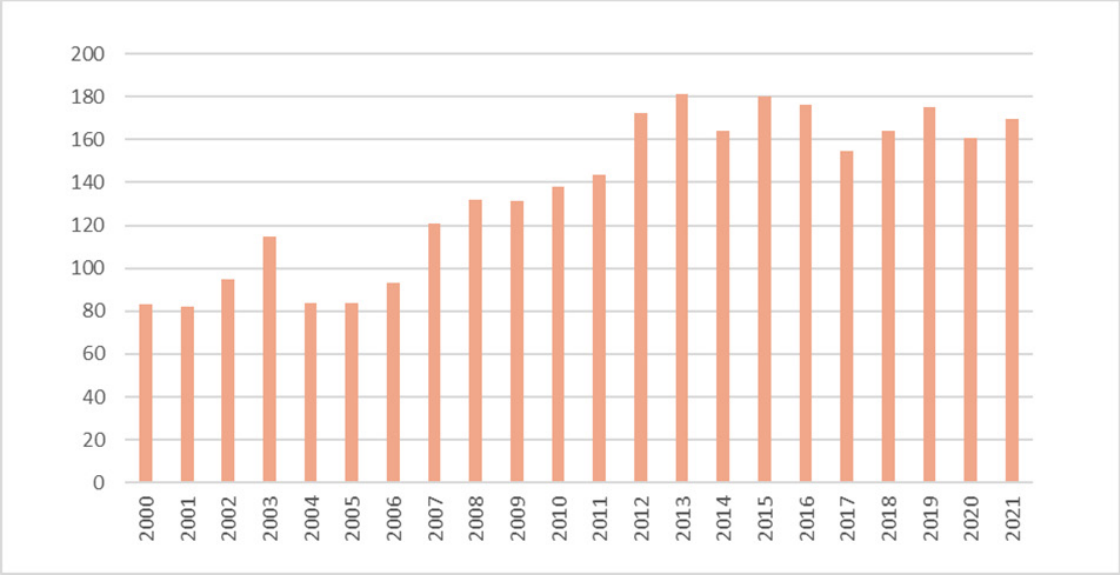
The EEE POM Tool has been used by the participating countries in the project to insert EEE trade data, to convert it into EEE POM and to validate the results. Consequently, EEE POM data were inserted in the e-waste generated tools by the country to calculate country specific e-waste generation. Kenya and Burundi conducted pilot household and business surveys and also used the EEE POM and e-waste generated tools; South Sudan, Tanzania, Uganda and Rwanda used only the tools.

Representatives of all countries have been trained how to use the tools both via online webinars and in person at the E-waste Data Harmonization Workshop in Nairobi from 11 to 13 October 2023. Representatives were asked to fill in the country trade data for the longest time series available and use the tools to calculate the amount of e-waste generated. For most countries, data were available for a maximum of 10 years, thus, they included in the analysis estimations of EEE POM calculated by UNITAR-SCYCLE to extend the timeseries. This was not possible for Burundi and South Sudan because existing estimates were either not in line with the data provided by the country (in the case of Burundi) or not available (in the case of South Sudan).

The data provided by the countries have been further processed and harmonized in this project. The section below presents a summary of the results.

EEE POM in East Africa has been rising rapidly hitting 170 kt in 2021 according to estimations made by the countries participating in the project.

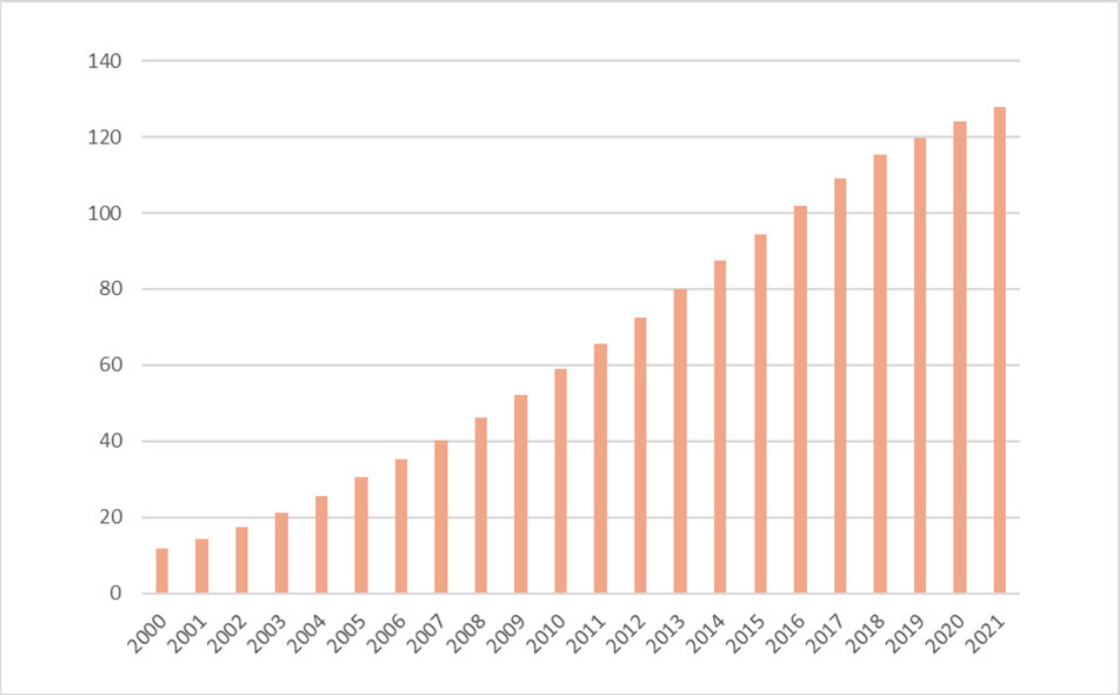
Figure 10 Evolution of EEE POM in East Africa over time (in kilotonnes)



The rapid increase of EEE POM has caused an increase of e-waste generated in the region reaching 128 kt in 2021. The rapid increase of e-waste generated represents a challenge in a region where the availability of e-waste recycling infrastructure is limited as the only available formal e-waste recycling facility is located in Rwanda with a capacity of approximately 7 kt per year. The e-waste that is not formally collected and recycled in the region is mainly managed by the informal sector. Several initiatives by local non-governmental organizations in the region are organizing drop-off points and collection in order to create business opportunities for the

communities either by repairing and refurbishment of the products or by dismantling and recycling of certain components. However, the constant increase of e-waste arising in the region and the limited or absent capacity available formal collection and recycling suggest that urgent actions are needed in order to set up environmentally-sound waste management systems for e-waste in the region.

Figure 11: Evolution of e-waste in East Africa over time (in kilotonnes)



According to the data provided by the countries and compiled using the E-waste Generated Tool, Kenya (with 51 kt) is generating the highest amount of e-waste, followed by Uganda (37 kt), Tanzania (36 kt), Rwanda (6 kt) and Burundi (2 kt). Unfortunately, it was not possible to estimate the e-waste for South Sudan in 2021 as data on EEE POM were available only from 2019 to 2021 and it was not sufficient to calculate e-waste generated. However, it can be estimated that data on e-waste generated for South Sudan are comparable with data for Burundi because of similarities between the two countries in terms of population and economy.

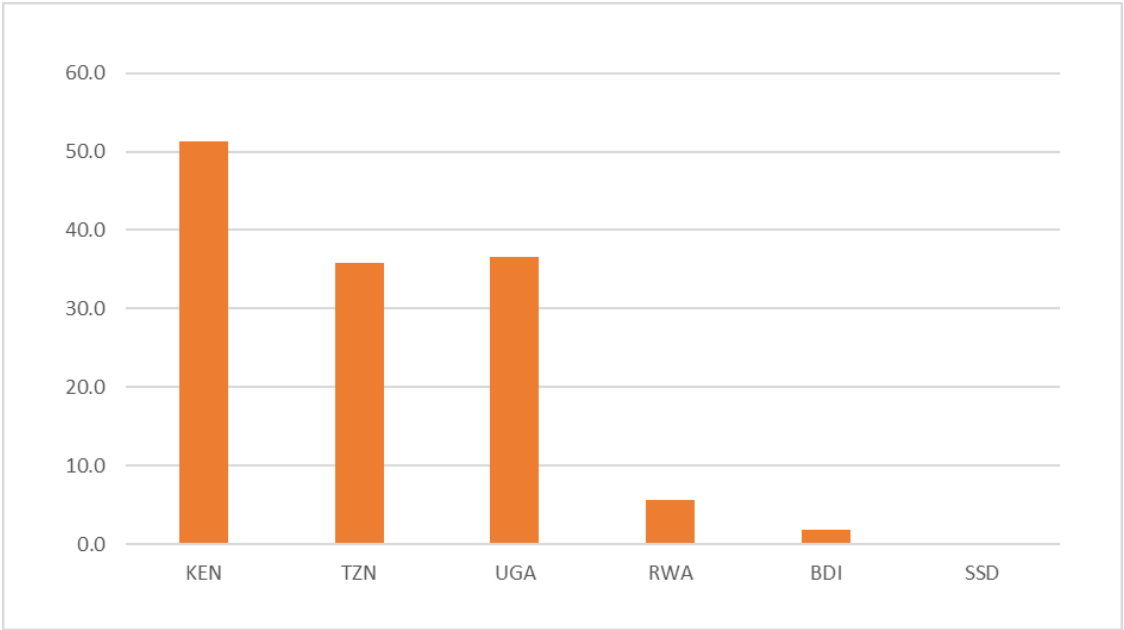
It is important to highlight that the results of the e-waste calculations using the e-waste tools are generally in line with the estimations published on the Global E-waste Monitor (GEM) 2020.[14] Results in line for most countries: in the Global E-waste Monitor, where the reference year is 2019, e-waste generation was estimated to be 51 kt in Kenya 2019, 32 kt in Uganda, 7 kt in Rwanda, 5 kt in Burundi. While for Tanzania the discrepancy is higher (50 kt estimated in the GEM 2020). The discrepancies between the two datasets are justified by the fact that in this project, country representatives gathered country data on trade of EEE, did some basic statistical corrections to ensure that data were accurate and calculated e-waste generated using the e-waste generated tool, while in the GEM 2020 the data presented are estimations based on trade data obtained from the Comtrade[15] database, in addition, several statistical checks and corrections were applied to fill data gaps by comparing trends with countries of similar

[14] Forti, V., Baldé, C., Kuehr, R., Bel, G. (2020). The Global E-waste Monitor 2020. UNU/UNITAR and ITU. https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf

[15] https://comtradeplus.un.org/

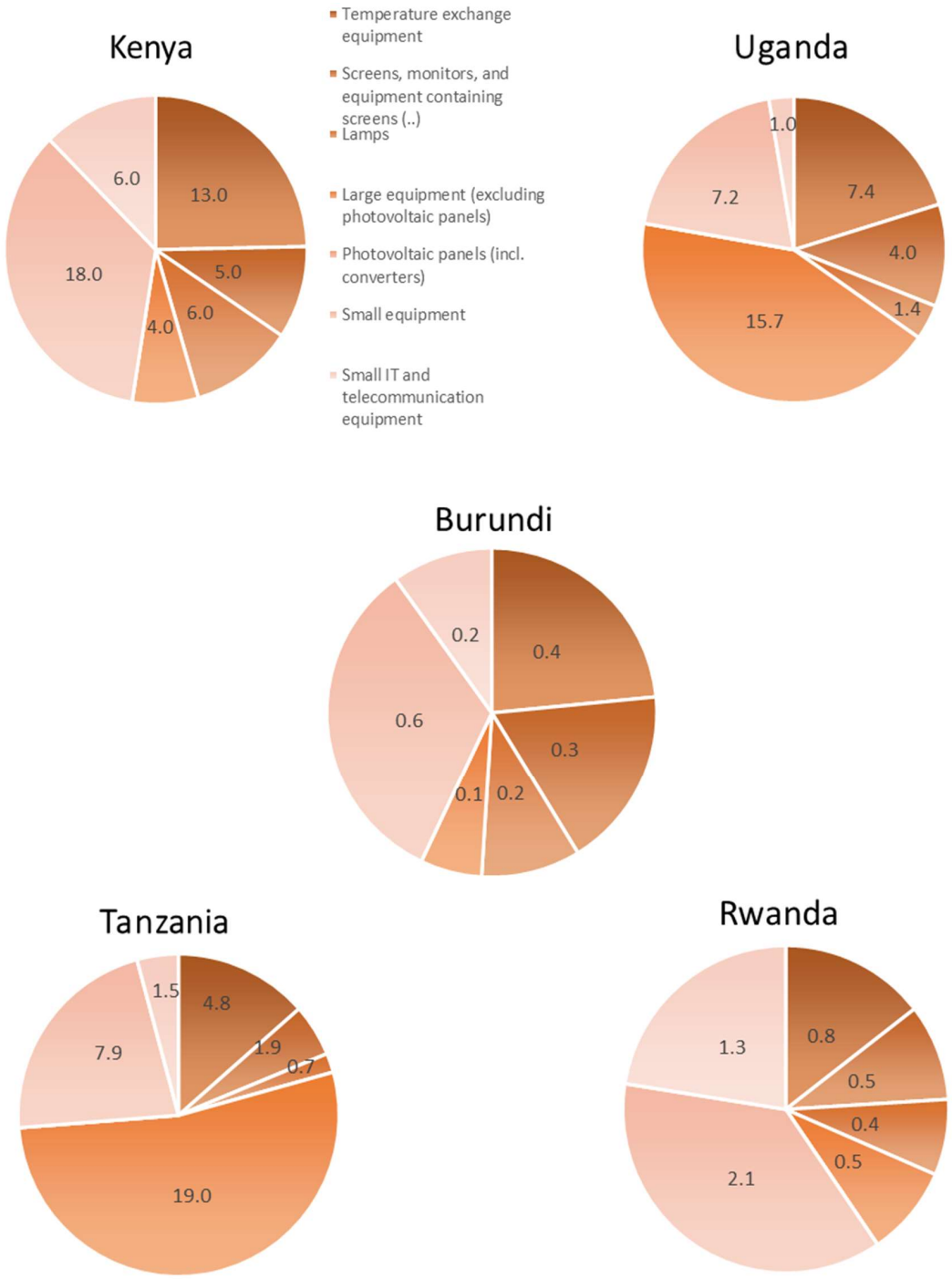
economy. In summary, the methodology used in the Global E-waste Monitor and the one used in the e-waste tools is the same and follow the same principles, however, the input data source differs. In addition, for the global statistics, cross country data validations and checks were performed, while this analysis is not conducted in the e-waste tools. In addition, national data may present data gaps and may be limited to some years only (this was the case of Tanzania where data was made available only until 2017), this could be an additional justification of the differences between the two datasets.

Figure 12: Estimations of e-waste generation in East Africa in 2021 by country (in kilotonnes)



Analysing the data for e-waste generated by country in 2021, it is possible to spot differences in the composition of e-waste generated. In the case of Tanzania and Uganda for example, the majority of e-waste is composed of large equipment, while in the case of Burundi, Kenya, and Rwanda the majority is comprised of small equipment.

Figure 13: E-waste generated by category for five of the six East Africa countries in 2021 (in kilotonnes



The composition of e-waste is a useful indication of the type of products that will most likely be disposed of in the year of reference and can therefore be useful when establishing a sustainable and efficient e-waste management system, including setting up of e-waste collection points, transport and identification and licensing of recycling facilities.

4 Evaluation and recommendations

Reflecting on the pilot surveys undertaken in Burundi and Kenya, in order to improve future surveys and expanding the scope to the national level, it is important to consider using local staff to conduct surveys, especially when communication in local languages is key. During mock interviews in Burundi, it was necessary for the survey team to switch to Kurundi instead of French, which was possible due to local teams being used. Team training and mock interviews were important and should be integral in future surveys. The local population should be informed about the surveys e.g. through radio, TV or newspapers, which may reduce refusals to respond or absence of responses. Resources should be allocated to future surveys to improve awareness-raising activities. At the same time, robust data collection methods, storage, and backup plans are necessary to avoid data loss. During the surveys, data from one question was lost but due to having recordings and call-back numbers, most of the data were thankfully recoverable.

Visual aids and continuously reinforcing the focus of the survey can help prevent issues in interpretation. During the surveys in Burundi, some participants interpretated 'personal care equipment' as non-EEE products like combs and toothbrushes which would have been clearer if visual aids of the different categories were available. Double counting of EEE should be avoided by asking if the product is for home or business use only. For example, some people may use a personal mobile for business use and vice versa. This was not an issue for the pilot surveys since the household and business respondents were unique, but this could be problematic when conducting national surveys. Drawing the line between a micro business and a single person can be challenging. Future surveys should consider the classification and ownership of EEE products that are commonly used for personal and business use e.g. mobile phones and laptops. Some other considerations include the use of supplementary approaches and additional questions. One additional or follow up question about repairing non-functioning EEE could be added to the survey to remove the assumption that the non-functioning EEE won't automatically become e-waste e.g. 'Do you plan to repair this item in the future?'. At the same time, focus group discussions could be developed, including via WhatsApp, in order to complement surveys by providing more qualitative insights into the survey responses.

Every surveying approach (e.g. telephone interviews, face-to-face, etc.) has its own strengths and weaknesses that are important to fully evaluate. It is also important to consider trade-offs between implementation costs and the numbers needed for robust statistics. Quality control measures are essential for every approach and can help mitigate some of the weaknesses e.g. multi-media recoding, listening to 10 per cent of calls, filtering out data or excluding participants if there are doubts about responses will help improve data quality. There are growing opportunities to embrace new technologies that are increasingly making options other than in-person surveying more favourable. During the COVID-19 pandemic, some staff from the National Statists Offices were adopting CATI over CAPI and found the results to be robust.

The assessment of e-waste generation by country using the E-waste Generated Tool presented limitations, the data provided by the countries present data gaps and the completeness of data differs from country to country. In fact, while for some countries it was possible to provide trade data for long time series (more than 10 years), for others trade data was available for a few years only and this did not allow for the estimation of e-waste generation.

In order to improve the monitoring of e-waste statistics in the region, it is recommended that countries update regularly the EEE POM Tool and E-waste Generated Tool, ideally once a year, to get the most reliable estimates about e-waste generation in the country. In turn, this exercise could be useful in the development of policies and waste management guidelines and targets.

It is recommended that the representatives of each country responsible for the compilation of e-waste statistics conduct statistical checks on available trade data as often as possible as those data can present outliers and inconsistencies. A careful check is required to ensure that e-waste statistics are reliable and coherent. Furthermore, it is important to check the completeness of the trade statistics because if relevant Harmonized System (HS) codes are missing the e-waste statistics will be underestimated. In contrary, if HS codes are added that are not applicable to EEE, then the e-waste generation results will be overestimated.

It is recommended that countries or regional associations such as EACO facilitate the exchange of information across countries to ensure that data are harmonized and comparable at the international level and that the data can contribute to the development of the national or regional policy agenda.

5 Conclusion

This study enabled countries in East Africa to produce national statistics on e-waste generated that are harmonized and comparable across countries because the same methods and tools have been used in the assessment. In addition, households and businesses surveys were piloted in Kenya and Burundi to find out more on the possession rates of EEE and disposal routes of the e-waste generated within the countries. E-waste generated was calculated separately, using the e-waste generated tools. The two tools, the E-waste generated Tool on one end and the survey on the other, are complementary and provide useful insights on the e-waste generation and management status in the countries and can be used as a basis for policy making purposes, such as designing e-waste collection and management systems.

The households and businesses surveys conducted in Kenya and in Burundi revealed that the higher possession rates in Kenya apply to mobile phones, flat display panel televisions and laptops. While in Burundi the products with the highest possession rates are mobile phones and personal care equipment. This indicates that high numbers of these items can be found in the e-waste stream and will be disposed of by the user.

Overall, this study highlights that the amount of e-waste in the region is increasing rapidly while there is a lack of e-waste recycling infrastructure in the region. The rapid increase of e-waste generated represents a challenge where the only available formal e-waste recycling facility is located in Rwanda with an annual capacity of approximately 7 kt.

Additionally, the survey reveals that several households or businesses reported to have non-functioning products stored. This may happen for different reasons, the most plausible ones are that the users may not dispose of non-functioning e-waste because of personal attachment, or because they are not provided with the necessary support or infrastructure to encourage the disposal (it may be the lack of collection points or lack of awareness). The surveys conducted in this study did not focus on consumer behaviour, it is suggested that in future surveys, questions are added that will explain the trends.

Ultimately, the survey revealed that a small percentage of the items are disposed of at designated collection points. Other viable disposal routes seem to be the sale to refurbishment or repair shops in Kenya or the disposal in the mixed municipal solid waste bin. It must be noted that in both countries, a large portion of the respondents indicated the disposal route "other", more research should be dedicated to understanding what other disposal routes may be used in the two countries, in addition to those already indicated in the survey.

In general, it is possible to notice differences in the disposal routes of different items, these are possibly linked to consumer behaviours as well as with the intrinsic dynamics of e-waste collection in the country. For example, laptops are perceived to contain greater value when it comes to reuse, therefore local refurbishers aim to make an income from refurbishing and selling them as a second-hand product and therefore less likely to end up in the mixed residual waste or in a designated collection point. On the other hand, that could be the case for products that contain fewer valuable materials.

It is recommended that future studies or efforts concentrate on conducting comprehensive surveys, increasing the coverage in terms of number of households and businesses surveyed as well as improving the geographical coverage ensuring that both urban and rural areas are included in the surveys. More comprehensive surveys can then be used to extrapolate data on possession rates at country level and could be used as a tool to estimate EEE stock in the countries. EEE stocks can in turn be used to model EEE POM and together with trade data it can contribute to better estimation of EEE POM and consequently E-waste Generated. This approach has been adopted in the Lebanese National E-waste Monitor.[16]

From the analysis of e-waste generated using the e-waste generated tools it can be concluded that harmonized e-waste statistics can be produced regionally and can be used for data comparison and validation as well as for designing joint policy initiatives or interventions. Representatives of the countries in the Eastern African region have been trained and capacity has been built in the region to enable countries to update the tools with national data on trade statistics regularly. Regional coordination would be useful to ensure that all countries are updating the tools regularly and that are harmonized and validated across the region. Since capacity has been built on the region, it is advisable that those that have been trained can train other colleagues to increase the outreach and ensure that the expertise is kept within the countries.

[16] Baldé C.P., Panchal R., Forti V. (2022). National E-waste Monitor for Lebanon 2022. United Nations Institute for Training and Research (UNITAR), Bonn, Germany. https://ewastemonitor.info/wp-content/uploads/2022/05/Lebanese-National-E-waste-Monitor-220526-UNITAR.pdf

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