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National E-waste Monitor

Namibia

2024

Namibia Statistics Agency

REPUBLIC OF NAMIBIA
MINISTRY OF ENVIRONMENT, FORESTRY AND TOURISM

unitar
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National E-waste Monitor

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Foreword

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, but also electrical toys, kitchen machines etc., 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 policymakers, 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 efficiently implemented based on 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 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 national e-waste monitor for Namibia introduces the use of tools to calculate the amount of electrical and electronic equipment put on the market and the amount of e-waste generated in Namibia.

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REPUBLIC OF NAMIBIA
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Executive summary

This report describes and summarizes the current status of e-waste management in Namibia and will help ITU to offer technical assistance on e-waste management and monitoring requested by the Ministry of Information and Communication Technology (MICT) of Namibia in 2019.

There are both public and private e-waste collectors and recyclers in Namibia including, City of Windhoek, E-waste Experts, and Namigreen, which focus exclusively on e-waste, whilst other private sector companies such as Transworld Cargo support professional handling and the transportation of various goods including e-waste. Kleen Tek Waste Management also offers a service component for e-waste collection.

The international framework used to measure e-waste statistics as well as the e-waste tools prepared by the UNITAR Sustainable Cycles Programme (SCYCLE), which was previously hosted by UNU-ViE, were applied and used to quantify e-waste stocks and flows in Namibia.

This report is intended to help Namibia to identify best practices in policies, set and evaluate appropriate targets, aids with the development of better management programmes, assist Namibia in regularly keeping internationally comparable e-waste statistics, as well as achieve the SDG targets that are relevant to e-waste management, and assess progress over time.

Namibia currently lacks the capacity to monitor e-waste, which makes e-waste hard to track and hampers the setting and assessment of targets that are necessary to move to a more sustainable and circular economy. In line with policy objectives, a draft national policy on management of waste electrical electronic equipment (WEEE) was requested to help build a framework to assess baseline data on volumes of electrical and electronic equipment put on the market and e-waste generated, including types, routes and flows.

Challenges encountered in Namibia including the lack of a quantification methodology, legislative processes, and the overall e-waste management are identified and a roadmap with recommendations on how to improve e-waste data quality and availability are presented in this report.

The national e-waste monitor constitutes the first step in helping MICT to develop a national policy and action plan on WEEE management, and to ensure an updated baseline to improve capacity to effectively manage the e-waste sector.

Acronyms

EEE	Electrical and electronic equipment
EEE POM	Electrical and electronic equipment placed on the market
EU	European Union
E-waste	Electronic waste
ICT	Information and communication technology
KG/INH	Kilograms per inhabitant
ITU	International Telecommunication Union
KT	Kilotonne
MT	Megatonne
POM	Placed on the market (also referred to as put on the market)
SCYCLE	Sustainable Cycles Programme
SDGs	Sustainable Development Goals
T	tonne
UNITAR	United Nations Institute for Training and Research
UNU-VIE	United Nations University Vice-Rectorate in Europe
WEEE	Waste electrical and electronic equipment
MICT	Ministry of Information and Communication Technology
NSA	Namibia Statistics Agency
NSS	National Statistical System
NSDI	National Spatial Data Infrastructure
FDES	Framework for Development of Environmental Statistics
GEM	Global E-waste Monitor
GESP	Global E-waste Statistics Partnership
NDP5	National Development Plan 5
HPP	Harambee Prosperity Plan
EMA	Environmentally Management Act 2007
EPR	Extended producer responsibility
LED	Led emitting diode
SADC	Southern Africa Development Community
UNEP	United Nation Environment Programme

1 Introduction

1.1 Background to the national e-waste monitor

In 2019, the Ministry of Information and Communication Technology (MICT) of Namibia requested technical assistance from ITU to help develop a national policy and action plan on management of waste electrical and electronic equipment (WEEE). Policy validation and the drafting of action plans are ongoing.

However, the country currently lacks the capacity to monitor e-waste quantities, which makes the e-waste problem largely unknown and hampers the setting and assessment of targets in transitioning to a more sustainable and circular economy. In line with policy objective 2 of the draft national policy on management of WEEE, building of technical capacity was requested in the assessment of baseline data on volumes of e-waste generated, including types, routes and flows.

The present report summarizes the outcomes obtained from the application of the international framework to measure e-waste statistics, and from the use of the e-waste tools delivered by the UNITAR Sustainable Cycles Programme (SCYCLE). Quantifying e-waste stocks and flows in a country helps to identify best practices in policies, to set and evaluate appropriate targets, develop better management programmes, achieve some of the SDGs, and assess progress over time.

The development of a national e-waste monitor for Namibia constitutes the first step of this process and will ensure an updated baseline to start improving the capacity to effectively manage the e-waste sector.

1.2 What is EEE and e-waste?

Electric and electronic equipment (EEE) is dependent on electric currents or electromagnetic fields in order to function, and equipment for the generation, transfer and measurements of such currents and fields. The production and use of EEE continues to rise significantly worldwide due to a rapid increase in the adoption of information and communications technology and its incorporation into other products. The more people acquire electronic equipment, such as mobile phones, television sets, refrigerators, washing machines, radios, computers, printers, photocopy machines, increases the need for old and end-of-life equipment to be collected and recycled.

Also known as e-waste, WEEE includes all items of EEE and its parts that have reached their end of life and are discarded as waste without the intent of re-use.[1] Currently, there is inadequate handling, recycling and disposal of e-waste in Namibia, which is leading to challenges in the adoption of a circular economy for EEE.

1.3 E-waste classification

The draft Namibia national policy on management of WEEE reflects six e-waste categories: temperature exchange equipment, screens and monitors, lamps, large equipment, small equipment, and small IT and telecommunication equipment. The policy reflects the guidance

1 https://www.step-initiative.org/e-waste-challenge.html

published in the *E-waste Statistics Guidelines on Classification Reporting and Indicators – Second Edition*[2], which describes the internationally accepted and adopted UNU-KEYs system that consists of 54 different product-centric categories.

The UNU-KEYs group EEE by similar function, comparable material composition, average weight, and similar end-of-life attributes. This report uses this same system of classification, and the full list of UNU-KEYs are presented in Annex A.

The 54 EEE product categories are grouped into six general categories that correspond closely to their waste management characteristics. The six categories are:

I

Temperature exchange equipment: Is commonly referred to as cooling and freezing equipment. Typical equipment includes refrigerators, freezers, air conditioners and heat pumps.

II

Screens and monitors: Are typical equipment that include televisions, monitor, laptops, notebooks and tablets.

III

Lamps: Is a typical equipment that includes fluorescent lamps, high intensity discharge lamps and LED lamps.

IV

Large equipment: Is a typical equipment that includes washing machines, clothes dryers, dish-washing machines, electric stoves, large printing machines, copying equipment and photovoltaic panels.

V

Small equipment: Are typical equipment's that includes vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments.

VI

Small information technology (IT) and telecommunication equipment: Are typical equipment that include mobile phones, global positioning systems (GPS), pocket calculators, routers, personal computers, printers and telephones.

Source: Adapted from the Global E-waste Monitor 2020

1.4 E-waste: rising quantities, issues and opportunities

First initiated by SCYCLE in 2014, three global e-waste monitors (GEMs) have been published thus far (2014, 2017, and 2020) that introduce the wider public to the global e-waste challenge. They explain how it currently fits into international efforts to reach the 17 Sustainable Development Goals (SDGs) and discuss how to create a circular economy and sustainable societies. In 2017, the Global E-waste Statistics Partnership (GESP), funded by the International Telecommunication Union (ITU), SCYCLE, and the International Solid Waste Association (ISWA), co-published the *Global E-waste Monitor 2017* which, in its third edition (2020), shows a continued growth in the generation of e-waste.

[2] http://collections.unu.edu/eserv/UNU:6477/RZ_EWaste_Guidelines_LoRes.pdf

The *Global E-waste Monitor 2020* highlighted that a record 53.6 million-metric tonnes (Mt) of e-waste was generated in 2019, equal to 7.3 kilograms per inhabitant (kg/inh), up by 21 per cent in the five years since 2014. Out of this amount, only 17.4 per cent (9.3 Mt) has been collected and recycled.

It has been estimated that e-waste is increasing at an alarming rate of almost 2 Mt per year and will increase to 74.7 Mt by 2030. These quantities show that the management and recycling of e-waste is not keeping pace with the global growth of the sector. Along with that, much of the e-waste generated in 2019 (82.6%, 44.3 Mt) has an undocumented fate outside the official system, and it is likely dumped, recycled with substandard techniques, traded (also illegally) or mixed with the other municipal waste.

For Africa in 2019, the *Global E-waste Monitor 2020* estimated that 2.9 Mt (2.5 kg/inh) of e-waste was generated and only 0.03 Mt (0.9%) was documented to be collected and properly recycled.[3] Currently, limited information is available on the amount of e-waste collected and recycled by the formal sector in Africa, and therefore that figure could also be only partially representative.

Managing e-waste requires specific legislation and collection infrastructure. In general, e-waste is, unfortunately, not regulated nor enforced at a global level. In Africa, only 13 countries have enacted e-waste specific policies, legislation or regulations according to the Global E-waste Monitor 2020.[4] Recycling activities are dominated by informal recyclers, with related inefficient resources recovery and environmental and health problems[5].

The current system for managing e-waste in Namibia is not formalized, and in the absence of regulations and awareness, there is little to guide stakeholders – whether producers, consumers, recyclers or government. The draft Namibia national policy on management of WEEE charts an ambitious way forward, upholding extended producer responsibility (EPR) as a fundamental principle. This will include establishing a national WEEE Steering Committee – a multi-stakeholder body to oversee, coordinate and monitor policy implementation – and identifying appropriate finance mechanisms for the management of Namibia's e-waste. Namibia faces two key challenges in terms of national e-waste recycling: large geographical distances and comparatively low current awareness among citizens. MICT identifies the need to intensify public awareness and consumer education of the three 'Rs' (reduce, reuse, and recycle), and enhance public-private partnerships to improve e-waste management in Namibia. While formally committed to environmental protection and environmentally responsible investment and production systems, local authorities in Namibia are mandated to manage solid waste, but this does not include e-waste. A policy on e-waste will lead to a specific e-waste management framework.

In many countries globally, including Namibia, e-waste statistics are not maintained, and flows are not systematically monitored. At present, only 21 per cent of countries (41 out of 193) collect data about indicators such as e-waste generation and collection, and this clearly results as a global gap in the quantification of waste arising from discarded EEE, ICT products and other electronics. The Namibia Statistics Agency (NSA) develops and coordinates the National Statistics System (NSS) and the National Spatial Data Infrastructure (NSDI) for Namibia. The Framework for Development of Environment Statistics (FDES 2013) was endorsed by the 44th session on the UN Statistical Commission in 2013, which provides a guide for data collection

3 https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_july1_low.pdf
4 https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf
5 https://www.nbs.go.tz/nbs/takwimu/Environment/EWASTE-REPORT-TZ-2019.pdf

and compilation of environmental statistics, including waste, at the national level. E-waste data collection in Namibia is challenging, and to improve collection, there is a need to improve the quality and quantity of municipal data, further build capacity and data infrastructure, and improve collaboration and coordination between key institutions.

E-waste also contains hazardous substances and the improper management, including inadequacies in recycling and disposing of it, can result not only as loss of valuable content, but also as potential hazards to human health and to the environment. For instance, e-waste can contain heavy metals such as cadmium and mercury, as well as chlorofluorocarbons, and flame retardants.

Great care must be taken to prevent unsafe exposure of the workers during treatment and recycling operations, and to prevent contamination and pollution problems for the environment for instance contamination from landfills or incineration ash. Whilst private sector initiatives do provide domestic and commercial collections for e-waste in Namibia, there is little clarity nor direction on the valorization process and the recycling of valuable waste fractions. A similar lack of clarity and understanding also applies to the management of non-valuable and potentially hazardous waste fractions, which results in the poor disposal of toxic waste. Therefore, there is a need in Namibia to handle such disposal of e-waste responsibly and in line with emerging global best practices and standards.

The complexity of this waste stream and its cross-sector nature, intersecting environmental policy, product policy and industrial policy necessitates a targeted and dedicated approach to e-waste management in Namibia.

1.5 E-waste and the SDGs

E-waste also constitutes an opportunity to move towards the achievement of the Sustainable Development Goals (SDGs). In 2015, United Nations Member States adopted the 2030 Agenda for Sustainable Development. This included the 17 Sustainable Development Goals (SDGs) and 169 targets for ending poverty, protecting the planet, and ensuring prosperity. Increasing levels of e-waste, improper and unsafe treatment, and disposal through incineration or in landfills pose significant challenges to the environment and human health, and to the achievement of the SGDs. A better understanding and more data on e-waste will contribute to measuring progress towards achievement of several SDGs. E-waste can contribute to SDG 11 "make cities and human settlement inclusive, safe, resilient and sustainable" and to SDG 12 "ensure sustainable consumption and production patterns". E-waste statistics are relevant for monitoring progress of SDG indicators 12.4.2 on "Treatment of waste, generation of hazardous waste, and hazardous waste management, by type of treatment" and 12.5.1 "National recycling rate and tonnes of material recycled (e-waste sub-indicator)".

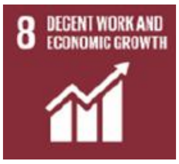
Indicator 12.5.1 is defined as:

Equation 1

$$\textit{Sub indicator } 12.5.1 = \frac{\textbf{Total e} - \textbf{waste recycled}}{\textbf{Total e} - \textbf{waste generated}}$$

The numerator is equivalent to the amount of e-waste that is collected by the formal system of a country, usually under the requirements of a national e-waste legislation. The final destination of this e-waste is in a treatment facility, where the valuable content is recovered in an environmentally responsible way. The denominator equates the amount of discarded EEE within a national territory, in a given reporting year, prior to any collection, reuse, treatment or export.

The custodian agencies of the indicator include the United Nations Environment Programme (UNEP), the United Nation Statistics Division (UNSD), and UNITAR as co-custodian for delivering e-waste datasets, which are developed by SCYCLE, based on methodologies developed by Global E-waste Statistics Partnership, and the Partnership Measuring ICT for Development. Next to the specific sub-indicator on e-waste, the management of e-waste is closely linked to several other goals of the 2030 Agenda for Sustainable Development. In fact, health risks posed by inadequate disposal of e-waste include contamination of water sources, air, and soil, which harm people's health due to direct contact with harmful materials or inhalation of toxic fumes. Moreover, dismantling processes that do not utilize adequate means, facilities, and trained personnel pose additional threats to people and the planet. The specific SDGs targets relevant to e-waste management are:

SDGs Goal	SDGs Targets
	Target 3.9 refers to the reduction of the number of deaths and illnesses caused by hazardous chemicals and air, water, and soil pollution and contamination.
	Target 6.1 seeks to achieve universal and equitable access to safe and affordable drinking water for all; and Target 6.3 aims at reducing pollution, eliminate dumping, and minimize release of hazardous chemicals and materials.
	Target 8.3 aims to promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity, and innovation, and to encourage the formalization and growth of micro, small, and medium-sized enterprises. Target 8.8 calls for the protection of labour rights and promotes safe and secure working environments for all workers, including migrant workers, particularly women migrants, and those in precarious employment. *The sound management of e-waste can create new employment and contribute to economic growth in the recycling and refurbishing sector. Now, e-waste is often processed in the informal sector, and many e-waste disposal and recycling jobs are unsafe and not protected by formal regulation (Brett et al. 2009; Leung, et al. 2008).* *It is therefore necessary to formalize the environmentally responsible management of e-waste and to take advantage of the business opportunities it offers.*

(continued)

SDGs Goal	SDGs Targets
11 SUSTAINABLE CITIES AND COMMUNITIES	Target 11.6 aims to reduce the adverse per capita environmental impact of cities, by paying special attention to air quality and to municipal and other waste management. *Since over half of the world's population lives in cities, rapid urbanization requires new solutions to address rising environmental and human health risks, especially in densely populated areas. Most e-waste will be generated in cities and it is particularly important to properly manage e-waste in urban areas, improve collection and recycling rates, and to reduce the amount of e-waste that ends up in dumpsites. The move towards smart cities and the use of ICTs for waste management offer new and exciting opportunities.*
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Target 12.4 aims to achieve the environmentally sound management of chemicals and all waste throughout the life cycle, in accordance with agreed international frameworks, and to significantly reduce their release into air, water, and soil in order to minimize their adverse impacts on human health and the environment. Target 12.5 aims to substantially reduce waste generation through prevention, reduction, repair, recycling, and reuse. An increasing number of people on the planet are consuming growing amounts of goods, and it is critical to make production and consumption more sustainable by raising awareness levels of producers and consumers, specifically in the area of electrical and electronic equipment.
14 LIFE BELOW WATER	Target 14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution. Target 14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.

Source: Adapted from the Global E-waste Monitor 2020

2 E-waste in the national context

2.1 National e-waste policy development

The Government of Namibia is committed and mandated to ensure environmental protection, promote environmentally responsible investment and production systems, and safeguard against land degradation. Within this context, Namibia aims to adopt a national policy on management of WEEE that will cover all EEE categories, including their components, sub-assemblies, consumables, and parts of the product at the time of discarding. The policy will set out the framework and measures required in Namibia to tackle the growing challenge of end-of-life EEE, enable the creation of a circular economy with better resource management, the formation of green jobs and the prevention of rudimentary e-waste disposal.

Through a regulatory and institutional framework, a draft national policy on management of WEEE will outline the requirements needed for the environmentally responsible management of e-waste. The policy will be implemented through a five-year implementation action plan that will identify responsible parties or entities. Namibia plans to establish a multi-stakeholder steering committee on e-waste to oversee and coordinate the implementation of the policy.

Extended producer responsibility (EPR) will be a key principle underpinning the national policy, where producers of EEE are responsible for covering the end-of-life and use costs of the equipment that they place on the market in Namibia.

Given the inter-disciplinary nature of e-waste management, the national policy on management of WEEE is planned to align with national development plans such as Vision 2030[6] (ICT is recognized as an enabling pillar for socio-economic development and Chapter 5 calls for a sustainable resource base, emphasizing ecological preservation), the Fifth National Development Plan (NDP5)[7] where environmental sustainability is one of the four pillars (with a particularly focus on natural resource use and environmental sustainability), and the Harambee Prosperity Plan II (HPPII) covering 2021 to 2025 to prioritise implementation of policy programmes through five main pillars[8]. A specific objective of the HPPII is to "re-align focus to proactively leverage technical cooperation in crucial areas of national interests such as the blue & green economies, climate change, agriculture, nuclear technology, environment, energy, education, logistics & ICT".

At present, protection of the environment is enshrined in Article 95 of the Constitution of the Republic of Namibia. The Environmental Management Act (EMA), 2007 (7 of 2007), an umbrella legislation, calls for the reduction, reuse and recycling of waste. The Environmental Impact Assessment Regulations of 2012 list activities which cannot be undertaken without an environmental clearance certificate (ECC). The Pollution Control and Waste Management Policy 2010 aims to improve the management of non-hazardous waste, hazardous waste, and special waste, to improve the management of potentially hazardous products. The National Solid Waste Management Strategy 2018 has the objective to strengthen solid waste collection and recycling services. However, this does not specifically govern environmentally responsible management of e-waste in Namibia.

2.2 International and regional conventions

Namibia has ratified a number of international and regional conventions and agreements related to environmental management, which are also of relevance for e-waste. Table 1 summarizes all the international agreements related to e-waste that have been signed and ratified by Namibia.

In 1995, Namibia has ratified and entered into force the Basel Convention on Control of Transboundary Movement of Hazardous Waste and their Disposal, one of the main global level agreements concerning e-waste. Namibia has also ratified and entered into force the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, and the Stockholm Convention on Persistent Organic Pollutants, both in 2005. Namibia has accessed the Minamata Convention on Mercury and it entered into force in 2017.

6 https://www.namfisa.com.na/wp-content/uploads/2017/10/Vision-2030.pdf
7 https://www.npc.gov.na/national-plans/national-plans-ndp-5/
8 https://hppii.gov.na/

However, Namibia is not a signatory of one of the main environmental agreements for the Africa region, the Bamako Convention on Ban of the Import into Africa and Control of Transboundary Movement and Management of Hazardous Waste within Africa[9].

Accession of Namibia to the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone occurred in 1993. These aim to phase out ozone depleting substances such as chlorofluorocarbons and hydro chlorofluorocarbon as refrigerants, which is relevant to EEE such as fridges, freezers, and air conditioners.

Table 1: Multilateral environmental agreement status

Agreement	Signature	Accession/ratification	Entry into force
Basel Convention[10]		15 May 1995	13 August 1995
Rotterdam Convention[11]	11 September 1998	24 June 2005	22 September 2005
Stockholm Convention[12]		24 June 2005	22 September 2005
Minamata Convention[13]		6 September 2017	16 August 2017
Bamako Convention			
Vienna Convention[14]		20 September 1993	
Montreal Protocol[15]		20 September 1993	

2.3 E-waste management infrastructure

Currently there is inadequate handling, recycling and disposal of EEE in Namibia, which is leading to challenges in the adoption of a circular economy for EEE. Local authorities will play an important role in identifying and supporting the implementation of e-waste collection, handling, disposal and recycling infrastructure in Namibia. Under Policy Objective 4 of the draft national policy on management of WEEE, there is a call to establish integrated waste management infrastructure that includes appropriate infrastructure for the collection and dismantling of e-waste backed by technical standards and guidelines. There is also a demand to construct new or repurpose existing waste drop-off, pre-treatment, dismantling and disposal sites to accommodate e-waste. The Southern African Telecommunications Association has drafted guidelines to support Member States with e-waste disposal. The guidelines call for the

9 https://www.informea.org/en/treaties/bamako-convention/treaty-parties
10 http://www.basel.int/?tabid=4499
11 http://www.pic.int/Countries/Statusofratification/PartiesandSignatories/tabid/1072/language/en-US/Default.aspx
12 http://www.pops.int/Countries/StatusofRatifications/PartiesandSignatoires/tabid/4500/Default.aspx
13 http://www.mercuryconvention.org/Countries/Parties/tabid/3428/language/en-US/Default.aspx
14 https://ozone.unep.org/all-ratifications
15 https://ozone.unep.org/all-ratifications

establishment of a South African Development Community (SADC) e-waste recycling plant for the environmental responsible management of e-waste[16].

There are several public and private collectors and recyclers of e-waste operating in Namibia of which some are explicitly focused on e-waste, others support the professional handling and the transportation of various goods including e-waste and a few dedicated to offer a service component for the collection of e-waste.

NamiGreen is an e-waste collection and recycling company that operates approximately 30 designated public e-waste drop-off points, 17 of which are in partnership with MultiChoice[17] (Namibia's largest private broadcaster), with the majority in Windhoek, Walvis Bay and Oranjemund. NamiGreen is a joint venture between Per Hansen (Denmark based e-waste trading company) and Transworld Cargo (Namibia based international logistics provider). For large amounts of e-waste, a collection can be booked online. The company collects e-waste from organizations, companies, and private individuals, adhering to ISO 14000 series environmental management systems. In 2021, NamiGreen partnered with EcoRobotics - Namibia's first online electronics shop - on e-waste collection that offers a container suitable for large e-waste items.[18] NamiGreen has a few dedicated EEE category specific recycling programmes, including printer and printer cartridges, phone, computer, as well as a server, mainframe, and telecommunication, where NamiGreen the company works with major EEE producers. The company also offers recycling certificates to clients that act as proof of destruction/disposal.

E-waste Experts Namibia recycles office and household electronic waste such as laptops, computers, printers, photocopiers, mobile phones, iPads, TV sets, hi-fi systems, fridges, washing machines, solar power accessories, generators, electrical cables, car batteries, and communications equipment. It also offers free door-to-door collection service from private homes, banks, mines, NGOs and government departments. E-waste Experts is a member of Recycle Namibia Forum[19] and works in conjunction with the City of Windhoek, the Document Warehouse and AST Recycling of South Africa to manage e-waste. The company also offers a certificate of destruction to clients on request. Recycle Namibia Forum is a community recycling project that aims to create zero-waste to landfill. The Forum organizes various collection drives and supports collection, for example, collection bins for household batteries are located in six locations across Namibia.

There are other private sector recycling companies operating more widely across Namibia, including Scrap Salvage and Rent-A-Drum. Scrap Salvage offers metal waste recycling through container supply and collection, with branches in Swakopmund, Walvis Bay, Rundu, Ondangwa, Oshakati and Windhoek. In terms of infrastructure equipment, the company has bin/skip trucks, long distance haulers, tippers, mobile balers, shears, and cable strippers, as well as weighbridges (some of which are open to the public). The majority (90%) of products are exported overseas and 10 per cent to South Africa.[20] Key products include copper, brass, aluminum, stainless steel, batteries, tungsten, and zinc.

16 https://www.sadc.int/themes/environment-sustainable-development/waste-management/
17 https://www.pressport.com/int/namigreen/pressreleases/great-news-for-namibia-namigreen-partners-with-multichoice-and-goes-nationwide-26793?utm_source=rss&utm_medium=rss&utm_campaign=Subscription&utm_content=pressrelease#rss
18 https://www.namigreen.com/ecorobotics
19 https://rnf.com.na/
20 http://www.scrapsalvagenam.com/?fbclid=IwAR3XT55gru9Ef9Nhg3a1JEQVCSnRq8yd0AzAPjqvPqCpSctwmAY9u5k2jQk

Rent-A-Drum is a waste management company that has been operating in Namibia since 1989, and which focuses on recycling, mining, landfill, and hazardous waste management.[21] They offer skip removals, general waste collection, including through household and mobile recycling stations, and hazardous waste collection. The company has a material recovery facility for dry municipal solid waste used to separate, process and temporarily store waste before transporting it to South Africa.

The City of Windhoek's solid waste management division has dedicated e-waste disposal and recycling infrastructure where recyclers, such as NamiGreen, are involved in the collection to such facilities. The general public is also able to drop-off e-waste in a dedicated container skip at the City owner Kupferberg landfill site.[22] Under the Health Services and Solid Waste Department of the municipality of Swakopmund, there is a dedicated division on environmental and waste management that facilitates a dedicated e-waste site in the town of Swakopmund.

3 E-waste statistics

3.1 Methodology

To improve comparability between countries, it is highly desirable to have a sound measurement framework that can integrate the harmonized existing data and serve as the basis for e-waste statistics and e-waste indicators.

The statistical methodology used in this report to quantify the main e-waste indicators follows the principles set out in the internationally harmonized framework that has been developed jointly through the Partnership on Measuring ICT for Development initiative by United Nations University (UNU), International Telecomunication Union (ITU), United Nations Environment Programme (UNEP), Eurostat, the Organization for Economic Cooperation and Development and other United Nations agencies. These principles are described in the *E-waste Statistics Guidelines on Classification Reporting and Indicators – Second Edition*.

3.1.1 International framework

The measurement framework of e-waste statistics follows a mass balance approach over the entire life cycle of EEE. This covers the manufacturing phase, the EEE placed on the market (EEE POM), the use phase, and the e-waste generated phase. Different flows should be distinguished to determine the amount of e-waste, which is formally collected and recycled, and the amount that undergoes other activities such as uncontrolled picking, disposal, illegal export etc (Figure 1).

As a first step, the framework quantifies the amount of EEE placed on market (EEE POM). EEE POM covers any product supplied to the national market for consumption and use by households, businesses and public authorities.

The UNU-KEYs classification system, which is used, can allow several operations from a statistical point of view. First of all, the UNU-KEYs are correlated to other e-waste classifications, so they

[21] https://www.rent-a-drum.com.na/
[22] Consultation with Kupferberg landfill, December 2021.

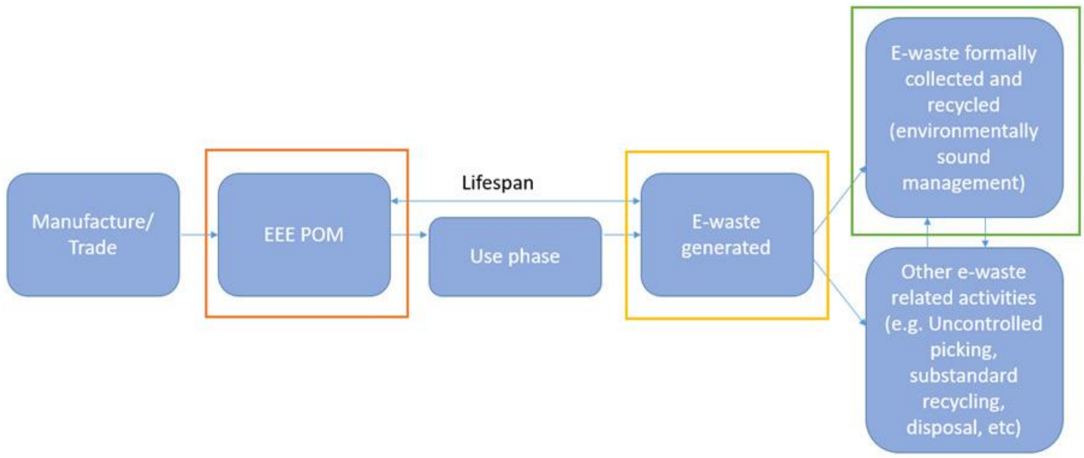
can be converted, for instance, to the six categories of the European Union (EU) WEEE Directive (see Annex A). Secondly, it can be used to collect statistical data on EEE placed on the market, through the link with the Harmonized Commodity Description and Coding System (HS codes) and converting the data in number of units to weight by applying the specific average weights of the UNU-KEYs. The lifetimes of the UNU-KEYs are also homogeneous, which enables to determine the amount of e-waste generated per year. In fact, the e-waste generated is based on a dataset of EEE put on market over a time series and the average lifetime of a product. Since the product composition of the products within a UNU-KEYs is homogeneous, the classification is also suitable for material flow analysis of the raw material components in EEE and e-waste.

To capture the most important dynamics of e-waste, the following indicators are defined for SDGs and e-waste international guidelines:

- Indicator 1: EEE POM (put on market)
- Indicator 2: E-waste generated
- Indicator 3: E-waste managed in an environmentally sound manner (also referred to as e-waste formally collected) - f.i. under e-waste legislation
- Indicator 4: E-waste collection rate (Indicator 3 divided by Indicator 2)

The performance of the entire e-waste management is expressed using the e-waste collection rate, defined as Indicator 4, which is expressed as a percentage. The collection rate can be an indication of the progress made by the country towards achieving a fit for purpose management of the e-waste sector.

Figure 1: Harmonized framework for e-waste statistics



Source: ITU

The EEE POM can be calculated though a variety of data sources. The easiest methodology is using the apparent consumption methodology, according to which EEE POM can be obtained with Equation 2:

Equation 2

$$POM = Import - Export + Domestic\ Production$$

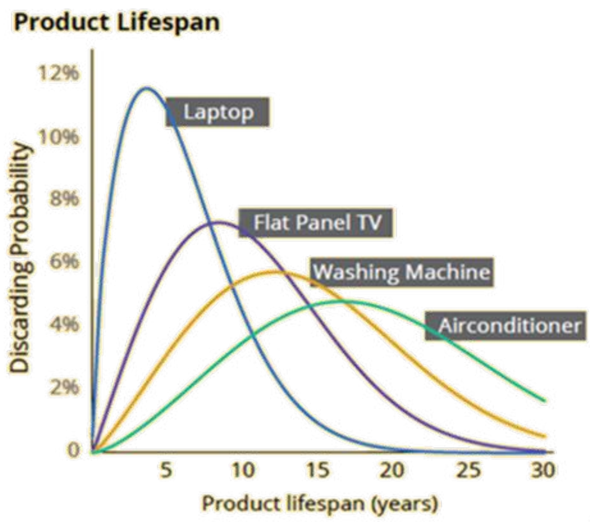
The EEE POM is calculated for each UNU-KEY, from preferably 1980 to the present day and includes imports of both new and used-EEE, but also all EEE domestically produced EEE (manufactured new EEE and used-EEE for reuse).

Since trade statistics and domestic production data are usually expressed in units, a unit to weight conversion factor for each UNU-KEY is calculated and applied to obtain the amount of EEE POM in mass.

After a product has been placed on the market, it stays in use, or at the household, or business or governmental institute until it is discarded. The lifespan of a product is counted from when the product has been put on the market to the time it becomes e-waste. This includes the hibernation phase, such as the storing/stockpiling of the equipment until it has been put on the market or the hoarding time of the equipment prior to actual discarding at end of life, as well as the passing on of the equipment from one owner to another (reuse). The lifespan of EEE is expressed as a Weibull function and varies per UNU-KEY (Figure 2), with the shape and scale parameters associated to the average lifespan for each UNU-KEY individually. The time series of EEE POM and lifespans are then used to calculate e-waste generated for each UNU-KEY. The mathematical description of 'e-waste generated' is explained in Annex E.

E-waste generated in a country refers to the total weight of all types of EEE (and its parts) that have been discarded by the owner as waste without the intention of re-use that resulted from EEE, which had been put on the market of that country, prior to any other activity such as collection, preparation for reuse, treatment, or recovery, including recycling and export[23].

Figure 2: Lifespans of product



Source: Adapted from the [E-waste Statistics Guidelines on Classification Reporting and Indicators]

In general, waste management involves the collection, transportation, storage, the disposal of waste, including after-care of disposal sites. It is of vital importance that e-waste undergoes depollution, and hazardous waste fractions are disposed of in an environmentally responsible manner, and recyclable components are properly recycled. This is typically, but not exclusively, performed under the requirements of national e-waste legislation. Therefore, this flow is referred

23 https://ec.europa.eu/environment/waste/weee/pdf/16.%20Final%20report_approved.pdf

to as "e-waste formally collected" in the context of this report and the *E-waste Statistics Guidelines on Classification Reporting and Indicators – Second Edition*.

Waste management can be undertaken by an economic unit within a legal framework, but there is also waste handling carried out by informal economic units (e.g. informal waste picking) or illegal waste-handling. In this context, "waste management", and "other waste related activities" as proposed by the Waste Statistics Framework from the United Nations Economic Commission for Europe[24] are distinguished.

In that framework, waste management is defined as the set of lawful activities carried out by economic units of the formal sector, both public and private for the purpose of the collection, transportation, and treatment of waste, including final disposal and after-care of disposal sites. The "other waste related activities" includes waste dumping, waste picking, disposal, etc., and may include the informal sector[25].

E-waste can also be managed in such a way that it can cause damage to the environment if hazardous substances are not treated. One such example of inferior treatment is when e-waste is mixed with residual waste and also ends up landfill as it had not been separated at source. It can also be mixed with other waste, for instance, metal scrap, and recycled together with metal scrap. Not all recyclable parts are recycled, and hazardous components of e-waste are left untreated. Thus, this waste management is not accounted for in the environmentally responsible e-waste flow.

For e-waste, "other waste-related activities" may involve the selective dismantling of the valuable parts, recovery of some metals, or dumping at uncontrolled landfills. The hazardous components of e-waste are untreated, this is typically done by informal waste operators. The activities performed by the informal sector usually do not imply minimum safety requirements, environmental standards and depollution techniques.

Import and exports can occur for used-EEE and e-waste. This is called transboundary movement. Transboundary movement of e-waste occurs with whole products, or parts / components. It needs to be distinguished whether the e-waste is exported according to the criteria in the national legislation, in other words managed by e-waste certified recyclers in the receiving countries, or not. Then the amounts of exported e-waste have to be added up to the environmentally responsible e-waste flow, otherwise, it should be added to other e-waste management. Imports of e-waste, however, do not have to be added to the national totals of e-waste formally collected and recycled, but should be recorded separately. Imported used-EEE has to be added to the EEE POM, and the exported used-EEE can be defined as a flow to measure[26].

3.1.2 Data sources

Several data sources have been used and compared to start quantifying the main statistics indicators. Statistical data on EEE POM and e-waste generated were obtained from the estimations provided by SCYCLE that were obtained from the Namibia Statistics Agency International Trade Statistics Database[27]. All the data on import and export of EEE for Namibia

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24 https://unece.org/sites/default/files/2021-03/04_WasteStatistics_forConsultation_0.pdf

25 ILO definition of informal sector: A group of production units comprised of unincorporated enterprises owned by households, including informal own-account enterprises and enterprises of informal employers (typically small and non-registered enterprises). See ILO (2017) section 4.5 on informal economy workers.

26 https://ewastemonitor.info/wp-content/uploads/2021/12/REM_2021_ARAB_web_final_nov_30.pdf

27 https://comtrade.un.org/

were downloaded. Then, to obtain a longer time series, a statistical regression was applied to get data starting from 1980 until the most recent year. The dataset is then cleaned through a statistical validation procedure to identify eventual outliers and data gaps and obtain the EEE POM dataset. From the complete dataset of EEE POM and information on the lifespan of products, it was then possible to quantify also the e-waste generated.

The Namibian Statistics Agency (NSA) was then in charge to improve the estimation provided by SCYCLE on the amount of EEE POM and e-waste generated in the country, using the data and information provided by other national institutions. Trade data which includes EEE HS codes is collected daily by the NAMRA and analysed monthly by the NSA. Data on EEE imports and exports were obtained for the years from 2004 until 2020.

A fundamental instrument to perform the calculations of the e-waste statistics indicators of the harmonized framework was the use of the E-waste Toolkit provided by SCYCLE. The E-waste Toolkit consists of two Excel files, two user manuals on the operational use of the Excel files, and the *E-waste Statistics Guidelines on Classification Reporting and Indicators – Second Edition*.

Data on e-waste formally collected have been obtained from by direct consultation with private companies active in field of e-waste collection.

3.1.3 Data processing

Data processing is a series of actions or operations that convert data into useful information. For this study, the data processing to obtain the first two e-waste indicators was possible through the use of the e-waste tools provided by SCYCLE. The e-waste tools are two excel files that are programmed to help the user to calculate the amount of EEE POM and e-waste generated in a country. The E-waste Generated Tool uses the outcomes of the EEE Put on the Market Tool (EEE POM Tool), which is the data on the EEE placed on the market, per UNU-KEY and per year, and calculates the amount of e-waste generated (again, per UNU-KEY and per year). The EEE POM Tool helps the user to prepare, adjust and convert the available country data on EEE POM prior to inserting it in the E-waste Generated Tool. The E-waste Generated Tool calculates the amount of e-waste generated and it is pre-populated with SCYCLE estimations of EEE POM data for each country through the Import/Export data of the UN Comtrade and used in the methodology described above.

This study combined validation techniques based on the experience and knowledge of trends of EEE in Namibia performed by the NSA, and SCYCLE methodology on e-waste statistics. In this context, raw data from Namibia Customs were harmonized as EEE datasets according to HS codes as per the *E-waste Statistics Guidelines on Classification Reporting and Indicators – Second Edition* and following the procedure explained in the manuals on the EEE POM Tool and the E-waste Generated Tool. The main steps conducted were:

1. Gathering and sorting the data on importation and exportation of EEE using the relevant codes that describe EEE in the Harmonized Commodity Description and Coding System (HS code) and UNU-KEYs system. The data on importation of EEE was in a time series format, covering the period of 2004-2020.
2. Linking the HS codes data to the UNU-KEYs classification system and converting the units to weight using the average weight data per EEE appliance type which is available at UNU-Key level using EEE POM Tool.
3. Undertake data validation by adjusting for outliers.

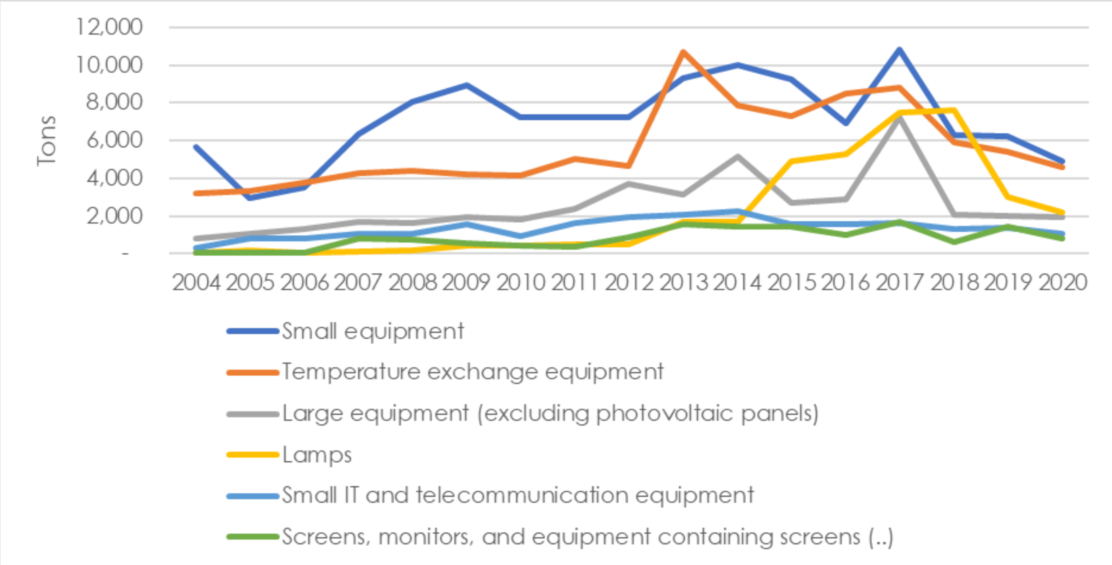
4. Computation of e-waste generated in the country using the E-waste Generated Tool, which uses the EEE POM dataset and the lifespan distributions.

3.2 Results

3.2.1 Electric and electronic equipment put on the market

From the applied methodology, it was possible to determine a complete dataset of electric and electronic equipment put on the market (EEE POM) in Namibia from 2004 to 2020 (Figure 3). The subset (2015-2020) of the dataset can be consulted in Annex C of this report.

Figure 3: Put on market in Namibia (EU6) in tonnes (2004 to 2020)



Source: ITU

Small equipment was the category with the highest amount of EEE put on the market. The category had an upward trend through most of the period under study, and the amount of EEE put on the market rose to 120 914 tonnes from 2004 to 2020. The amount of EEE put on the market decreased by 21.6 per cent in 2020 compared to the 6 234 tonnes that were recorded in 2019. Regarding annual contribution, 2017 recorded the highest weight with a percentage share of 8.9, while 2014 recorded the second highest contribution to the total EEE put on the market with 8.3 per cent. In addition, the lowest amount of EEE put on the market was recorded in 2005 with a share of 2.4 per cent.

Temperature exchange equipment was the second highest category for the amount of EEE put on the market contributing 96 237 tonnes from 2004 to 2020. Vast amounts of this category of equipment were put on the market in 2013 contributing 11.1 per cent, and 2017 recorded the second highest amount with a share of 9.1 per cent while the lowest recorded amount of temperature exchange equipment put on the market was recorded in 2004 with a weight of 3 236 tonnes. The amount of e-waste POM from this category decreased by 15 per cent in 2020 from its level of 5 399 tonnes recorded in 2019.

Large equipment (excluding photovoltaic) contributed 43 472 tonnes of e-waste POM from 2004 to 2020. The highest amount was recorded in 2017, with 16.6 per cent. The second highest amount of large equipment put on the market was recorded in 2014 accounting for

11.9 per cent while the lowest amount was witnessed in 2004 with a contribution of 1.8 per cent. In terms of percentage change, 2020 recorded a drop of 5.7 per cent from the 2 045 tonnes recorded in 2019.

In 2020, the highest EEE categories put on the market are:

- small equipment;
- temperature exchange equipment;
- lamps.

Table 2: Top 3 EEE categories put on the Market (2020)

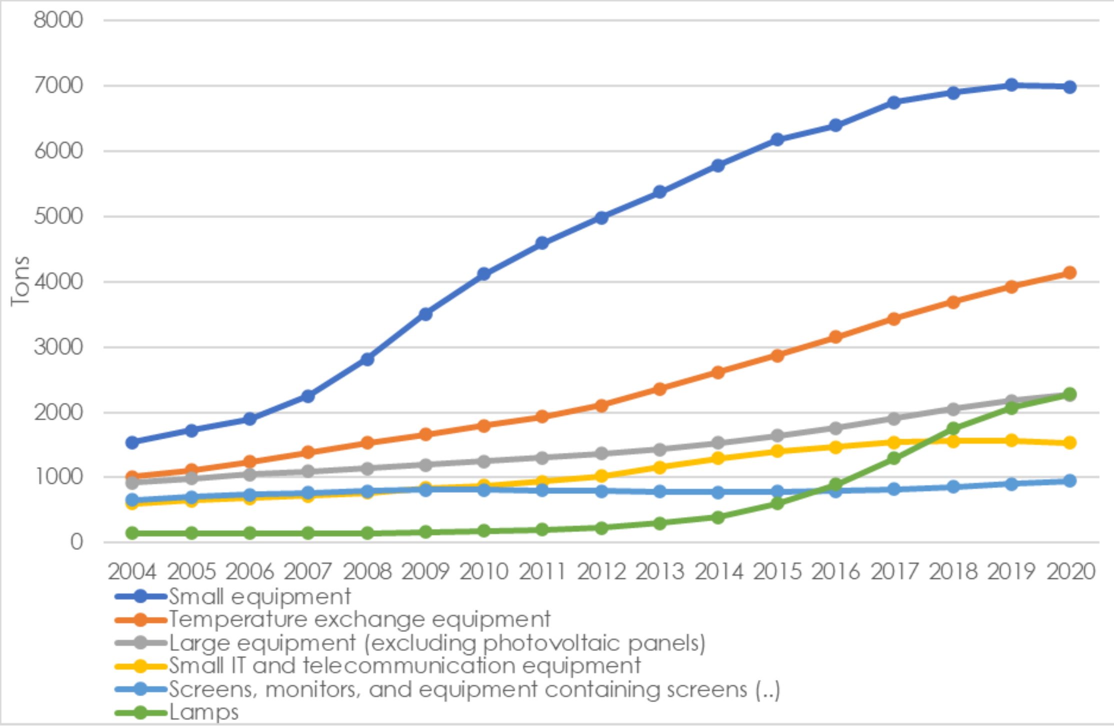
EEE category	Weight (tonnes)	Year
Small equipment	4 887	2020
Temperature exchange equipment	4 590	2020
Lamps	2 224	2020

Table 2 outlines the top three highest categories of EEE put on the market in Namibia. The small equipment category contributed the most to e-waste with a share of 31.5 per cent of the total EEE POM in 2020. A total weight of 4 887 tonnes of small equipment was put on the market in 2020, reflecting a decrease of 1 347 tonnes compared to 2019. Temperature exchange equipment ranked second with a weight of 4 590 tonnes of EEE put on the market, representing 29.6 per cent of the total EEE POM in 2020. This represents a decrease of 809 tonnes compared to the previous year. The lamps category was the third highest category with 14.4 per cent of the total EEE POM in 2020. This is a decrease of 27.1 per cent from the 3 048 tonnes recorded for 2019.

3.2.2 E-waste generated

Similarly, it was possible to see the amount of e-waste generated in Namibia for the period from 2004 to 2020 (Figure 4). The dataset can be consulted in Annex D of this report.

Figure 4: E-waste generated in Namibia (EU6) in tonnes (2004 to 2020)



Source: ITU

All six categories of EEE have been generating electronic waste products, with an upward trend throughout the period under study. The small equipment category generated the highest amount of e-waste with a total of 78 830 tonnes from 2004 to 2020, representing 8.9 per cent of the total amount of e-waste for that period, with most electronic waste for small equipment recorded in 2019. The amount of e-waste generated for small equipment in 2020 dropped by 0.5 per cent to 6 986 tonnes.

The temperature exchange equipment category was the second highest generator of e-waste, amounting to 39 989 tonnes throughout the period under study. The highest level of e-waste for this category was recorded in 2020, rising to 10.4 per cent of e-waste generated in that year. This was an increase of 5.5 per cent from 2019 figures.

E-waste generated by the large equipment category (excluding photovoltaic panels) amounted to 25 093 for the period from 2004 to 2020 and its highest output was noted in 2020, with an increase of 4.5 per cent compared to 2019.

The *Global E-waste Monitor 2020* estimated that Namibia generated a total of 15 700 tonnes of e-waste in 2019, equivalent to an average of 6.4 kg per inhabitant.[28] In comparison, estimates from this national study show that Namibia generated a total of 18 161 tonnes in 2020, which is equivalent to 7.1 kg per inhabitant. The EEE categories which appear to be most relevant for the amounts of e-waste generated of the country in 2020 are the small equipment, temperature exchange equipment, and lamps categories.

[28] https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_july1_low.pdf

Table 3: Top 3 categories of e-waste generated in Namibia (2020)

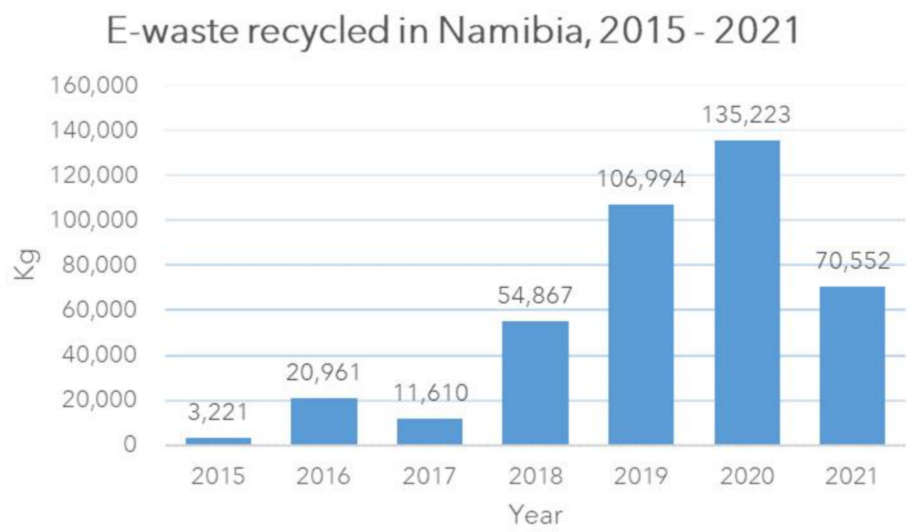
EEE category	Weights (tonnes)	Year
Small equipment	6 986	2020
Temperature exchange equipment	4 140	2020
Lamps	2 280	2020

The small equipment category generated the most electronic-waste in 2020, accounting for 38.5 per cent of the total e-waste generated, followed by the temperature exchange equipment category and lamps category accounting for 22.8 per cent and 12.6 per cent, respectively.

3.2.3 Electronic waste flows

Namibia saw a growth in recycling between 2018 and 2020, with e-waste recycling in 2020 increasing by 26 per cent when compared to 2019 (Figure 5). In 2020, recycled e-waste reached 135 220 kg but fell to 70 552 kg in 2021, which coincides with the period of COVID-19 restrictions. The overall growth in recycling is a result of increased awareness of e-waste in society, including through government efforts, and the work of other organizations, in raising awareness of this issue.

Figure 5: E-waste recycled in Namibia, 2015-2021[29]



Source: Namigreen

Items such as printed circuit boards are exported to Europe for recycling. Digital decoders remain the most EEE-related imported waste into the country, mainly sourced from Zambia.

Namibia disposes of e-waste that has not been recycled or exported. The main e-waste recycler in the country contracts a private company to collect all un-recycled e-waste. This is disposed of at the Kupferberg Landfill Site owned by the City of Windhoek, with the private contractor

[29] Data provided by Namigreen. https://www.pressport.com/int/namigreen/pressreleases/namibians-continues-to-recycle-e-waste-26753?utm_source=rss&utm_medium=rss&utm_campaign=Subscription&utm_content=pressrelease#rss

charging a meagre amount per tonne for disposal. Considering the challenges at the landfill, the e-waste recycler is seeking investment to implement environmentally friendly e-waste disposing processes.

In the informal sector, recyclers are mostly interested in high value copper wires found in computer cables. The informal recyclers cut off or burn these cables on open fires in order to remove the copper wires and sell the copper to scrap yards. The plastics from computer cables are burned during this process causing pollution.

There is a lot of e-waste that ends up at the national landfills. People are allowed to drop off e-waste at the City of Windhoek in the same way as waste management companies. At the landfill, agents of the private contractor running the landfill only capture the weight of waste and record all e-waste being dropped off as general waste.

Due to the present lack of data, other dimensions of e-waste such as uncontrolled picking and sub-standard recycling were not explored in this study.

4 Issues and challenges

The purpose of this section is to identify the main challenges encountered in Namibia in terms of the quantification methodology, the legislative process, and the overall management of e-waste.

Concerning e-waste management, stakeholders identified distance to facilities as the main issue. Waste collection infrastructure is not equally distributed across Namibia, and this results in a lack of incentive to recycle e-waste, especially when associated travel costs do not make recycling economically viable.

The e-waste industry is faced with other challenges such as low awareness among citizens, increasing volumes of e-waste, competition with the informal sector, absence of an established regulatory framework, which is still in development, lack of financial investments, absence of e-waste data collection and statistics, absence of reporting and monitoring systems, scarce management infrastructure and large geographical distance of citizens from recycling points.

5 Roadmap and recommendations

The final goal of the national e-waste monitor is to develop a roadmap and recommendations to improve e-waste data quality and availability in Namibia. The goal is to help Namibia to regularly record internationally comparable e-waste statistics. Table 4 lists key actions to achieve this goal.

Table 4: Roadmap for e-waste statistics

Recommended actions
Continue to expand and annually update the time series of trade statistics data to improve the estimation of EEE POM and e-waste generated.
Perform quality checks and validation of the data obtained (e.g. missing years or UNU-KEYs, outliers, etc.).
Consider including data on domestic production of EEE if relevant for Namibia.
Integrate other data sources into the model (for instance to get a picture of the e-waste collected and recycled, or e-waste illegally imported and exported, e-waste in general waste, etc).
Start including e-waste in the country-wide census and surveys.
Develop an internal routine to implement the e-waste statistics methodology regularly in Namibia.
Build a national database to record yearly e-waste generated and e-waste collected.
Develop a strategy/routine for the collection of information from all stakeholders involved.
Define an e-waste classification to be included in the draft national policy on management of WEEE, improving harmonization and uniformity at the national/international level (e.g. adoption of the UNU-KEYs or six e-waste categories).
Develop a specialized team to monitor and control e-waste data.
Develop training programmes to build skills and technical knowledge and continue to build on the training provided by UNITAR, ITU and UBOS.
Engage academia and conduct research on e-waste nation-wide.
Create public-private partnerships in order to help keep track of the e-waste industry.

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Annexes

Annex A

UNU-KEYs classification and link to the six categories.

UNU-KEY	Full Name	Six Categories
0001	Central Heating (household-installed)	IV
0002	Photovoltaic Panels	IV
0101	Professional Heating & Ventilation (excl. cooling equipment)	IV
0102	Dishwashers	IV
0103	Kitchen (e.g. large furnaces, ovens, cooking equipment)	IV
0104	Washing Machines (incl. combined dryers)	IV
0105	Dryers (wash dryers, centrifuges)	IV
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	IV
0108	Fridges (incl. combi-fridges)	I
0109	Freezers	I
0111	Air Conditioners (household-installed and portable)	I
0112	Other Cooling (e.g. dehumidifiers, heat pump dryers)	I
0113	Professional Cooling (e.g. large air conditioners, cooling displays)	I
0114	Microwaves (incl. combined, excl. grills)	V
0201	Other Small Household (e.g. small ventilators, irons, clocks, adapt-ers)	V
0202	Food (e.g. toaster, grills, food processing, frying pans)	V
0203	Hot Water (e.g. coffee, tea, water cookers)	V
0204	Vacuum Cleaners (excl. professional)	V
0205	Personal Care (e.g. tooth brushes, hair dryers, razors)	V
0301	Small IT (e.g. routers, mice, keyboards, external drives & accesso-ries)	VI
0302	Desktop personal computers (excl. monitors, accessories)	VI
0303	Laptops (incl. tablets)	II
0304	Printers (e.g. scanners, multi-functionals, faxes)	VI
0305	Telecom (e.g. [cordless] phones, answering machines)	VI
0306	Mobile Phones (incl. smartphones, pagers)	VI

(continued)

UNU-KEY	Full Name	Six Categories
0307	Professional IT (e.g. servers, routers, data storage, copiers)	IV
0308	Cathode Ray Tube Monitors	II
0309	Flat Display Panel Monitors (LCD, LED)	II
0401	Small Consumer Electronics (e.g. headphones, remote controls)	V
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	V
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	V
0404	Video (e.g. video recorders, DVD, Blu-ray, set-top boxes)	V
0405	Speakers	V
0406	Cameras (e.g. camcorders, photo, and digital still cameras)	V
0407	Cathode Ray Tube TVs	II
0408	Flat Display Panel TVs (LCD, LED, Plasma)	II
0501	Lamps (e.g. pocket, Christmas, excl. LED and incandescent)	V
0502	Compact Fluorescent Lamps (incl. retrofit and non-retrofit)	III
0503	Straight Tube Fluorescent Lamps	III
0504	Special Lamps (e.g. professional mercury, high & low pressure sodium)	III
0505	LED Lamps (incl. retrofit LED lamps and household LED luminaires)	III
0506	Household Luminaires (incl. household incandescent fittings)	V
0507	Professional Luminaires (offices, public space, industry)	V
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawn-mowers)	V
0602	Professional Tools (e.g. for welding, soldering, milling)	IV
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers)	V
0702	Game Consoles	VI
0703	Leisure (e.g. large exercise, sports equipment)	IV
0801	Household Medical (e.g. thermometers, blood pressure meters)	V
0802	Professional Medical (e.g. hospital, dentist, diagnostics)	IV
0901	Household Monitoring & Control (alarm, heat, smoke, excl. screens)	V

(continued)

UNU-KEY	Full Name	Six Categories
0902	Professional Monitoring & Control (e.g. laboratory, control panels and invertors)	IV
1001	Non-Cooled Dispensers (e.g. for vending, hot drinks, tickets, money)	IV
1002	Cooled Dispensers (e.g. for vending, cold drinks)	I

Annex B

Six categories in the EU WEEE Directive classification.

6 Categories in EU WEEE Directive[30]	Description
I	Temperature exchange equipment (TEE)
II	Screens and monitors
III	Lamps
Iva	Large equipment (excl. PV panels)
IVb	Photovoltaic panels
V	Small equipment
VI	Small IT

30 European Commission (2018). Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012L0019 (accessed January 2020).

Annex C

EEE POM in Namibia (kt) – per category.

EU-6		2015	2016	2017	2018	2019	2020
I	Temperature exchange equipment (TEE)	7.3	8.5	8.8	5.9	5.4	4.6
II	Screens and monitors	1.5	1.0	1.7	0.7	1.5	0.8
III	Lamps	4.9	5.3	7.5	7.6	3.0	2.2
IVa	Large equipment (excl. PV panels)	2.7	2.9	7.2	2.1	2.0	1.9
IVb	Photovoltaic panels	-	-	-	-	-	-
V	Small equipment	9.3	6.9	10.8	6.3	6.2	4.9
VI	Small IT	1.5	1.6	1.6	1.3	1.4	1.1
	Total	**27.2**	**26.2**	**37.6**	**23.9**	**19.5**	**15.5**

EEE POM in Namibia (kg/inh) – per category.

EU-6		2015	2016	2017	2018	2019	2020
I	Temperature exchange equipment (TEE)	3.2	3.7	3.7	2.5	2.2	1.9
II	Screens and monitors	0.6	0.4	0.7	0.3	0.6	0.3
III	Lamps	2.1	2.3	3.1	3.2	1.3	0.9
IVa	Large equipment (excl. PV panels)	1.2	1.3	3.0	0.9	0.9	0.8
IVb	Photovoltaic panels	-	-	-	-	-	-
V	Small equipment	4.0	3.0	4.5	2.6	2.6	2.0
VI	Small IT	0.7	0.7	0.7	0.6	0.6	0.4
	Total	**11.8**	**11.4**	**15.7**	**10.0**	**8.1**	**6.5**

Annex D

E-waste generated in Namibia (kt) – per category.

EU-6		2015	2016	2017	2018	2019	2020
I	Temperature exchange equipment (TEE)	2.9	3.2	3.4	3.7	3.9	4.1
II	Screens and monitors	0.8	0.8	0.8	0.9	0.9	0.9
III	Lamps	0.6	0.9	1.3	1.8	2.1	2.3
IVa	Large equipment (excl. PV panels)	1.6	1.8	1.9	2.1	2.2	2.3
IVb	Photovoltaic panels	-	-	-	-	-	-
V	Small equipment	6.2	6.4	6.7	6.9	7.0	7.0
VI	Small IT	1.4	1.5	1.5	1.6	1.6	1.5
	Total	**13.5**	**14.5**	**15.7**	**16.8**	**17.7**	**18.2**

E-waste generated in Namibia (kg/inh) – per category.

EU-6		2015	2016	2017	2018	2019	2020
I	Temperature exchange equipment (TEE)	1.25	1.37	1.43	1.54	1.57	1.66
II	Screens and monitors	0.34	0.35	0.34	0.36	0.36	0.38
III	Lamps	0.26	0.39	0.54	0.73	0.83	0.91
IVa	Large equipment (excl. PV panels)	0.72	0.77	0.80	0.86	0.87	0.91
IVb	Photovoltaic panels	-	-	-	-	-	-
V	Small equipment	2.69	2.78	2.81	2.88	2.81	2.79
VI	Small IT	0.61	0.64	0.64	0.65	0.63	0.61
	Total	**5.86**	**6.29**	**6.56**	**7.01**	**7.06**	**7.26**

Annex E

The mathematical description of e-waste generated is a function of the lifespan of EEE and the amount of EEE put on the market (POM) in previous years. In particular:

- *E-waste generated (n)* is the quantity of e-waste generated in evolution year *n*.
- *POM (t)* is the product sales (POM) in any historical year (*t*) before year *n*.
- t_0 is the initial year that a product was sold.
- *L* $^{(p)}$ *(t, n)* is the discard-based, lifetime profile for the batch of products sold in historical year *t*.

Equation 3

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

The lifespan *L* $^{(p)}$ *(t, n)* is the lifespan profile of an EEE product sold in year *t,* which reflects its probable obsolescence rate in evaluation year *n*. The discard-based lifespan profile for a product can be modelled using several probability functions. The Weibull distribution function is considered the most suitable for describing discard behaviour for EEE and has been applied in the European Union and in scientific literature.

Owing to social and technical developments, product lifespan can be time-dependent. For instance, the cathode ray tube monitor rapidly became outdated as a result of technological developments in flat-screen monitors. In such cases, lifespan distributions should ideally be modelled for each historical sales year. The Weibull function is defined by a time-varying shape parameter α *(t)* and a scale parameter β *(t)*, as described in the equation below:

Equation 4

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

For other, more stable products, time-independent lifespans are sufficient to describe actual behaviour. In such cases, the variations in the shape and scale parameter over time are minor and, as such, can be disregarded. The distribution of product lifespans in such cases can thus be simplified as follows:

Equation 5

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

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