THE GLOBAL E-WASTE MONITOR 2024

Authors: Cornelis P. Baldé, Ruediger Kuehr, Tales Yamamoto, Rosie McDonald, Elena D'Angelo, Shahana Althaf, Garam Bel, Otmar Deubzer, Elena Fernandez-Cubillo, Vanessa Forti, Vanessa Gray, Sunil Herat, Shunichi Honda, Giulia Iattoni, Deepali S. Khetriwal, Vittoria Luda di Cortemiglia, Yuliya Lobuntsova, Innocent Nnorom, Noémie Pralat, Michelle Wagner

Image: Muntaka Chasant for Fondation Carmignac

unitar
United Nations Institute for Training and Research
ITU
FONDATION CARMIGNAC | PHOTOJOURNALISM AWARD

Copyright and Publication Information

Contact Information

For enquiries, please contact the corresponding author, Cornelis P. Baldé, at balde@unitar.org.

Required Citation

Cornelis P. Baldé, Ruediger Kuehr, Tales Yamamoto, Rosie McDonald, Elena D'Angelo, Shahana Althaf, Garam Bel, Otmar Deubzer, Elena Fernandez-Cubillo, Vanessa Forti, Vanessa Gray, Sunil Herat, Shunichi Honda, Giulia Iattoni, Deepali S. Khetriwal, Vittoria Luda di Cortemiglia, Yuliya Lobuntsova, Innocent Nnorom, Noémie Pralat, Michelle Wagner (2024). International Telecommunication Union (ITU) and United Nations Institute for Training and Research (UNITAR). 2024. Global E-waste Monitor 2024. Geneva/Bonn.

Pdf version: 978-92-61-38781-5
Epub version: 978-92-61-38791-4
Mobile version: 978-92-61-38801-0

United Nations Institute for Training and Research (UNITAR) - Sustainable Cycles (SCYCLE) Programme

Since January 2022, Sustainable Cycles (SCYCLE) has been a programme under the United Nations Institute for Training and Research (UNITAR) Division for Planet. SCYCLE's mission is to promote sustainable societies. Its activities focus on the development of sustainable production, consumption and disposal patterns for electrical and electronic equipment (EEE), as well as for other ubiquitous goods. SCYCLE leads the global e-waste discussion and advances sustainable e-waste management strategies based on life-cycle thinking. SCYCLE's vision is to enable societies to reduce the environmental load of production, usage and disposal of their day-to-day goods to sustainable levels through independent, comprehensive, and practical research that provides facts for more thorough policy development and decision-making. Key for SCYCLE is also the transition of research findings into appropriate trainings. www.unitar.org; www.scycle.info.

International Telecommunication Union (ITU)

ITU is the United Nations specialized agency in the field of ICTs. Its mandate is to develop programmes in response to the challenges of climate change and the growing quantities of e-waste globally. It is involved in circular economy and climate change activities such as research, capacity building and developing international standards. Its strategic plan for 2024-2027 sets a target (2.5) of "significant improvement of ICTs' contribution to climate and environment action", as measured by concrete indicators, including the global e-waste recycling rate, the number of countries with an e-waste legislation and the contribution of telecommunications/ICTs to global greenhouse gas emissions. For more information on ITU Telecommunication Development Sector environmental work, see https://www.itu.int/itu-d/sites/environment.

Fondation Carmignac

The Fondation Carmignac was founded in 2000 by Edouard Carmignac, a French entrepreneur, CEO and Chairman of asset management company Carmignac. Today, it is structured around 3 main pillars which developed one after the other: The Carmignac Collection, the Carmignac Photojournalism Award and the Villa Carmignac in Porquerolles.

Since 2009, the Carmignac Photojournalism Award has been funding the production of an investigative photo reportage on human rights violations and geo-strategic issues and allows photographers to conduct long-term fieldwork. The 13th edition of the Carmignac Photojournalism Award is dedicated to Ghana and the ecological and human challenges associated with the transboundary flow of e-waste. The 3 laureates - investigative journalist and activist Anas Aremeyaw Anas and photojournalists Muntaka Chasant and Bénédicte Kurzen (NOOR) - spent 9 months documenting an incredibly ambiguous and complex ecosystem in a transnational approach. Their photographs taken in Ghana and in parts of Europe are featured throughout this report. From European ports where Ghanaian exporters from the diaspora export their merchandise, to the many informal scrapyards peppered around southern Ghana, and back to repair shops where e-waste is recycled, Anas, Muntaka and Bénédicte dive deep into the ramifications of e-waste trafficking and reveal the opacity of this globalized circle. They highlight the embedded paradox of the e-waste economy, which is both a crucial opportunity for thousands of people in Ghana and has a considerable human and environmental impact.

Table of Contents

Acknowledgements

The Global E-waste Monitor 2024 is funded, and prepared in partnership, by the UNITAR SCYCLE Programme, ITU and Fondation Carmignac. The authors would like to thank the United Nations Environment Programme for the additional financial contribution, the cooperation with data collection and the overall support towards the development of this Monitor.

Overall coordination was provided by Dr. Cornelis P. Baldé and Professor Ruediger Kuehr of UNITAR and Vanessa Gray of ITU. The following persons contributed to the report in varying capacities (their affiliations are included for identification purposes): Dr. Cornelis P. Baldé (UNITAR), Professor Ruediger Kuehr (UNITAR), Tales Yamamoto (UNITAR), Elena D'Angelo (UNITAR), Vittoria Luda di Cortemiglia (UNITAR), Dr. Otmar Deubzer (UNITAR), Elena Fernandez-Cubillo (UNITAR), Vanessa Forti (UNITAR), Giulia Iattoni (UNITAR), Vanessa Gray (ITU), Garam Bel (ITU), Dr. Rosie McDonald (ITU), Noémie Pralat (ITU), Dr. Shahana Althaf (Aligned Incentives), Professor Sunil Herat (Griffith University), Dr. Shunichi Honda (UNEP), Dr. Deepali S. Khetriwal (international expert), Yuliya Lobuntsova (CSD Center), Professor Innocent Nnorom (Abia State University), Michelle Wagner (WEEE Forum). For more details, see About the Authors.

The authors would like to thank Professor Maria Holuszko (University of British Columbia), Ekaterina Poleshchuk (UNEP), Dr. Ulrich Kral (Environment Agency Austria), Professor Colin Fitzpatrick (University of Limerick), Simon van Walle (Umicore), Kristine Sperlich (German Environment Agency) and Professor Sutha Khaodhiar (Chulalongkorn University) for reviewing the manuscript, Terry Collins for support in the launch of the publication and media campaign and Dr. Ludgarde Coppens (UNEP) and Takahiro Nakamura (UNEP) for their support in the development of this Monitor.

Muntaka Chasant for Fondation Carmignac

Abbreviations

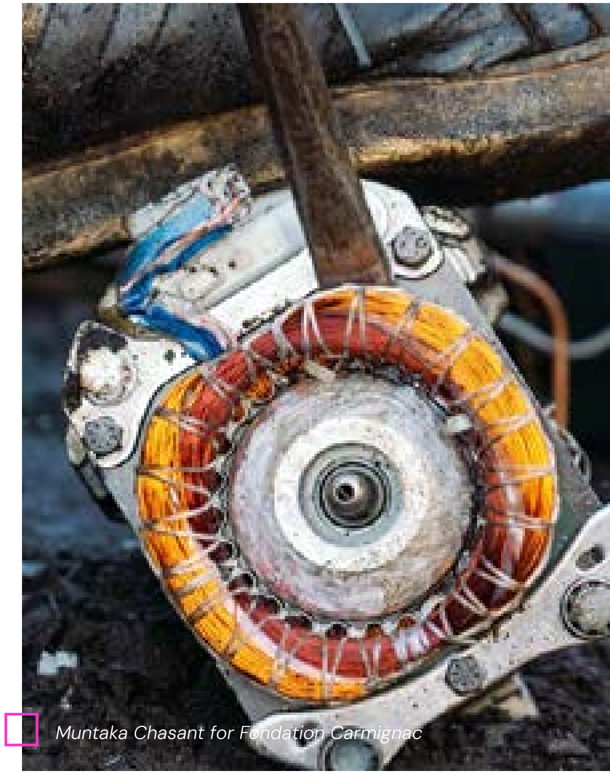
ABBREVIATION	FULL NAME
Basel Convention	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Bamako Convention	Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa
CFC	Chlorofluorocarbons
EACO	East African Communications Organisation
EEE	Electrical and Electronic Equipment
EPR	Extended Producer Responsibility
EU	European Union
EU WEEE Directive	Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast) (Text with EEA relevance)
EU RoHS Directive	Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) (Text with EEA relevance)
EU Waste Framework Directive	Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance)
GEF	Global Environment Facility
GESP	Global E-waste Statistics Partnership
HFC	Hydrochlorofluorocarbons
HS code	Harmonized System Code

ABBREVIATION	FULL NAME
ICT	Information and Communications Technology
ITU	International Telecommunication Union
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
POM	Placed On Market
Rotterdam Convention	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
SDGs	Sustainable Development Goals
StEP Initiative	Solving the E-waste Problem Initiative
Stockholm Convention	Stockholm Convention on Persistent Organic Pollutants
SCYCLE	Sustainable Cycles Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
UNU	United Nations University
WEEE	Waste Electrical and Electronic Equipment

Foreword

The world is experiencing significant electronification, including a digital transformation, with technologies profoundly changing the way we live, work, learn, socialize, and do business. Many people own and use multiple electronic devices, and the increasing interconnectivity of urban and remote areas has led to a rise in the number of devices and objects linked to the Internet. This growth has seen a concomitant surge in the amount of EEE and e-waste. At the same time, the global e-waste collection and recycling rate is not keeping pace with this growth. The Global E-waste Monitor finds that by 2022, the world generated 62 billion kg of e-waste, or an average of 7.8 kg per capita. Only 22.3 per cent (13.8 billion kg) of the e-waste generated was documented as properly collected and recycled. In 2010, the world generated 34 billion kg of e-waste, and that amount has increased annually by an average of 2.3 billion kg per year. The documented formal collection and recycling rate has gone up as well, growing from 8 billion kg in 2010 at an average rate of 0.5 billion kg per year. The rise in e-waste generation is therefore outpacing the rise in formal recycling by a factor of almost 5. The Monitor highlights that growing amounts of EEE are being sold for the first time in developing countries; however, much of the equipment is originally used in developed countries and shipped for further use due to the subsequent relatively lower prices of devices.

Monitoring e-waste quantities and flows is essential for evaluating developments over time, for setting and assessing targets, and for gauging the extent to which electronics can help reduce the impacts of climate change and minimize resource scarcity. When used to augment sound collection and recycling, appropriate data and laws can be extremely effective in accelerating environmental protection and the retention of valuable materials. However, without a comprehensive and representative picture of the global e-waste challenge, the true extent of this waste stream, and the negative externalities it creates, will remain unknown. On the other hand, for industry and policymakers to truly exploit the positive circular economy potential of the electronics sector, reliable data must be freely available to inform decision making.



Muntaka Chasant for Fondation Carmignac

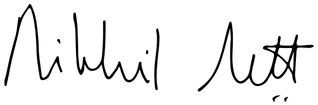
Universal and meaningful connectivity are prerequisites of digital transformation, which among other things, includes the development and use of information and communication technology (ICT), applications and services and the closing of the digital divide. However, there are still 2.6 billion people worldwide without a connection to the Internet. In recent years, the rapid digitalization of economy and society, a significant shift to e-mobility and an evident transition to green and renewable energy solutions, have led to concerns by policymakers over the continued availability of rare-earth elements and critical raw materials to feed these transitions. While the digital, transport and energy sectors increasingly compete for similar raw materials of high importance, global supply chains have become progressively more sensitive to global pandemics and political tensions over resources.

E-waste is a special waste stream due to its varied nature which includes a complex composition of materials and components, a broad array of product types and a rapidly evolving product stream which increasingly comprises miniaturised parts, embedded electronics in traditional equipment, clothing, and toys etc., and more and more interoperable products having the ability to connect to the Internet. At the same time, electrical and electronic equipment - anything with a plug or a battery - holds enormous potential for the transformation of societies, through photovoltaics, solar energy and heat pumps, electric vehicles, smart houses, smart clothes and smart cities, intelligent logistics, smart agriculture, Artificial Intelligence, and the Internet of Things.

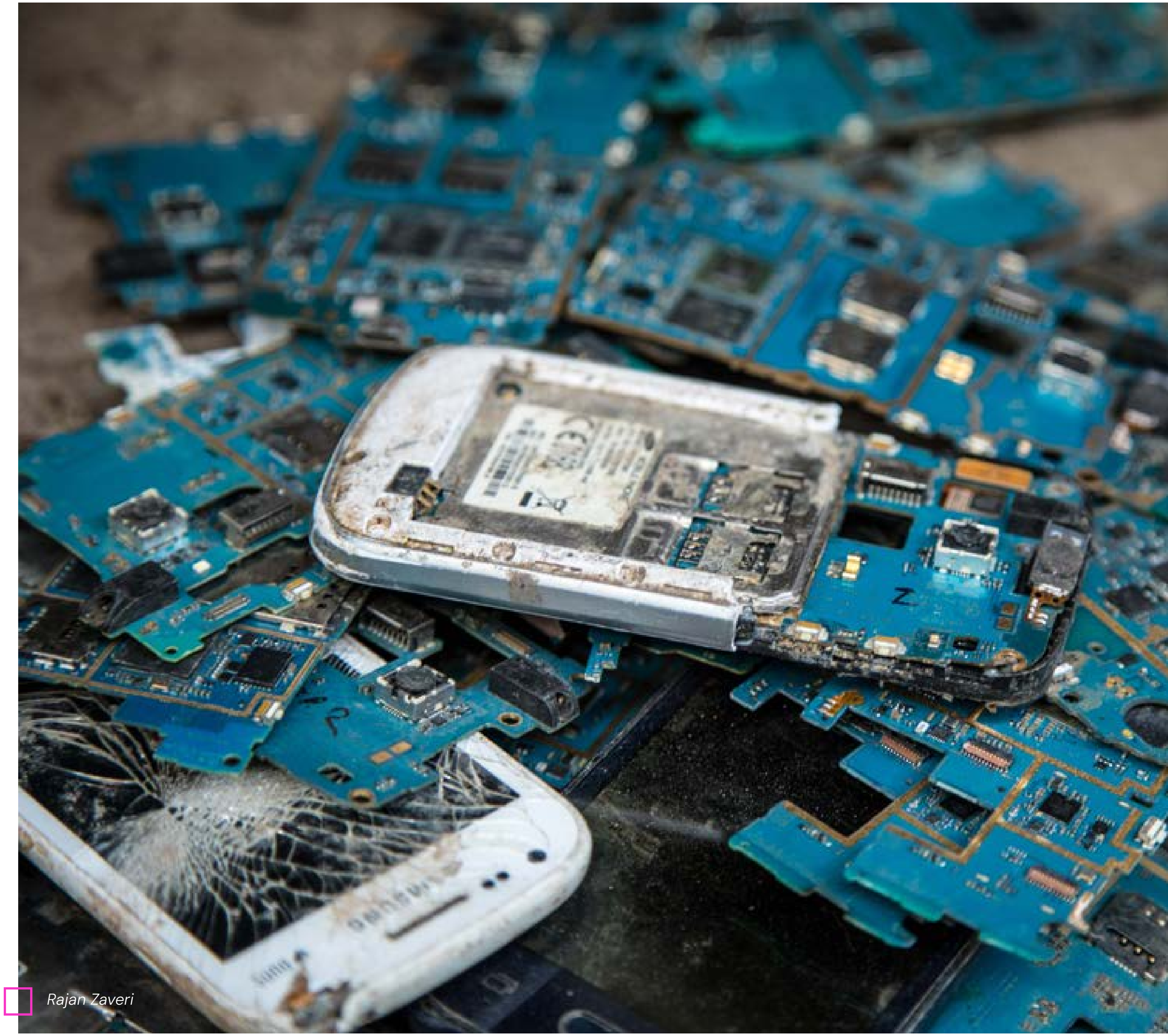
Natalia Catalina / Shutterstock.com

ITU and UNITAR have joined forces in the Global E-waste Statistics Partnership (GESP). The GESP collects data from countries in an internationally standardized way and ensures that this information is publicly available via its open-source global e-waste database (www.globalewaste.org). Since 2017, the GESP has substantially boosted national and regional capacities to produce e-waste statistics in various countries. Ultimately, it supports national efforts to compile e-waste statistics that are useful for national policy-making using an internationally recognized, harmonized measurement framework. It is our pleasure to present to you The Global E-waste Monitor 2024. The fourth edition is an indispensable reference tool for policymakers and industry, that shows us the world where we stand in terms of the global e-waste challenge.

Mr. Nikhil Seth
United Nations Assistant Secretary-General, Executive Director,
United Nations Institute for Training and Research (UNITAR)



Dr. Cosmas Luckyson Zavazava
Director, Telecommunication Development Bureau
International Telecommunication Union (ITU)



Rajan Zaveri

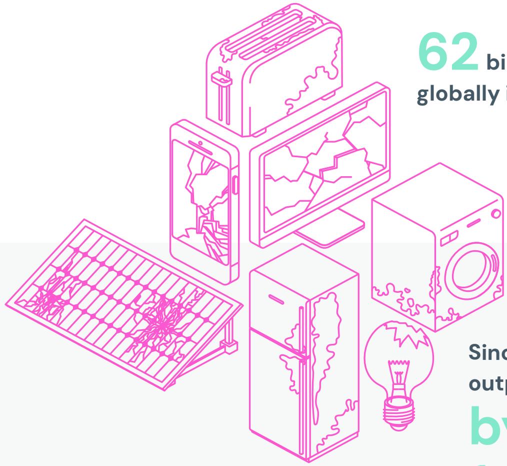
Executive Summary

The world is experiencing significant electronification, including a digital transformation, with technologies profoundly changing the way we live, work, learn, socialize and do business. Many people own and use multiple electronic devices, and the increasing interconnectivity of urban and remote areas has led to a rise in the number of devices and objects linked to the Internet. These include the usual computers and phones, but also a growing list of objects such as household appliances, e-bikes and e-scooters, health monitors, environmental sensors, electronics embedded in furniture and clothes, more and more toys and tools, and energy-saving equipment such as LEDs, photovoltaics and heat pumps.

This growth has seen a concomitant surge in the amount of EEE and e-waste. When EEE is disposed of, it generates a waste stream that contains both hazardous and valuable materials, collectively known as e-waste, or waste electrical and electronic equipment (WEEE). The Global E-waste Monitor has been the foremost source of reporting on this pressing issue since 2014, providing the most up-to-date overview of global e-waste data, statistics, and progress in policy and regulation since 2014. It also provides a look at what the future holds if things change or stay the same.

In 2022, a record 62 billion kg of e-waste was generated globally (equivalent to an average of 7.8 kg per capita per year); 22.3 per cent of this e-waste mass was documented as formally collected and recycled in an environmentally sound manner.

In 2010, the world generated 34 billion kg of e-waste, an amount that has since increased annually by an average of 2.3 billion kg. The documented formal collection and recycling rate has increased as well, growing from 8 billion kg in 2010 at an average rate of 0.5 billion kg per year to 13.8 billion kg in 2022. The rise in e-waste generation is therefore outpacing the rise in formal recycling by a factor of almost 5 – driven by technological progress, higher consumption, limited repair options, short product lifecycles, growing electronification and inadequate e-waste management infrastructure – and has thus outstripped the rise in formal and environmentally sound collection and recycling.



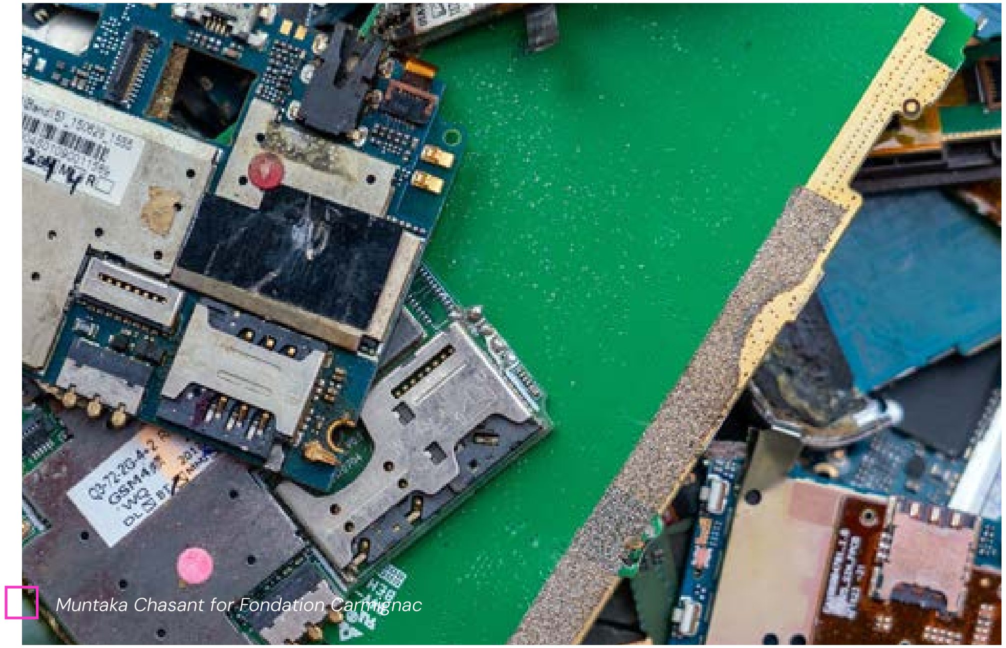
62 billion kg of e-waste generated globally in 2022.

7.8 kg per capita.

22.3% of this e-waste was documented as formally collected and recycled in an environmentally sound manner.

Since 2010, the growth of e-waste generation is outpacing the formal collection and recycling **by almost a factor of 5.**

Source: The Global E-waste Monitor 2024



Muntaka Chasant for Fondation Carmignac

62 billion kg
of e-waste in 2022 have the following characteristics:

13.8 billion kg
of e-waste is documented as formally collected and recycled in an environmentally sound manner.

16 billion kg
of e-waste is estimated to be collected and recycled outside of formal systems in high- and upper-middle-income countries with developed e-waste management infrastructure.

18 billion kg
of e-waste is estimated to be handled in low- and lower-middle-income countries with no developed e-waste management infrastructure, mostly by the informal sector.

14 billion kg
of e-waste is estimated to be disposed of as residual waste, the majority of which is landfilled globally.

Source: The Global E-waste Monitor 2024

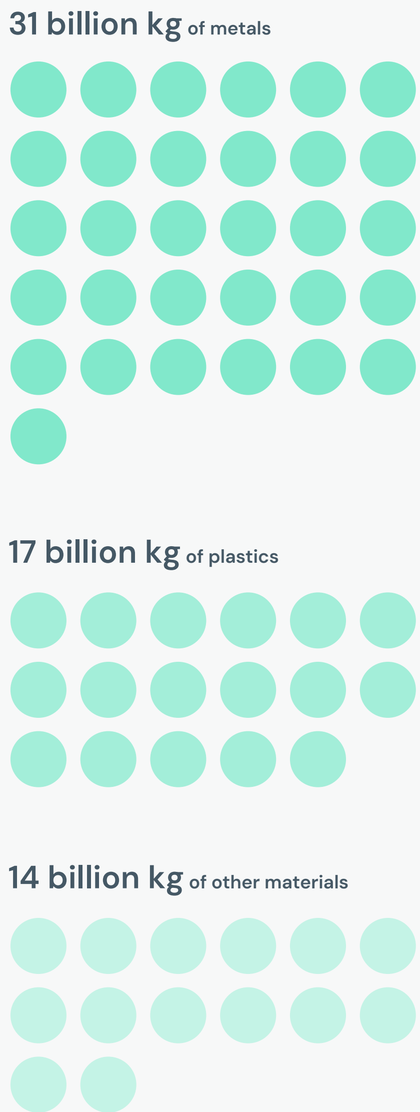
The e-waste generated in 2022 contained 31 billion kg of metals, 17 billion kg of plastics and 14 billion kg of other materials (minerals, glass, composite materials, etc.)

An estimated 19 billion kg of e-waste, mainly from metals like iron which is present in high quantities and has high recycling rates in almost all e-waste management routes, were turned into secondary resources. Platinum-group metals and precious metals were among the most valuable metals but present in much lower quantities; nonetheless, an estimated 300 thousand kg were turned into secondary resources through formal and informal recycling practices.

The share of patent applications for e-waste management rose from 148 per million in 2010 to 787 per million in 2022. Most of those applications were related to technologies for cable recycling, with hardly any signs of an increase in the number of patents filed for technologies related to critical raw materials recovery. Although rare earth elements have unique properties that are crucial for future technologies, including renewable energy generation and e-mobility, the world remains stunningly dependent on the production chains of a few countries. The recycling of such elements remains economically challenging, even in the case of devices with a higher content. Consequently, recycling activities are taking only around 1 per cent of the current demand for the recycling of rare earth elements. The market price for rare earth elements is still too low to support larger-scale commercial recycling operations.

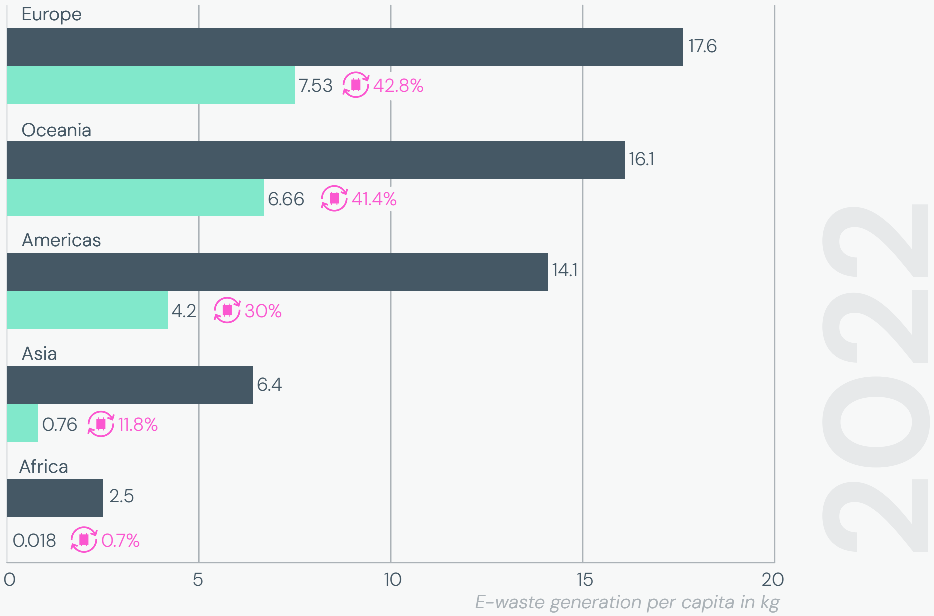
Most e-waste is managed outside formal collection and recycling schemes. As a result of non-compliant e-waste management, 58 thousand kg of mercury and 45 million kg of plastics containing brominated flame retardants are released into the environment every year. This has a direct and severe impact on the environment and people's health.

Composition of Global E-waste in 2022



Source: The Global E-waste Monitor 2024

Amount of E-waste Generated and Collected



E-waste generated per capita in kg E-waste documented to be collected and recycled per capita in kg
Annual average formal collection and recycling rate

Minor inconsistencies may have occurred due to rounding of values during the calculations.

Source: The Global E-waste Monitor 2024

Documented formal collection and recycling rates vary significantly across regions, with Europe boasting a rate of 42.8 per cent.

Nevertheless, EU Member States have made little progress towards reaching their own legally binding collection targets. African countries generate the lowest rates of e-waste but struggle to recycle it; their recycling rates are below 1 per cent. Countries in Asia generate almost half of the world's e-waste (30 billion kg) but have made limited advances in e-waste management; moreover, relatively few of them have enacted legislation or established clear e-waste collection targets. In 2022, the regions that generated the highest amount of e-waste per capita were Europe (17.6 kg), Oceania (16.1 kg) and the Americas (14.1 kg). Since these are the regions with the most advanced collection and recycling infrastructure, they also have the highest documented per capita collection and recycling rates (7.53 kg per capita in Europe, 6.66 kg per capita in Oceania and 4.2 kg per capita in the Americas).

Around one-third (20 billion kg) of the world's e-waste takes the form of small equipment such as toys, microwave ovens, vacuum cleaners and e-cigarettes, yet recycling rates for this category of equipment remain very low, at only 12 per cent globally. Another 5 billion kg of e-waste are made up of small IT and telecommunication equipment, which include laptops, mobile phones, GPS devices and routers; only 22 per cent is documented as formally collected and recycled. Typically, collection and recycling rates are highest for heavier and bulkier equipment categories, such as large equipment, temperature exchange equipment, and screens and monitors.

Bénédicte Kurzen / NOOR for Fondation Carmignac

The growth rate of countries implementing e-waste policy, legislation or regulation is decelerating, according to June 2023 data. In all, 81 countries (42 per cent of all countries worldwide) have adopted e-waste policies, covering 72 per cent of the global population.

Between 2019 and 2023, the number of countries with such legislation increased slightly, from 78 to 81. Of those 81 countries, 67 had a legal instrument governing e-waste management containing provisions promoting the environmental policy principle of extended producer responsibility (EPR). Countries having such a legal instrument tend to have a wide network of collection points for the separate collection of e-waste, financing mechanisms to properly manage e-waste, and better documentation and e-waste management infrastructure. However, the enforcement of e-waste policy, legislation and regulation remains a genuine challenge globally, and the stagnation of the global e-waste collection and recycling rate is likely exacerbated by the fact that only 46 countries have collection rate targets and only 36 have recycling rate targets.

Overall, the level of awareness about e-waste remains low and there are few appropriate disposal options. Moreover, the gap between awareness and actual action and implementation remains huge, as many high-income countries have experienced. While there are limited e-waste disposal options and an ecological footprint from production, there is a momentum to promote the extended use of EEE products through their repair and refurbishment. However, clear limitations remain in terms of environmentally sound recycling practices, owing to the low collection rates and limited recycling infrastructure in many parts of the world. To address this, greater investment in infrastructure development, more promotion of repair and reuse, capacity building, and measures to stop illegal shipments of e-waste are crucial.

81 countries
have adopted e-waste policy, legislation or regulation.

67 countries
have legal provisions on EPR for e-waste.

36 countries
have provisions on e-waste recycling rate targets.

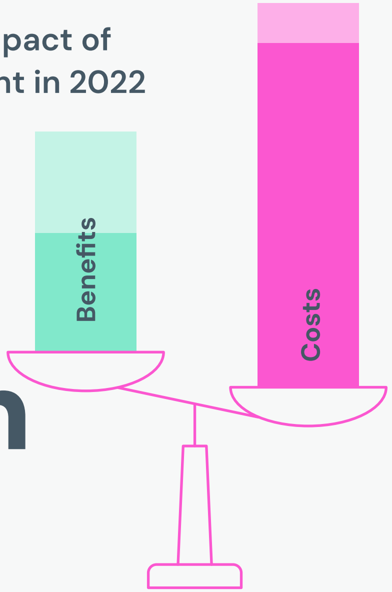
46 countries
have provisions on e-waste collection rate targets.

Source: The Global E-waste Monitor 2024

Bénédicte Kurzen / NOOR for Fondation Carmignac

Overall Economic Impact of E-waste Management in 2022

–37 billion USD



Annual economic monetary impact of e-waste management globally.

Benefits

23 billion USD
of monetized value of avoided greenhouse gas emissions.

28 billion USD
worth of recovered metals brought back into the circular economy.

Costs

10 billion USD
associated to the cost for treatment of e-waste.

78 billion USD
in externalized costs to the population and the environment.

Source: The Global E-waste Monitor 2024

The economic value of the metals contained in the e-waste generated globally in 2022 is estimated at USD 91 billion.

Valuable secondary raw materials are copper (USD 19 billion), gold (USD 15 billion) and iron (USD 16 billion). These metals can be efficiently reclaimed with high recycling rates using current e-waste management technologies, implying that improved collection rates could substantially increase current value recovery rates.

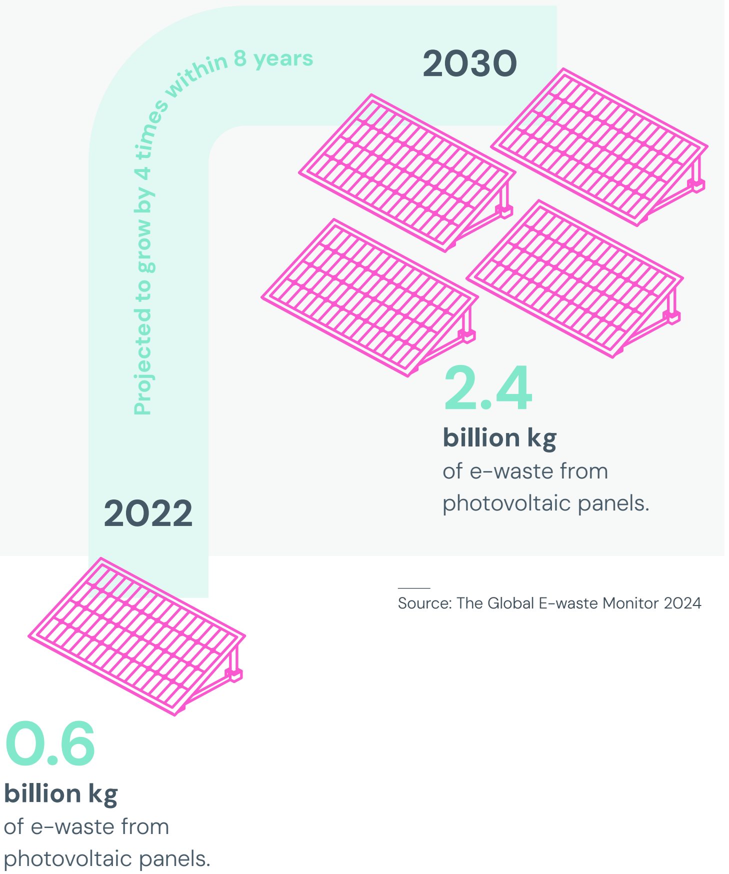
Currently, e-waste management generates USD 28 billion worth of secondary raw materials out of the maximum of USD 91 billion. Most losses occur due to incineration, landfilling or substandard treatment. The current secondary raw material production avoids extraction of 900 billion kg of ore.

This highlights the importance of a circular economy to create more secure and sustainable value chains. Moreover, urban mining is essential to further reduce environmental degradation. E-waste management globally prevents 93 billion kg of CO_2-equivalent emissions in the form of refrigerants in temperature exchange equipment (41 billion kg) and through the lower greenhouse gas emissions obtained by recycling metals versus mining (52 billion kg). In addition, urban mining constitutes a more sustainable approach to resource use, as it conserves natural resources, reduces the environmental impact and land disturbance compared to primary mining activities, saves energy, diverts e-waste from landfills, creates local economic opportunities and enhances supply chain security.

According to current economic assessments, e-waste management in its current status has economic benefits (e.g. the recovery of metals) but also costs (e.g. e-waste treatment and hidden externalized costs for society). The overall annual economic monetary cost of e-waste management is estimated at USD 37 billion worldwide.

The main costs consist of USD 78 billion in externalized costs to the population and the environment, stemming from lead and mercury emissions, plastic leakages and contributions to global warming, particularly in cases where hazardous substances are not properly managed. Additional costs arise from the treatment of e-waste and amount to USD 10 billion; the largest share is paid by producers in countries with EPR regulations. Environmentally sound treatment costs consist primarily of compliant e-waste recycling to depollute and manage hazardous substances, and administrative cost. The benefits are estimated to be USD 28 billion of recovered metals that are brought back into the circular economy and have a positive market value, and USD 23 billion representing the monetized value of avoided greenhouse gas emissions.

Global E-waste Generated from Photovoltaic Panels



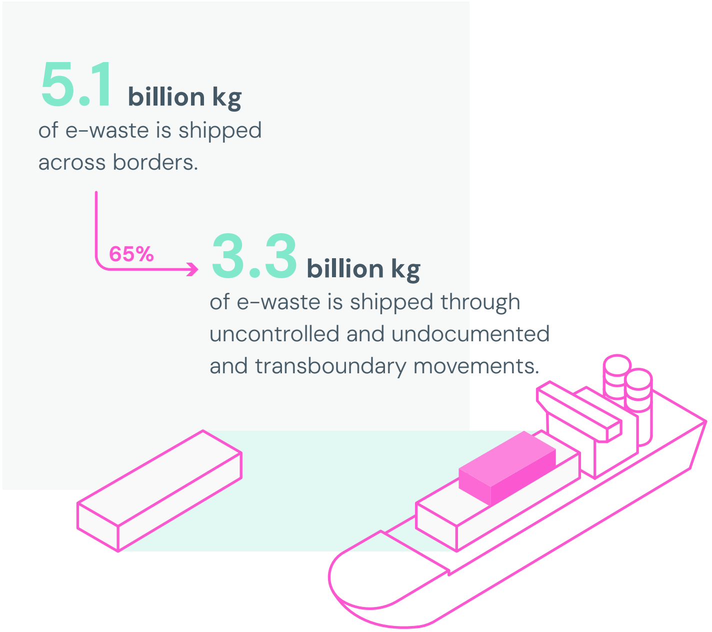
Source: The Global E-waste Monitor 2024

While the twin green and digital transition could be of tremendous benefit for humanity, policy-makers must also ensure that they reinforce each other and address any adverse environmental impacts.

Efforts to achieve universal connectivity and shift from fossil fuels to cleaner energy production will ultimately generate more e-waste. It must be borne in mind that several of the Sustainable Development Goals (SDGs), notably Goals 7 (affordable and clean energy) and 13 (climate action), stress the importance of sustainable and environmentally responsible energy practices for a sustainable future. E-waste from photovoltaic panels, for example, is expected to quadruple from 0.6 billion kg in 2022 to 2.4 billion kg in 2030; its management is an important aspect when it comes to the adoption of clean and renewable energy sources.

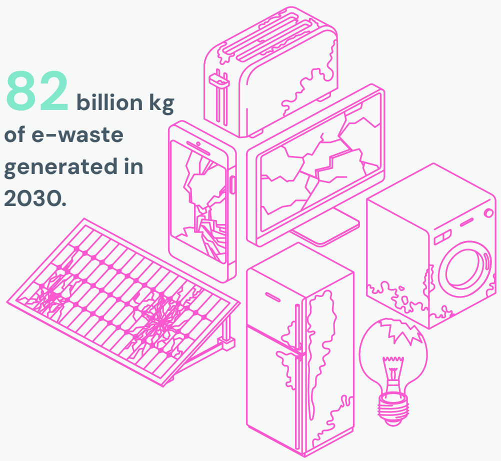
A total of 5.1 billion kg of e-waste were shipped across borders in 2022. Of this, an estimated 3.3 billion kg were shipped from high-income to middle- and low-income countries through uncontrolled and undocumented transboundary movements, accounting for 65 per cent of the total transboundary movement of e-waste globally.

Most controlled transboundary flows take place within and into Europe and East Asia. However, many subregions face specific hurdles; for example, countries in Africa, Latin America and the Caribbean have concerns about transboundary movements and illegal shipments. One of the primary challenges in controlling the transboundary movement of e-waste is distinguishing between waste and used EEE (which is not waste). Illegal shipments can take advantage of the fact that international trade codes do not differentiate between new and used equipment; this opens the door to misclassification and misdeclarations, and to the mixing of legal used EEE and illegal e-waste items.



Source: Adapted from Global Transboundary E-waste Flows Monitor 2022

2030 Projections and Future Scenarios



Source: The Global E-waste Monitor 2024

A total of 3 distinct scenarios have been developed which include business as usual and progressive and aspirational scenarios. It is projected that 82 billion kg of e-waste will be generated in 2030.

In a business as usual scenario based on previous growth in documented formal collection and recycling, such rates will decline to 20 per cent in 2030.

With documented formal collection and recycling rates at 22.3 per cent in 2022, the world would not be able to meet the 30 per cent target for 2023 set by ITU.

E-waste management is projected to lead to losses amounting to USD 40 billion in 2030. The primary costs consist of USD 93 billion in externalized costs to the population and the environment, stemming from lead and mercury emissions, plastic leakages and contributions to global warming, particularly in cases where hazardous substances are not properly managed. Additional costs arise from the treatment of e-waste and amount to USD 15 billion, primarily for compliant e-waste recycling. The benefits are USD 42 billion of metals recovered from e-waste and USD 26 billion representing the monetized value of avoided greenhouse gas emissions.

E-waste management remains a cause for concern and requires immediate attention and action, as the amount of e-waste has grown 5 times faster than compliant collection and recycling since 2010. Despite this, there is room for optimism if action is undertaken by all countries to set up e-waste management infrastructure and regulate the management of e-waste.

In a progressive scenario, the global collection and recycling rate would increase to 38 per cent by 2030. The overall economic assessment indicates this to be close to net zero. This could be realized if high-income countries with e-waste management infrastructure and legislation attain collection rates of 85 per cent by 2030 (the target set in EU legislation on e-waste) and if other countries take action to collect and manage e-waste at a rate of 10 per cent in an environmentally sound manner.

In an aspirational scenario, the global collection and recycling rate would increase to 60 per cent by 2030. The overall economic assessment indicates that the benefits would then be greater than the costs and amount to over USD 38 billion. The main reasons are lower externalized costs for the population and the environment, positive monetized contributions to global warming, and higher value of recovered resources. In this scenario, all countries with e-waste management infrastructure boost their collection rates to 85 per cent (the EU targets); upper-middle and high-income countries with no formal e-waste management infrastructure start to divert e-waste from landfills; and low- and lower-middle-income countries improve the working conditions of the informal sector with a view to collecting and managing 40 per cent of their e-waste in an environmentally sound manner, with further collaborative efforts between the low-income and high-income countries leading to increased treatment of imported used EEE.

E-waste formally documented to be collected and recycled by 2030

20%
2030 Business as Usual

38%
2030 Progressive

60%
2030 Aspirational

Source: The Global E-waste Monitor 2024

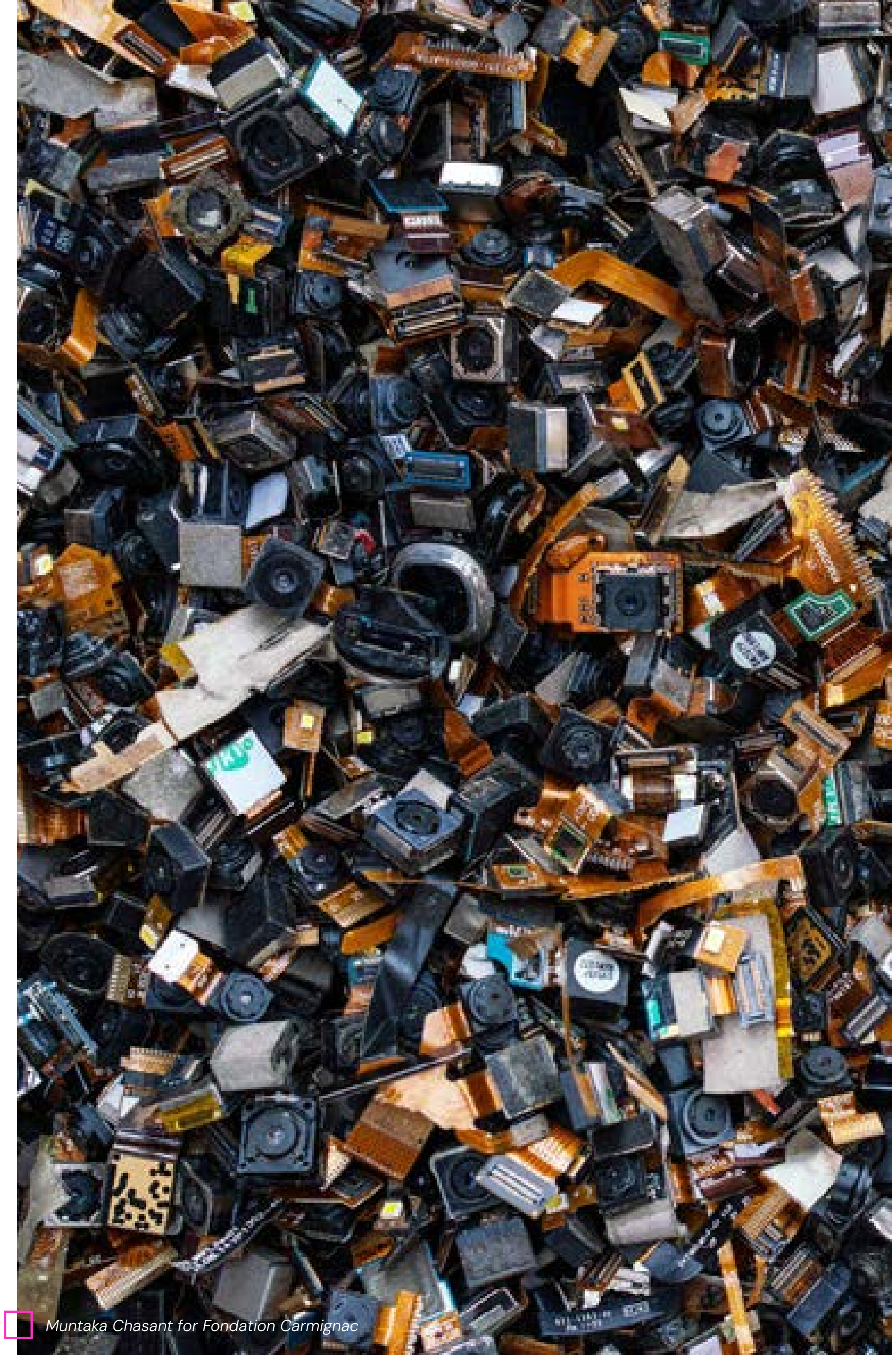

Bénédicte Kurzen / NOOR for Fondation Carmignac

Any substantial increase in the collection and recycling of e-waste will require significant cooperation between the formal and informal sectors, and major improvements to/formalization of the work of the informal sector. This includes prioritizing source separation of e-waste in high-income countries lacking specific e-waste legislation and the establishment of effective collection schemes. The separately collected e-waste is then transferred to environmentally sound e-waste recyclers. National governments with existing recycling systems should prioritize increasing collection rates through targeted interventions and setting appropriate collection rates. At the same time, ideally all imported EEE that is used should be used and then collected in low- and middle-income countries. Substantial investments in e-waste management capacity will drive demand for recycled materials, resulting in higher prices for both informal recyclers and formal waste managers and leading to a further increase in the e-waste collection and recycling rates. In addition, repair and refurbishment should be supported, and smarter designs developed, to extend the lifetime of EEE. The easiest solution for all e-waste issues is still not to generate any e-waste in the first place.

Chapter 1.
What is EEE and E-waste?

EEE refers to all products with circuitry or electrical components and a power or battery supply.[1]

EEE encompasses a wide range of products used by households and businesses. It comprises electrical appliances such as refrigerators, stoves, washing machines and hairdryers, but also electronic devices such as mobile phones, wireless headphones and tablets. Much of the world is currently in the process of electronification and digital transformation, with electronics and digital technologies profoundly changing the way we live, work, learn, socialize and do business. According to recent global data, for every 100 people there are 108 mobile phone subscriptions.[2] The data used in this issue of the Global E-waste Monitor shows that high-income countries have, on average, 109 items of EEE (excluding lamps) per capita. That figure is much lower in low-income countries, at only 4 items per capita.



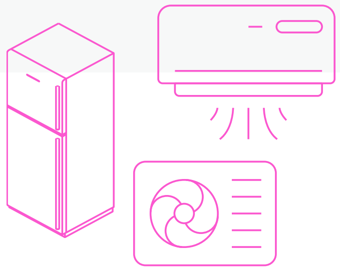
Muntaka Chasant for Fondation Carmignac

EEE comprises a wide variety of products, each with its unique material content, form of disposal and recycling approaches, and each causing unequal harm to the environment and human health if not managed in an environmentally sound manner. In this publication, EEE is classified by function, material composition, average weight and end-of-life attributes into 54 distinct product-centric categories known as the UNU-KEYs.[3] EEE becomes e-waste (or WEEE) once it has been discarded by its owner as waste without the intent of reuse.[4]

The full list of UNU-KEYs can be found in Annex 1. The 54 EEE product categories are further grouped into 6 general categories that broadly correspond to their waste management characteristics (Figure 1).

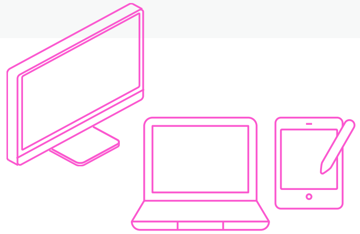
This categorization is in line with both the EU WEEE Directive and the internationally endorsed framework for e-waste statistics outlined in the E-waste Statistics Guidelines.[5]

Figure 1. Equipment Categories



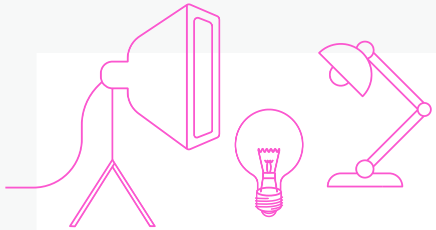
1. TEMPERATURE EXCHANGE EQUIPMENT:

More commonly referred to as cooling and freezing equipment, this category comprises items such as refrigerators, freezers, air conditioners and heat pumps.



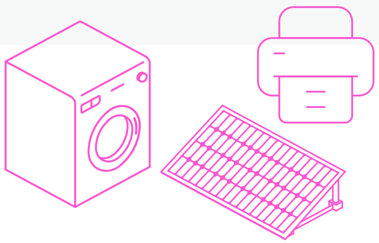
2. SCREENS AND MONITORS:

This category typically includes televisions, monitors, laptops, notebooks and tablets.



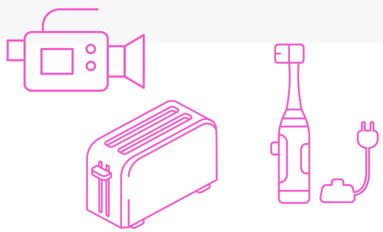
3. LAMPS:

This category typically includes fluorescent, high-intensity discharge and LED lamps.



4. LARGE EQUIPMENT:

This category typically includes washing machines, clothes dryers, dishwashers, electric stoves, large printers, copying equipment and photovoltaic panels.



5. SMALL EQUIPMENT:

This category typically includes vacuum cleaners, microwave ovens, toasters, electric kettles, electric shavers, electronic scales, calculators, radios, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments, and e-cigarettes.

6. SMALL IT AND TELECOMMUNICATION EQUIPMENT:

This category typically includes mobile and other phones, personal computers, GPS devices, routers and printers.

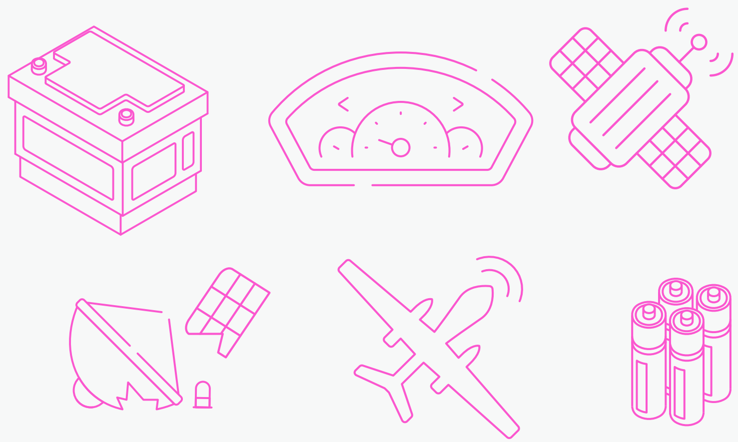
Source: Adapted from E-waste Statistics - Guidelines on Classification Reporting and Indicators

VanderWolf Images / Adobe Stock

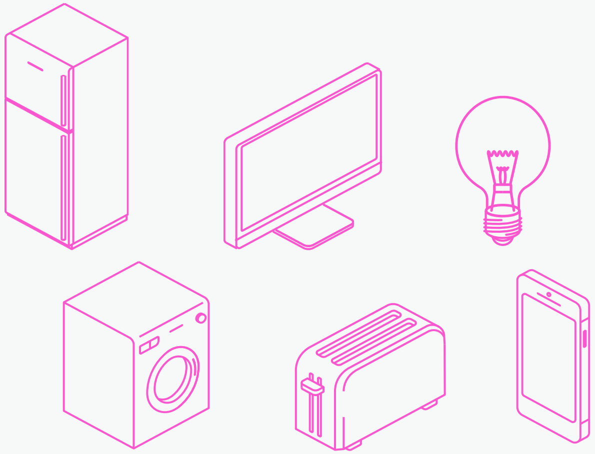
Pixel-Shot / Adobe Stock

It is important to understand what is not EEE. Batteries and other electricity storage devices are not EEE, and most legislation globally recognizes them as separate waste streams, mainly because they require different end-of-life treatment. When EEE is designed for and installed in an automotive apparatus, it is also not categorized as EEE because it lacks functionality as a stand-alone device and can only work as part of the automotive apparatus. Examples include built-in audio and entertainment systems, or satellite navigation units installed in cars, boats or airplanes. However, in countries where e-waste legislation is still in the pipeline and electric vehicles are being rolled out, there may be opportunities to reassess the regulatory boundaries between batteries and e-waste. Items that protect a country's security, such as arms, munitions and items for military use only, are also not considered EEE in legal terms and are exempt from associated regulations. This usually has to do with the act of maintaining national security. Furthermore, emerging waste streams such as space waste / debris containing EEE also currently fall outside of current regulatory frameworks. For example, the European Space Agency is developing a plan to make recycling in space a reality and intends to become space debris-neutral by 2030.[6]

What is not electrical and electronic equipment?



What is electrical and electronic equipment?



Although e-waste is relatively well defined, the distinction between waste and non-waste remains a major concern, including for economic and policy decisions. Not everything that is technically reusable has a market value, often because it is outdated. On the other hand, not everything discarded by its owner is unusable; some equipment remains functional, while some non-functional equipment can be repaired. The political concern to distinguish between waste and non-waste is crucial because specific international regimes or national laws regulate the transboundary shipment of products. In cases where equipment can be repaired and reused, transboundary movements should be promoted to expand the lifespan of EEE and reduce its environmental footprint. However, declaring products as repairable and/or reusable when they are not, or shipping equipment someplace where no consumer market exists, has led to an increase in the amount of e-waste worldwide, especially in regions lacking proper infrastructure for appropriate repairs, upgrading and follow-up recycling and treatment.

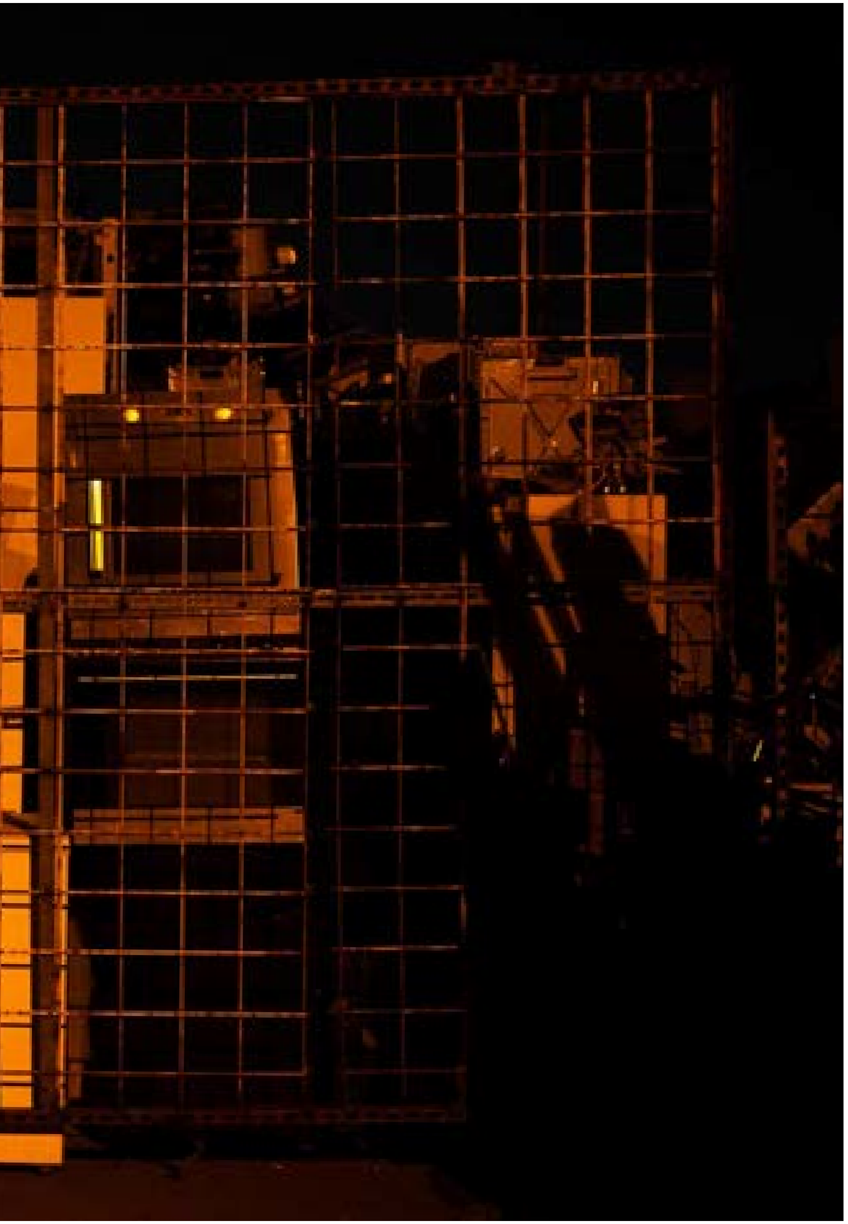
Muntaka Chasant for Fondation Carmignac

Chapter 2. Methodology

Comprehensive monitoring and analysis of e-waste quantities and flows play a vital role in assessing the progress of e-waste management over time, establishing and evaluating e-waste management goals, and implementing essential policy corrections or adjustments. It is important to collect accurate and up-to-date data about e-waste in order to develop effective policy and legal frameworks that enable policy-makers to make informed decisions and formulate appropriate strategies. By understanding the amounts, characteristics and pathways of e-waste, we can also establish a solid foundation for effectively monitoring, controlling and ultimately preventing illegal activities such as unauthorized shipments, improper disposal and inadequate treatment of e-waste. This knowledge allows us to detect and address instances of illegal dumping and ensures that e-waste is managed in a responsible, appropriate and environmentally sound manner.

Insight into the composition of e-waste, including specific components and materials, leads to targeted resource recovery efforts. Efficient extraction of valuable resources from discarded electronics facilitates circularity of materials while reducing reliance on mining activities and the environmental impact associated with extracting raw materials from the Earth's crust. For example, in 2023, the European Union introduced the Critical Raw Materials Act to safeguard the resources needed for technologies like renewable energy and battery power. The Act calls on the Union to step up domestic production and reduce its reliance on critical raw materials from non-EU/EFTA countries by 2030.[7]

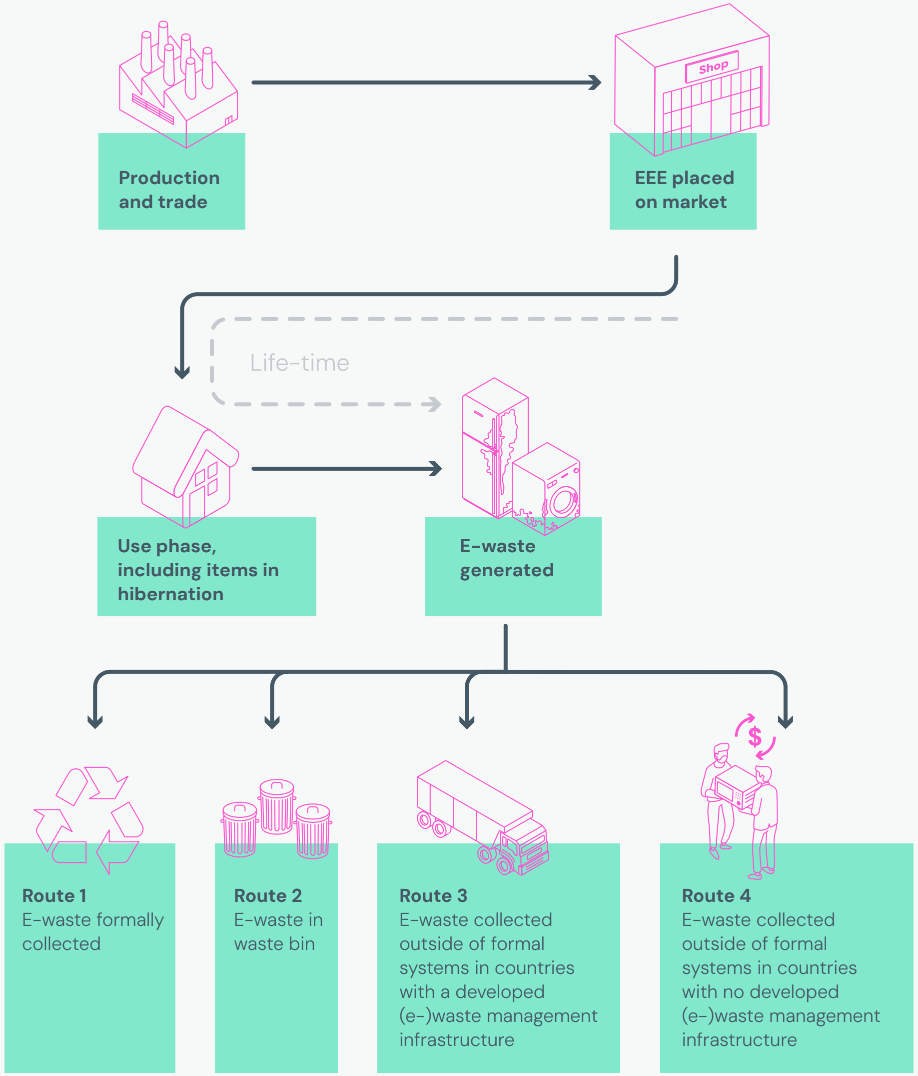
Bénédicte Kurzen / NOOR for Fondation Carmignac



The SCYCLE Programme, working with the Task Group on Measuring E-waste of the United Nations Partnership on Measuring ICT for Development, has developed an internationally standardized methodology for measuring e-waste. The initial version of the E-waste Statistics Guidelines, which focuses on classification, reporting and indicators, was published in 2015 by UNU-SCYCLE, Eurostat, the OECD, ITU, UNCTAD, UNEP (Basel, Rotterdam and Stockholm Conventions Secretariats) and the United Nations Economic (and Social) Commissions for Asia and the Pacific, Western Asia and Africa, following a global consultation process.[8] The Guidelines were subsequently updated in 2018 by the UNU SCYCLE Programme.[9] This updated edition was endorsed by the United Nations Statistics Commission and is now applied to monitor the SDGs using specific e-waste indicators under SDG 12, on sustainable consumption and production practices and the creation of inclusive and sustainable societies.

This internationally recognized methodology plays a crucial role in harmonizing the measurement framework and indicators used for e-waste. It represents a significant milestone towards the establishment of an integrated and comparable global measurement framework for e-waste. The principles and concepts outlined in the Guidelines also serve as the foundation for the development of the global, regional and national e-waste monitor series. Notably, this methodology has been integrated into Regulation EU/2017/699 as the common methodology for calculating the collection targets of the recast EU WEEE Directive.

Figure 2. E-waste Statistics Framework



Source: Adapted from E-waste Statistics – Guidelines on Classification Reporting and Indicators

The measurement framework employed in the E-waste Statistics Guidelines effectively captures and assesses the fundamental aspects of a country's e-waste in relation to the dynamics of EEE and e-waste flows and stocks (Figure 2).

Once e-waste is discarded by its owner (e-waste generated), its management process begins. This typically involves collection, pre-treatment (mainly depollution, dismantling, shredding, sorting, or cleaning and repairing) and final treatment (preparation for reuse, recycling or other recovery). The first step – collection of e-waste – is crucial for its further management, and therefore 4 main e-waste management routes are considered, to produce the e-waste statistics provided in this issue.

- **Route 1:**
  Formal e-waste collection and recycling – the preferred e-waste management route (see Figure 6);
- **Route 2:**
  Disposing of e-waste in residual waste – a less-than-optimal solution (see Figure 11);
- **Route 3:**
  E-waste collection and recycling outside formal systems with developed e-waste management (see Figure 12);
- **Route 4:**
  E-waste collection and recycling outside formal systems with no developed e-waste management (see Figure 13).

The SDGs monitoring framework has 3 e-waste indicators: total e-waste generated (unit: kg); e-waste formally collected and managed (unit: kg); and e-waste collection rate[i], which is calculated by dividing the amount of e-waste formally collected and managed (indicator 2) by the amount of e-waste generated (indicator 1) times 100 per cent (unit: per cent).[10]

The Global E-waste Monitor 2024 has 6 building blocks in support of the 2030 Agenda for Sustainable Development. The core block is "e-waste statistics", which quantifies time series of EEE placed on the market, e-waste generation, transboundary movements and e-waste management by country. E-waste statistics are instrumental for quantifying 3 indicators related to SDG 12, on sustainable consumption and production practices and the creation of inclusive and sustainable societies, and to SGD 11, on sustainable cities and communities. They are a prerequisite for estimating the 5 other building blocks:

- "Resources in e-waste" (related to SDG 12);
- "Economic impact" (related to SDG 8, on decent work and economic growth);
- "Environmental impact" (related to SDG 3, on good health and well-being, SDG 13, on climate action, and SDG 15, life on land);
- "Innovations for e-waste treatment" (related to SDG 8);
- "Legislation" (related to SDG 17, on partnerships for the Goals).

For a more detailed explanation of the methodology, see Annex 1.

Economic impact has been researched by analysing the broader cost and benefits of global e-waste management. The benefits are the value of metals recovered using viable technologies and the monetized long-term value of avoided greenhouse gas emissions. The direct costs of treating e-waste (split into environmentally sound (compliant) treatment costs, treatment of e-waste in residual waste, treatment costs of e-waste mixed with metal waste, and treatment costs in the informal sector) and the indirect externalized costs to society resulting from releases into the environment, which lead to costs elsewhere in society and are not included in the direct pricing mechanisms. These indirect costs are estimated based on the environmental and health damage caused by emissions of mercury, lead, plastics and greenhouse gases stemming from e-waste that is part of mixed residual waste, where it is not specifically separated for proper management and is collected outside formal systems.

Policy, legislation and regulation refers to the number of countries having specific e-waste policy, legislation or regulation**.**

Resources in e-waste are calculated for the total of metals in e-waste. This is disaggregated into currently viable recovery and currently non-viable recovery of metal resources. Viable recovery is defined as the resources that are currently recovered as secondary resources. Non-viable recovery is interpreted as the resources that are lost in the e-waste management process as a result of inefficiencies and losses that occur during waste management.

Environmental impact discusses the relation to climate change, the release of hazardous materials (mercury, lead and brominated flame retardants) and the avoided extraction of minerals from the Earth's crust thanks to the viable recovery of metals.

E-waste management technology has been researched through patent applications on e-waste recycling, and disaggregated as denoted or expressed by several keywords.

UNITAR

[i] The three indicators are set out in SDG targets 12.5.1 and 12.4.2. The wording used in the SDGs is slightly different, but the definitions and datasets are the same as those used in the Global E-waste Monitor. To report on these indicators, the custodian agencies UNEP and the United Nations Statistics Division use the datasets and methodologies developed by the co-custodians UNITAR-SCYCLE, the Global E-waste Statistics Partnership and the United Nations Partnership on Measuring ICT for Development. The relevant data sources are set out in Annex 1.

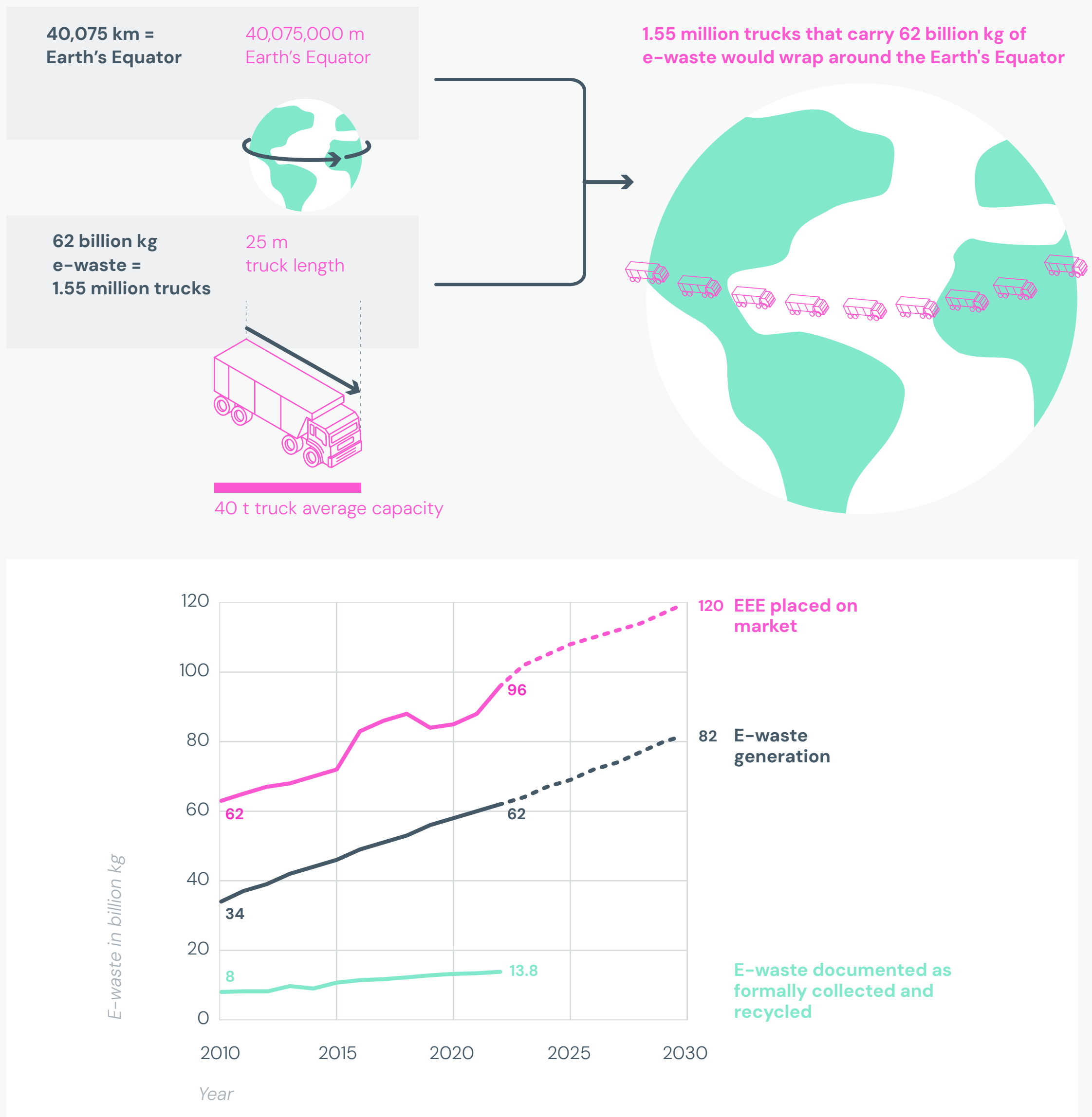
Chapter 3.
Key Global Statistics

In only 12 years, the amount of e-waste generated per year worldwide almost doubled, to 62 billion kg in 2022. Driven by technological progress, increased consumption, limited repair options, short lifecycles and inadequate e-waste management infrastructure, the growth in the amount of e-waste is outpacing growth in documented formal collection and recycling.

Globally, the amount of EEE placed on market (POM) grew from 62 billion kg in 2010 to 96 billion kg in 2022. It is projected to increase to 120 billion kg in 2030 (Figure 3). During the same period, the amount of e-waste generated annually grew from 34 billion kg to a record 62 billion kg. It is projected to increase to 82 billion kg by 2030. Although some advances have been made in the amount of e-waste being documented as formally collected and recycled, rising from 8 billion kg in 2010 to 14 billion kg in 2022, this achievement is overshadowed by the rapid growth in the amount of e-waste overall.[ii]

The detailed datasets are presented in Annex 2. For further information, please contact the corresponding author.

Figure 3. Headline Figures (2010 - 2030)



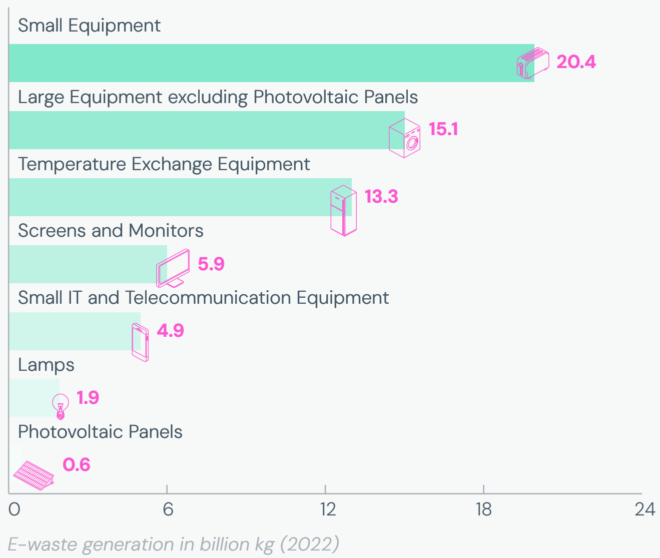
Source: The Global E-waste Monitor 2024

[ii] The authors have reconstructed previous time series using novel data from countries, including data from new countries and revisions of existing time series. Therefore, the collection rates indicated in the previous E-waste Monitors are not directly comparable with the time series presented here.

Small equipment, such as video cameras, toys, microwave ovens and e-cigarettes (see Box 1), constitutes the largest category of e-waste in terms of mass, accounting for 20 billion kg in 2022, or almost one-third of the world's total e-waste.

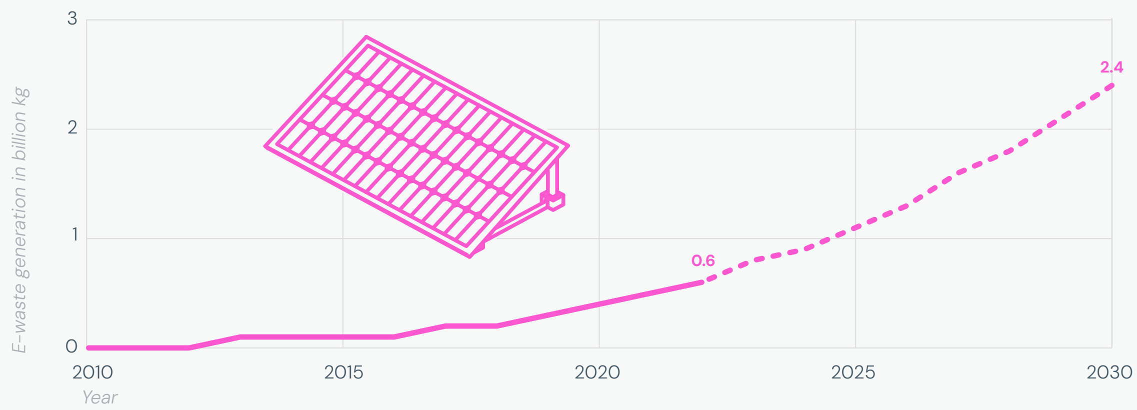
The second largest category is large equipment, excluding photovoltaic panels (15 billion kg in 2022). After photovoltaic panels, the smallest category is lamps (2 billion kg). Screens and monitors currently represent 10 per cent of e-waste generated (5.9 billion kg). Small IT and telecommunication equipment – such as mobile phones, GPS devices, routers, personal computers, printers and telephones – totaled 5 billion kg in 2022 (Figure 4).

Figure 4. Total E-waste Generated by Type of EEE



Source: The Global E-waste Monitor 2024

Figure 5. Total E-waste Generated from Photovoltaic Panels



Source: The Global E-waste Monitor 2024

The green transition and the connecting of off-grid communities will lead to a quadrupling of waste from photovoltaic panels from 0.6 billion kg in 2022 to 2.4 billion kg in 2030.

Photovoltaic panels (on- and off-grid) play a critical role in the green energy transition, providing off-grid communities with electricity. Categorized as "large equipment", they are shown separately as they deserve a separate mention. While the waste generated (both on- and off-grid) remains low for the time being, at 0.6 billion kg annually, it is expected to grow fourfold, to 2.4 billion kg, by 2030, based on a lifespan of 22 years (Figure 5). There is some concern about the significant rise in the use of small-scale off-grid solar products with relatively short lifespans (typically 3 to 4 years) in low- and middle-income countries, and such devices should therefore be repaired rather than disposed of.[11]

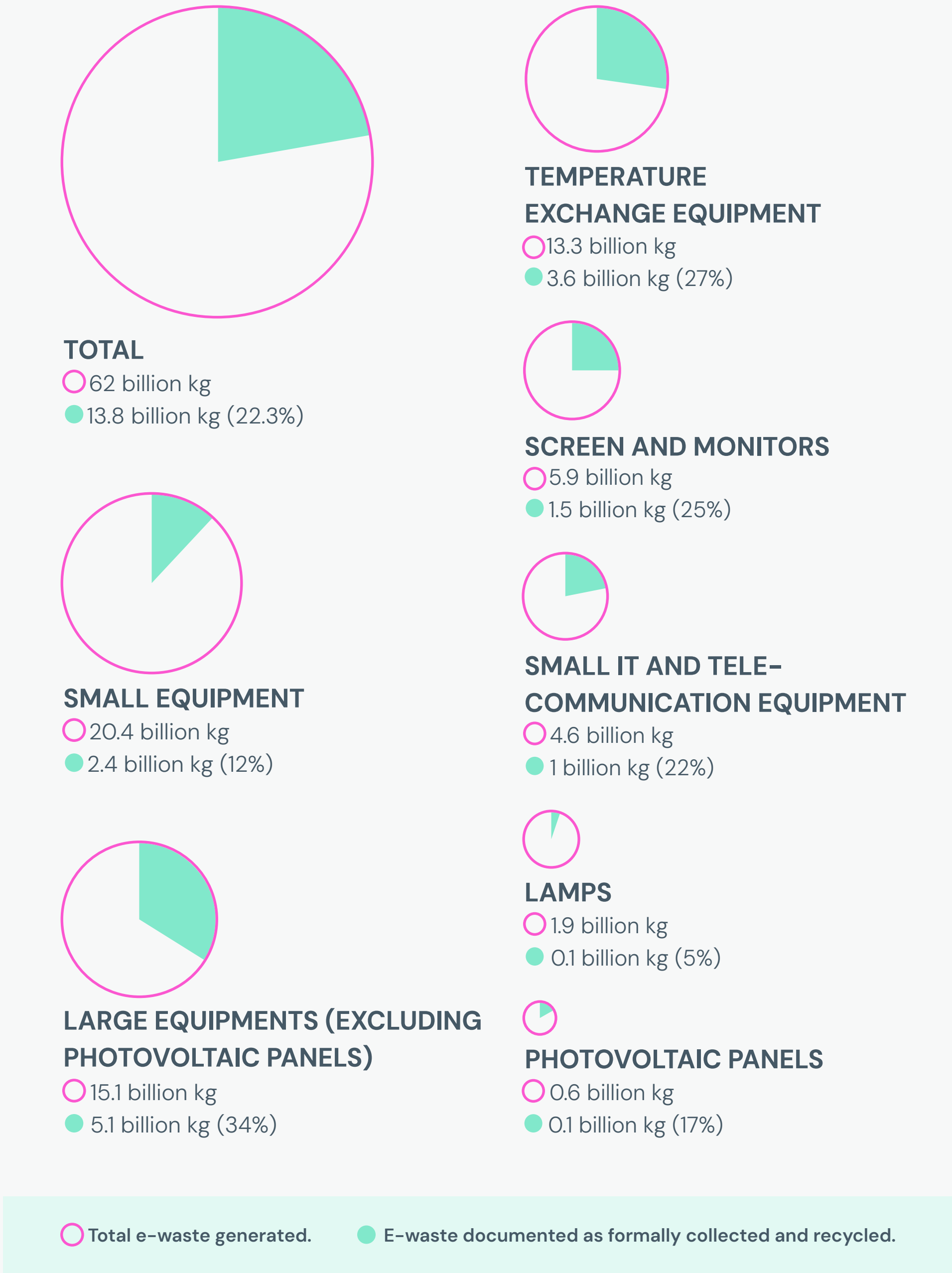
Box 1. Major E-waste Contributor: Vaping

Vaping, or the use of flavored e-cigarettes, is also on the rise. The market, valued at over USD 22 billion in 2022, is expected to grow by 31 per cent annually until 2030.[a] It is estimated that over 844 million vapes were sold in 2022. At an average weight of 50 g, this amounts to more than 42 million kg of e-cigarettes (including the weight of the batteries), many of which are disposable and become instant waste. Vapes are e-waste as they contain not only plastic but also lithium-ion batteries, a heating element and a circuit board. E-cigarettes produced in 2022 contained various metals, including roughly 130 thousand kg of lithium in the batteries, and it is obvious that recycling them will be critical to addressing the e-waste challenge.

[a] Grand View Research. 2023. E-cigarette and Vape Market Size and Share Report, 2030. Grand View Research Market Analysis Report, p. 139.

In 2022, the world produced 62 billion kg of e-waste (7.8 kg per capita), of which 13.8 billion kg (1.7 kg per capita) were documented as formally collected, for a global formally documented collection and recycling rate of 22.3 per cent.

Verena Radulovic



Source: The Global E-waste Monitor 2024

Figure 6. Route 1: Formal E-waste Collection and Recycling – The Preferred E-waste Management Route

Source: The Global E-waste Monitor 2024

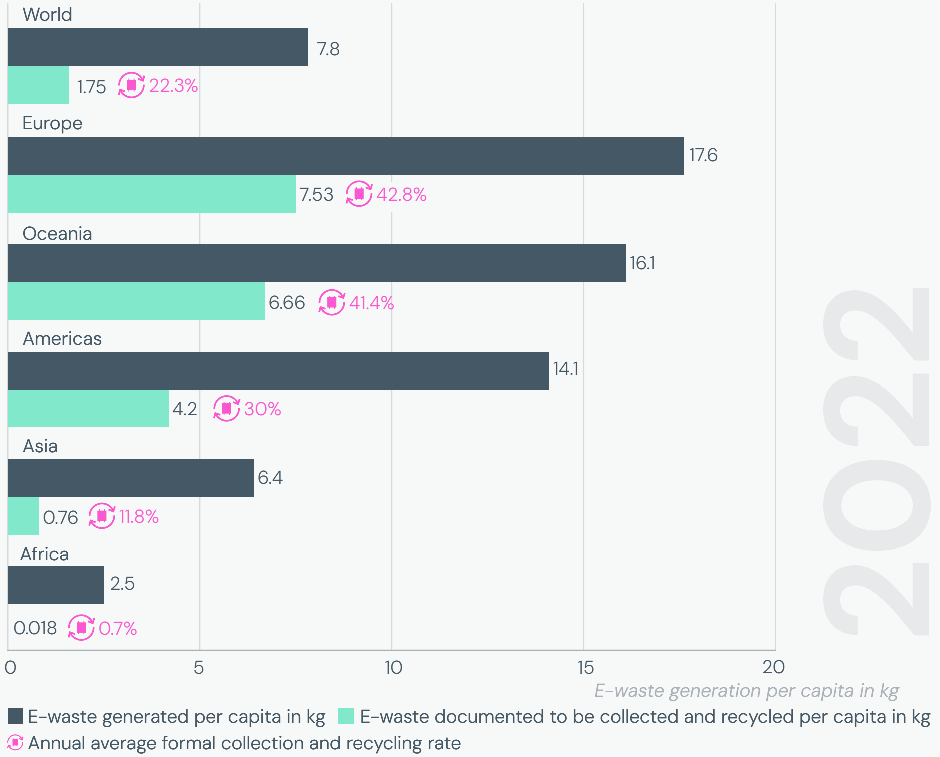
"Formal" collection activities are managed in line with national e-waste legislation in the 81 countries that have legal instruments in place. Designated organisations, producers and/or the government are responsible for collecting e-waste via retailers, municipal collection points or pick-up services (in 2022, 13.8 billion kg of e-waste were collected).

Once collected, the e-waste is sent to specialized treatment facilities where valuable materials are recovered in an environmentally controlled manner and hazardous substances are managed in an environmentally sound way (6 billion kg of metals in 2022). Any residuals are either incinerated or disposed of in controlled landfills (in 2022, this led to the loss, or non-viable recovery, of 1 billion kg of metals during formal e-waste recycling). This approach (see Figure 6) currently represents the most efficient and environmentally sound way to treat e-waste; the main challenge lies in establishing effective collection systems and increasing collection rates, as to date only 22.3 per cent of total global e-waste is managed in this way.

In 2022, Europe was the region that generated the most e-waste (17.6 kg per capita) and had the highest documented collection and recycling rate (7.5 kg per capita), recycling 42.8 per cent of the e-waste generated. African countries had the lowest rate, with less than 1 per cent of e-waste being documented as formally collected and recycled (Figure 7).

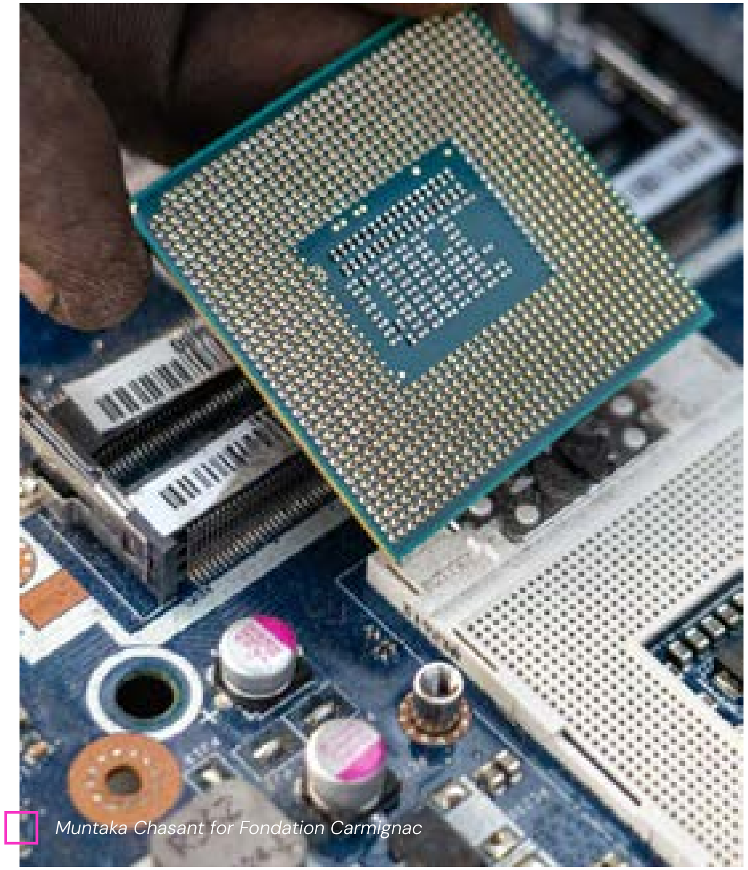
In 2022, the regions that generated the highest amount of e-waste per capita were Europe (17.6 kg), followed by Oceania (16.1 kg) and the Americas (14.1 kg). Since these are also the regions with the most advanced collection, treatment and recycling infrastructure, they had the highest per capita collection rates (7.5 kg in Europe, 6.7 kg in Oceania and 4.2 kg in the Americas).

Figure 7. E-waste Generated and Documented as Formally Collected and Recycled by Region



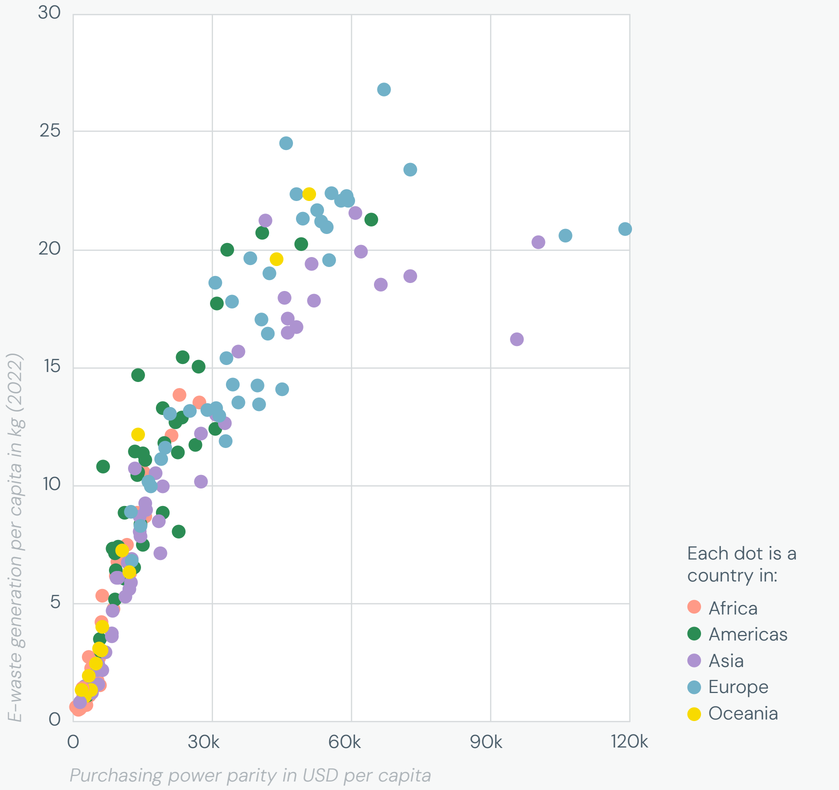
Minor inconsistencies may have occurred due to rounding of values during the calculations.

Source: The Global E-waste Monitor 2024



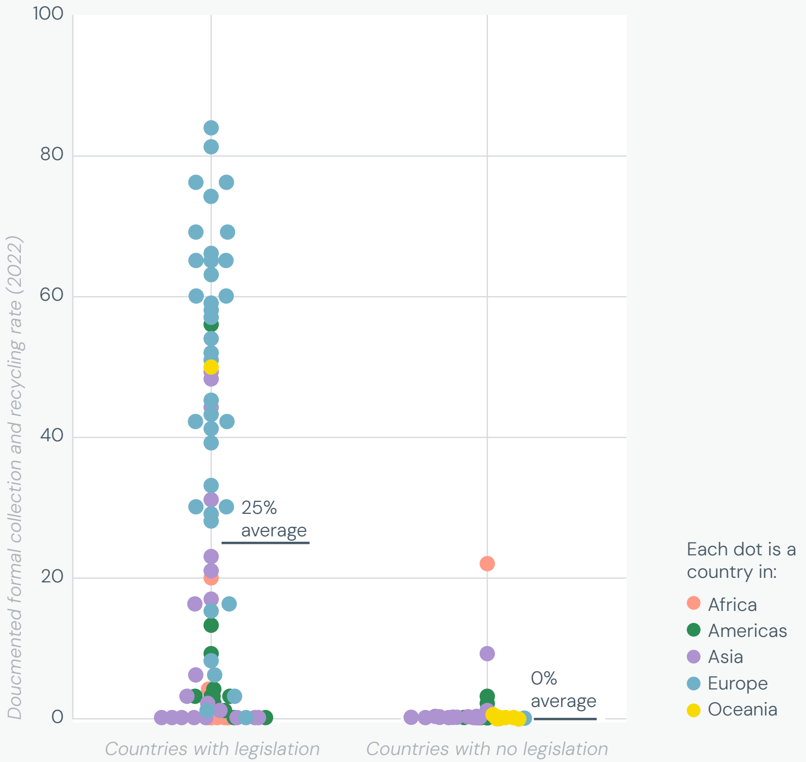
Muntaka Chasant for Fondation Carmignac

Figure 8. Linking E-waste and Income: E-waste Generation and Purchasing Power Parity



Source: The Global E-waste Monitor 2024

Figure 9. E-waste Generated and Documented as Formally Collected and Recycled by Region



Source: The Global E-waste Monitor 2024

Regional comparisons reveal significant differences in e-waste management; these are often linked to several factors.

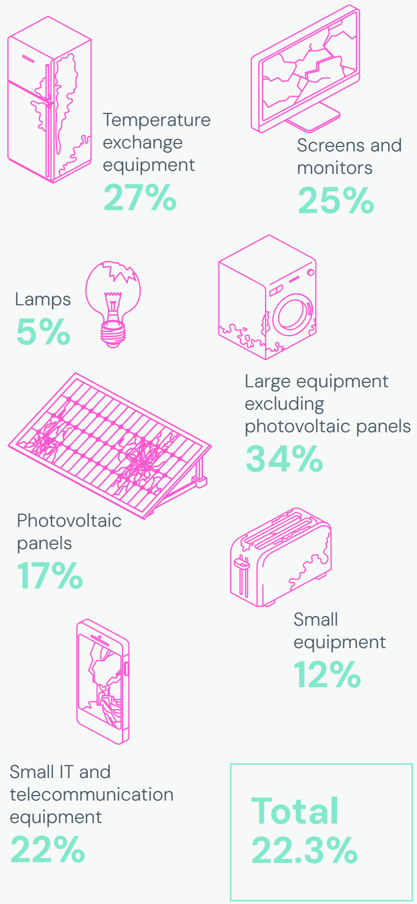
1. Income level and purchasing power
There is a link between a region's per capita purchasing power and the amount of e-waste it generates.[iii] Generally, higher-income regions tend to generate more e-waste as they consume more goods and have greater access to EEE (Figure 8).

2. E-waste legislation and regulation
Countries that regulate and enforce e-waste management with legally binding instruments setting collection and recycling targets, or with e-waste legislation or policies, have an average documented formal collection and recycling rate of 25 per cent. Countries that have no such legislation in place, not even in draft form, have collection rates equal to 0 per cent (Figure 9). Comparisons also highlight differences in disposal behaviours between citizens in a continent's different regions and subregions. In several low-income regions, the informal sector plays an important role in e-waste management. While the informal sector contribution can be significant, it is not generally reflected in official data or monitored by governments. Too often, informal recycling results in very low resource-efficiency rates and thus does not meet environmental or health and safety standards.

3. Maturity of e-waste management systems
Countries with well-established and formalized e-waste management systems tend to have higher collection rates. However, it is worth noting that informal e-waste collection, while not always documented, can also be efficient and contribute significantly to overall collection efforts.

[iii] Purchasing power is the value of a currency expressed in terms of the number of goods or services that one unit of money can buy.

Figure 10. Documented Formal E-waste Collection and Recycling Rates by Category (2022)



Source: The Global E-waste Monitor 2024

Items with a high unit weight, such as large equipment, temperature exchange equipment, screens and monitors, feature the highest collection rates.

Documented formal collection rates are generally higher (34 per cent) for items with a high unit weight, such as large equipment (washing machines, dishwashers, large printers, photocopiers, etc.), followed by temperature exchange equipment (refrigerators, freezers, air conditioners, and heat pumps), which has a recycling rate of 27 per cent (Figure 10). One of the reasons why products with a higher unit weight are more often recycled may be that suppliers in some parts of the world are obliged to pick up, for example, discarded temperature exchange equipment, screens and monitors when they sell/deliver new ones. Because of the weight and size of such appliances, consumers are less likely to hoard or store them.[12]

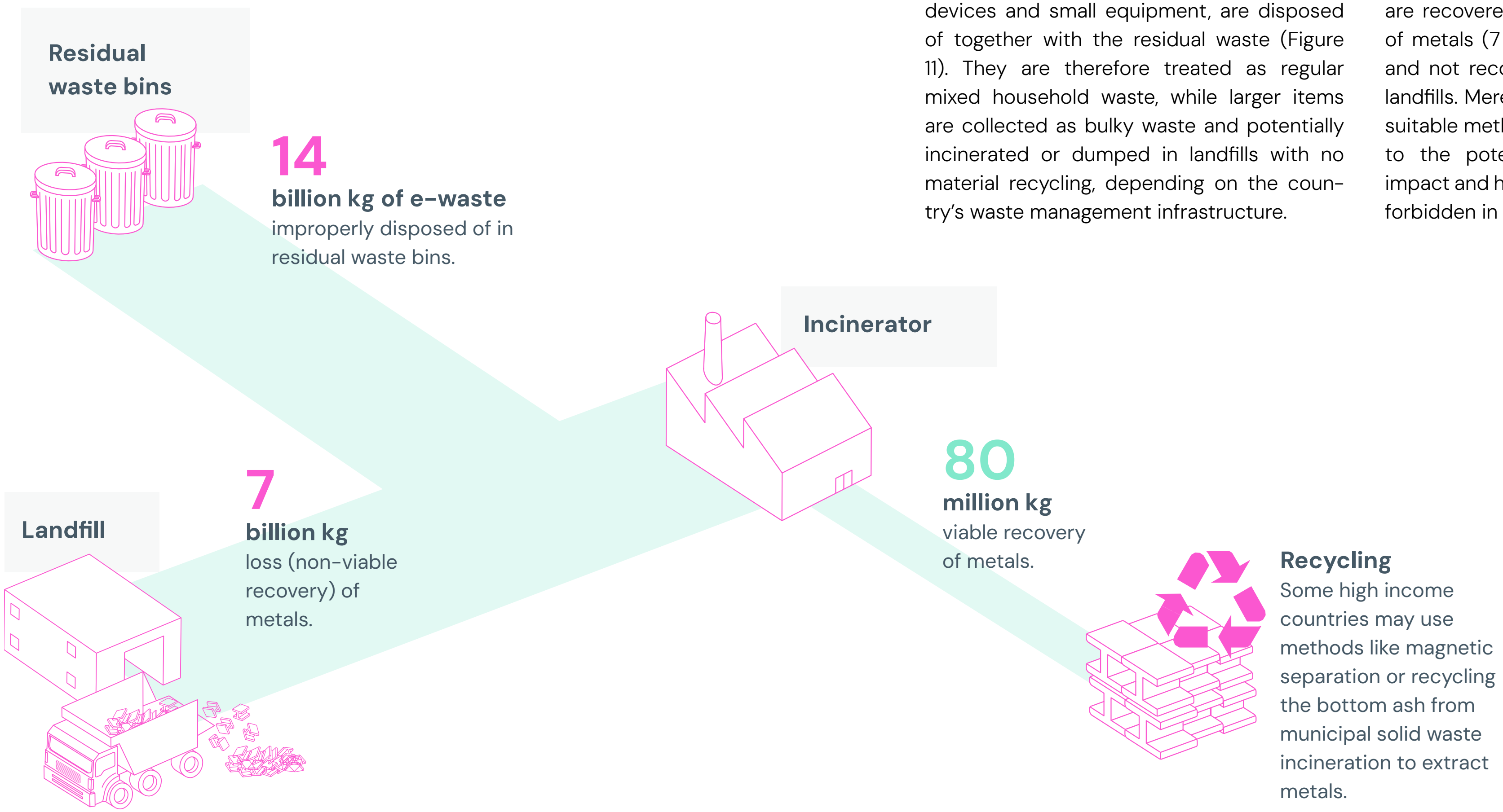
Photovoltaic panels are also large, but typically have lower documented collection and recycling rates (17 per cent) than other large equipment. This may be because steps have only recently been taken to collect them and their management is not yet as developed as for other types of equipment. In addition, photovoltaic panels can be a challenge to recycle as the cost of proper recycling is high, they contain hazardous metals and the technologies for their recycling are still being developed.

Bénédicte Kurzen / NOOR for Fondation Carmignac

Smaller e-waste items must be returned to the retailer or dropped off at special collection points; they can more easily end up either languishing in people's cupboards for years or in normal household bins. While small equipment (toys, vacuum cleaners, microwave ovens, radios, etc.) are the largest category of e-waste in terms of mass, the recycling rates for this category remain low, at only 12 per cent. Lamps are the least recycled category of e-waste, with only 5 per cent collected for recycling, even though they contain valuable resources such as rare earth elements, metal and glass, along with hazardous resources like mercury. Increasing the recycling rate of lamps would bring additional benefits for the environment and society.[13] This highlights the importance of convenience in ensuring that consumers do their part in the take-back system.

Small IT and telecommunication devices, despite their size, have documented formal collection and recycling rates of 22 per cent, which is higher than other types of small equipment or lamps. It could be that more countries have legislation on this category of e-waste than on lamps and small equipment, and that such devices have valuable components and that their collection is therefore prioritized by compliant e-waste managers. Their documented collection and recycling rates are nevertheless lower than for other equipment, possibly because small IT devices contain personal data and consumers may therefore be reluctant to give them back.

Figure 11: Route 2: Disposing of E-waste in Residual Waste – A Less-Than-Optimal Solution

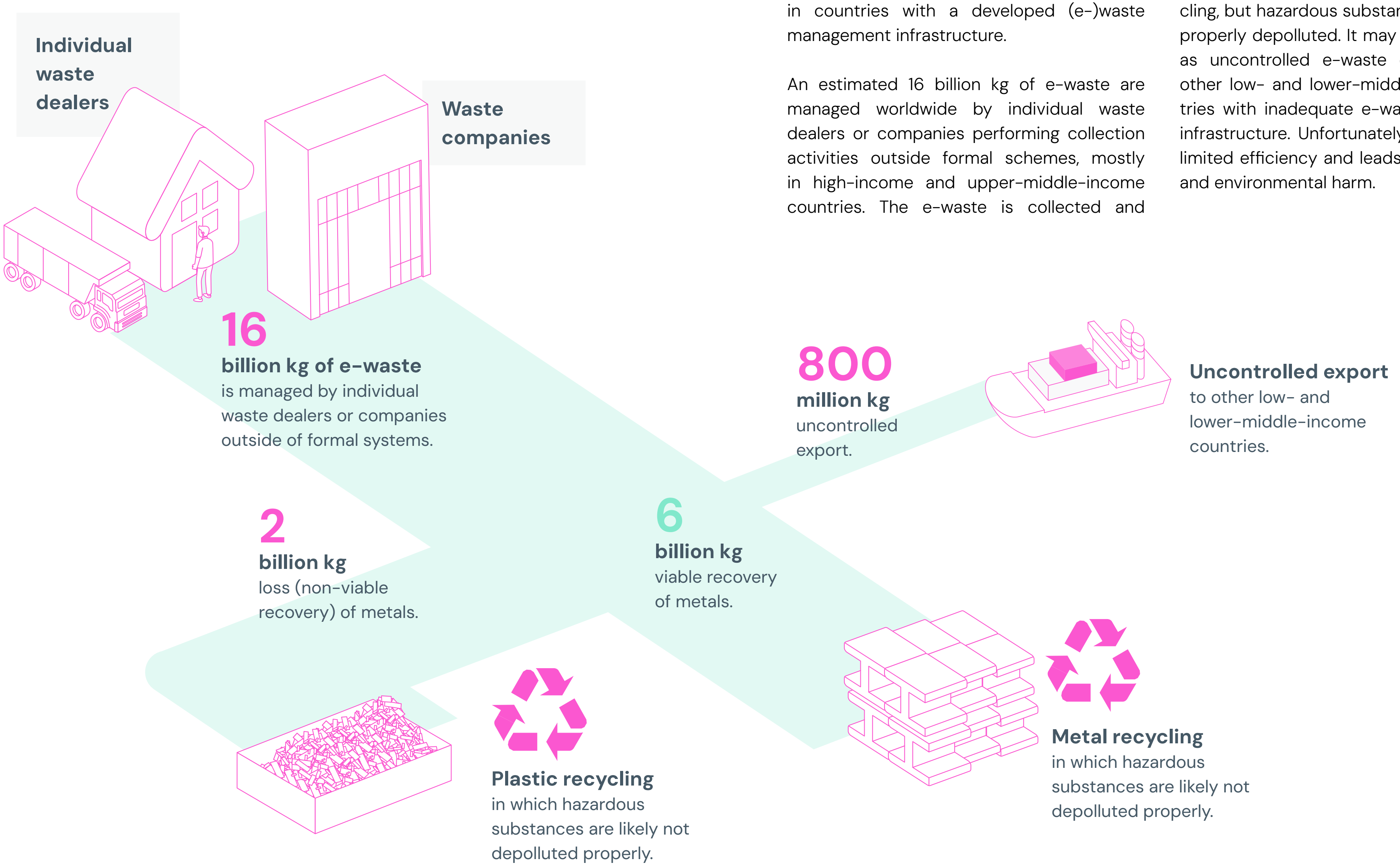


Source: The Global E-waste Monitor 2024

It is estimated that 14 billion kg of e-waste were improperly disposed of worldwide in 2022 in normal waste bins, alongside other household waste, mostly in high- and upper-middle-income countries. Typically, smaller items of e-waste, such as lamps, small IT devices and small equipment, are disposed of together with the residual waste (Figure 11). They are therefore treated as regular mixed household waste, while larger items are collected as bulky waste and potentially incinerated or dumped in landfills with no material recycling, depending on the country's waste management infrastructure.

Some high-income countries use methods such as magnet separation, or recycle the bottom ash from municipal solid waste incineration to extract metals. According to the Global E-waste Monitor datasets and modelling, an estimated 80 million kg of metals are recovered in this way. The vast majority of metals (7 billion kg) are nevertheless lost and not recovered during incineration or at landfills. Merely disposing of e-waste is not a suitable method of e-waste treatment, owing to the potentially negative environmental impact and high resource losses, and is hence forbidden in most e-waste legislation.

Figure 12. Route 3: E-waste Collection and Recycling Outside Formal Systems with Developed E-waste Management

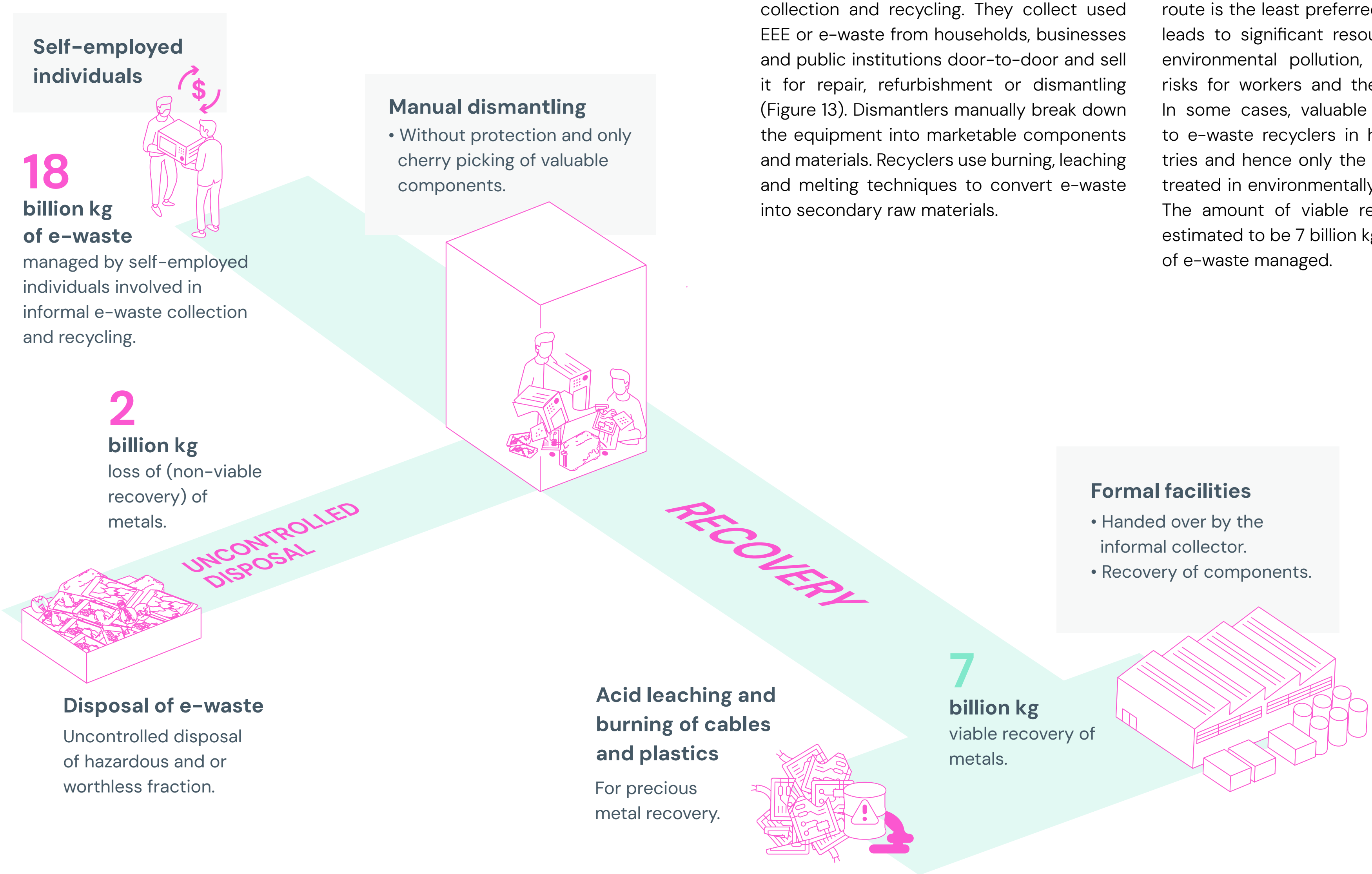


Source: The Global E-waste Monitor 2024

An estimated 16 billion kg of e-waste were collected outside formal systems in 2022 in countries with a developed (e-)waste management infrastructure.

An estimated 16 billion kg of e-waste are managed worldwide by individual waste dealers or companies performing collection activities outside formal schemes, mostly in high-income and upper-middle-income countries. The e-waste is collected and traded through various channels (Figure 12). It may be destined for metal or plastic recycling, but hazardous substances are likely not properly depolluted. It may also be exported as uncontrolled e-waste or used EEE to other low- and lower-middle-income countries with inadequate e-waste management infrastructure. Unfortunately, this route is of limited efficiency and leads to resource loss and environmental harm.

Figure 13. Route 4: E-waste Collection and Recycling Outside Formal Systems with No Developed E-waste Management

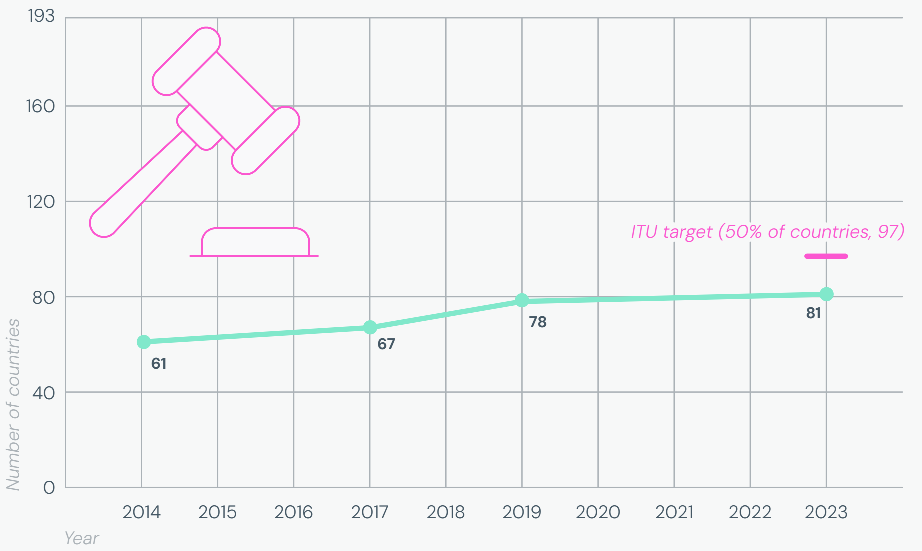


Source: The Global E-waste Monitor 2024

In many low- and middle-income countries, a significant number of self-employed individuals are involved in informal e-waste collection and recycling. They collect used EEE or e-waste from households, businesses and public institutions door-to-door and sell it for repair, refurbishment or dismantling (Figure 13). Dismantlers manually break down the equipment into marketable components and materials. Recyclers use burning, leaching and melting techniques to convert e-waste into secondary raw materials.

This "backyard recycling" lacks proper treatment standards, leading to harmful emissions of acids, dioxins, furan, etc. This route is the least preferred: it is not efficient, leads to significant resource loss and high environmental pollution, and poses health risks for workers and the local community. In some cases, valuable fractions are sold to e-waste recyclers in high-income countries and hence only the valuable fraction is treated in environmentally sound conditions. The amount of viable recovered metals is estimated to be 7 billion kg of the 18 billion kg of e-waste managed.

Figure 14. Number of Countries with E-waste Legislation, Policy or Regulation



Source: The Global E-waste Monitor 2024

Worldwide, 81 countries (or 42 per cent) currently have an e-waste policy, legislation or regulation. This falls short of the ITU target of 50 per cent (97 countries) by 2023.

As of June 2023, 81 of the 193 countries analysed had either a policy, legislation or regulation pertaining to e-waste (Figure 14). The fact that 72 per cent of the world's population was therefore covered can be attributed mostly to the populous countries of India and China, both of which have e-waste legislation. While the number of countries adopting legal instruments to regulate e-waste has grown steadily since 2014, only 3 new countries have adopted such instruments since 2019, meaning that 112 countries remain without any form of legal instrument for the management of e-waste. In 2018, the highest policy-making body of the ITU, the Plenipotentiary Conference, set a global non-binding target for 2023, to increase the number of countries with an e-waste legislation to 50 per cent. That target had not been met as of June 2023, as only 42 per cent of countries (81) were covered by a national e-waste policy, legislation or regulation.

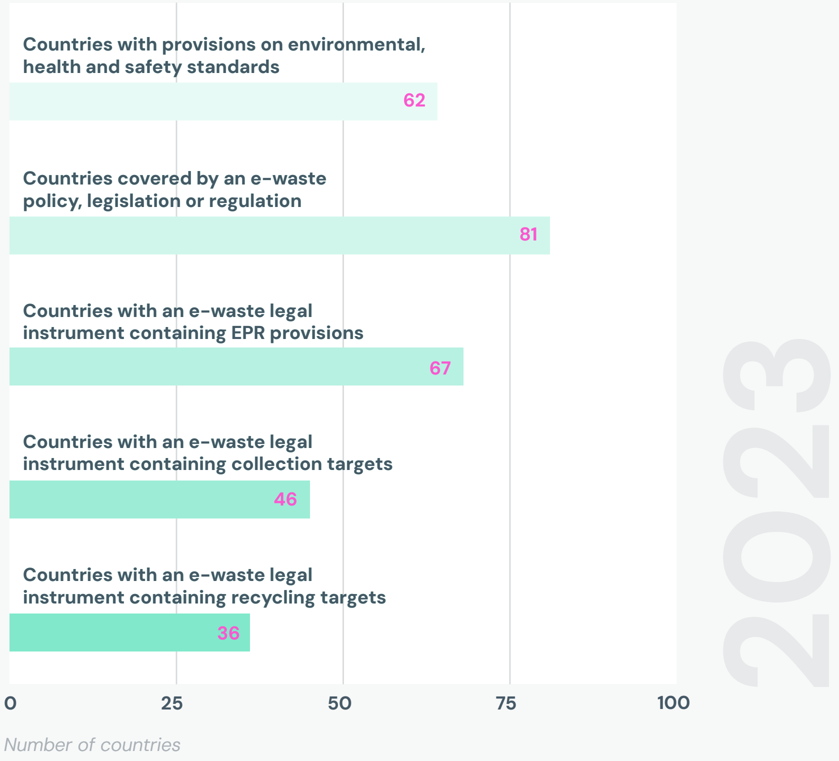
Bénédicte Kurzen / NOOR for Fondation Carmignac

Of the 81 countries covered by a national e-waste policy, legislation or regulation, most (67) also applied EPR. In countries where legislation included collection targets, the average collection rate was much higher at 35 per cent compared to 22.3 per cent worldwide.

In the 81 countries with instruments in place, one of the most frequently applied principles is EPR, which underpinned their respective national e-waste management system (Figure 15). EPR aims to ensure that a producer - which in the many cases where there is no registered manufacturer in a country also refers to the importer or distributor – is responsible for a product up to and including the post-consumer stage of its lifecycle. 67 of the 81 countries had legislation on EPR, 62 had legislation that referred to national or international environmental, health and safety standards, 46 had enshrined national e-waste collection targets in their regulations and 36 had done so for e-waste recycling targets at the national level. It is essential to legislate such targets in order to monitor progress and stimulate the collection and recycling of e-waste.

Countries with such legislation had an average documented formal e-waste collection and recycling rate of 25 per cent, compared to 0 per cent for countries that had no such legislation. The collection and recycling rate in countries applying the EPR principle was 27 per cent, compared to 10 per cent for countries that had legislation but did not apply the EPR principle. Countries that had enshrined collection targets in their e-waste legislation had a documented formal collection and recycling rate of 35 per cent. While these figures show what items to include in legislation to improve collection rates, they also show that collection and recycling targets are not a panacea. The rates are also higher in countries with long-standing and well-established e-waste management systems and hence a good level of e-waste management infrastructure).

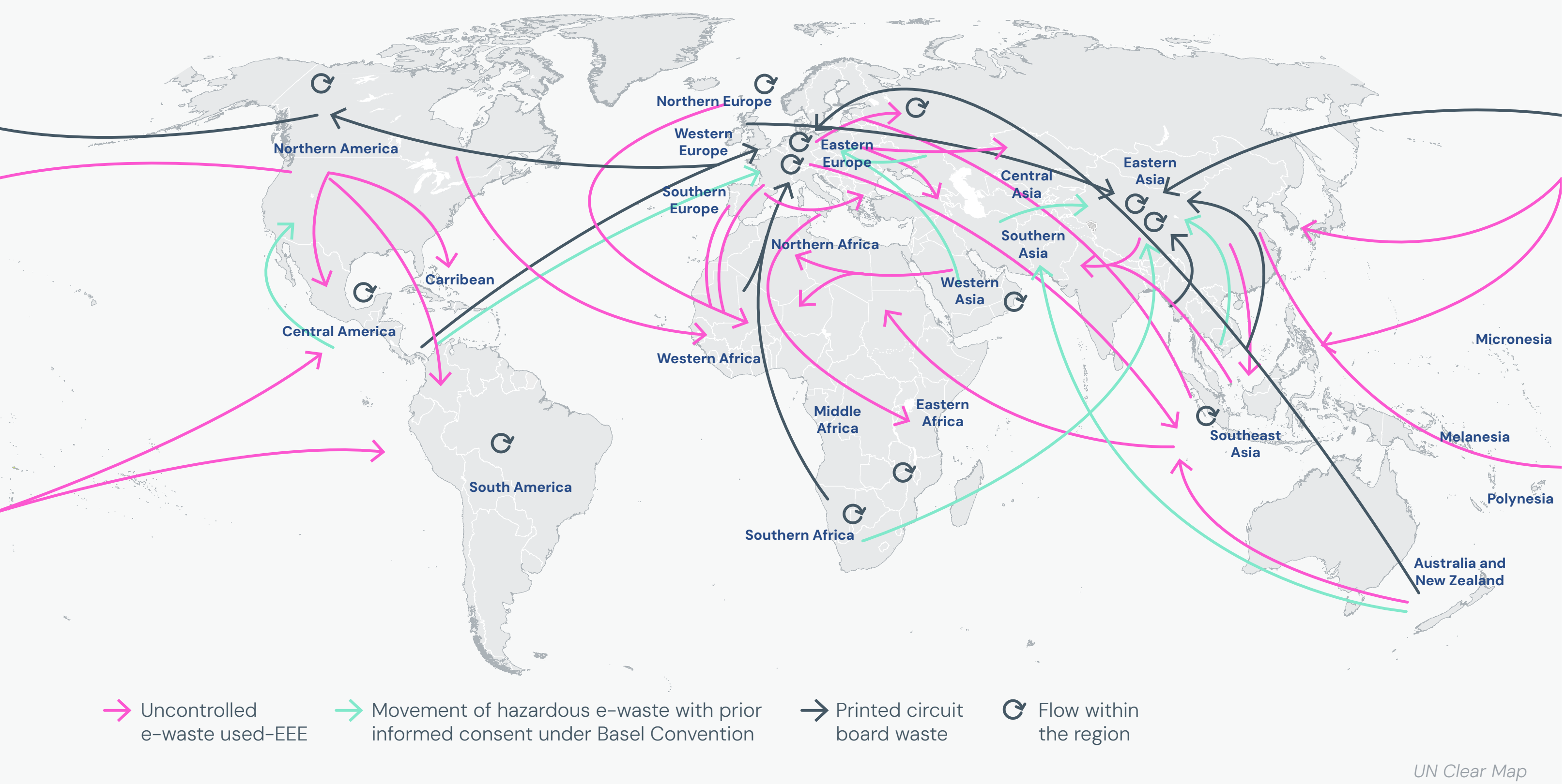
Figure 15. Status of E-waste Legislation and Specific Provisions for all Countries



Source: The Global E-waste Monitor 2024

Chapter 4.
Transboundary Movements

Figure 16. Global E-waste Flows (2019)



Adapted from C.P. Baldé, E. D'Angelo, V. Luda O. Deubzer, and R. Kuehr (2022), Global Transboundary E-waste Flows Monitor - 2022, United Nations Institute for Training and Research (UNITAR), Bonn, Germany. Available at: https://ewastemonitor.info/wp-content/uploads/2022/06/Global-TBM_webversion_june_2_pages.pdf.

Around 5.1 billion kg of used EEE/e-waste are shipped from one country to another annually. Of that total, 3.3 billion kg (65 per cent) are uncontrolled transboundary movements of used EEE/e-waste from high- to middle- and low-income countries. The uncontrolled shipments may be made up of 33 to 70 per cent e-waste declared as used EEE goods. Most controlled transboundary movements occur within and to Europe and East Asia (Figure 16).

Transboundary movements of hazardous and other wastes, including e-waste, pose significant global challenges: they have an adverse impact on the environment and human health when not managed properly in countries lacking adequate infrastructure and capacity for managing e-waste in an environmentally sound manner. In some cases, transboundary movements of e-waste or its components are necessary to recover high-value materials (the transportation of waste printed circuit boards to specialized recycling facilities or of e-waste from regions where no e-waste management systems exist). Hence the importance of putting in place rules and procedures to distinguish between illegal and legal transboundary movements.

Box 2. The Basel Convention Prior Informed Consent Procedure and the Amendment on E-waste (2022)

The Basel Convention, which was adopted in 1989 and has been in force since 1992, is a multilateral environmental agreement that reflects and guides global government efforts to control transboundary movements of hazardous waste, which includes e-waste. It has been signed to date by 187 countries. Under the Basel Convention, transboundary movements of hazardous and other wastes must follow a Prior Informed Consent procedure whereby the competent authority in the exporting State needs to notify the competent authorities of the importing State (and any transit State). National reporting, which is carried out voluntarily by Parties to the Convention, currently stands at less than 50 per cent of signatories. Moreover, the Prior Informed Consent procedure remains administratively burdensome.[a]

The fifteenth meeting of the Conference of the Parties to the Basel Convention, held in June 2022, adopted amendments to Annexes II, VIII and IX of the Convention aimed at increasing the control of transboundary movements of e-waste and making all electronic and electrical waste, including non-hazardous waste, subject to the Prior Informed Consent procedure. The main objective of the e-waste amendment, jointly proposed by the Governments of Switzerland and Ghana, is to improve international monitoring and recoding of e-waste shipments, with a view to maximizing resource recovery and minimizing the negative effects of environmentally unsound e-waste management in recipient countries. However, private sector and other entities raised concerns regarding the system and stressed the need for reforms to avoid slowing down cross-border movements of products, particularly those containing non-hazardous components of potential significance in terms of promoting the implementation of a circular economy.[b]

[a] PREVENT Waste Alliance and StEP. 2022. Practical Experiences with the Basel Convention: Challenges, Good Practice and Ways to Improve Transboundary Movements of E-Waste in Low and Middle Income countries. Bonn, Germany.

[b] Basel Convention Secretariat. 2023. Basel Convention E-waste Amendments. Geneva, Switzerland.

Monitoring transboundary movements of e-waste is challenging, since the movements are frequently conducted illegally and the e-waste being moved declared as used EEE. Additionally, there are no global registries or reporting obligations for used EEE,[14] and no international regime dealing with shipments of used equipment. Furthermore, national reporting on hazardous waste under the Basel Convention is not mandatory. In 2022, 91 out of 187 countries (less than 50 per cent) submitted a report, and discrepancies and inaccuracies in reporting data are very common. Moreover, e-waste movements often involve illegal activities; those involved are therefore reluctant to provide information and the movements are extremely difficult to track.

The Global Transboundary E-waste Flows Monitor represents a major effort to improve the global statistics on licit and illicit e-waste movements. In 2019, 5.1 billion kg of e-waste were moved across countries, with 3.3 billion kg (65 per cent) considered uncontrolled, meaning its treatment is unknown and likely not managed in an environmentally sound manner.[15]

One of the primary challenges in these uncontrolled transboundary shipments is distinguishing between e-waste and used EEE. Illicit shipments falsely declare used EEE instead of e-waste, exploiting the fact that used EEE is not covered by the Basel Convention or any other international regime and therefore more easily avoids controls. The illicitly shipped items can make up between one-third of the weight (as quantified in the 2017 person-in-the-port project in Nigeria)[16] and 77 per cent (the percentage of items identified as e-waste based on the criteria stipulated in the Basel Convention technical guidelines, including improper packaging, absence of functionality certificates, essential parts missing, damaged or outdated technologies, in a similar 2021/2022 person-in-the-port project conducted in the United Republic of Tanzania).[17]

Bénédicte Kurzen / NOOR for Fondation Carmignac

The remaining 1.86 billion kg (35 per cent of total transboundary movements) are shipped in the form of controlled movements, most of them falling under the Basel Convention Prior Informed Consent procedure (see Box 2).[iv] However, only a small fraction of illegally traded e-waste exported from the European Union, estimated at 2 to 17 million kg, has been seized by port authorities, suggesting that the actual numbers are likely much higher. This also reflects the fact that port authorities are potentially limited by their means and training to properly detect illegally traded e-waste.

From a regional perspective, Europe, East Asia and North America have the capacity to effectively manage hazardous e-waste, making these regions the primary global importers. At the same time, these same regions are also the main exporters of e-waste, with Africa, South-east Asia, and Central and South America being the main recipient regions. Unfortunately, these recipient regions often have low recycling rates and a high presence of informal workers in the domestic sector.

Similar patterns are observed in all other regions. Eastern Europe, which receives e-waste primarily from Western Europe, and South-east Asia, which receives e-waste mainly from East Asia and North America, are experiencing increasing flows of e-waste, mirroring intercontinental trade patterns. Overall, transboundary movements occur both intercontinentally and within continents: the higher the e-waste material value per mass, the further it can be transported.[v]

Bénédicte Kurzen / NOOR for Fondation Carmignac

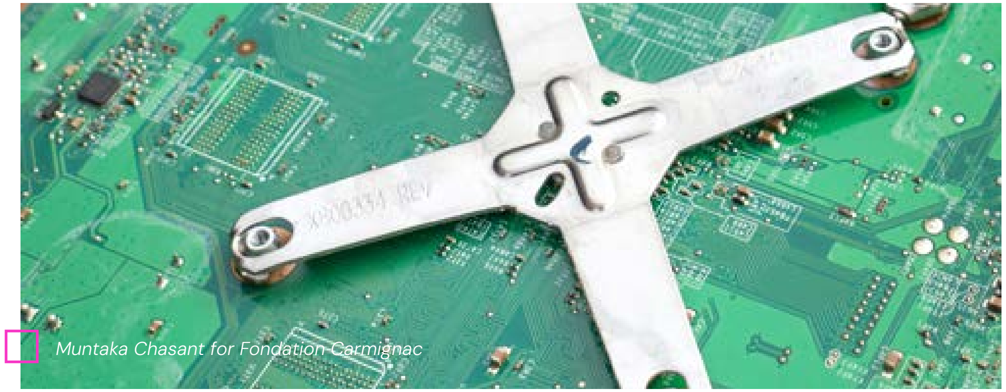
[iv] For additional information on the methodology used to calculate the different e-waste transboundary movements, see Baldé et al., 2022, note 16, pp. 20-25.
[v] For further information on quantities imported and exported at regional level, see Baldé et al., 2022, note 16, pp. 30-33.

Moreover, trade codes (see Box 3) still do not differentiate between new and used EEE, making it even easier to avoid scrutiny. Mixing legal and illegal items is one of the main strategies used by criminal parties illegally shipping e-waste. Misclassification, misdeclaration and fraud are among the most prevalent strategies used to mix the items for illegal transboundary movements of waste in general, and e-waste in particular.

Conducting further pilot projects to investigate the actual composition of used EEE received in exporting and importing countries could lead to significant enhancements in the global monitoring of e-waste shipments. Such initiatives would facilitate a more accurate assessment of the volume of e-waste entering low-income countries, which is often mixed with other types of waste and not properly declared.

As anticipated, East Asia, which is a major producer of EEE and has the capacity to recycle and process e-waste, receives substantial shipments of e-waste, mainly from Western Europe (34.8 million kg), North America (29 million kg), Northern Europe (11.6 million kg) and South-east Asia (9.9 million kg). Despite this, Asia faces constraints with regard to its processing capacities for critical components. North America also has some level of intraregional e-waste flows (52.7 million kg).

The driving force behind such transboundary movements is most often commercial, as the demand for cheaper second-hand used EEE is high in the recipient countries. For example, large quantities of ICT equipment and accessories are being imported into low- and lower-middle-income countries as substandard and counterfeit devices. Type approval, conformity and interoperability procedures carried out by telecommunication regulators aim to address these issues for new models by verifying that imported ICT equipment conforms to functional standards (e.g. power levels and frequencies), in order to ensure that the EEE does not simply become redundant. Ultimately, the lifecycle of counterfeit devices is short, which is likely to result in the product becoming e-waste quicker. In many low- and lower-middle-income countries, distributors and outlets should be subject to periodic inspections, so as to dissuade them from stocking and distributing any EEE without a type-approval and/or acceptance certificate. These recipient countries are often situated in South-east Asia (from East Asia) and in Africa (from Europe).



Muntaka Chasant for Fondation Carmignac

Box 3. The World Customs Organization Harmonized System

In 2022, countries started using the new Harmonized System (HS) code administered by the World Customs Organization specifically for e-waste (HS 8549). As of June 2023, data available from the United Nations Comtrade database[a] indicated that approximately 1 per cent of e-waste generated is moved across borders. The results of the analysis are mainly influenced by the fact that not all countries are yet reporting under this new code. Currently, the highest trade flows are intraregional, particularly within Western Europe (100 million kg) and Northern Europe (80 million kg). These movements primarily involve the proper treatment of e-waste in the recycling facilities of the respective regions. For this purpose, these shipments are assumed not to contravene the Basel Convention and the EU's Regulation (EC) No. 1013/2006 on shipments of waste.

[a] The analysis uses the following 6-digit HS codes: 854991 waste and scrap, n.e.c. in heading no. 8549; 854999 waste and scrap, n.e.c. in item no. 8549.91; 854921 electrical and electronic waste and scrap, of a kind used principally for the recovery of precious metal, containing primary cells and batteries, electric accumulators, mercury switches, glass from cathode ray tubes or other activated glass, or electrical; 854929 waste and scrap, of a kind used principally for the recovery of precious metals, n.e.c. in item no. 8549.21; 854931 electrical and electronic waste and scrap, electrical and electronic assemblies and printed circuit boards, other than those used principally for the recovery of precious metal, containing primary cells and batteries, electronic accumulators, mercury-switch; 854939 waste and scrap; electrical and electronic assemblies and printed circuit boards, other than those used principally for the recovery of precious metal, n.e.c. in item no. 8549.31.

Chapter 5. Legislation

Efficient and effective regulation of e-waste is essential to curb the ever-increasing undocumented flows of this waste stream, to protect the environment, society and human health, but also to secure future supply chains by recovering the resources contained in e-waste.

Muntaka Chasant for Fondation Carmignac

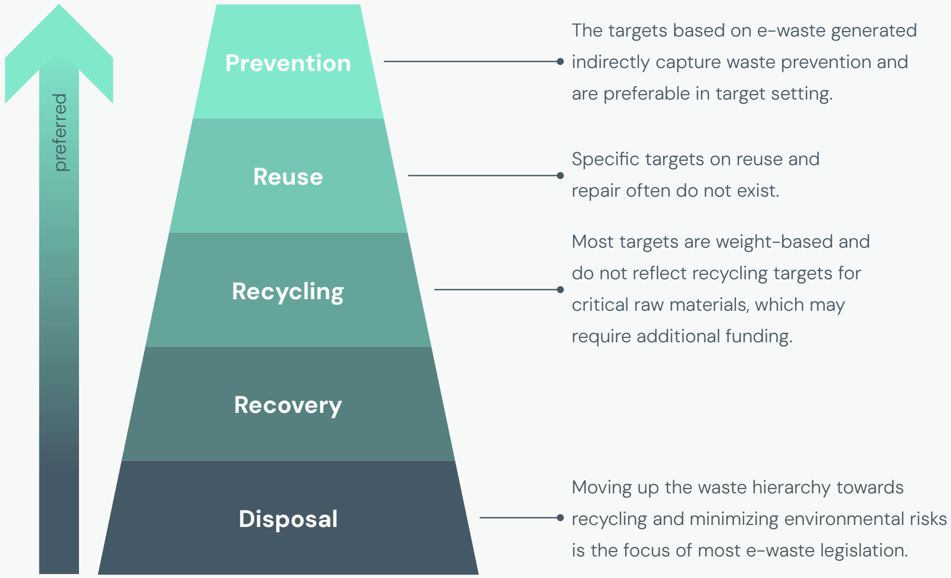
Regulation encourages a level playing field that enables the environmentally sound management of e-waste through responsible collection, transportation, sorting, depollution, dismantling, pre-treatment, management of problematic (i.e. hazardous) fractions and export of materials and components to advanced treatment facilities.

As stated earlier (see Key Global Statistics from 2010 to 2022), as of June 2023, 81 of 193 countries analysed had a policy, legislation and/or regulation pertaining to e-waste. Ultimately, however, the quality of e-waste legislation and its enforcement is as important as the number of countries covered by legal instruments. A substantial number of existing legal instruments and tools do not set targets for the collection and recycling of e-waste or may not cover all 6 types of EEE. While targets can help elevate waste management ambitions higher up the waste management hierarchy from disposal to recycling, the preferred options (see Figure 17) leading to waste prevention, such as repair and reuse targets, are currently not set out in specific e-waste policy, legislation and regulation. This hinders the transition to a circular economy, instead focusing on keeping the consumption / waste generation / collection / recycling model intact. With respect to the methodology for measuring waste prevention, targets based on e-waste generated in the denominator, instead of targets based on EEE POM in the denominator, are preferred[18], as they reflect the amount of e-waste in a country and allow it to engage in better forward-looking planning and management.

For many years, the overall perception of policy-makers has been that they cannot influence the design of EEE with a view to extending its lifetime; the environmental footprint of the production phase remains enormous. There is nevertheless mounting evidence of new policy developments in several parts of the world that encourage the right to repair. For example, in the United States of America[19] many states have begun working on specific legislative proposals, while in the European Union, the European Commission has published a proposal for a directive on common right-to-repair rules.[20] The aim is to prioritize repair over replacement and to give consumers the right to have faulty products repaired by manufacturers. In the European Union, plans are being made, under the Ecodesign for Sustainable Products Regulation (Directive 2009/125/EC), for an obligatory digital product passport that would enhance transparency and unlock circularity aspects by sharing product information across the entire value chain, including data about raw material extraction, production and recycling.[21]

Interestingly, most policies, legislation and regulations focus on collection and recycling; hardly any include targets for recovering critical raw materials, including rare earth elements. As a result, the focus is on the easier process of recovering materials occurring in large quantities (steel, plastics, iron, copper, gold, silver, etc.), to the detriment of critical raw materials such as hafnium, indium, lithium and rhodium, and the recycling rate for rare earth elements contained in e-waste is only around 1 per cent (see Recovery of Valuable and Critical Metals).

Figure 17. The Waste Hierarchy and Considerations for E-waste Targets



Policy measures on the supply of critical raw materials are being considered in various parts of the world, with the ultimate aim of strengthening the supply of such materials. The measures also aim to bolster economic resilience by reducing dependency, increasing preparedness and promoting supply chain sustainability and circularity, however, the broader transposition of this worldwide, in national e-waste policy, legislation and regulation, and the fruits of its implementation, remain to be ascertained.

The challenge facing policy-makers is the constantly growing diversity of EEE being made available to consumers, in the form, for example, of e-cigarettes, e-vehicles and invisible EEE (smart clothes with a heating function, smart furniture with a massage function, etc.). These latest technological developments lead to the use of products of variable composition, requiring different end-of-life treatments and posing special and possibly new requirements in terms of appropriate collection techniques. Moreover, the complex composition of EEE also makes it necessary to align e-waste-specific requirements with other less specific legislation that is nevertheless of relevance for appropriate e-waste treatment, supporting the shift towards a circular economy.

According to an OECD report, about 400 EPR systems exist for various waste streams worldwide.[22] According to the StEP Initiative, a producer is any natural or legal person who is established in the country and manufactures EEE under their own brand name or trademark, or has EEE designed or manufactured and markets it under their name or trademark within the country; is established in the country and places imported new or used EEE on the market for sale or personal use; or is not established in the country and is registered with a locally, legally approved authorized representative and sells EEE by means of distance communication in the country.[23]

The majority of countries with e-waste legislation also apply EPR, and expectations are high that this combination will lead to a well-financed e-waste management system. This will only work, however, if each producer's share of e-waste is appropriately monitored, documented, collected and administered - data availability and accessibility remain major weaknesses in most countries. In addition, a pool of funding does not automatically lead to a well-functioning, state-of-the-art e-waste management system. Funds may be misappropriated, used corruptly or set aside for the administrative costs of managing funds and operations, discouraging producers from investing more. In essence, the development of an appropriate and well-functioning e-waste management system requires substantial and longer-term financial investment. The provisions dictating, for example, what exactly has to be financed and what producers are responsible for, must be clear and strict. Otherwise, only the minimum will be done.

When it comes to e-waste legislation, steps are being taken in the right direction by countries in all regions of the world. However, governments simply lack the institutional capacity to implement and enforce legislation. This means that even if targets are enshrined in the legislation, compliance may not be enforced, and even if the legislation provides for a financial mechanism, the funds may not be collected or may be used inefficiently. Furthermore, even if the legislation clearly and succinctly defines EEE producers, efforts by governments to track - and in many cases to register - these producers may be woefully understaffed and under-resourced. Hence the need for different approaches to financing, target setting and enforcement.

Governments may find it very challenging to track producers placing EEE on the market in a given jurisdiction, given the varied definitions of "producer" and the opportunities for free riding. Information about producers is first captured at customs and at the point of registration with the government. To improve the success rate of tracking and enforcement of e-waste legislation, it is important to know who the producers are and where to find them easily. Businesses that place EEE on the market are required by law to register with the authorities for other purposes, i.e., to be authorized to do business, to operate licensed premises, to pay tax, to register EEE products for health and safety, for environmental efficiency purposes, etc. If the relevant registration processes were streamlined into one service that grouped similar requirements, the authorities would be better equipped to track and prevent free riding much more efficiently.

Online retailing and marketplaces present another enforcement challenge, where cross-border sales are affecting the way traditional national regulations function, whereby consumers have more access to overseas sellers but these sellers fail to comply with EPR requirements in the countries where their products are sold.

In essence, e-waste legislation should at a minimum comprise clear provisions on stakeholder definitions, roles and responsibilities, product scope, enforcement measures and penalties for non-compliance, the financing mechanism and, if it includes EPR, the organizational mechanism(s) for EEE producers, along with clear terminology on who covers the cost of e-waste management.[24]

UNITAR

Chapter 6.
Recovery of Valuable and Critical Metals

In 2022, all e-waste worldwide contained 31 billion kg of metals, of which an estimated 19 billion kg were viably recovered and brought back into circulation. The metal most successful recovered was iron, which is known for its high recycling rates. Other metals, such as zinc and lead, had much lower viable recovery rates. Precious metals were present in much lower quantities but estimated to have a viable recovery of 300 thousand kg.

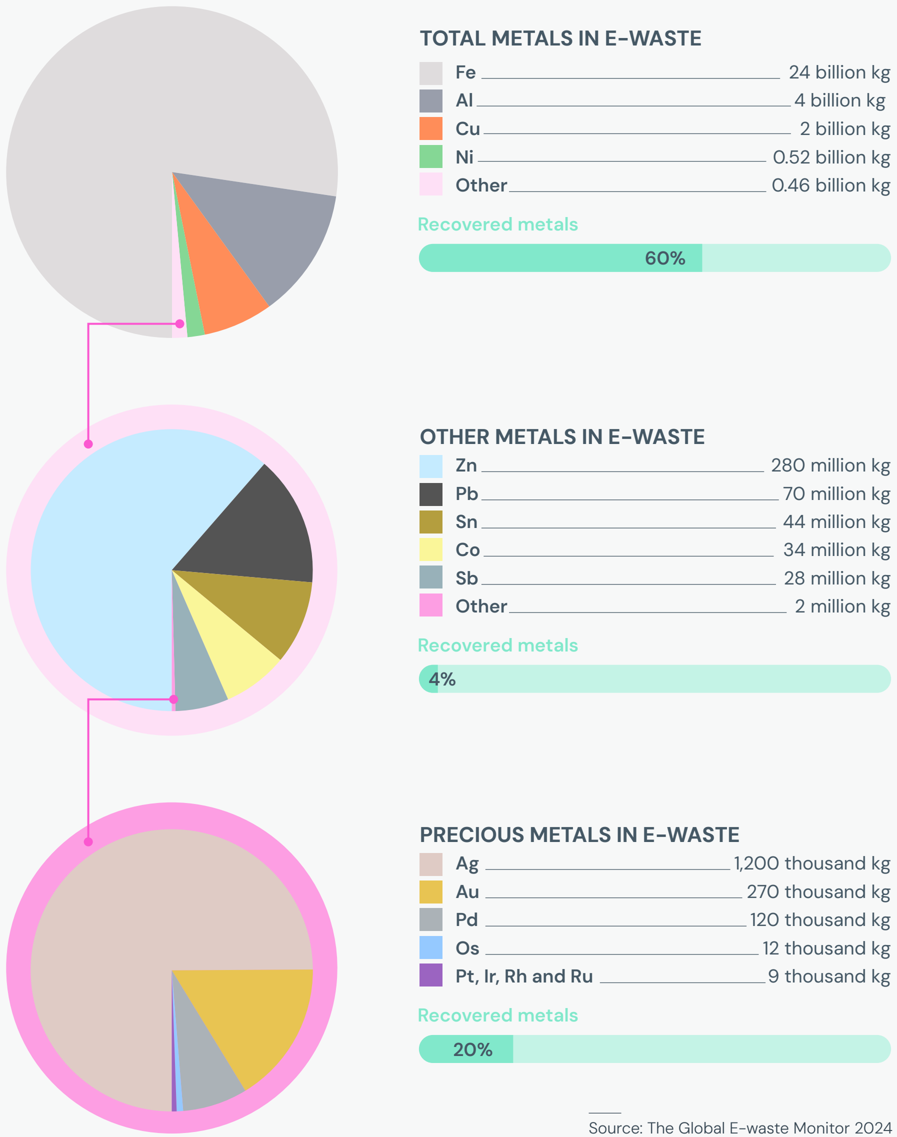
The composition of e-waste varies by type of equipment, but it consists primarily of metals (Figure 18) and plastics. The amount of metals in the datasets is estimated to be 31 billion kg, and the amount of plastics in e-waste is estimated to be 17 billion kg. The remaining 14 billion kg comprise other components, such as some alloys, composite materials, glass and concrete, or could not yet be properly quantified in the datasets. Among the metals, iron/steel (Fe, approximately 24 billion kg) is the most used, followed by aluminum (Al, 3.9 billion kg) and copper (Cu, 2.1 billion kg).

In the small equipment category, 1 billion kg of copper were found in cables and printed circuit boards, while temperature exchange equipment contained 500 million kg of copper from compressors and cables.

Smaller quantities of other highly valuable precious metals (1.6 million kg), such as gold (Au), palladium (Pd) and silver (Ag), were also present, along with toxic substances such as lead (Pb, 70 million kg) and the critical metal cobalt (Co, 34 million kg).

In 2022, all e-waste worldwide contained a total of 31 billion kg of metals, of which an estimated 19 billion kg were viably recovered by current e-waste management routes. This means that 12 billion kg of metals were lost, either in the compliant recycling process, or because they ended up in non-compliant management schemes or dumpsites with typically lower efficiencies. Those losses were therefore non-viable for recovery.

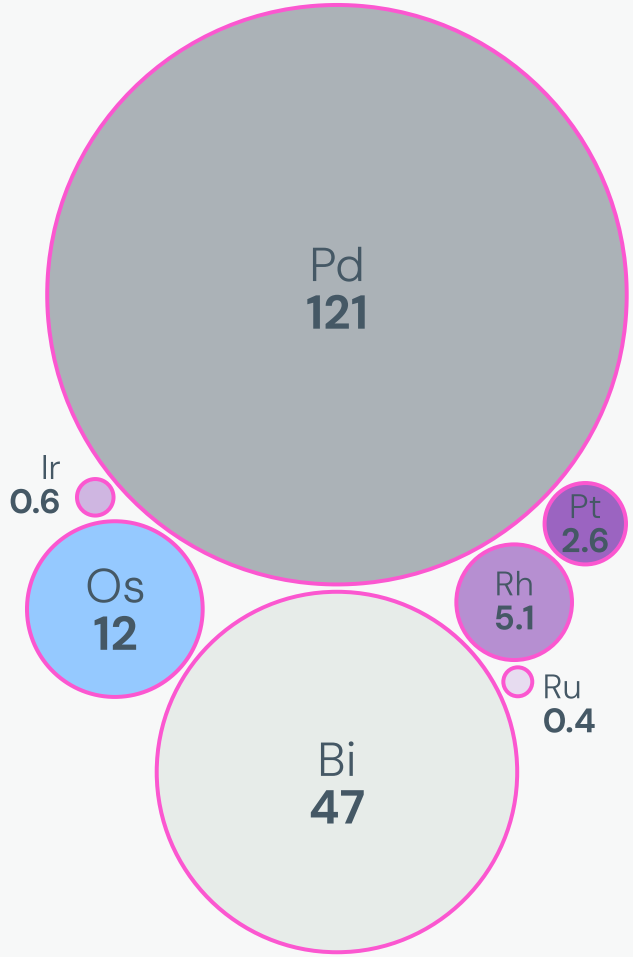
Figure 18. Recovered and Non-Recovered Metals in E-waste with Current E-waste Management Practices



Source: The Global E-waste Monitor 2024

Precious metals such as silver, gold and palladium, but also copper, iron/steel and aluminum, can be recycled at very high rates in smelters, which also recycle other metals, such as lead, nickel, tin and zinc, albeit at lower recycling rates. Achieving high recycling rates requires separate pre-treatment of e-waste and minimizing metal losses to generate fractions suitable for recycling in smelters[25], which is not the case in current e-waste management globally.

Figure 19. Platinum-Group Critical Raw Materials that have Potentially High Recovery Rates if Processed at the Right Final Treatment Facilities (in thousand kg, 2022)



Source: The Global E-waste Monitor 2024

In 2022, all e-waste worldwide contained approximately 4 billion kg of metals classified as critical raw materials, most often aluminum (Al, 3.9 billion kg), cobalt (Co, 34 million kg) and antimony (Sb, 28 million kg).

Figure 19 shows that other critical raw materials of higher material value were present in much smaller quantities. These included platinum-group metals such as palladium (Pd), bismuth (Bi), osmium (Os), rhodium (Rh), platinum (Pt), iridium (Ir) and ruthenium (Ru), and accounted for approximately 140 thousand kg, of which approximately 121 thousand kg were palladium.

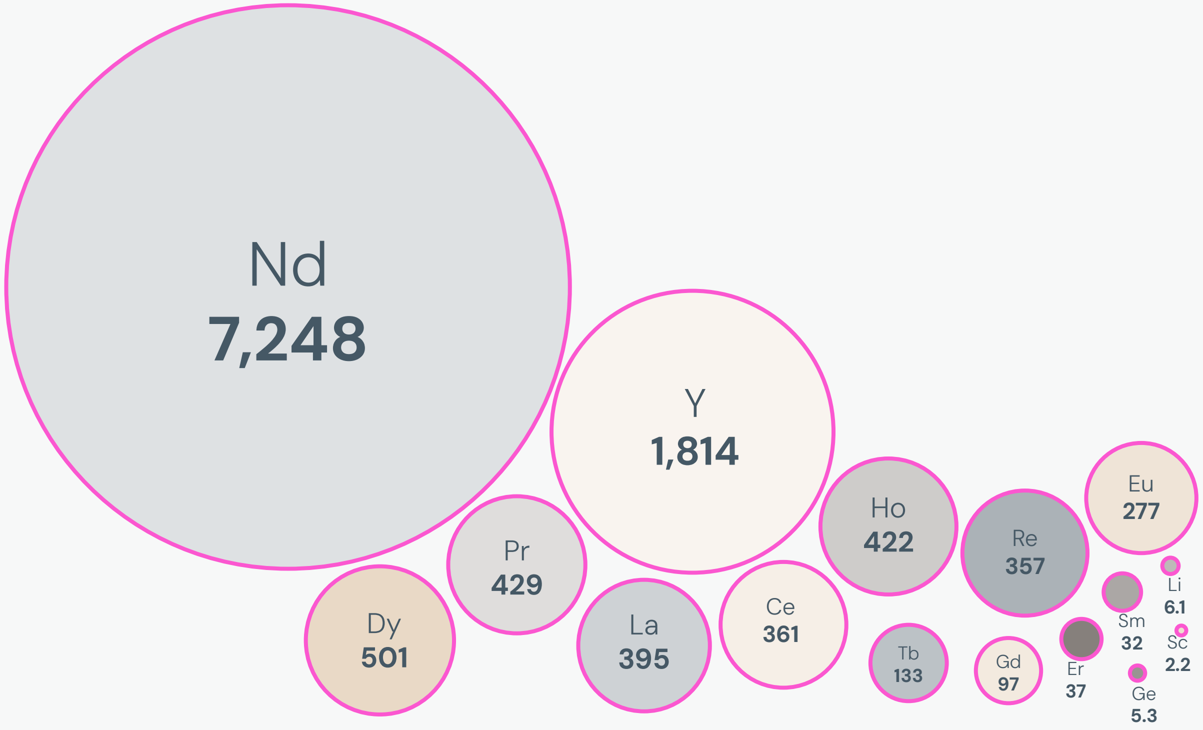
Critical raw materials play a vital economic role but are also highly vulnerable to supply disruptions, as they are typically sourced from a few countries. Critical raw materials are in growing global demand, driven by the shift towards decarbonizing economies.[26] They are used extensively in various applications, including in EEE, and are therefore prevalent in e-waste. Approximately 44 per cent of the aluminium in e-waste is found in small equipment. Other critical raw materials may be present in smaller quantities; they offer indispensable functionalities that are difficult to substitute.

Platinum-group metals, especially palladium, are primarily used in printed circuit boards. When they are processed in copper route smelters, palladium recycling rates can reach 95 per cent or higher.[27]

With the exception of lithium (Li) and germanium (Ge), several critical raw materials, primarily rare earth elements, are difficult to recycle from e-waste. In 2022, approximately 12 million kg of these elements were present in the e-waste generated globally, with neodymium (Nd) accounting for 7.2 million kg (commonly used in magnets) and yttrium (Y) accounting for 1.8 million kg (Figure 20).

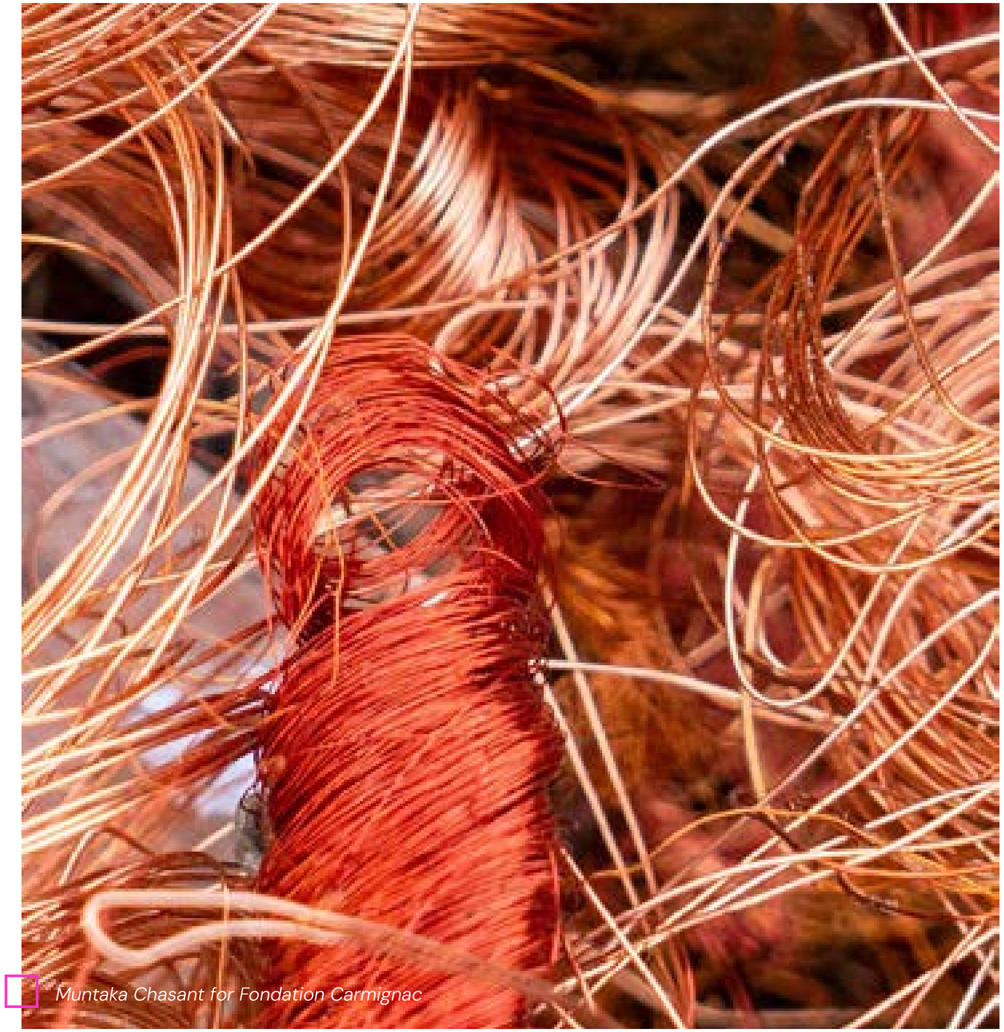
Bénédicte Kurzen / NOOR for Fondation Carmignac

Figure 20. Critical Raw Materials in Global E-waste as per European Union Definitions, with No or Low Recovery Rates (in thousand kg, 2022)



Source: The Global E-waste Monitor 2024

Rare earth elements have unique properties that are crucial for future technologies, including renewable energy generation and e-mobility. Reducing dependency on a few countries for production chains has become a significant political concern. Rare earth elements are often used in small quantities and low concentrations in various EEE components. They remain economically challenging to recycle, even from components with a higher content, and recycling therefore currently accounts for only around 1 per cent or less of demand.[vi] The market prices for rare earth elements are still too low to support larger-scale commercial recycling operations, although neodymium magnets have some potential for industrial-scale recycling from e-waste. However, the current high cost of separating such magnets from e-waste and their subsequent treatment have hindered their widespread adoption and made recycling economically unattractive.[28] Concentrations of germanium are too low in e-waste. According to the CEWASTE project[29], germanium is currently not recycled from e-waste; for lithium, recycling is technically feasible but not economically viable in the current economic framework conditions. Lithium battery recycling technology and capacity are nevertheless growing worldwide.[30]



Muntaka Chasant for Fondation Carmignac

[vi] The source refers to Europe, but the authors interpret this to mean that the value applies to the rest of the world as well.

Chapter 7.
Treatment Technology Innovations

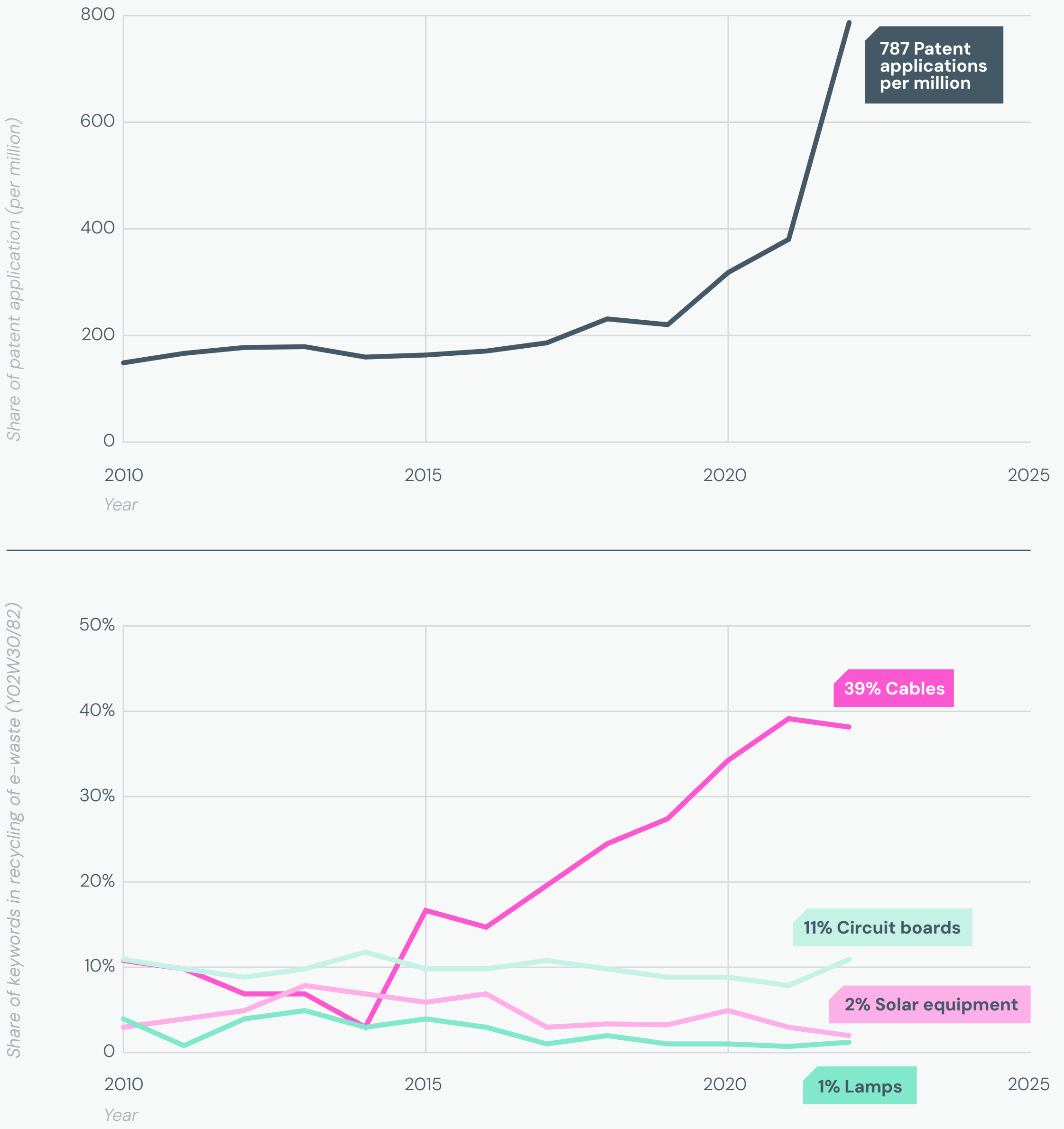
The share of patent applications for e-waste recycling grew from 148 per million in 2010 to 787 per million in 2022. The figures were calculated as the number of patent applications filed under the Customs Procedure Code (CPC) for e-waste recycling divided by the total number of patent applications. The increase was driven by cable recycling, and there are no signs yet of increases in the number of patents filed specifically for critical raw materials recovery.

Technological developments play an essential role in improving recycling rates and the overall efficiency of e-waste management, particularly when it comes to the recycling of critical raw materials. The data on patent applications are a valuable indication of inventiveness, where e-waste patents reflect the capacity of innovators to foresee new technological and economic opportunities in e-waste management.

Muntaka Chasant for Fondation Carmignac

The main findings reveal that, between 2010 and 2019, there was a modest increase in the share of patent applications related to e-waste recycling, from 148 per million to 220 per million (Figure 21). After 2019, however, that share accelerated rapidly, to 787 applications per million in 2022. Keyword searches indicate that this rapid growth was driven by patents related to cable processing technologies. In contrast, the share of applications relating to technologies for the recycling of other components or products, such as printed circuit boards, solar panels or lamps, which may contain large concentrations of critical raw materials, remained relatively stable. There are therefore no signs as yet of an increase in the share of patent applications for critical raw materials recovery.

Figure 21. Patent Applications for E-waste Recycling Technologies as a Share of Total Applications (top) and by Type of Equipment (bottom)



Source: The Global E-waste Monitor 2024

Chapter 8. Environmental Impact

Environmentally sound e-waste management systems prevent damage to the environment and help recover secondary raw materials and avoid emissions.

There are a number of ways in which the management of e-waste impacts economies, societies and the environment. It is also important to recognize the important spill-over effects, and to assess the direct and indirect costs. This includes the price paid by society in terms of long-term and externalized health and environmental costs emanating from unmanaged hazardous substances and greenhouse gas emissions.

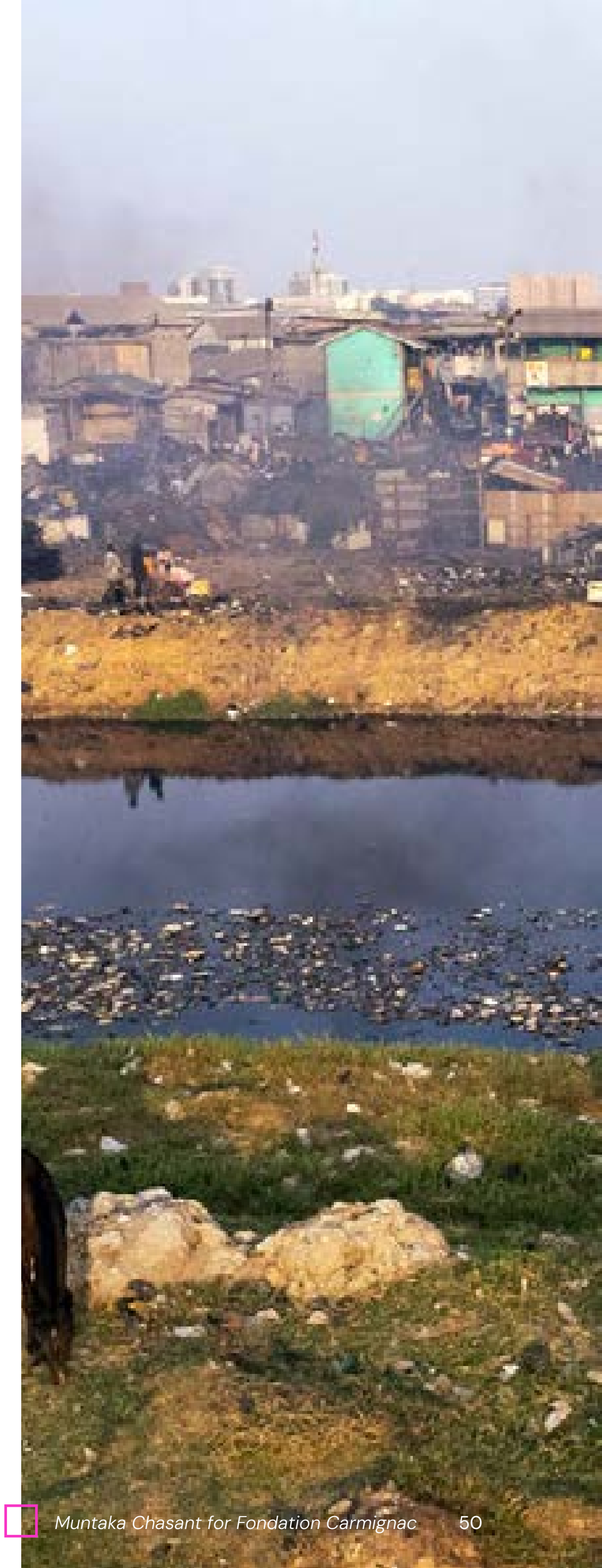
Thanks to the production of secondary raw material from e-waste recycling, 900 billion kg of ore were not excavated during primary mining and 52 billion kg of CO_2-equivalent emissions were avoided.

Urban mining (i.e. the extraction of resources from waste instead of the Earth's crust) reduces reliance on mining but also prevents environmental degradation. The extraction of minerals from the Earth's crust provides materials for many economic activities but also poses risks for sustainable development.[31] The most challenging environmental impacts of both large-scale and artisanal mining activities are air and water pollution, damage to land and biodiversity loss.[32] Human health is also affected by mining activities, for example, when respiratory diseases are caused by the air pollution resulting from the use of mercury to extract gold.[33] Other detrimental effects are related to non-respect for basic human rights, as when child labour is used for mining activities or basic worker rights are flouted, or to illegal mining, if organized crime is involved. One of the main reasons why mining poses challenges is that the minerals that contain the metals of interest are rare and difficult to extract. Large volumes of rock have to be extracted to produce a substantive amount of the minerals containing the metals. For instance, 3 million kg of mineral ore (rock) have to be mined to produce 1 kg of gold. Recycling, or urban mining, on the other hand, brings secondary raw materials back into economies and lowers the demand for primary mining. The largest contributors to the 900 billion kg of ore that were not excavated are recovered copper (around 50 per cent), followed by gold (around 20 per cent), iron (around 10 per cent) and palladium (less than 5 per cent).

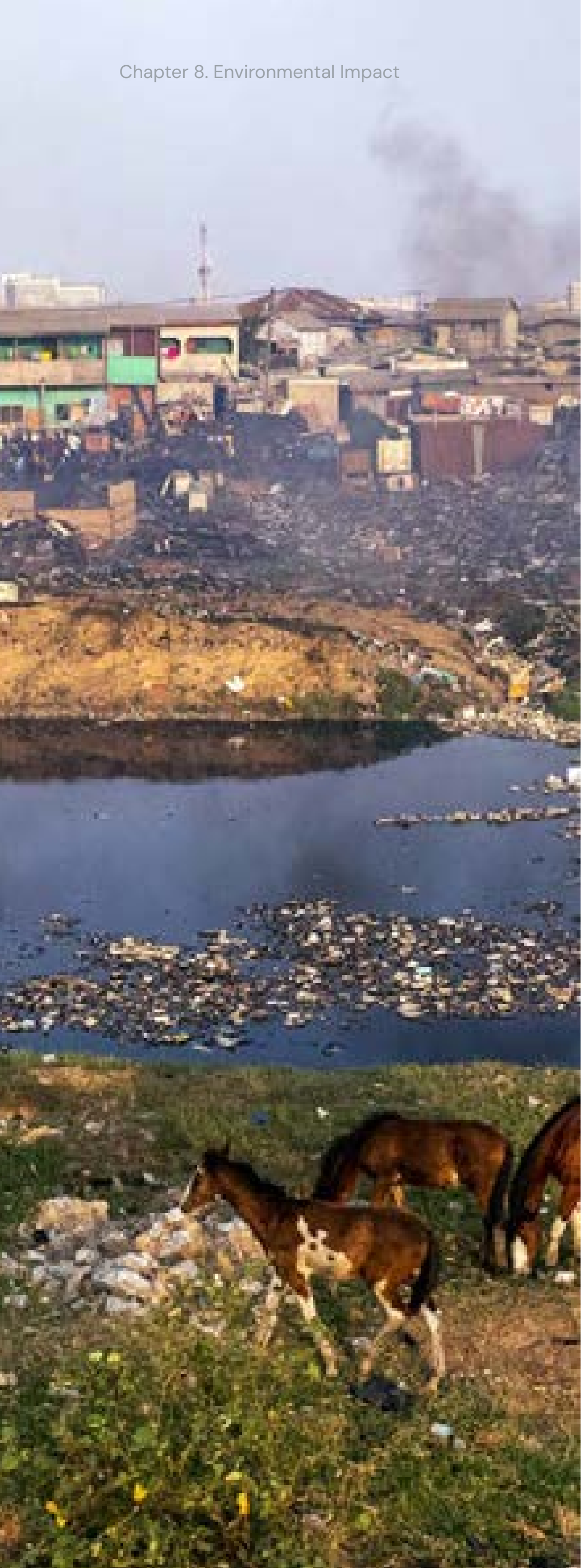
The recovery of secondary raw materials from e-waste recycling also avoided 52 billion kg of CO_2-equivalent emissions. The avoided emissions of environmentally sound management of refrigerants that also contribute to global warming is estimated to be 41 billion kg, both curbing climate change and its effects. In 2022, 145 billion kg of CO_2-equivalent emissions escape into the environment as a result of mismanagement of refrigerants. With an annual global net anthropogenic greenhouse gas emissions of 59 ± 6.6 trillion kg of CO_2-equivalent in 2019, the current emissions of e-waste management on climate change is just above 0.2 per cent.[34] The emissions during use and production of EEE are not yet calculated.

Unmanaged e-waste has a direct impact on the environment and people's health. Currently, 58 thousand kg of mercury and 45 million kg of plastics containing brominated flame retardants are released into the environment every year as a result of non-compliant management of e-waste.

E-waste contains toxic and persistent substances, such as the flame retardants that are used in appliances and in EEE containing plastics. There are currently 17 billion kg of e-waste plastics. Of that, 59 million kg contain flame retardants, an estimated 45 million kg of which are not managed under compliant conditions. Most flame retardants (80 per cent) are found in screens and monitors. They are used, for example, in computer chassis, printed wiring boards, connectors, relays, wires and cables. The recycling of plastic containing brominated flame retardants represents a major challenge because of the cost of separating the plastic containing the retardants from other plastics. Several international studies of the emissions caused by open burning of various materials, including hazardous materials, highlight the health risks of inhaling the heavy metals (e.g. lead, cadmium, chromium, copper) and brominated flame retardants contained in plastic e-waste.[35]



Muntaka Chasant for Fondation Carmignac



A recent study revealed a high risk of harm to a large group of 11 million informal entrepreneurs who work closely with waste in low- and middle-income countries, and to the wider communities living in geographical proximity.[36]

Mercury is another dangerous substance found in e-waste. New provisions on how to treat it are set out in the Minamata Convention on Mercury[37], which was adopted in 2013 and entered into force in 2017. A milestone for chemical safety, the Convention has since been amended to include (when alternatives are available) the phasing out of certain uses of mercury by 2025, including for compact fluorescent lamps and satellite propellant.[38] While mercury is contained in different types of EEE, including screens and small IT devices, up to 95 per cent of mercury emissions are derived from lamps. In 2022, 58t of mercury emissions were produced as a result of environmentally unsound e-waste management, according to the data collected for the Global E-waste Monitor.

Finally, another major - but often overlooked - concern is the unmanaged recycling of temperature exchange equipment, which contributes to climate change and depletion of the ozone layer.

Temperature exchange equipment contains refrigerants. Depending on the type of refrigerant used, it contributes to climate change and helps deplete the ozone layer. According to the Global E-waste Monitor datasets, 73 per cent of all temperature exchange equipment worldwide is managed in an environmentally unsound manner. Countries with no e-waste legislation (i.e. most low- and middle-income countries) release refrigerants into the atmosphere directly. Countries with e-waste legislation usually provide for the safe degassing and recycling or disposal of the refrigerants, but fail to collect and manage all temperature exchange equipment, and also face significant illegal scavenging and emissions from the compressors containing a significant part of the refrigerants.[39] In addition, not only chlorofluorocarbons and hydrochlorofluorocarbons, but also hydrofluorocarbons which are not ozone-depleting, contribute to climate change. Hydrofluorocarbons are regulated under the Kyoto Protocol to the United Nations Framework Convention on Climate Change and are targeted for net zero emissions. Some hydrofluorocarbons are regulated by the Montreal Protocol (see Box 4) and are targeted for phasing down. The unregulated export of e-waste from high-income to lower-income countries for recycling can also result in additional emissions from transport and handling, adding to the overall carbon footprint. It is crucial to implement proper e-waste management practices, including regulated recycling processes and responsible disposal, and to adopt circular economy principles to minimize waste and resource use.

Box 4. The 1987 Montreal Protocol and the Management of Refrigerant E-waste

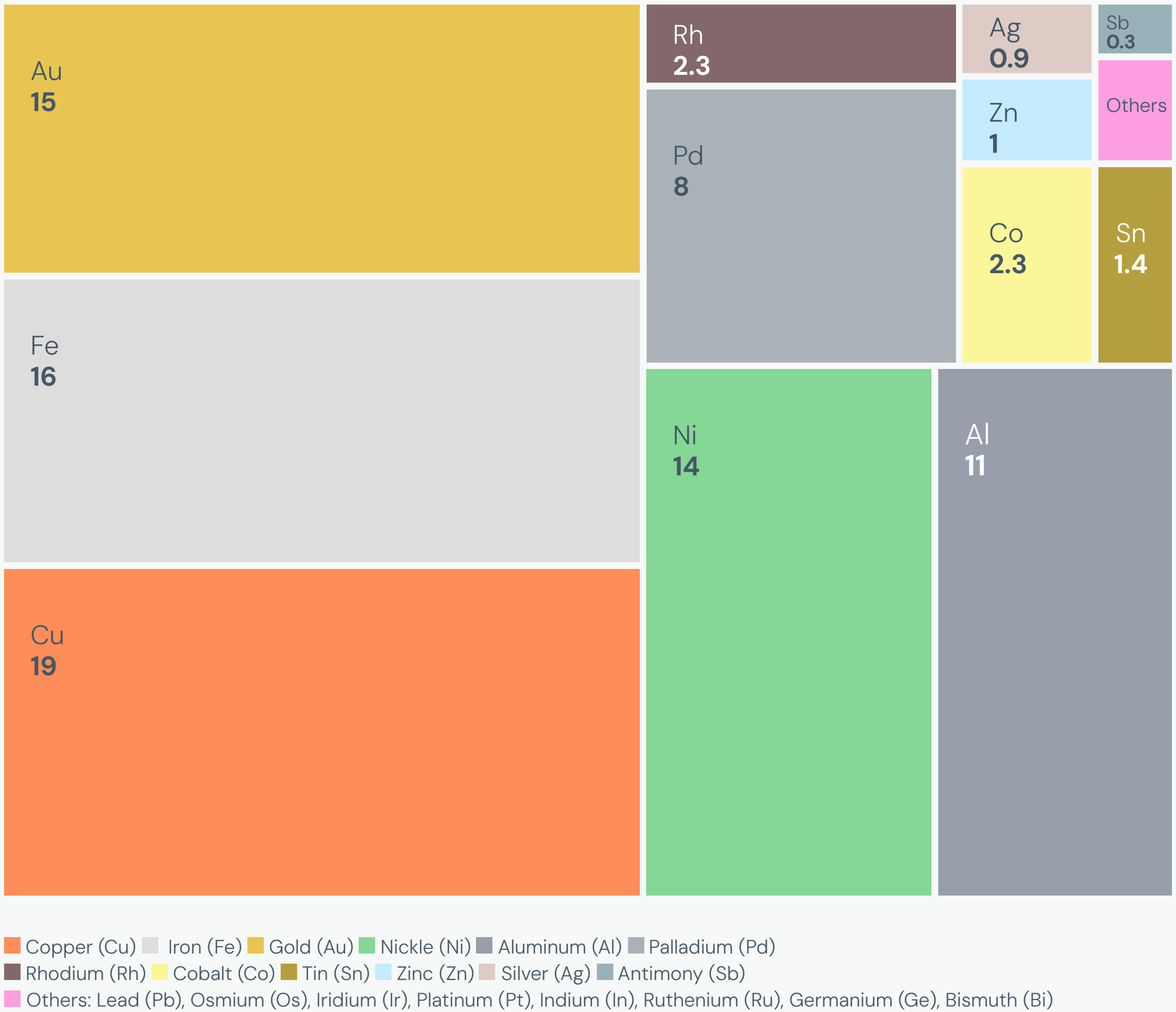
The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer regulates the production and consumption of manmade chemicals known as ozone-depleting substances. It covers the phasing out of the chlorofluorocarbons and hydrochlorofluorocarbons that remain present in the refrigerant circuits and insulating foams of cooling and freezing equipment, such as refrigerators, freezers and air-conditioning systems produced before 2000. While neither chlorofluorocarbons nor hydrochlorofluorocarbons are used in cooling equipment produced since 2000, they continue to be released in environmentally unsound recycling procedures, especially lower-middle-income and low income countries. These molecules have a long-term negative effect since they have a long lifespan in the atmosphere and react with ozone molecules, generating molecular oxygen that thins the stratospheric ozone layer. This in turn increases the amount of ultraviolet radiation that can pass through the stratosphere, heightening the risk of skin cancer, eye-related diseases and weakening of the immune system.

Chapter 9. Economic Assessment

Current e-waste management practices result in around USD 28 billion worth of metals being turned into secondary raw materials worldwide in 2022. However, the overall impact of e-waste management represents a net cost of approximately USD 37 billion, mainly in the form of externalized health and environmental costs arising from unmanaged hazardous substances and emissions of greenhouse gases.

In 2022, the overall gross value of the metals contained in e-waste was estimated at USD 91 billion.[vii] Most of the potential value in secondary raw materials in e-waste lies in copper (USD 19 billion), gold (USD 15 billion) and iron (USD 16 billion). These metals can be efficiently reclaimed with high recycling rates using current e-waste management technologies and in current financial conditions. That said, not all metals are recycled into secondary raw materials in an environmentally sound manner, owing to the low global collection rate of 22.3 per cent, and significant amounts are managed by the informal sector (Figure 22). These factors are further explored in the simple cost-benefit analysis as shown on the next pages.

Figure 22. Economic Value of Metals from E-waste (Before Management) in USD billion (2022)



Source: The Global E-waste Monitor 2024

[vii] This is a significant increase from the USD 57 billion estimated in 2019. The increase can be attributed to two main factors: the rising prices of secondary raw materials and the growing volume of e-waste generated.

The economic benefits of e-waste management were calculated in terms of metal recovery and contributions to climate change. **The value of the metals recovered in e-waste (viable recovery) is estimated at USD 28 billion for all e-waste management routes in 2022.** For some metals, recycling is at present technically or economically not feasible, or the metals are collected in other flows with lower recovery efficiencies. The viable recovered materials (USD 9 billion of iron, copper, aluminum and platinum-group metals) come from documented formal collection and recycling schemes. The informal sector in low- and lower-middle-income countries is estimated to have processed around USD 12 billion of metals (mostly iron, copper and platinum-group metals). Approximately USD 7 billion of metals (mostly bulky iron and copper components) are recovered outside compliant e-waste management schemes in high- and upper-middle-income countries. The least value is recovered from e-waste ending up as residual waste in high- and upper-middle-income countries (around USD 0.5 billion). This was calculated using World Bank data to the effect that 15 per cent of residual waste worldwide is incinerated[40] and ends up as bottom ash, from which only a few metals are viably recovered.
The estimated value of the greenhouse gas emissions avoided in this way is USD 23 billion. When added to the value of USD 28 billion worth of viable recovered metals, a value of USD 51 billion is created for society by global e-waste management.

However, the collection and management of e-waste also has costs. The highest are the externalized costs of USD 78 billion to human health and the environment and are not reflected in treatment costs or costs paid for through EPR systems. They arise when e-waste is not managed in line with proper environmental health and safety standards. Examples are shredding entire devices together with scrap metal or selective dismantling of the equipment into marketable components and materials by the informal sector. When this happens, hazardous substances and greenhouse gases from refrigerants are released into the environment or the e-waste ends up in uncontrolled landfills.

The externalized costs amount to an estimated

- **USD 36 billion in long-term socio-economic (see Box 5 for an example of gender dynamics) and environmental costs arising from the emission of the greenhouse gases that drive climate change;**
- **USD 22 billion representing the cost of illnesses and decreases in human capital (productivity and wages) and the average monetized value of working lives caused by mercury emissions;**
- **USD 19 billion arising from the release of plastic waste into the environment;**
- **Less than USD 1 billion arising from the release of lead into the environment and its effects on wildlife and humans.**

Other externalized costs, arising, for instance, from the mismanagement of other hazardous materials such as flame retardants and cadmium, or from the use of primitive informal recycling techniques, could not be quantified. The above costs are estimated and vary greatly across regions.

Bénédicte Kurzen / NOOR for Fondation Carmignac

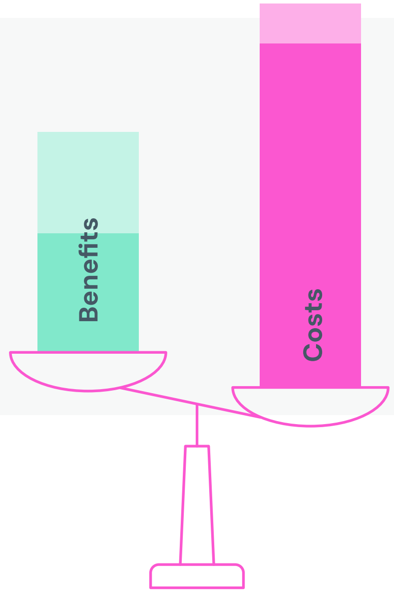
Another cost is the price of treating e-waste, which amounts to USD 10 billion worldwide.[viii] Half of that amount (USD 5 billion) is incurred by the environmentally sound treatment of e-waste, and the other half by the disposal of residual waste, by recycling outside compliant systems in upper-middle- and high-income countries, and by the informal sector in low- and lower-middle-income countries. In all, 13.7 billion kg of e-waste undergo environmentally sound treatment at a cost USD 0.36/kg; this is 3 times more than the average cost of e-waste disposed of as residual waste, recycled outside compliant recycling schemes or managed by the informal sector (USD 0.12/kg). The higher treatment costs are mostly attributable to the costs of depolluting e-waste and of auditing, administrating and attaining the minimum environmental health and safety standards associated with compliant management of e-waste.

When the total benefits from viable recovery of metals as secondary resources (USD 28 billion) and avoided greenhouse gas emissions (USD 23 billion) are deducted from the costs of e-waste treatment (USD 10 billion) and externalized costs to human health and the environment (USD 78 billion), the result is a net loss of USD 37 billion in the world's current e-waste management practices.

–37 billion USD

lost because of e-waste management external effects

benefits minus costs



Monetized value of avoided greenhouse gas emissions.
Worth of recovered metals brought back into the circular economy.

Associated to the cost for treatment of e-waste.
Externalized costs to the population and the environment.

Source: The Global E-waste Monitor 2024

[viii] This figure does not include all costs; the costs of separate collection of e-waste at municipalities or retailers, for example, were not assessed.

Muntaka Chasant for Fondation Carmignac

Box 5. Gender Dynamics in E-waste Management[a]

Formal regulatory frameworks for overseeing e-waste management are still emerging in most countries, with even well-established systems, such as those in the European Union, being only 2 decades old. In the absence of comprehensive regulations, informal e-waste businesses have proliferated in many nations to address the growing e-waste issue. These informal systems often involve refurbishing used electronic equipment for resale or dismantling and processing for valuable components, frequently utilizing rudimentary tools and techniques. However, the extraction of metals from e-waste through hazardous processes and chemicals exposes workers to risks, including improper chemical handling, toxic fumes and harmful substances. Evidence suggests that the chronic exposure associated with such practices may disproportionately affect women, especially pregnant women, who have gender-specific vulnerabilities related to reproductive health, and children, potentially impacting neonatal development, hormonal levels and immune function.

Gender disparities in the e-waste sector

Women's participation in the e-waste management sector is both limited and context-dependent. Unlike the plastic waste management sector, where women frequently constitute a substantial portion of the workforce, the presence of women in the e-waste sector varies widely depending on social contexts, which tend to be shaped by gender norms and systemic biases. In many cases, women have less representation in the sector and the roles they do occupy are often non-specialized, low-paying and lack safety measures tailored to women's specific needs.

For instance, in Nigeria's predominantly informal e-waste sector, the workforce is primarily composed of men and young boys. The few women involved in this sector typically serve as collectors, gathering electronic items from households and dumpsites for sale to recyclers, often with limited negotiation opportunities due to gender power imbalances.[b] In India's informal sector, women often engage in specific tasks, such as wire stripping or waste collection at the lowest tiers of the waste management hierarchy.

However, some women are employed in formal e-waste recycling companies as, for example, dismantlers and machinery operators, or in administrative, management and leadership positions, but they frequently face gender-specific challenges and biases in these spaces. In these more formal settings, women might confront biases in hiring and promotion processes, wage disparities, or even a lack of gender-sensitive facilities and protective equipment tailored to their needs.

Despite growing evidence regarding e-waste management and increased concerns about its practices, there remains limited globally documented evidence concerning women's experiences within the sector, particularly regarding the gender-specific challenges they face. Gender stereotypes related to strength and technical expertise frequently discourage women from participating, perpetuating the gender gap in the e-waste management field.

Opportunities for women in e-waste management

The e-waste management sector presents an untapped opportunity for women to excel, especially as the sector becomes more regulated and formalized. Given that e-waste represents a valuable secondary source of metals with steadily increasing volumes, the reverse supply chain for e-waste management can offer lucrative prospects for individuals and businesses alike. The growing push to regulate and formalize this value chain, coupled with gender-responsive policy frameworks, is creating an enabling policy environment that could potentially provide entrepreneurial and employment opportunities for women.

Efforts should concentrate on upskilling women by offering specialized vocational training programmes that are sensitive to women's unique needs and constraints, improving access to financial incentives and resources tailored for women, and providing mentorship opportunities from female leaders in the field to unlock their potential. Moreover, increasing the visibility of successful women in the sector can help counteract societal prejudices that discourage women from entering technical fields while also providing role models for aspiring female professionals.

In some instances, community mobilization efforts, as seen in Bhavnagar, India[c], have successfully organized female e-waste workers, allowing them to purchase and process smaller e-waste components, challenging traditional gender roles and providing livelihood-enhancing opportunities.

By addressing these challenges and implementing supportive strategies, the e-waste management sector can promote gender equality, provide more opportunities for women to excel, and ensure a more inclusive and sustainable future for all.

[a] UNEP International Environmental Technology Centre. 2022. The role and experience of women in e-waste management [online]; Fan M, Khalique A, Qalati SA, Gillal FG and Gillal RG. 2022, Antecedents of sustainable e-waste disposal behavior: the moderating role of gender. Environmental Science and Pollution Research, Vol. 29, pp. 20878-20891; Bhatia A and Kiran C. 2022. A study on attitude of women towards management of e-waste. National Seminar on Gender Sensitive Issues and Women Empowerment, pp. 362-370; Sama AA. 2017. Women Empowerment: Issues and Challenges [online]. The International Journal of Indian Psychology, Vol. 4, Issue 3, No. 103, April - June. Gender Issues.

[b] Bhatia A and Kiran C. 2022, note a above.

[c] Sama AA. 2017, note a above.

Chapter 10. Improvement Outlook from 2022 to 2030

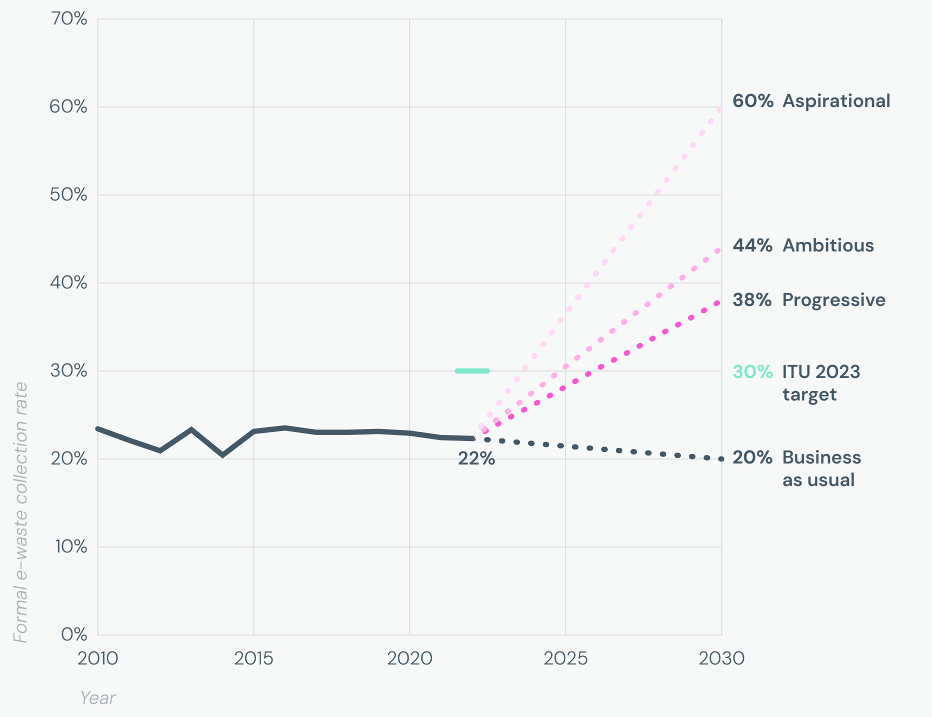
Over time, there has been a decline in the global e-waste collection and recycling rate, which stood at 22.3 per cent in 2022. The ITU target to increase the rate to 30 per cent by 2023 seems unattainable in the light of that trend. However, if there is a shift in momentum and adequate e-waste management infrastructure is put in place, the global e-waste collection and recycling rate might be increased to at least 38 per cent by 2030.

SDG target 12.5 is to, "by 2030, substantially reduce waste generation through prevention, reduction, repair, recycling, and reuse". SDG sub-indicator 12.5.1 measures total formal e-waste collected and recycled divided by total e-waste generated. Measurements to date point to neither an increase in the e-waste recycling rate nor a proportionate increase in environmentally sound treatment as opposed to e-waste generated. In 2010, the formal documented collection and recycling rate for e-waste was 23.4 per cent worldwide, which is higher than the 2022 global collection rate of 22.3 per cent.[ix] The documented collection rates reported in the 3 previous Global E-waste Monitors deviated from this, as the fact that more data on e-waste statistics were available in some countries led to better global statistics. This means that the data in the 2020 Monitor and the current edition cannot be directly compared. The time series that can be compared is provided in this edition. This indicates an overall decrease in the global e-waste collection rate.

Formally documented e-waste collection and recycling rates are calculated by dividing the mass of formally collected and recycled e-waste by the total mass of e-waste generated. Collection methods and recycling infrastructure have improved over time, resulting in better documentation of e-waste. However, the rapid growth in e-waste generated has outpaced these efforts, resulting in a larger denominator and a decline in the global collection rate.

To achieve the SDGs targets for e-waste, the current trend must be reversed. 4 scenarios are considered here: business as usual, and 3 levels of ambition (Figure 23 and Figure 24). All 4 envision the future (up to 2030) based on the current situation, with very little deviation from past and present consumption levels. The model used makes projections based on the current situation and changes in existing trends, whereby the amount of EEE placed on the market keeps pace with GDP growth and demographic trends. It encompasses trends in miniaturization and dematerialization due to obsolete technologies up to

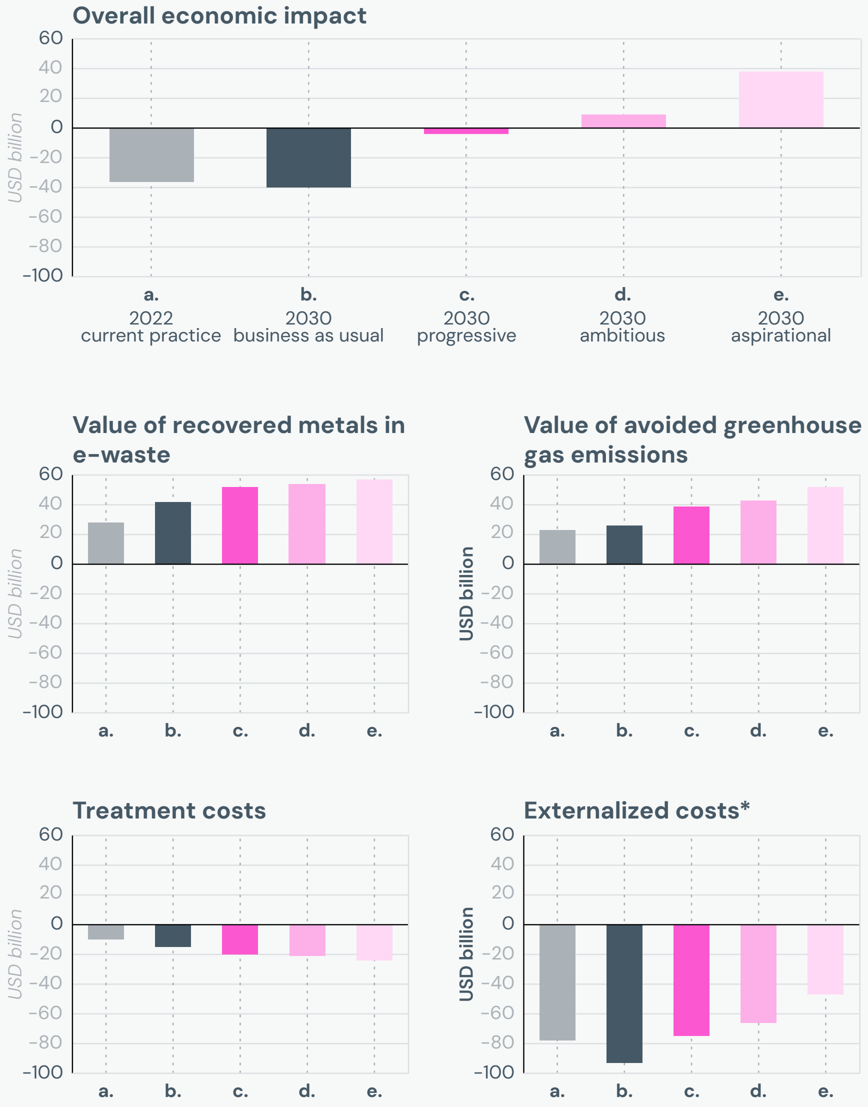
Figure 23. Possible Future Formal E-waste Collection and Recycling Rates According to Different Scenarios



Source: The Global E-waste Monitor 2024

[ix] The documented collection rates reported in the three previous Global E-waste Monitors deviated from this, as the fact that more data on e-waste statistics were available in some countries led to better global statistics. This means that the data in the 2020 Monitor and the current edition cannot be directly compared. The time series that can be compared is provided in this edition.

Figure 24. Potential Impacts of Different Scenarios



*due to lead, mercury emissions, plastic leakages and global warming contribution

Source: The Global E-waste Monitor 2024

2030. The model assumes that there will be no additional waste prevention arising from the transition to a global circular economy and no disruptive changes in consumption patterns. This is because 2030 is relatively close and most products that will become waste in 2030 are already in use today and not yet designed optimally for circular strategies like repair, remanufacturing or reuse. Additionally, there are not enough refrigerators, laptops and other items on the market to supply every household with at least one of these items. Therefore, even if the transition to a circular economy occurs, the demand for new products being placed on the market remains, leading to limited waste prevention at the global level until 2030. E-waste generation has been projected for each country worldwide up to 2030, for an estimated total of 82 billion kg.

The primary distinction between the scenarios lies in the extent to which e-waste management infrastructure, legislation and technology is projected. The scenarios appear achievable, given that the technology for e-waste management currently exists and requires mainly capital investment in developing infrastructure and legislative efforts.

UNITAR

The quantities of e-waste formally documented as collected and managed in an environmentally sound manner are projected to increase at the same pace as observed in the time series between 2010 to 2022, reaching 16 billion kg by 2030. This implies a further decline in the global e-waste collection rate to only 20 per cent of the e-waste generated, because the substantially higher rate of e-waste generation will outpace any improvements in e-waste management. Therefore:

- A rising share of e-waste (24 billion kg) will be managed outside formal systems by the informal sector in low- and middle-income countries. This shift is anticipated because of the faster growth in formally undocumented collection and recycling of e-waste in countries without regulated e-waste management systems. The environmental impact will be 46 thousand kg of mercury released and 149 billion kg of CO_2-equivalent emissions contributing to global warming.
- E-waste collected and recycled outside formal systems in upper-middle-income and high-income countries is expected to increase to 22 billion kg.
- As a result, approximately 25 billion kg of metal resources are projected to be viably recovered by various means, including formal (environmentally sound) collection and recycling, mixing with scrap metal, residual waste and the involvement of the informal sector. The amount of metals lost (non-viable to recover) is estimated to be 17 billion kg.
- The overall economic assessment for this scenario is that the cost of e-waste management is projected to **grow to USD 40 billion by 2030**.

Benefits

- Viable recovery of metals: USD 42 billion.
- Value of avoided greenhouse gas emissions: USD 26 billion.

Costs

- The primary costs consist of USD 93 billion in externalized costs to the population and the environment, stemming from lead and mercury emissions, plastic leakages and contributions to global warming as a result of non-compliant activities, particularly in cases where hazardous substances are not properly managed (such as in the informal sector, e-waste in residual waste and e-waste mixed with scrap metal).
- Additional costs are associated with the treatment of e-waste, amounting to USD 15 billion, primarily comprising compliant e-waste recycling costs. Costs incurred by the informal sector, scrap metal and residual waste management are comparatively lower, as such processes are considerably cheaper to manage.

Scenario 1: Business as Usual by 2030

KEY E-WASTE STATISTICS

16 billion kg | 20%
e-waste projected to be formally collected and managed by 2030.

METALS

25 billion kg
metal resources are viably recovered.

17 billion kg
metal resources are lost.

ENVIRONMENTAL IMPACT

46 thousand kg
emissions of mercury released.

149 billion kg
CO_2-eq. contributing to global warming.

11 thousand kg
mercury emissions avoided.

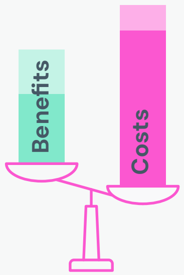
105 billion kg
CO_2-eq. emissions avoided.

OVERALL ECONOMIC IMPACT OF E-WASTE MANAGEMENT

Benefits

26 billion USD
value of avoided greenhouse emissions.

42 billion USD
value in viable recovery of metals.



Costs

15 billion USD
value of compliant recycling costs.

93 billion USD
value of externalized costs to the population and the environment.

-40 billion USD
projected annual economic monetary impact of e-waste management globally.

Source: The Global E-waste Monitor 2024

Scenario 2: Progressive by 2030

KEY E-WASTE STATISTICS

31 billion kg | 38%
e-waste projected to be formally collected and managed by 2030.

METALS

28 billion kg
metal resources are viably recovered.

14 billion kg
metal resources are lost.

ENVIRONMENTAL IMPACT

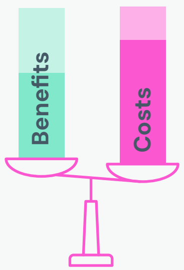
36 thousand kg
of mercury emissions released.

21 thousand kg
emissions of mercury avoided.

116 billion kg
CO_2-eq. emissions released.

155 billion kg
CO_2-eq. emissions avoided.

OVERALL ECONOMIC IMPACT OF E-WASTE MANAGEMENT



-4 billion USD
projected annual economic monetary impact of e-waste management globally.

Benefits

39 billion USD
value of avoided greenhouse emissions.

52 billion USD
value in viable recovery of metals.

Costs

20 billion USD
value of compliant recycling costs.

75 billion USD
value of externalized costs to the population and the environment.

Source: The Global E-waste Monitor 2024

In this scenario, global action takes the form of voluntary collection schemes in regions where no legislation is currently in force. In regions that currently have legislation and decent e-waste management infrastructure, formal collection rates increase to 85 per cent. The dismantling and final treatment of waste printed circuit boards is expected to be optimized, to extract more value.

Countries with unregulated e-waste management will launch voluntary collection schemes, essentially starting from scratch, with the aim of collecting 10 per cent of the total e-waste generated. Countries that already have (drafted) legislation for e-waste collection but do not have an established e-waste management infrastructure will start strengthening their enforcement efforts so as to substantially increase collection rates, to 15 per cent. Countries with established e-waste management infrastructure will boost their collection rates by improving enforcement and implementing more accessible return systems covering a wider range of products. This means that the majority of EU and high-income countries (except those in which collection rates are currently below 40 per cent) will achieve the EU collection target of 85 per cent. At the same time, the resource efficiency of environmentally sound e-waste management increases such that there will be lower losses of printed circuit boards thanks to higher specific dismantling, and the implementation and optimization of waste management technologies using artificial intelligence, automation and advanced robotics play a growing role in waste treatment processes. Therefore:

- The global e-waste collection and recycling rate will increase to 38 per cent.
- Most changes will occur in upper-middle- and high-income countries optimizing their collection rates and printed circuit board dismantling rates.
- As a consequence, in middle- and high-income countries, the amount of e-waste being collected and recycled outside formal channels will fall to 14 billion kg and the amount disposed of as residual waste to 13 billion kg. Resources will still be lost, however, and there will still be an environmental impact.
- The amount of e-waste collected and recycled outside formal systems in low- and lower-middle-income countries is expected to stay the same, at 24 billion kg. It will be managed mainly by the informal sector and will continue to have a serious negative environmental and social impact.
- There will nonetheless be some improvement in terms of environmental impact: the release of 21 thousand kg of mercury, the emission of 116 billion kg of CO_2 equivalents and the generation of 1.4 trillion kg of waste from ore extraction will be avoided.
- As a result, approximately 28 billion kg of metal resources are projected to be brought back into the economy as secondary resources (viable recovery) by various means, including formal (environmentally sound) collection and recycling, mixing with scrap metal, residual waste and the involvement of the informal sector.
- The amount of metals lost (non-viable to recover) will be reduced to an estimated 43 billion kg.
- The overall economic assessment for this scenario is that the cost of e-waste management will be close to net zero (-USD 4 billion).

Benefits

- Viable recovery of metals as secondary resources: USD 52 billion.
- Value of avoided greenhouse gas emissions: USD 39 billion.

Costs

- The primary costs consist of USD 75 billion in externalized costs to the population and the environment, stemming from lead and mercury emissions, plastic leakages and contributions to global warming from the release of refrigerants.
- The costs associated with the treatment of e-waste increase to USD 20 billion, primarily comprising compliant e-waste recycling costs. The costs incurred by the informal sector, scrap metal and residual waste management are comparatively lower, as they are considerably cheaper to manage.

In scenario 3, global action takes the form of effective voluntary collection schemes, while governments focus on enhancing source separation of e-waste in regular waste management systems. Efforts will be made to formalize the informal sector, and formal collection schemes will be established to collect a portion of imported used EEE items in low- and middle-income countries. As in the progressive scenario, the dismantling and final treatment of waste printed circuit boards is expected to be optimized, to extract more value.

Under this more ambitious scenario, all countries that currently lack formal e-waste management systems will actively participate in the collection and management of more e-waste, building on the voluntary actions already carried out. They will gradually engage with the informal sector and formalize its working conditions, providing safety measures and training in more efficient and environmentally sound treatment. They will guarantee acceptance of the materials collected in the informal sector by formalized environmentally sound final treatment processes in low- and middle-income countries. Furthermore, high-income countries lacking specific e-waste legislation will commence source separation, bolstered by the establishment of effective collection schemes.

National governments with existing recycling systems will place higher priority on further increasing collection rates through targeted interventions, such as implementing eased return systems and setting appropriate and ambitious collection rates. There will also be a focus on collecting imported used EEE in low- and middle-income countries after they became waste. Therefore:

- The global e-waste collection rate will increase to 44 per cent, with 37 billion kg of e-waste managed in an environmentally sound manner.
- A total of 12 billion kg of e-waste will eventually be diverted from residual waste and less e-waste will be managed outside the formal e-waste management system in upper-middle- and high-income countries.
- Better efforts in low- and middle-income countries will lead to a modest decrease in the amount of e-waste managed by the informal sector, to 21 billion kg.
- The impact on the environment will be further improved, and approximately 29 billion kg of metal resources are projected to be viably recovered by various means, including formal (environmentally sound) collection and recycling, mixing with scrap metal, residual waste and the involvement of the informal sector. The amount of metals lost (non-viable) will be reduced to an estimated 13 billion kg.
- The overall economic assessment for this scenario is that e-waste management will be net positive.

Benefits

- Viable recovery of metals: USD 54 billion.
- Value of avoided greenhouse gas emissions: USD 43 billion.

Costs

- The primary costs consist of USD 66 billion in externalized costs to the population and the environment, stemming from lead and mercury emissions, plastic leakages and contributions to global warming arising from non-compliant activities, particularly in cases where hazardous substances are not properly managed (such as in the informal sector, e-waste in residual waste and e-waste mixed with scrap metal).
- The costs associated with the treatment of e-waste increase to USD 21 billion, primarily comprising compliant e-waste recycling costs. Costs incurred by the informal sector, scrap metal and residual waste management are comparatively lower, as they are considerably cheaper to manage.

Scenario 3: Ambitious by 2030

KEY E-WASTE STATISTICS

37 billion kg | 44%
e-waste projected to be formally collected and managed by 2030.

METALS

29 billion kg
metal resources are viably recovered.

13 billion kg
metal resources are lost.

ENVIRONMENTAL IMPACT

32 thousand kg of mercury emissions released.

25 thousand kg emissions of mercury avoided.

103 billion kg CO_2-eq. emissions released.

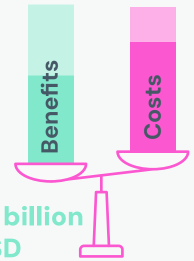
171 billion kg CO_2-eq. emissions avoided.

OVERALL ECONOMIC IMPACT OF E-WASTE MANAGEMENT

Benefits

43 billion USD
value of avoided greenhouse emissions.

54 billion USD
value in viable recovery of metals.



10 billion USD
projected annual economic monetary impact of e-waste management globally.

Costs

21 billion USD
value of compliant recycling costs.

66 billion USD
value of externalized costs to the population and the environment.

Source: The Global E-waste Monitor 2024

In scenario 4, high- and upper-middle-income countries with legislation will attain a formal collection rate of 85 per cent. All other countries with legislation will collect and formally manage 40 percent of their e-waste, as will countries without legislation. Furthermore, collaborative efforts between low-income and high-income countries will lead to the treatment of more imported used EEE goods. Similar to the progressive scenario, the dismantling and final treatment of waste printed circuit boards will be optimized, to extract more value.

There will be significant cooperation between the formal and informal sectors, focused on substantially improving and formalizing the work of the latter. This will include prioritizing source separation of e-waste in countries lacking specific e-waste legislation and establishing effective collection schemes. The separately collected e-waste is then transferred to environmentally sound e-waste recyclers. National governments with existing recycling systems will prioritize increasing collection rates through targeted interventions and setting appropriate collection rates. Under this scenario, all imported used EEE will be collected at end of life in low- and middle-income countries. Large investments in e-waste management capacity will drive demand for recycled materials, resulting in higher prices for both informal recyclers and formal waste managers.

Consequently, the global e-waste collection rate will further increase to 60 per cent, with 54 billion kg of e-waste being managed in an environmentally sound manner. In this scenario most gains are realized in low- and middle-income countries, as follows:

- The amount of e-waste managed outside the formal sector in lower-middle- and low-income countries (the informal sector) will fall to 13 billion kg.
- The amounts disposed of in mixed residual waste and/or treated outside compliant schemes in high- and upper-middle-income countries will fall slightly, to 10 billion kg.
- Consequently, an estimated 30 billion kg of metal resources will be viably recovered globally. The amount of metals lost (non-viable to recover) will be reduced to an estimated 12 billion kg.
- The main gains for society are improvements in terms of releases into the environment, as 34 thousand kg of mercury emissions and 209 billion kg of CO_2-equivalent emissions will be avoided. This will essentially be due to significant improvements in working conditions in the informal sector.
- The overall economic assessment for this scenario is that e-waste management will be net positive globally, at 38 billion USD, mainly thanks to monetized mitigated greenhouse gas emissions. However, in low- and middle-income countries, the result could be still negative. Realistically, the revenue gained will not be used to pay the externalized costs.

Benefits

- Viable recovery of metals: USD 57 billion.
- Value of avoided greenhouse gas emissions: USD 52 billion.

Costs

- The primary costs consist of USD 47 billion in externalized costs to the population and the environment, stemming from lead and mercury emissions, plastic leakages and contributions to global warming arising from non-compliant activities, particularly in cases where hazardous substances are not properly managed (such as in the informal sector, e-waste in residual waste and e-waste mixed with scrap metal).
- The costs associated with the treatment of e-waste increase to USD 24 billion, primarily comprising compliant e-waste recycling costs. Costs incurred by the informal sector, scrap metal and residual waste management are comparatively lower, as they are considerably cheaper to manage.

Scenario 4: Aspirational by 2030

KEY E-WASTE STATISTICS

54 billion kg | 60%
e-waste projected to be formally collected and managed by 2030.

METALS

30 billion kg
metal resources are viably recovered.

12 billion kg
metal resources are lost.

ENVIRONMENTAL IMPACT

23 thousand kg of mercury emissions released.

34 thousand kg emissions of mercury avoided.

73 billion kg CO_2-eq. emissions released.

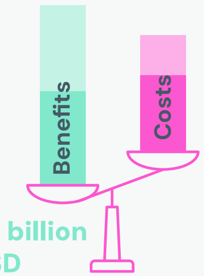
209 billion kg CO_2-eq emissions avoided.

OVERALL ECONOMIC IMPACT OF E-WASTE MANAGEMENT

Benefits

52 billion USD
value of avoided greenhouse emissions.

57 billion USD
value in viable recovery of metals.



38 billion USD
projected annual economic monetary impact of e-waste management globally.

Costs

24 billion USD
value of compliant recycling costs.

47 billion USD
value of externalized costs to the population and the environment.

Source: The Global E-waste Monitor 2024

E-waste Status in Africa in 2022

KEY E-WASTE STATISTICS

5.5 billion kg
EEE POM

3.5 billion kg | 2.5 kg per capita
E-waste generated

25 million kg | 0.7%
E-waste documented as formally collected and recycled rate

LEGISLATION

11 countries
have a national e-waste policy, legislation or regulation

9 countries
use the EPR principle

1 country
has collection targets in place

0 countries
have recycling targets in place

ENVIRONMENTAL IMPACT

12.4 billion kg CO_2 equivalents
Greenhouse gas emissions (GHG)

6 thousand kg
Emissions of mercury

3 million kg
Plastics containing brominated flame retardants, unmanaged

GENERAL INFO

1,408 million
population

54 countries
analyzed

E-WASTE TRANSBOUNDARY MOVEMENT (2019)

546 million kg imports

Controlled, 19 Uncontrolled, 527

132 million kg exports

Controlled, 19 Uncontrolled, 113

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION PER SUB-REGION

Eastern Africa 470 million

430 2.4 | 0.5% *E-waste (million kg)*

1. Kenya ... 88
2. Ethiopia ... 88
3. Tanzania, United Repbullic of ... 61

Central Africa 190 million

310 0.1 | 0% *E-waste (million kg)*

1. Angola ... 150
2. Congo, Democratic Rep. of the ... 56
3. Cameroon ... 33

Northern Africa 260 million

1,500 0 | 0% *WEEE (million kg)*

1. Egypt ... 690
2. Algeria ... 330
3. Morocco ... 180

Southern Africa 68 million

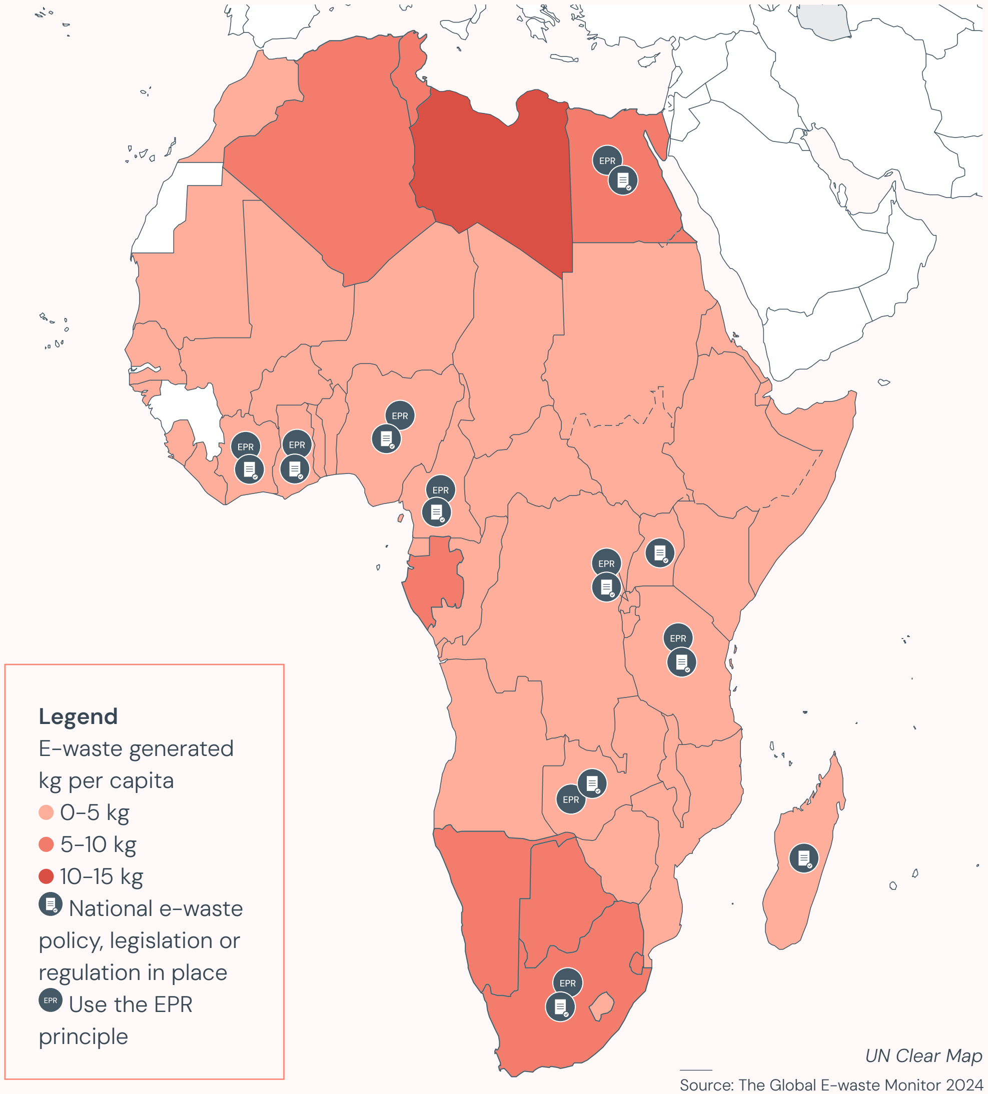
580 23 | 4% *E-waste (million kg)*

1. South Africa ... 530
2. Botswana ... 23
3. Namibia ... 17

Western Africa 420 million

750 0 | 0% *E-waste (million kg)*

1. Nigeria ... 500
2. Ghana ... 72
3. Côte d'Ivoire ... 42



UN Clear Map

Source: The Global E-waste Monitor 2024

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION IN THE REGION

Total million kg

1. Egypt ... 690
2. South Africa ... 530
3. Nigeria ... 500
4. Algeria ... 330
5. Morocco ... 180

kg per capita

1. Libya ... 14
2. Seychelles ... 14
3. Mauritius ... 12
4. Equatorial Guinea ... 11
5. South Africa ... 9

Africa

NORTHERN AFRICA

In North Africa, only Egypt has legislation referring to e-waste management. Law No. 202 of 2020 established a new regulatory agency for the waste management industry, and Decree 165/2002 prohibits the importation of hazardous substances and wastes, and lists e-waste resulting from EEE.[41] Tunisia is also taking steps to regulate e-waste, drafting a decree that will establish a polluter pays system for importers of EEE.[42]

North African countries suffer a persistent lack of awareness of the importance of collecting and recycling e-waste, although some mobile network operators and e-waste treatment facilities are implementing awareness-raising initiatives. In Tunisia, an e-waste treatment facility, Collectun D3E Recyclage, partnered with the GIZ (the German international development cooperation agency) on an advocacy campaign that motivated more than 30 companies to hand over e-waste for recycling. In Egypt, some operators have designated several branches as collection points for e-waste and the Ministry of the Environment is supporting the construction of e-waste treatment facilities to high environmental and technological standards.[43] In some countries in North Africa (e.g. Egypt), open markets for collected e-waste supply materials to recyclers.

Muntaka Chasant for Fondation Carmignac

An e-waste collection and sorting centre has recently opened in Soukra, Tunisia. Moreover, the Korea International Cooperation Agency, which supports projects to improve e-waste management in low-income countries, is helping to set up an e-waste treatment facility in Tunisia that will handle some of the e-waste that is currently not being recycled, such as coolers, polyurethane foam, freon and other CFCs/HFCs, and screens containing cathode-ray tubes.[44] Given the absence of e-waste treatment facilities in many North African countries, a more coordinated approach at the subregional level could facilitate the movement of materials across borders to locations where the environmentally sound management of e-waste can be guaranteed.

WEST AFRICA

In the subregion of West Africa, Ghana, Nigeria and Côte d'Ivoire have specific legislation on e-waste management. Both the National Environmental (Electrical and Electronic Sector) Regulations (2022) in Nigeria and the Hazardous and Electronic Waste Control Act (917) (2016) in Ghana underscore the EPR principle but there is little information on how EPR systems operate and perform, and it is therefore unclear to what extent the principle is being enforced.

In Ghana, all EEE producers pay an "eco levy" to the Ghana Revenue Authority, according to their market share; the levy is allocated by the Environmental Protection Agency, which is also responsible for setting up a formal e-waste recycling facility. Pursuant to the Electronic Waste Control Act, 10 formal e-waste management companies established an association in 2020 called the Electronic Waste Round Table Association. The German Development Bank is funding the construction of a dedicated centre for the purchase of e-waste from informal collectors or private individuals and the establishment of a sustainable national e-waste recycling system.

In Nigeria, the EPR system is private sector-led, operationalized by the E-waste Producer Responsibility Organisation Nigeria (EPRON) and regulated by the government. EPRON maintains a registry to determine the market share of EEE producers and on that basis then collects an EPR fee that it allocates to collection and recycling, awareness-raising, research, standards development and its own administrative functions. In January 2023, Nigeria amended the National Environmental (Electrical and Electronics Sector) Regulations (originally of 2011), which aim to strengthen the EPR system.

Progress is being made in other West African countries. In Senegal, plans were announced in 2022 to set up a regulatory framework for e-waste management but currently face delays.[45] Pending the legislation entry into force, awareness raising and collection and pre-treatment activities continue, supported by the telecommunication regulatory authority (Autorité de Régulation des Télécommunications et des Postes). Other countries in West Africa, such as Niger and Gambia, are in the process of preparing and approving national e-waste management strategies. Neither Niger nor Gambia currently has an official e-waste management system or adequate regulatory framework and e-waste collection network. Although e-waste generation in countries like Niger is not at the levels seen in Nigeria and Ghana, there is the possibility that Niger will experience an increase in the near future as a result of digitalization.[46]

Other initiatives in West Africa have been driving formal e-waste collection by, for example, training informal sector workers and arranging for donations of personal protective equipment. Furthermore, mobile phone repair has been one of the most marketable technical artisan opportunities in West Africa for several years now and some countries in the region have established training centres at which young people can learn the requisite skills. For example, in Côte d'Ivoire, a project launched in 2020 in Abidjan called Create Lab has been teaching the public how to repair, reuse and recycle EEE and e-waste in their communities.[47]

In an endeavour to increase home lighting, especially in off-grid areas, an estimated 2.23 million solar products were sold in East, West and Central Africa in the second half of 2018.[48] Technicians from repair hubs use off-grid batteries discarded by businesses such as banks to provide solar energy for households while increasing the capacity to collect and refurbish other off-grid solar products.[49] Such products have high reuse rates, and off-grid solar waste is therefore reportedly only a fraction of the total sum of e-waste generated in Africa.[50]

For many years, demand for imported used EEE in West Africa has been significant. However, in some countries (e.g. Nigeria), increasingly strict enforcement of bans on the import of certain second-hand products, such as screens containing cathode-ray tubes and non-tested EEE, has recently led to a reported decline in the import of used EEE. There have also been reports, by the Lagos State Environmental Protection Agency, of a decline in the amount of e-waste being disposed of at dumpsites.

As a result of improvements in enforcement and regional collaboration, progress has been reported in the control of illegal shipments of e-waste in West Africa. However, in January 2023, an organized crime group was caught smuggling over 5 million kg (331 containers) of e-waste from the Canary Islands to Ghana, Mauritania, Nigeria and Senegal. Furthermore, in 2020, the Spanish authorities intercepted a network responsible for shipping 2.5 billion kg of material to several countries in Africa, including 750 thousand kg of falsely certified e-waste.[51] Even though the import of e-waste into Africa is being monitored, it is notoriously difficult to control. 3 of Africa's most active ports – Durban (South Africa), Bizerte (Tunisia) and Lagos (Nigeria) – have all been identified as major ports of entry for used EEE, suggesting that e-waste shipments continue to circumvent the Basel and Bamako Conventions.

A study in Ireland that used the StEP Initiative person-in-the-port methodology found that roll-on/roll-off vehicles, rather than containers, were the main carriers of used EEE from Ireland to West Africa. The study, which involved vehicle and enforcement document inspections at Ringaskiddy port in Ireland, scaled sampling data to annual shipment figures and estimated that over seventeen thousand kg of used EEE were exported from Ireland annually and around 1 in 5 vehicles exported contained used EEE.[52] In response to findings like these, countries in West Africa are taking steps to introduce better monitoring of used EEE and e-waste imports by strictly enforcing existing guidelines and conducting thorough physical inspections of import shipments.

Muntaka Chasant for Fondation Carmignac

CENTRAL AFRICA

Cameroon was one of the first African countries to have developed e-waste legislation. However, many neighbouring countries in Central Africa have no such legislation. Some countries have integrated the promotion of circular principles into their high-level sustainable development or green economy policies but have yet to introduce any specific legal framework for e-waste management. In 2019, Solidarité Technologique established the Ewankan Centre to recycle e-waste in Cameroon; the centre aims to treat 5 million kg of e-waste per year.[53] Unfortunately, in Cameroon - as in other countries in Central Africa - there are few licensed e-waste operators, which creates partnership challenges for collecting and recycling e-waste. An e-waste initiative at the Benelux Afro Center, in the Democratic Republic of the Congo, introduced courses on sustainable management of e-waste. By 2021, the centre, an NGO that imports and donates computers, had recycled nearly 141 thousand kg of e-waste.[54]

There have been reports of an increase in the intra-African movement of e-waste between countries such as South Africa, Nigeria and Tunisia, on the one hand, and other countries such as the Democratic Republic of the Congo, Zimbabwe and Mozambique, on the other. In an attempt to control imports, the Government of Cameroon has introduced a robust "one-stop shop" (guichet unique) system to manage the import and control of products that use HFCs, verifying all shipments entering the country.[55] Generally speaking, however, e-waste collection and treatment infrastructure is lacking across Central Africa, and in many countries the informal sector still dominates activities and processes many thousands of kilograms of e-waste each year.

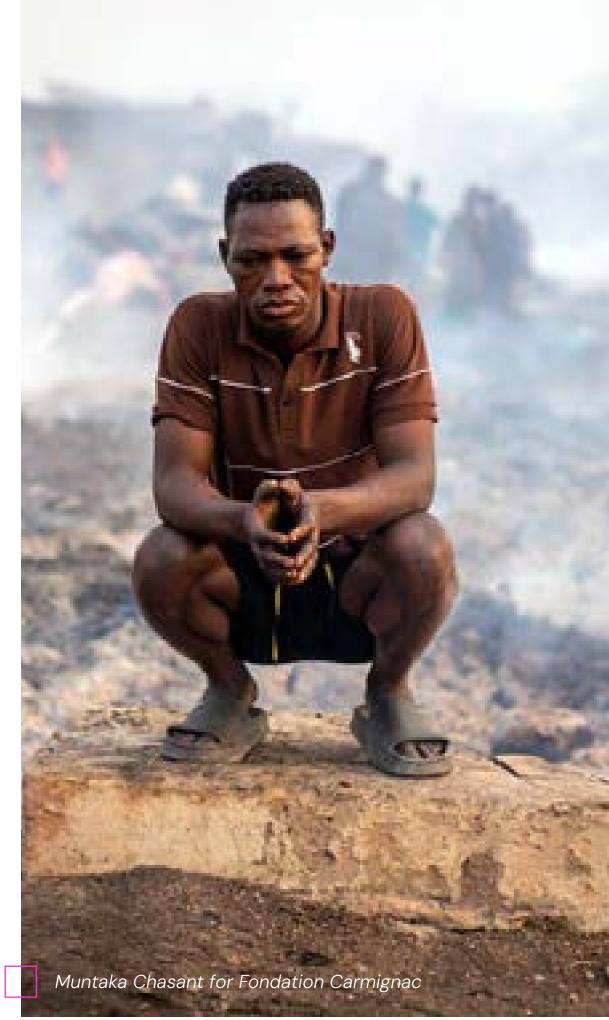
EAST AFRICA

As in other parts of Africa, e-waste generation is on the rise in East Africa, where the following countries have an e-waste policy, legislation or regulation: United Republic of Tanzania, Rwanda and Uganda. A regulation has been drafted in Kenya but has not yet been approved, and the existing national e-waste strategy and guidelines are the current normative references. The United Republic of Tanzania has general environmental management regulations that refer to certain restrictions on e-waste. Rwanda has had a regulation on e-waste management since 2018. A second regulation is currently in draft form and is expected to set out provisions relating to EEE being put on the market in the context of the registration of importers, with a view to incorporating EPR into business operator licensing. Uganda has a national e-waste policy and in Burundi a national e-waste policy is currently being approved following its validation in 2022. There is currently no policy instrument in place in South Sudan covering e-waste management.

A growing topic of discussion in East Africa is the growth and integration of e-waste collection and recycling infrastructure and networks and the harmonized incorporation of the EPR principle into national regulations. The discussion has been led at the regional level by the East African Communications Organisation, through the implementation of its Regional E-waste Management Strategy 2022-2027. In East Africa, regional harmonization could help overcome limitations to collection, sorting and high-end recycling. In this regard, the African Telecommunications Union has issued pan-African guidelines for the ICT sector aimed at harmonizing approaches to e-waste.

In recent years, some countries in East Africa have begun establishing collection, recycling and repair services. Created in 2010, the Burundi-based Great Lakes Initiative for Communities Empowerment (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 established in 2012 offers training and disposal services for e-waste, while in Rwanda the Enviroserve Rwanda Green Park is dedicated to e-waste dismantling and recycling. Although it is an objective of the EACO regional strategy, there is currently limited harmonization when it comes to the categorization of EEE across countries in East Africa. For example, Appendix B of the 2012 Electronic Waste (E-waste) Management Policy for Uganda categorizes EEE in 7 groups, while Annex A of Regulation No.002 of 26/04/2018 on Governing E-waste Management in Rwanda lists 13 categories of EEE, as does Schedule 5 of the draft Kenyan Environmental Management and Co-ordination (E-waste Management) Regulations, 2013.

The development of policy and regulations in the region has to some extent been delayed by changing priorities. In Kenya, for example, there have been delays in implementing EPR[56], although the current draft EPR regulations are at an advanced stage of preparation. The delays have been caused by the government endeavour to establish a comprehensive



Muntaka Chasant for Fondation Carmignac

EPR framework that covers a wider range of product categories, as opposed to prior initiatives that mainly focused on single products. The draft Environmental Management and Coordination EPR Regulations, 2021 are a result of this endeavour.[57] In Rwanda, the Government is revising the existing regulation governing e-waste management, in particular Article 24, on EPR. The country has also been making significant efforts to operationalize the EPR system by unifying the digital registration process for all business operators in the EEE sector.

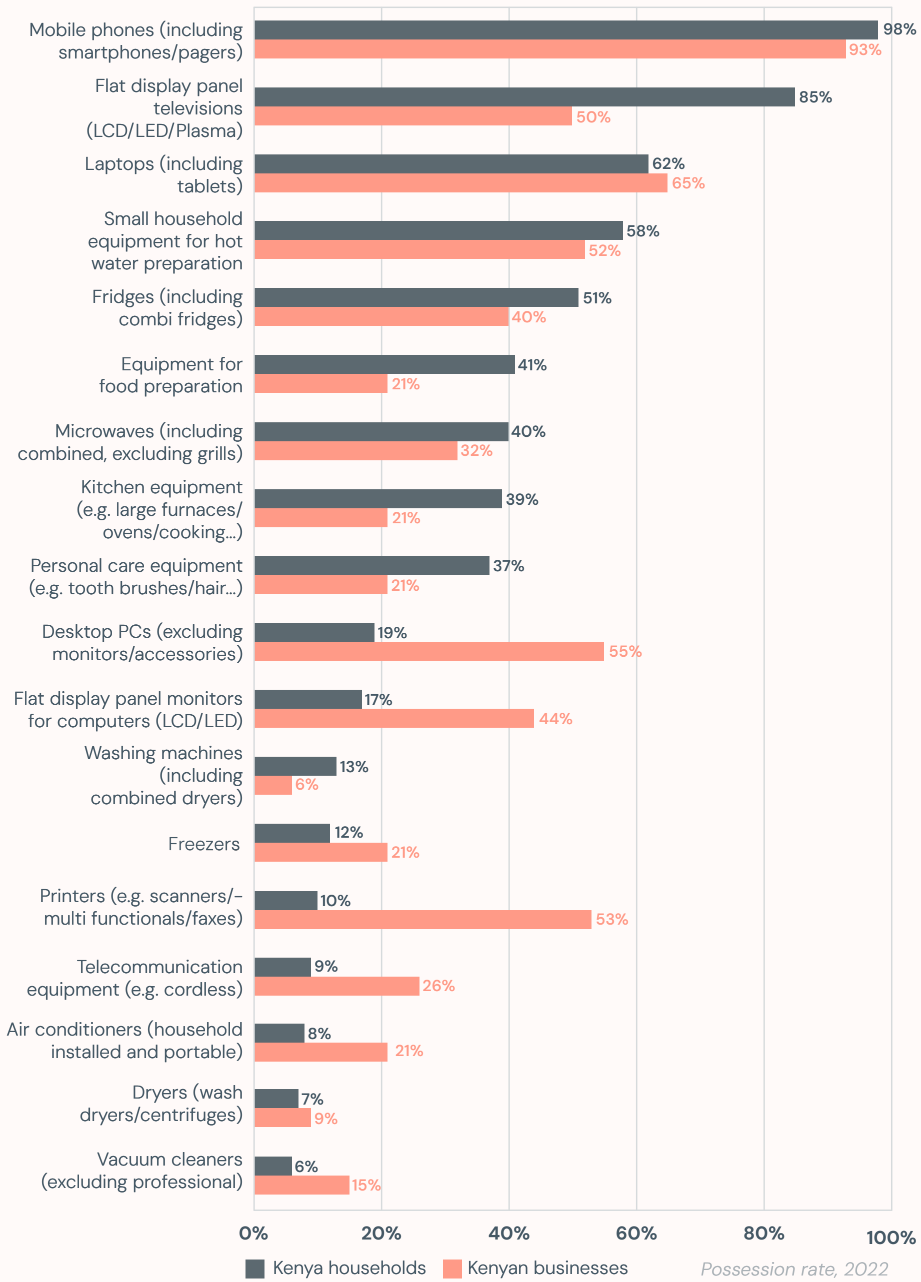
Data-collection efforts have improved in some countries in East Africa thanks to international support. In collaboration with the EACO Secretariat, ITU and UNITAR – as part of the Global E-waste Statistics Partnership – have conducted household surveys in Burundi and Kenya which revealed that higher ownership rates apply to mobile phones in both countries: 96 per cent of the Burundian households and up to 98 per cent of the Kenyan households interviewed possess at least one mobile phone (Figure 25).

The surveys also sought responses regarding the most common disposal routes for EEE. In Kenya, refrigerators, for example, are usually brought to an e-waste collection centre or to a county-designated drop-off point (20 per cent of the total), or they are picked up from homes by the companies that sold the product (30 per cent). The latter route is not used to dispose of small household equipment, most of which is discarded together with mixed residual solid waste (31 per cent) or sold to a refurbishment or repair shop (33 per cent). Other studies in Kenya indicate that the current annual volume of e-waste being generated there is 11.4 million kg from refrigerators, 2.8 million kg from televisions, 2.5 million kg from personal computers, 500 thousand kg from printers and 150 thousand kg from mobile phones.[58] In Burundi, less equipment is picked up from homes by the company that sold the products and there is no evidence of equipment being collected by the local authorities. Moreover, a higher number of households reported that they had not been informed about the disposal route or were still in possession of the product.[59]

The tools for calculating EEE POM and e-waste generated provided to the 6 beneficiary countries (Uganda, South Sudan, Rwanda, United Republic of Tanzania, Kenya and Burundi) by the Global E-waste Statistics Partnership revealed a rapid rise in EEE POM in East Africa in recent years, to as much as 170 million kg in 2021. This has caused a concomitant increase in the generation of e-waste, to as much as 128 million kg in 2021, which presents a challenge in a region with limited e-waste collection and recycling infrastructure, and only one formal e-waste recycling facility (in Rwanda) with a capacity of approximately 7 million kg per year.

National quantification studies using EEE POM and e-waste generated tools have also been conducted in East Africa. The first National E-Waste Statistics Report of the United Republic of Tanzania, published in 2019, showed that EEE POM on the Tanzanian mainland increased from 21.7 million kg (0.72 kg per capita) in 1998 to 47.5 million kg (0.93 kg per capita) in 2017, with large equipment accounting for the bigger share of EEE POM and small equipment becoming increasingly prominent in recent years. The findings further indicate that the amount of e-waste generated increased from about 2 million kg (0.01 kg per capita) in 1998 to 35.8 million kg (0.70 kg per capita) in 2017.[60] The few reported e-waste generation, collection and recycling rates across the continent are difficult to compare due to different interpretations.

Figure 25. Percentage of Kenyan Households and Businesses in Possession of at Least One Type of EEE by Type



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

SOUTHERN AFRICA

In South Africa, mandatory EPR came into effect in 2021 under Section 18 of the National Environmental Management Waste Act, which covers EEE among other waste streams. Amendments to the Act allow EEE producers to establish and implement their own EPR schemes. All existing EEE producers of identified products must register with the government. Producer responsibility organizations must also register and are obliged to integrate informal sector e-waste operators into the post-consumer collection value chain, while EEE producers operating individual take-back schemes must compensate informal collectors who register with the National Registration Database for collection services and environmental benefits.

In Zambia, Statutory Instrument No. 65 on Extended Producer Responsibility Regulations (2018) is a legally binding instrument that regulates EPR but has been infrequently implemented. However, with support from international organizations, the government has begun preparing a specific regulation on e-waste management and in 2023 it started developing a specific EPR regulation covering electronics and packaging materials. Zambia has also made progress towards introducing standards on e-waste management, with 11 of 4 proposed standards having been adopted.[61]

In Malawi, a draft national e-waste management policy is currently in the process of being approved. The policy was developed via a detailed process of stakeholder consultation and validation and will be implemented over a 5-year period. It will be Malawi's first guiding document for e-waste management. Furthermore, with support from the Global E-waste Statistics Partnership, a recent national quantification study conducted with the National Statistics Office found that the availability of EEE in Malawi has increased significantly, from 1.3 million kg in 1995 to 12.5 million kg in 2022. Small equipment and temperature exchange equipment are currently the main categories being put on the market. This has been accompanied by a concomitant rise in the amount of e-waste generated, to 12.8 million kg in 2021 from 600 thousand kg in 1995. The main contributors in the past 20 years have been the small equipment and small IT and telecommunication equipment categories.


Muntaka Chasant for Fondation Carmignac

Several other countries in Southern Africa are also in the process of developing a first guiding document on e-waste management. For example, in Botswana and Namibia, a draft national e-waste strategy and policy, respectively, were recently validated and are currently in the approval stage. Despite the recent normative progress, however, it is still too often the case in Southern Africa that even when an e-waste policy, legislation or regulation is in place, sometimes for many years, implementation and enforcement fall short, mostly because of underfunding and a lack of government capacity and resources. In collaboration with the Global E-waste Statistics Partnership, national quantification studies were also conducted in Botswana and Namibia, in collaboration with the respective national statistics offices. In Botswana, for example, it was found that 21.1 million kg of EEE were placed on the market in 2020 and 13.5 million kg of e-waste were generated.

The island States of Southern Africa have also been making progress towards regulating e-waste management. The Government of Mauritius is in the process of introducing Environment Protection Regulations aimed at implementing a collective EPR scheme for EEE.[62] Madagascar's Decree No. 2015-930, on WEEE, sets out a framework for the classification and management of e-waste by promoting the disposal of goods in an environmentally sound manner. In 2018, an e-waste recycling centre was set up in Madagascar in partnership with a Kenyan recycler; the emphasis is on the creation of innovative practices for waste management related to urban mining and on stimulating greater awareness among the public for the need to safely manage e-waste. In other island States, such as Seychelles, there is currently no legally binding instrument in place for e-waste management. However, some peripheral laws do refer to EEE, such as the Consumer Protection Act (2010) in Seychelles, which sets the minimum warranty for EEE at 6 months. The law requires EEE suppliers to repair products returned for a valid reason within 60 days or to replace them within 7 days or to refund the customer within 24 hours. The high logistics costs for island States can be reduced by increasing the longevity of EEE (e.g. by repairing it) and thereby reducing the need to export waste.

Only a few countries in Southern Africa have formal take-back schemes, but specific e-waste collection points are made available in many countries by e-waste collection and recycling companies, such as the fledgling businesses operating in Botswana, Namibia and Zambia. Where there are greater volumes of e-waste, medium- and large-scale collection and recycling operations exist (e.g. in South Africa), with formal e-waste collection systems and the technical capability in some cases to extract precious metals.[63] Like in East Africa, there has been increasing discussion of regional harmonization in Southern Africa, driven chiefly by the perceived need to create economies of scale in the region, given the varied size of neighbouring economies and populations, and thus of the volumes of e-waste being generated in each country.

E-waste Status in the Americas in 2022

KEY E-WASTE STATISTICS

19 billion kg
EEE POM

14 billion kg | 14.1 kg per capita
E-waste generated

4.3 billion kg | 30%
E-waste documented as formally collected and recycled rate

LEGISLATION

12 countries
have a national e-waste policy, legislation or regulation

9 countries
use the EPR principle

3 countries
have collection targets in place

0 countries
have recycling targets in place

ENVIRONMENTAL IMPACT

30.9 billion kg CO_2 equivalents
Greenhouse gas emissions (GHG)

12.4 thousand kg
Emissions of mercury

9 million kg
Plastics containing brominated flame retardants, unmanaged

GENERAL INFO

1,020 million
population

36 countries
analyzed

E-WASTE TRANSBOUNDARY MOVEMENT (2019)

393 million kg imports

Controlled, 89 ☐ Uncontrolled, 305

547 million kg exports

Controlled, 159 ☐ Uncontrolled, 388

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION PER SUB-REGION

Carribean 32 million
240 0.1 | 0% *E-waste (million kg)*

1. Dominican Republic 100
2. Puerto Rico 65
3. Trinidad and Tobago 24

Central America 180 million
1,800 60 | 3% *E-waste (million kg)*

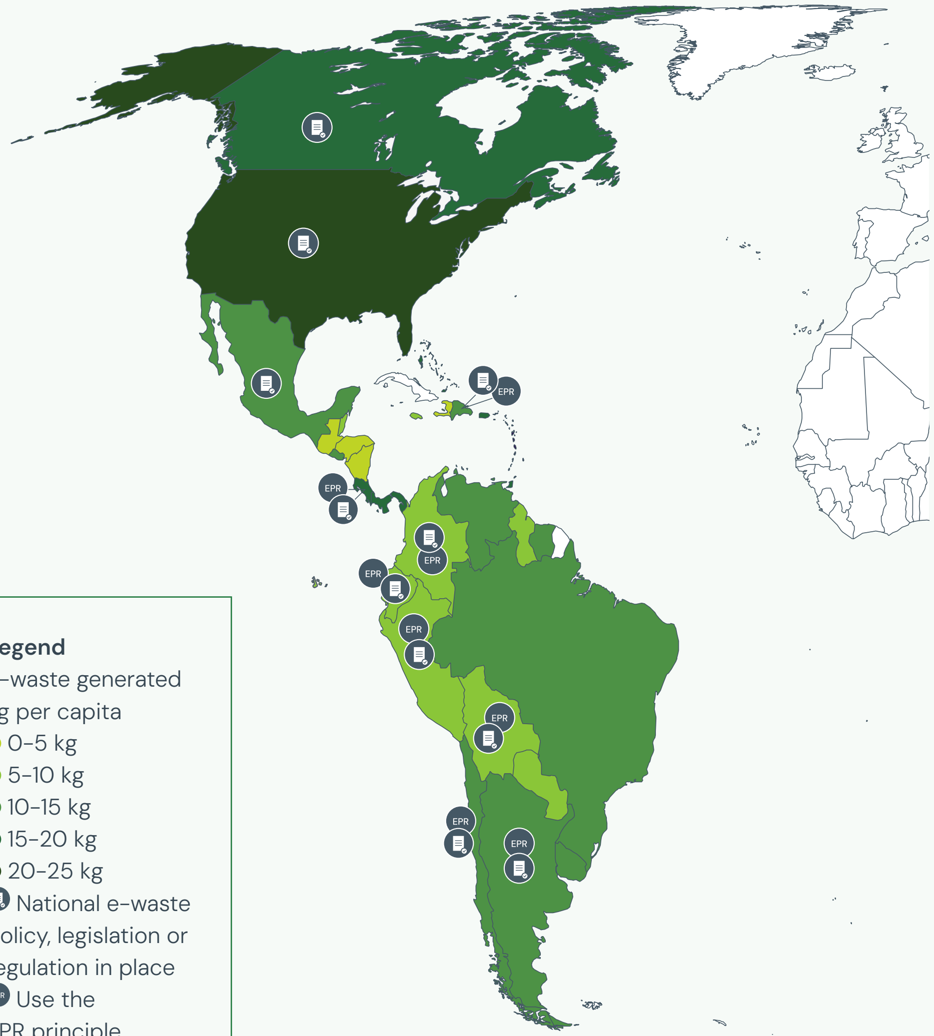
1. Mexico 1,500
2. Guatemala 92
3. Costa Rica 66

Northern America 380 million
8,000 4,100 | 52% *E-waste (million kg)*

1. United States of America 7,200
2. Canada 770

South America 440 million
4,400 230 | 52% *E-waste (million kg)*

1. Brazil 2,400
2. Argentina 520
3. Colombia 390



Legend
E-waste generated
kg per capita
- 0-5 kg
- 5-10 kg
- 10-15 kg
- 15-20 kg
- 20-25 kg
- National e-waste policy, legislation or regulation in place
- Use the EPR principle

Source: The Global E-waste Monitor 2024

UN Clear Map

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION IN THE REGION

Total million kg

1. United States of America 7,200
2. Brazil 2,400
3. Mexico 1,500
4. Canada 770
5. Argentina 520

kg per capita

1. United States of America 21
2. Aruba 21
3. Canada 20
4. Puerto Rico 20
5. Bahamas 18

Americas

The Americas is one of the regions with the highest levels of e-waste generation globally, at 14 billion kg, and yet, the national e-waste legislation in place across the region differs in many ways. In the United States of America and Canada there is no federal legislation because e-waste is regulated at the state/provincial level, whereas in South American countries it is regulated at the national level. These laws vary in terms of the financial models they apply and the scope of targeted product categories, among other stipulations. In North America, the design of state/provincial waste management systems and the roles and responsibilities of the various participants also differ, ranging from EPR with and without consumer fees to various shared responsibility models. Apart from the United States of America, all countries in the Americas have ratified the Basel Convention.

NORTH AMERICA

United States of America

In the United States of America, a total of 25 states and the District of Columbia have implemented legislation establishing state-wide e-waste recycling programmes.[64] Some states have also enacted laws prohibiting e-waste landfilling and incineration, and requiring separate treatment. The EPR principle is the most common policy approach and is applied in the majority of states. State policies on EPR typically apply the same approach as in other countries, with the exception of California, where there is an advance recycling fee. Under this model, consumers pay retailers a fee of USD 6 to 10 (depending on the product type) at the time of purchase; the fee is then paid into a fund supporting state-wide e-waste management.

In EPR-based e-waste management models in the United States of America, the state environment department defines a set of targeted product categories for recycling, often called "covered electronic devices". These categories usually encompass only consumer electronics (laptops, television sets, monitors, printers) and not large appliances.[65] Large appliances are excluded from most official statistics as they are disassembled and recycled by removal companies. Each producer is assigned an annual collection target by the state department based on its share of EEE put on the market in the state. The list of eligible EEE categories for free recycling varies from state to state.[66] While some states cover consumer electronics, others exclude items such as tools, toys, e-cigarettes, smart furniture and clothes. Similarly, state laws also differ in terms of "covered entities", which are eligible consumer groups from whom used products can be collected for recycling under that state EPR system. These groups may include households, government/non-profit organizations, businesses and schools. State-level e-waste programmes typically collect e-waste from households, and some include non-profits, businesses and other entities.[67] However, large businesses are often excluded from end-of-life product recycling programmes.

The absence of a uniform federal law has led to a regulatory patchwork of different state laws, creating EPR compliance challenges for producers. A significant share of used EEE is either stored in households or disposed of in landfills and incinerators. Another concern is the export of collected e-waste from the United States of America to low-income countries with cheap labour, where informal dismantling poses health risks in the form of exposure to toxic materials.[68] However, recycling standards and certifications such as R2 (Responsible Recycling) and e-Stewards aim to limit the improper handling and illegal export of e-waste containing toxic chemicals.

The plethora of participants and products covered by regulation across states in the United States of America makes it challenging to compare e-waste recovery rates at the federal level. Recently, state-level e-waste collection rates per capita have shown a decline.[69] This has been attributed to changes in the quantity and types of used televisions in the e-waste stream, where traditionally large cathode-ray tube televisions are being replaced by lighter flat panel televisions with liquid crystal display and LED screens.[70]

Prior research had forecast this change in e-waste composition and highlighted the need to expand the product scope in e-waste legislation, in order to capture critical metals from newer technologies.[69] For example, the state of California, in anticipating such changes, expanded its product scope in 2022 to include organic light-emitting diode and LCD devices.[72] Other states have amended their e-waste legislation to expand the product scope and to increase the number of collection sites.[73] While states typically use the producers' market share and the previous year's e-waste collection rates to set annual collection targets, recent research on e-waste generation has also been used to inform decision-making about collection targets. For example, the state of Oregon relied heavily on academic literature to gain insights into near-term e-waste flows when determining collection goals for 2023 and 2024.[74]

Photointoto / Shutterstock.com

In 2023, New York became the first state to enact right-to-repair legislation for digital electronic devices. Under the legislation, which is to take effect within one year[75], EEE producers must provide repair manuals, enabling individuals and small businesses to repair digital devices. It is anticipated that other states will follow suit, paving the way for a national right-to-repair law. Such initiatives indirectly support the management of e-waste by extending product lifespans and thus reducing the annual e-waste flow rate and volume.

Canada

In Canada, e-waste is regulated at the provincial level. All provinces and territories, except Nunavut, have implemented e-waste legislation based on the EPR model, often called product stewardship for targeted EEE in Canada.[76] Landfill bans have been imposed in the provinces of Newfoundland, Nova Scotia and Prince Edward Island and in the municipality of Vancouver and parts of British Columbia and Ontario. Moreover, at the federal level, Environment and Climate Change Canada has enacted toxic substance control legislation and other instruments that indirectly support e-waste management.

In most Canadian provinces, EPR legislation requires EEE producers to charge consumers.[77] Unlike most models in the United States of America, where producers bear the cost of e-waste collection and recycling, aside from the state of California, in Canada an environmental fee is charged on the purchase of certain EEE, at the point of sale. However, some provinces are shifting the direct financial responsibility from consumers to producers. For example, in the province of Ontario changes made to the e-waste legislation under the Resource Recovery and Circular Economy Act, 2016, which came into force in 2021, introduced individual producer responsibility, so no eco or environmental handling fee is passed to the consumer. Instead, producers are financially responsible for collecting, reusing or recycling their products.[78]

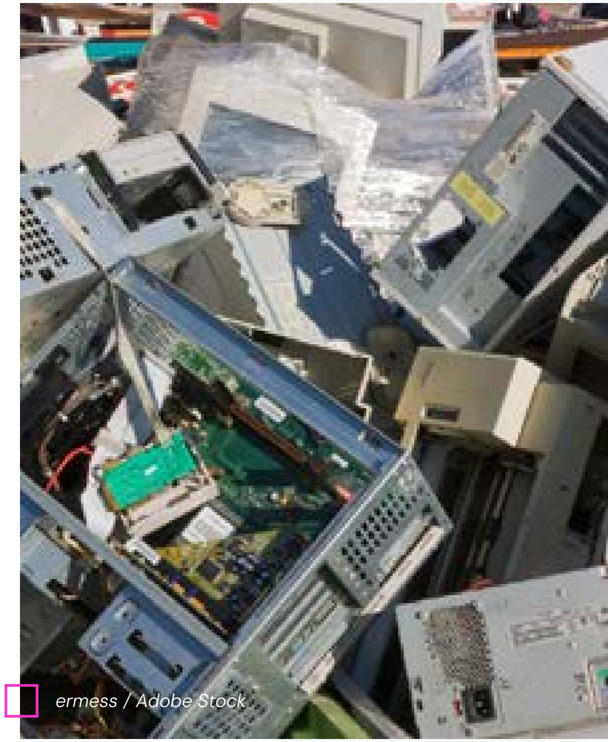
Canada's e-waste flow tripled between 2000 and 2019 and is forecast to reach 1.2 billion kg by 2030.[79] This increase is partly attributed to the country's growing population, to some extent as a result of immigration. As in the United States of America, the absence of federal legislation complicates e-waste management across Canada because varying provincial statutes on e-waste result in compliance challenges and higher costs for EEE producers and service providers operating in more than one province. National institutions and standards play a crucial role in harmonizing the range of provincial regulations. Provincial EPR programmes often include community education initiatives to inform stakeholders about their responsibilities in e-waste management. Although initiatives supported by the government support the eco-design of EEE, the current EPR programmes in Canada do not directly incentivize any improvement in EEE product design, such as enhanced repairability or recyclability.

CENTRAL AMERICA

In most Central American countries, e-waste management is governed by general hazardous waste legislation. El Salvador, Guatemala, Honduras, Nicaragua, Belize and Panama have no specific legislation covering EPR or official e-waste collection targets.[80] They have hazardous waste regulations that address persistent organic pollutants, but not e-waste. Costa Rica, on the other hand, has e-waste legislation and is implementing it. General Law No. 8839 on Integrated Waste Management was enacted in 2010 and the Regulation for the Declaration for Waste Requiring Special Management in 2014. These regulations adopt the EPR principle, with producers reporting their annual e-waste collection volumes on a voluntary basis.

In Mexico, the Secretariat of Environment and Natural Resources, which oversees environmental laws and standards[81], has developed national standards to control the end-of-life management of EEE. For example, Official Standard NOM-161-SEMARNAT-2011 (NOM-161) defines the obligations for handling urban solid/special waste, including technological waste generated by the IT sector and EEE producers, which is classified as waste requiring "special handling".[82]

The General Law for the Prevention and Integral Management of Waste requires companies or individuals generating waste to have special waste-handling plans. The law is modelled on shared responsibility principles involving all stakeholders, such as producers, exporters, marketers, consumers, waste management companies, and federal, state and municipal levels of the Mexican Government.[83] Mexico's states are authorized to establish their own guidelines or specific legislation for special waste handling. Their plans must include waste diagnostics or data provision on the quantity of waste generated during specific periods and information on its movement within and outside the country. At the municipal level, Mexico City recently implemented Environmental Standard for



ermess / Adobe Stock

the Federal District NADF-019-AMBT-2018, which focuses on e-waste management[84] and mandates producers, marketers and distributors of EEE to submit their e-waste management plans to Mexico City's Secretary of the Environment.

A 5-year project funded by UNDP and the Global Environment Facility (GEF) and successfully wound up in 2022 helped Mexico meet specific requirements under the Stockholm Convention. The project specifically addressed the release of persistent organic pollutants from the e-waste stream in Mexico. 4 pilot programmes for managing e-waste were successfully carried out in Baja California, Mexico City and Jalisco, and the project facilitated e-waste sampling analysis for substances like bromine.[85,86] At the supranational level, the latest version of the United States of America-Mexico Environmental Program: Border 2025, established by the United States Environmental Protection Agency and Mexico's Secretariat of Environment and Natural Resources, identifies e-waste as a priority waste stream to target when developing strategies to reduce illegal dumping and promote material recovery.[87]

In Costa Rica and El Salvador, environmental health and safety standards for the environmentally sound management of e-waste exist and are being implemented. In Honduras and in El Salvador, the government departments in charge of the environment oversee the regulation of e-waste, while in Costa Rica and Panama the Ministry of Health is the lead authority responsible for regulating e-waste. Other countries, such as Belize, have general waste policies that do not, however cover e-waste management.[88] Generally speaking, the absence of e-waste collection and recycling infrastructure in Honduras, Nicaragua and Belize leads consumers to rely on informal collectors or to simply dispose of e-waste with residual waste.

In recent years, several international projects have been implemented in Central America. For example, the UNIDO-GEF PREAL project (2018-2022) aimed to strengthen national e-waste initiatives and promote regional cooperation on the management of persistent organic pollutants in e-waste. As a result, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama made significant progress towards drafting rules for e-waste collection and expanding their e-waste recycling capacity. EPR has been identified as the main financing mechanism for e-waste management in the majority of countries in Central America. In Honduras, however, changes in the government have hampered the development of an EPR system for e-waste. As a result of the PREAL project, El Salvador and Panama have drafted new regulations, with El Salvador also being in the process of approving a regulation. Additionally, Costa Rica, El Salvador and Panama have developed complementary financing strategies for e-waste management. Another project involving UNEP has resulted in the publication of regulations on the treatment of luminaires - covered by the Minamata Convention on Mercury - in Honduras. The UNEP project is expected to pave the way for an EPR system for broader e-waste categories in Honduras.

According to the Regional E-waste Monitor for Latin America, countries in Central America rarely report the export of e-waste components to other countries, despite having ratified the Basel Convention.[89] To address this issue, the StEP Working Group for Latin America and the Caribbean is actively working to identify and solve the challenges faced by e-waste recyclers and government officials in limiting illegal transboundary shipments of hazardous e-waste.

ShutterPrice / Shutterstock.com

Carribean

Most Caribbean countries do not have a significant EEE manufacturing industry. The Dominican Republic, Jamaica, and Trinidad and Tobago have a small EEE manufacturing sector that produces items such as TVs, radios, home appliances, audio equipment, cables, circuit boards, refrigerators and air conditioning units.[90,91]

E-waste management poses a pressing challenge in the Caribbean in the absence of any specific regulations and policies addressing the issue. While countries such as Jamaica, Trinidad and Tobago and Barbados have taken steps to develop waste management policies, they do not have specific e-waste regulations. E-waste management responsibilities in different Caribbean countries are shared among various entities. In Antigua and Barbuda, the Ministry of Health and the Solid Waste Management Corporation oversee e-waste management. In Barbados, that responsibility lies with the Ministry of Environment and National Beautification, the Environmental Protection Department and the Solid Waste Management Unit. In Trinidad and Tobago, the regulation of e-waste management is overseen by the Environmental Management Authority.

In Jamaica, the National Solid Waste Management Act empowers the National Solid Waste Management Authority to regulate the collection, transport and disposal of all solid waste, including e-waste. The Act requires e-waste collectors and recyclers to register and prohibits the disposal of e-waste in landfills. In Trinidad and Tobago, the Environmental Management Act is the overarching law on the management of all waste, including e-waste. Trinidad and Tobago, for its part, regulates the provision of import licenses for EEE importers and environmental permits for e-waste recyclers.

In the Dominican Republic, Law No. 225-20 on the Integral Management and Co-processing of Solid Waste introduced the principle of EPR. As a result of an ITU/UNEP project, the recently enacted Decree 253-23 aims to implement the EPR principle under Law No. 225-20. The regulation of e-waste in the Dominican Republic is overseen by the Ministry of Environment and Natural Resources. Decree 253-23 lays out the legal responsibilities of producers of EEE and retailers, bulk consumers and waste managers. It stipulates several reporting, registration and EPR requirements.

Comprehensive data on transboundary e-waste movements in the region are limited. From 2016 to 2021, only 6 out of 12 Caribbean countries (Antigua and Barbuda, Barbados, the Dominican Republic, Jamaica, Saint Lucia, and Trinidad and Tobago) submitted national reports on their e-waste exports to various destinations for treatment and material recovery to the Basel Convention Secretariat.[92,93,94,95,96,97] For example, in 2019, Jamaica exported 39.8 thousand kg of e-waste to the Republic of Korea, and in 2021, Antigua and Barbuda, Barbados, and Trinidad and Tobago exported 114 thousand kg of e-waste components to France for treatment and recovery. However, unreported exports exist, as some Caribbean countries are not party to the Basel Convention and do not report their e-waste movements. The challenges in accurately mapping and monitoring these movements arise from incomplete data coverage.

Within the region, the Dominican Republic, Puerto Rico, and Trinidad and Tobago are the largest generators of e-waste. Limited infrastructure, a lack of awareness, and the presence of informal recycling and illegal dumping practices pose e-waste management challenges in the Caribbean. To address these issues, various initiatives have been taken, including e-waste collection drives, public education campaigns and the establishment of e-waste recycling programs in Jamaica and Trinidad and Tobago.[98,99] The presence of an informal e-waste recycling sector in the Caribbean underscores the need for improved e-waste management systems and regulatory frameworks. In response, some countries are exploring initiatives, such as refurbishment programmes, to promote the repair and reuse of electronic devices. However, the development and implementation of effective e-waste policy and regulation face various obstacles, including the lack of comprehensive legislation, limited recycling infrastructure, insufficient public awareness and financial constraints.[100]

SOUTH AMERICA

Andean Region

In the Andean subregion, countries such as Colombia, Ecuador, Peru and the Plurinational State of Bolivia have been actively working to improve e-waste management practices. Recognizing the potential environmental and human health hazards posed by e-waste management, these countries have taken steps to address the issue by adopting legislation and ratifying international treaties. All countries in this subregion have established specific e-waste regulations that include EPR; with the exception of the Plurinational State of Bolivia and Ecuador, they all have EPR schemes.[101,102,103,104]

In Colombia, the Ministry of Commerce, Industry and Tourism recently published a resolution that modifies the registration process for producers and sellers of EEE. The resolution adds new devices, such as e-bicycles, scooters, skateboards and motorcycles, to the list of items subject to registration. It offers a 50 per cent reduction in registration fees for small and medium-sized enterprises, in order to promote their development and competitiveness. Collection points for computers, lamps and batteries nationwide have been mapped and their locations shared with the public through an official government website.

In Ecuador, the Ministry of Environment and Water established a comprehensive legal framework in June 2002 that classifies e-waste into 6 categories: large appliances, small appliances, ICT equipment, consumer equipment, lighting equipment, and electrical and electronic tools.

The framework sets out responsibilities for consumers and collectors/recyclers of e-waste, including proper disposal at authorized collection points, compliance with technical standards and environmental regulations for e-waste management, obtaining licences and permits for their activities, and reporting on their operations. The framework also incorporates guidelines for the application of EPR and outlines the creation of a national plan for the integral management of e-waste.[105]

There is strong recognition in Peru of the importance of revising and updating national e-waste policy. In this regard, new rules require mandatory collection targets and controlled e-waste management across all categories.[106,107] The Ministry of the Environment is responsible for overseeing e-waste management, implementing the national e-waste regulations and coordinating with various stakeholders, including municipalities, the private sector, civil society and international organizations.[108]

In the Plurinational State of Bolivia, national legislation places primary responsibility for waste management on producers, who are held accountable for the products they sell. Consumers, the government and municipal authorities share additional responsibilities. Despite the progress made in e-waste management and e-waste legislation, supplementary instruments defining concrete requirements (e.g. collection targets) are missing in many countries, including the Plurinational State of Bolivia. These supplements to existing laws are crucial for facilitating the implementation of collection targets and enhancing the overall environmentally sound management of e-waste.

Countries in the Andean region are party to international agreements but, for example, only Colombia and Peru have been providing annual national reports under the Basel Convention (from 2016 to 2021). According to these reports, Peru exported 260 thousand kg of e-waste to Switzerland and Sweden in 2019, while Colombia exported 19 thousand kg to Canada and the United States of America between 2019 and 2020 for treatment and disposal purposes.[109,110] It is important to note that importing e-waste or hazardous waste for recovery or disposal is prohibited in South America[111], yet shipments of used EEE enter the continent frequently.

The informal e-waste sectors in Colombia, Peru, Ecuador and the Plurinational State of Bolivia play a significant role in managing e-waste. Informal recyclers manually dismantle e-waste to extract valuable components, at the risk of their health and safety, and of environmental pollution. In Peru, successful partnerships have been formed between formal e-waste operators and informal sector cooperatives comprising former informal workers.[112] Across South America, voluntary initiatives for e-waste collection are widespread, with countries conducting collection campaigns and awareness programmes. These initiatives often involve collaboration with municipalities and key stakeholders, including universities, private sector entities like mobile phone companies and retailers, and sometimes NGOs.

rblfmr / Shutterstock.com

EASTERN SOUTH AMERICA AND BRAZIL

In Eastern South America, specifically Venezuela, Guyana and Suriname, specific e-waste legislation is lacking. Instead, e-waste management is primarily regulated by general waste or hazardous waste law (in the case of Venezuela, the Organic Law on the Environment).[113] In Venezuela, proposals for the regulation of e-waste management have been drafted. Once approved, they will lay the foundation for implementing effective management practices and contribute to the establishment of sustainable e-waste management systems in the country.[114]

In Guyana, e-waste management is covered in the Environmental Protection Act (1996). The National Solid Waste Management Strategy 2017-2030 also contains provisions on e-waste management, relating to the proposed development of a legal framework, public awareness campaigns and the establishment of collection centres.[115] Similarly, in Suriname, e-waste management is covered by general waste and hazardous waste law, specifically in the Environmental Management Act (2002) and its associated regulations providing the overarching framework for waste management. In Paraguay, the management of e-waste is referred to in the integrated waste management law, which proposes a national waste management system encompassing e-waste and other waste streams. The overarching law outlines principles and responsibilities for prevention, reduction, reuse, recycling, treatment and final disposal. EEE producers are required to register with the Ministry of Environment and Sustainable Development and to submit an annual report on the amount and destination of collected and processed e-waste.[116]

Joa Souza / Shutterstock.com

Since the end of 2023, support is being provided through a project with ITU focusing on the development of specific e-waste regulations in Paraguay.

Various laws have been implemented in Brazil to address e-waste management. The National Solid Waste Policy (Law 12.305/2010) provides a framework for waste management, including e-waste. E-waste is specifically regulated by Decree No. 10 240, issued in 2020, which establishes a mandatory reverse logistics system (SisResíduos) that tracks and monitors e-waste throughout its lifecycle and outlines the roles and responsibilities of stakeholders. It sets targets for e-waste collection and recycling, aiming for 17 per cent of average annual sales by 2023 and 30 per cent by 2025. The system performance is monitored, reported and evaluated through established mechanisms. Brazil also has technical standards (ABNT NBR 16156:2014) issued by the Brazilian Association of Technical Standards, which provide guidance for the environmentally sound management of e-waste.[117,118,119,120]

All countries in the subregion are party to the Basel, Rotterdam and Stockholm Conventions. In addition, Venezuela is a signatory and Suriname is in the process of acceding to the Minamata Convention on Mercury. In 2020 and 2021, a reported 536 000 kg of printed circuit boards from e-waste were exported from Venezuela to Japan and Spain for treatment and recovery. According to national reports for 2021, 550 thousand kg of printed circuit boards from e-waste were exported from Brazil to the Republic of Korea for treatment and recovery.

The largest generator of e-waste in South America is currently Brazil, at 2.4 billion kg annually, followed by Venezuela with 303 million kg and Paraguay with 56.5 million kg. Suriname and Guyana generate the least amount of e-waste, with 6.8 and 6.5 million kg, respectively. Brazil is the sole country engaged in the manufacturing of EEE in South America, particularly in the production of consumer electronics such as televisions, smartphones and home appliances. The environmentally sound management of e-waste is a challenge due to the country's vast size and the extensive involvement of the informal sector in precarious collection, recycling and refurbishment activities. The national e-waste management system is based on shared responsibility among stakeholders and EPR by producers. To tackle these challenges effectively, partnerships and initiatives have been fostered among the private and public sectors, academia and civil society. These partnerships have been raising awareness, conducting research, promoting innovation, improving recycling technologies, developing best practices and enhancing public education and participation.[121,122]

In Venezuela, e-waste management is of mounting concern, with the significant involvement of informal sector activities raising safety issues. In Guyana, Suriname and Paraguay, e-waste management is in its infancy, lacking proper infrastructure and regulations and relying heavily on scavengers to collect valuable materials from discarded EEE. While Guyana and Suriname have launched awareness campaigns and collection points, further measures are necessary in both countries for effective e-waste management. In Paraguay, where the Government has launched awareness campaigns and is working with private organizations, the comprehensive regulation of e-waste and the improvement of collection and recycling infrastructure are crucial for the future of effective e-waste management.[123,124,125]

SOUTHERN CONE

The Southern Cone subregion comprises Argentina, Chile and Uruguay. Each country has different levels of development and regulation of e-waste management. In Chile, Law 20.920 (2016) represents a significant step towards addressing e-waste. The law makes EEE producers responsible for managing the lifecycle of the products they place on the market, including their collection, recycling and disposal. It positions EPR as the main policy principle covering 6 priority products: lubricant oils, EEE, batteries, packaging, tires and expired medicines.[126] The law calls for the establishment of a national registry of EEE producers, to track and monitor their activities. It also promotes the establishment of e-waste collection points, encourages recycling and recovery, and aims to reduce the environmental impact of e-waste disposal.[127] However, the inclusion of specific collection targets and collection categories remains pending.[128]

Argentina and Uruguay have also made significant progress towards addressing e-waste management. Both countries have established comprehensive management frameworks that encompass the proper handling, disposal and recycling of hazardous waste, including e-waste. In Uruguay, Law No. 19.829 (2017) serves as a comprehensive overarching legal framework for waste management, including high-level provisions on e-waste and EPR. It lays out provisions for the collection, treatment and recycling of e-waste in respect of 6 categories of EEE: large household appliances, small household appliances, ICT equipment, consumer equipment, lighting equipment, and electrical and electronic tools.[129] A draft decree on the management of e-waste specifically is currently pending.

In Argentina, Law No. 25.916 (2004) and Resolution No. 92/2019 offer guidelines for managing hazardous waste, specifically including e-waste. Both instruments encourage the proper handling and disposal of e-waste and urge producers to support the management of this waste stream. Although Argentina lacks specific national e-waste legislation, certain provinces, including Buenos Aires, Córdoba and Santa Fé, have implemented their own e-waste management regulations.[130] Argentina, Uruguay and Chile are all party to the Basel, Rotterdam, Stockholm and Minamata Conventions, but only Uruguay and Argentina have submitted national reports to the Basel Convention Secretariat. In 2019, a reported 118 thousand kg of printed circuit boards from e-waste were exported from Argentina to France for treatment and recovery. However, there are also understood to be unreported exports from South American countries, which makes it a challenge to track and address the transboundary movement of e-waste.

Argentina is the second-largest generator of e-waste in South America, with 517 million kg annually, after Brazil. This is followed by Chile with 230 million kg and Uruguay with 44 million kg. In addition to Brazil, the only other countries manufacturing EEE in South America are Chile and Argentina. Chile is known for specializing in mining-related technologies and renewable energy equipment, while Argentina plays a prominent role globally in the production of automotive electronics, large household appliances and televisions.[131]

Argentina, Chile and Uruguay all face challenges owing to the limited existence of treatment facilities, exacerbated by increasing amounts of e-waste. All 3 countries rely heavily on the informal or semi-formal sectors, where hazardous e-waste is recovered and processed in suboptimal conditions.[132,133] In the Southern Cone, e-waste collection rates are highest in Chile at 3.2 per cent (equivalent to 7.3 million kg nationally); in Uruguay and Argentina they are estimated at 2.9 per cent (equivalent to 1.3 million kg nationally) each. Existing infrastructure and practices remain inadequate in the face of the broader e-waste challenge across these countries. The informal sector contributes significantly to e-waste management throughout South America. In Chile however, efforts have been made to establish partnerships between formal e-waste operators and informal sector cooperatives.[134] These cooperatives engage in the sale of informally collected e-waste and informal operators participate in e-waste collection and preliminary processing activities.

E-waste Status in Asia in 2022

KEY E-WASTE STATISTICS

56 billion kg
EEE POM

30 billion kg | 6.6 kg per capita
E-waste generated

3.6 billion kg | 11.9%
E-waste documented as formally collected and recycled rate

LEGISLATION

18 countries
have a national e-waste policy, legislation or regulation

11 countries
use the EPR principle

7 countries
have collection targets in place

4 countries
have recycling targets in place

ENVIRONMENTAL IMPACT

82.4 billion kg CO_2 equivalents
Greenhouse gas emissions (GHG)

34.5 thousand kg
Emissions of mercury

26 million kg
Plastics containing brominated flame retardants, unmanaged

GENERAL INFO

4,577 million
population

49 countries
analyzed

E-WASTE TRANSBOUNDARY MOVEMENT (2019)

2.9 billion kg imports

Controlled, 1.1 Uncontrolled, 1.8

2.5 billion kg exports

Controlled, 1.0 Uncontrolled, 1.5

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION PER SUB-REGION

Central Asia 76 million
400 | 13 | 3.2% — *E-waste (million kg)*

1. Kazakhstan	200
2. Uzbeikstan	130
3. Turkmenistan	45

Eastern Asia 1,600 million
16,000 | 3,200 | 20% — *E-waste (million kg)*

1. China	12,000
2. Japan	2,600
3. Korea, Republic of	930

South-Eastern Asia 680 million
4,400 | 0 | 0% — *E-waste (million kg)*

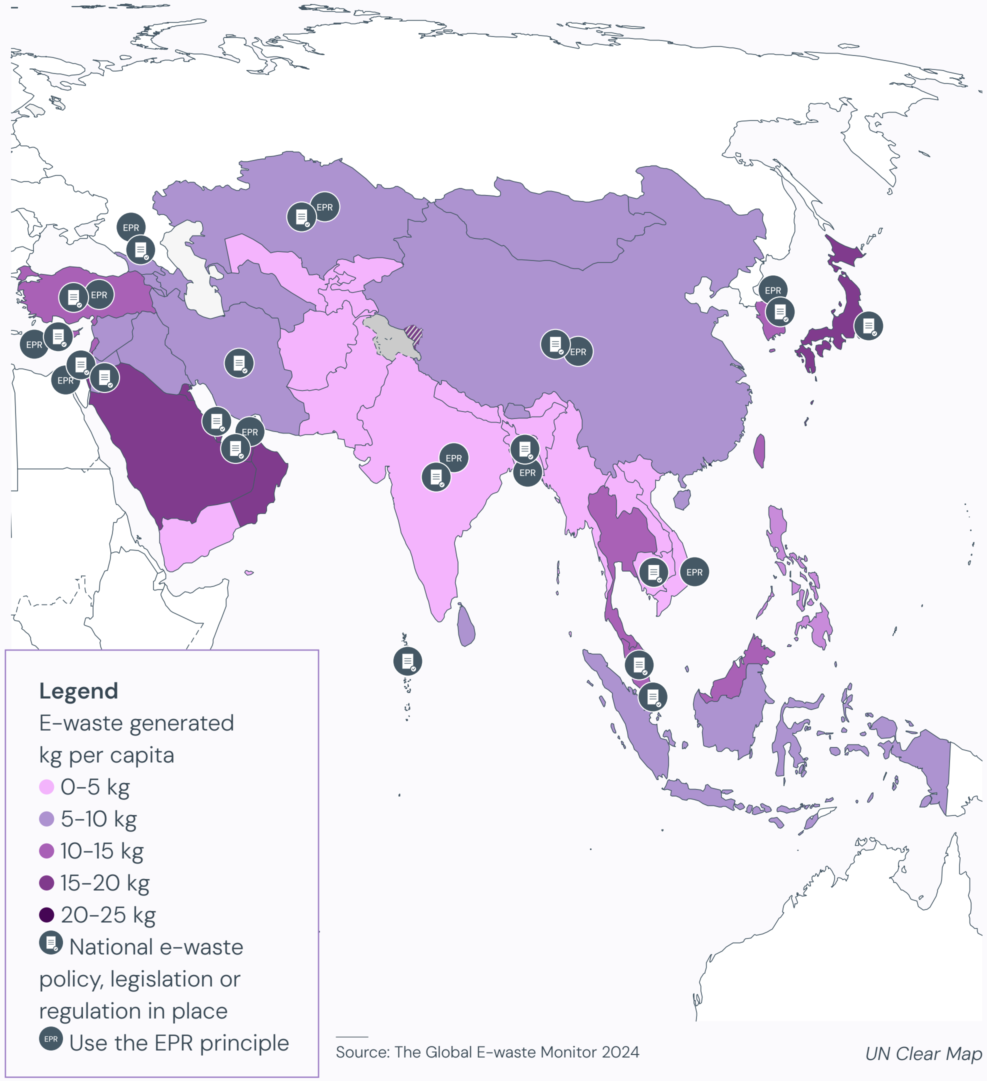
1. Indonesia	1,900
2. Thailand	750
3. Philippines	540

Southern Asia 2,000 million
6,100 | 60 | 1% — *E-waste (million kg)*

1. India	4,100
2. Iran	820
3. Pakistan	560

Western Asia 290 million
3,000 | 270 | 9.1% — *E-waste (million kg)*

1. Turkey	1,100
2. Saudi Arabia	620
3. Iraq	270



Source: The Global E-waste Monitor 2024 — *UN Clear Map*

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION IN THE REGION

Total billion kg

1. China	12,000
2. India	4,100
3. Japan	2,600
4. Indonesia	1,900
5. Turkey	1,100

kg per capita

1. Hong Kong, China	22
2. Japan	21
3. Singapore	20
4. Brunei Darussalam	20
5. Taiwan (Province of China)	19

Asia

EASTERN ASIA

China

The Government of China has implemented various policies and regulations and has undertaken initiatives to manage e-waste.[135] One of its key policy initiatives was the introduction of the EPR principle in 2008; there have since been several updates to include more EEE. In addition to the EPR principle, a comprehensive regulatory framework for e-waste management has also been established. The framework comprises various laws and regulations, such as the Circular Economy Promotion Law and the Solid Waste Law that provide guidance for the safe and effective management of e-waste.[136] The Chinese Government has invested heavily in infrastructure development for e-waste management. For example, the Ministry of Ecology and Environment has launched a national e-waste recycling pilot programme to establish a standardized and regulated e-waste recycling system.[137] The programme aims to build a network of licensed recycling facilities across the country and provide incentives for manufacturers to design products that are easier to recycle.[138] Another significant initiative is the establishment of the National Hazardous Waste List, which specifies the hazardous substances contained in EEE and provides guidance for their management.

Despite the efforts made by the Chinese Government and various stakeholders to manage e-waste, several challenges remain. One of the main challenges is the informal sector, whose unregulated and often unsafe practices in the collection, recycling and disposal of e-waste[139] make it a significant contributor to environmental pollution and human health risks. Informal workers often work with limited resources and inadequate protective equipment, exposing them to hazardous chemicals that can lead to long-term health issues.

Another significant challenge in China is the lack of public awareness and understanding about e-waste management.[140] Many consumers in China know little about the proper disposal and recycling of e-waste, and this often leads to e-waste being discarded in regular waste streams. The absence of an effective e-waste collection and transportation system also poses a significant challenge to the recycling process. Due to the high transportation costs and logistical challenges, many e-waste recyclers in China are located in large urban centres, which results in e-waste from rural areas being left uncollected or improperly disposed of.[141] One promising development is the increasing adoption of circular economy models, which prioritize resource efficiency and waste reduction. For instance, several Chinese companies have started implementing circular business models in the electronics industry, such as product design for recycling, product take-back programmes and the use of recycled materials in new products. Moreover, advances in technology, such as blockchain and the Internet of Things, are expected to play a crucial role in improving e-waste management in the country.[142] These technologies can enable the transparent tracking of e-waste from collection to disposal, ensuring that e-waste is properly recycled and disposed of without harm to the environment or human health.


zlikovec / Adobe Stock

Taiwan, Province of China

Taiwan, Province of China has made significant strides in the management of e-waste, demonstrating its commitment to environmental sustainability.[143] It has established a robust legal framework to regulate e-waste management, ensuring proper disposal and recycling of EEE. The Waste Disposal Act and the Recycling Fund Management Act serve as the cornerstone of this regulatory framework. One key aspect of its approach to managing e-waste is the implementation of an EPR system, which follows a 4-in-1 approach involving the collaboration of multiple stakeholders to achieve comprehensive e-waste management. The 4 key stakeholders in this system are the government, manufacturers/importers, retailers and consumers.

The Government of Taiwan, Province of China plays a crucial role in establishing regulations and standards, and in monitoring compliance with e-waste management requirements. It sets targets for recycling rates, defines product categories subject to EPR and enforces penalties for non-compliance. Manufacturers and importers of EEE are responsible for fulfilling their obligations under the EPR system.[144] They are required to design products with recycling in mind, establish collection systems and finance the recycling and proper disposal of e-waste. This encourages manufacturers to adopt environmentally friendly product design and take responsibility for the entire lifecycle of their products. Retailers also play a role in e-waste management by providing collection points for consumers to return their old or unwanted EEE. These collection points can be found at retail stores, service centres or designated drop-off locations. Retailers are responsible for properly handling e-waste and transferring it to approved recycling facilities. Consumers also have a vital role to play in the 4-in-1 system. They are encouraged to separate their e-waste from general waste and to bring it to designated collection points. By participating in proper e-waste disposal, consumers contribute to recycling efforts and minimize the environmental impact of electronic products.

Taiwan, Province of China boasts a well-developed collection and recycling infrastructure for e-waste. Consumers have access to designated collection points, including recycling centres, drop-off locations and collection events organized by local authorities or recycling organizations. These collection points provide convenient avenues for individuals to dispose of their unwanted electronic devices, preventing them from ending up in landfills or being improperly discarded. When consumers bring their old or unwanted EEE to these collection points, the equipment is sorted based on type and condition. This sorting process enables efficient and appropriate recycling procedures. The collection points typically have separate containers or bins to accommodate different types of e-waste, such as televisions, computers, mobile phones and small household appliances.

Once collected, the e-waste is transported to advanced recycling facilities using specialized vehicles designed for safe transportation. These facilities are equipped with state-of-the-art technology to handle e-waste in an environmentally sound manner. The recycling processes involve dismantling devices and separating various components such as metals, plastics, glass and circuit boards. Advanced technologies are used to extract valuable metals like gold, silver, copper and rare earth elements from electronic components.[145] These extracted materials are either reused or sold, contributing to resource conservation and the minimization of primary resource extraction.

It is important to note that while the collection and recycling of e-waste in Taiwan, Province of China is well-established, there are costs associated with the recycling processes as part of the 4-in-1 system. These costs relate to transportation, sorting, dismantling, processing and ensuring compliance with environmental regulations. They vary depending on the type and quantity of e-waste being processed and on the specific recycling facility involved. As a result of these comprehensive measures and cost-sharing mechanisms, recycling rates in Taiwan, Province of China are tending to increase. Research indicates that the recycling rate for formally regulated e-waste has consistently reached around 80 per cent in recent years[146], with around 31.4 per cent of the e-waste generated being collected in these formally regulated schemes. This achievement can be attributed to the efficient collection infrastructure and the active participation of EEE producers in recycling programmes. Through their involvement, producers contribute to the proper treatment and recycling of e-waste materials.

Boris Golovnev / Shutterstock.com

Japan

Japan has a comprehensive regulatory framework for e-waste management, with the Resource Circulation Act as the main law governing collection and recycling.[147] Under this law, manufacturers and importers are responsible for collecting and recycling e-waste, and consumers are required to separate their e-waste for proper disposal. In 2021, the government announced plans to revise the Resource Circulation Act to strengthen the responsibility of manufacturers and importers for the proper disposal of their products and to require more detailed reporting on the collection and recycling of e-waste.[148] This is indicative of the government continued commitment to improve e-waste management practices in the country. The government has also announced plans to expand the number of designated collection sites and to improve recycling rates for e-waste.

Japan has been promoting the use of more sustainable products through eco-labeling programmes, which are used to identify products that meet certain environmental criteria; Eco Mark is the most widely recognized eco-label.[149] The programmes encourage manufacturers to produce more environmentally friendly products and consumers to make more sustainable purchasing decisions. However, one of the primary challenges for Japanese consumers remains lack of awareness and knowledge about proper e-waste management. This has led to many devices being discarded. Additionally, the cost of recycling e-waste is relatively high in Japan and as such the burden falls on manufacturers, who may choose to export the e-waste to countries with lower recycling costs.

Japan is taking significant steps to improve its e-waste management system. Its goal is to recycle 70 per cent for the 4 items indicated in the Home Appliance Recycling Law by 2025, and it has taken several measures to that end.[150] One of these measures is the expansion of recycling programmes, which includes regulations and guidelines to ensure proper disposal and recycling of e-waste. In 2020, the Ministry of the Environment revised the Act on the Promotion of Recycling of Small Waste Electrical and Electronic Equipment to require retailers to accept old EEE from consumers at no charge. This has helped increase the collection of e-waste for recycling. In addition to expanding recycling programmes, Japan is promoting a circular economy approach to e-waste management, encouraging the reuse and refurbishment of EEE and the recycling of valuable resources such as rare metals. To help achieve this, the government is encouraging manufacturers to design products with recyclability in mind.

Republic of Korea

The Republic of Korea has made significant progress in terms of e-waste management in recent years. It has implemented a comprehensive legal framework and institutional mechanisms to manage e-waste effectively. The main goal of the Ministry of Environment is to promote a circular economy by extending the lifespan of EEE, reducing waste generation and promoting recycling and resource recovery.

One significant measure is the Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles, enacted in January 2020.[151] The act mandates producers of EEE to take responsibility for managing the e-waste generated by their products. It also requires mandatory recycling rates for different types of e-waste and the development of a tracking system for e-waste management. Another initiative is the Green Card programme, launched by the Ministry of Environment in 2011.[152] The programme provides incentives to consumers who choose environmentally friendly products, including EEE that is energy-efficient and eco-friendly.[153]

Mongolia

Mongolia faces an increase in the amount of e-waste being generated owing to the rapid development of its electronics industry and the rising demand for EEE. The government has recognized the need for proper e-waste management and has begun establishing a relevant legal framework and policies. In 2012, the Law on Environmental Protection was amended to include provisions on e-waste management, and in 2016, the National Programme on Environmental Protection was updated to include specific targets for e-waste management.[154] However, many people still dispose of their electronic devices in regular waste bins or burn them, and the country has very little infrastructure or capacity for e-waste management. There are only a few e-waste recycling facilities and most of them are located in the capital, Ulaanbaatar. This leads to the accumulation of e-waste in other parts of the country and makes it difficult to collect and transport e-waste to recycling facilities.[155]

To address these challenges, the Government of Mongolia has taken steps to improve e-waste management. In 2020, the Ministry of Environment and Tourism launched a campaign to raise public awareness about the proper disposal of e-waste.[156] In addition, the government has promoted the establishment of e-waste recycling facilities in other parts of the country. In 2021, it signed a memorandum of understanding with a private company to establish an e-waste recycling facility in Darkhan, the second-largest city in Mongolia.[157]

One major government initiative is the establishment of the National Electronic and Electric Equipment Management and Recycling Programme, which aims to manage e-waste through a comprehensive approach that includes awareness-raising campaigns, the setting up of collection centres, proper treatment and disposal of e-waste, and the promotion of sustainable practices.[142] Another notable initiative is the Eco Town Project, which was launched in 2019 to promote e-waste recycling and reuse in Ulaanbaatar. The project focuses on creating eco-friendly urban communities that promote sustainable waste management practices, including the collection, separation and disposal of e-waste.

Bénédicte Kurzen for Fondation Carmignac

SOUTH EASTERN ASIA

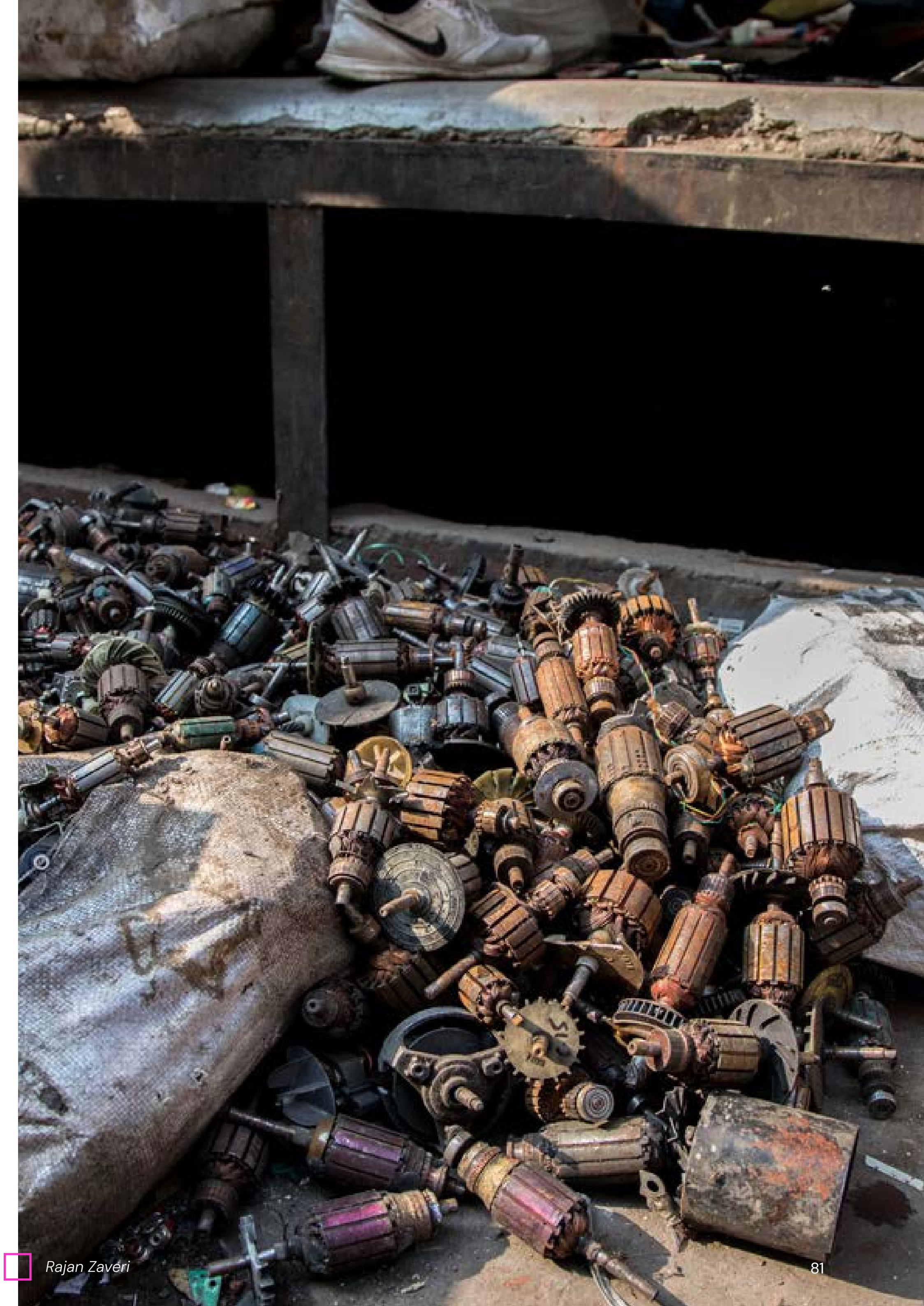
Brunei

The Government of Brunei Darussalam has been taking steps to address environmental concerns, including waste management. Its vision for 2035 is to achieve sustainable development and reduce environmental impact, emphasizing responsible and efficient waste management practices. The aim is to reduce waste to 1 kg per capita per day by 2035.[159]

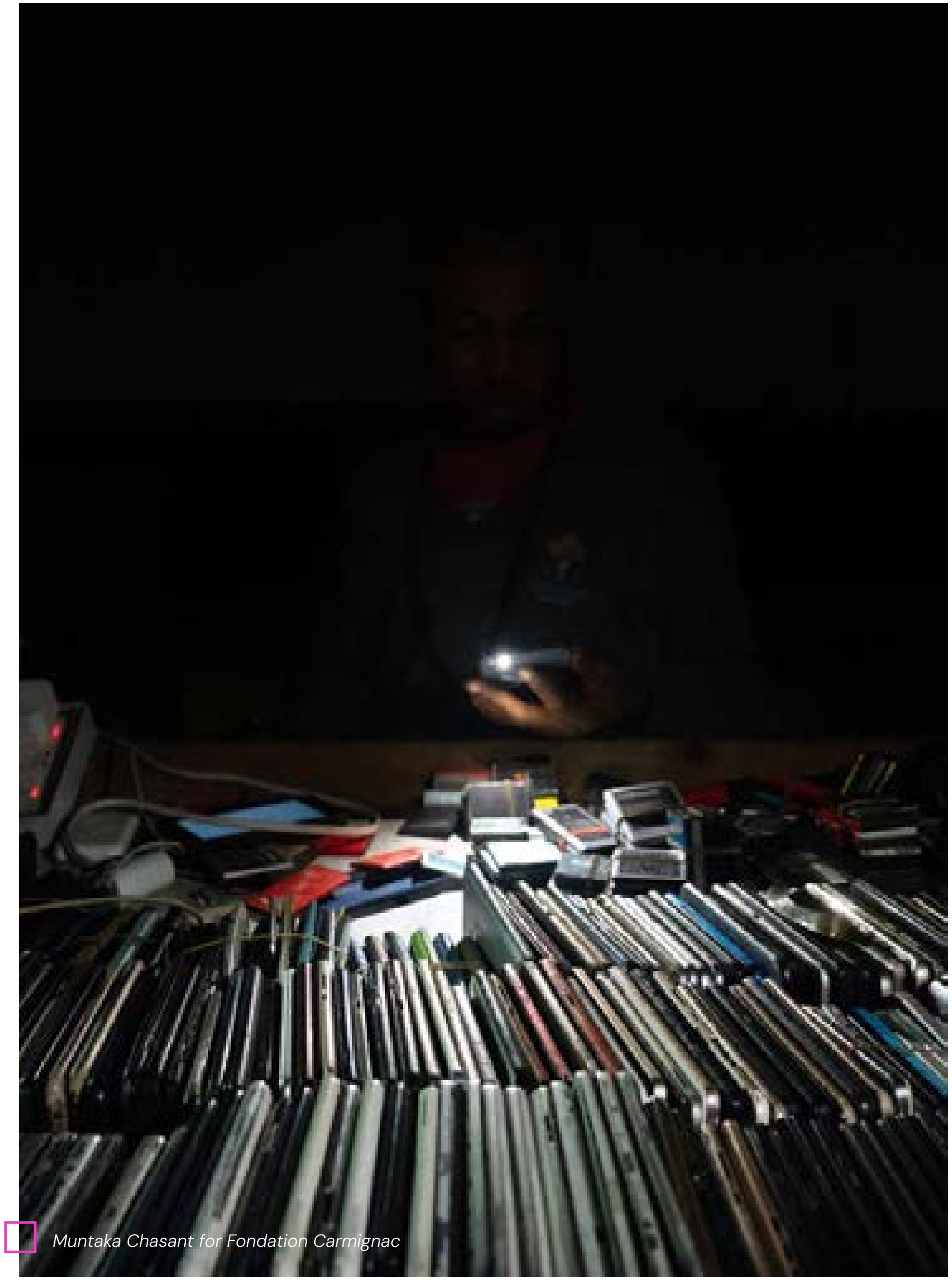
A waste management strategy was developed for the period 2019 to 2030. The strategy contains a comprehensive government plan to promote sustainable waste management practices in the country. It sets out a range of targets and initiatives aimed at reducing waste generation, increasing recycling rates to 60 per cent by 2030, and promoting sustainable waste management practices. It also sets out a comprehensive e-waste management system, including the development of an e-waste recycling facility and promotion of environmentally friendly practices in the handling and disposal of e-waste. In 2021, the Department of Environment, Parks and Recreation released the Guidelines for the Management of E-waste in Brunei Darussalam, which provide a framework for e-waste management with a view to promoting sustainable practices in the handling, storage, transport and disposal of e-waste. The guidelines also emphasize the need to prioritize the reuse and recycling of e-waste in line with the Waste Hierarchy approach.[160] They outline the responsibilities of various stakeholders in the management of e-waste, including producers, importers and retailers of EEE, waste management operators and government agencies responsible for the enforcement of regulations and laws related to e-waste management.[161]

Cambodia

In Cambodia, the 2016 National Environment Strategy and Action Plan recognizes that e-waste is a growing environmental and health concern, and that it must be properly managed and disposed of to protect public health and the environment.[162] The plan covers a range of activities and strategies to address the e-waste challenge, including promoting sustainable production and consumption patterns; strengthening e-waste management infrastructure; enhancing public awareness and participation; and boosting institutional capacity. The 2018 Law on Environmental Protection and Natural Resources Management also contains provisions on e-waste management. The current informal recycling system in Cambodia is creating challenges, with workers exposed to hazardous materials and environmental pollution.[163,164] The country lacks the necessary infrastructure, including recycling facilities and collection systems, to manage e-waste properly. To improve e-waste management in Cambodia, it is crucial to invest in infrastructure development, establish proper collection systems and promote recycling facilities with environmentally sound practices. In order to foster a culture of sustainable disposal practices, it is vital to raise awareness among the public, businesses and government agencies of the importance of responsible e-waste management.



Rajan Zaveri



Muntaka Chasant for Fondation Carmignac

Indonesia

In Indonesia, e-waste is referred to in the Hazardous and Toxic Waste Management Regulation (Peraturan Pemerintah No. 101/2014), which aims to ensure that e-waste does not harm public health and the environment. The regulation sets out the procedures for handling hazardous waste, including e-waste, focusing on collection, transportation and disposal. Despite this overarching regulation, e-waste management in Indonesia is still in the early stages of development.[165] Moreover, there is no specific regulation on e-waste. The country has limited facilities and technologies for the safe and responsible disposal of e-waste and there is little effective policy or public awareness about the issue.[166] As a result, much of the e-waste generated in Indonesia ends up in landfills, where it can pose significant risks to the environment and human health.

To address these challenges, the Government of Indonesia developed the National Action Plan on E-waste Management in 2019.[167] The plan was launched in February 2020 and covers the period from 2020 to 2025. It aims to establish a sustainable e-waste management system in Indonesia by implementing various initiatives, such as developing regulations, building recycling facilities, heightening public awareness and supporting research and innovation. It also aims to create job opportunities in the formal e-waste management sector and increase the country's capacity to manage e-waste. One of its most significant achievements is the development of a roadmap for e-waste management in Indonesia. The E-waste Management System set up by the Ministry of Environment and Forestry aims to provide a comprehensive database of EEE producers, e-waste collectors, recyclers and disposal sites, which will help to ensure that e-waste is managed safely and responsibly. The system is still being developed and is expected to be fully operational by 2023.

Lao People's Democratic Republic

The Lao PDR has experienced rapid economic growth in recent years, resulting in increased consumption of EEE and mounting e-waste generation. There is limited awareness that the country's e-waste management involves inadequate solid waste management practices such as open dumping and burning, which can harm human health and the environment.[168] As a result, most e-waste is disposed of in an unsafe and unsustainable manner. Additionally, there is no proper e-waste management infrastructure or policies governing e-waste. To address this issue, the government has adopted several instruments, including the National Solid Waste Management Strategy and Action Plan for 2019-2028, which aims to promote environmentally friendly waste management practices and the recycling of e-waste.[169] In 2021, the government also announced a policy that will require EEE producers to be responsible for managing the disposal of their products at the end of their lifecycle.[170] E-waste management is further hindered by insufficient funding and investment. The lack of coordination among stakeholders and limited access to technology and expertise for e-waste management and recycling also add to the challenges in this sector.

Malaysia

In Malaysia, laws and regulations such as the Environmental Quality (Scheduled Wastes) Regulations 2005, the National Solid Waste Management Act 2007 and the Communications and Multimedia Act 1998 have been enforced for some time, with various measures being taken over the years to ensure compliance.[171] For example, in 2021, the Department of Environment conducted a series of enforcement operations in several states to monitor the handling and disposal of scheduled wastes, including e-waste. These operations resulted in several premises being issued with notices for non-compliance and fines for violating the regulations. Furthermore, in 2022, the Malaysian Communications and Multimedia Commission launched a voluntary certification scheme for electronic communication equipment complying with the Commission standards. The scheme is intended to promote the use of longer-lasting and repairable electronic devices, and to reduce the amount of e-waste being generated.[172]

The Malaysian Government has recognized the need for sustainable e-waste management and has implemented several initiatives to address the issue. The National Strategic Plan for Solid Waste Management (2018-2030) outlines the government commitment to promote sustainable waste management practices, including the management of e-waste. One of the key initiatives is the promotion of e-waste collection and recycling systems throughout the country. This includes the establishment of e-waste collection centres and the implementation of EPR schemes. The plan also encourages the development of the e-waste recycling industry in Malaysia. In so doing, the government hopes to promote a circular economy where valuable resources are recovered from e-waste rather than being lost.[173] Awareness and education on e-waste management is another important aspect of the plan.

One challenge in Malaysia is the prevalence of informal e-waste recycling activities. Many informal workers dismantle e-waste without proper protective equipment or environmental controls. There is also a lack of infrastructure for e-waste collection and recycling. The National Strategic Plan for Solid Waste Management sets targets for e-waste management that will guide efforts to that end in Malaysia.[174]

Myanmar

The Government of Myanmar has recognized the need to address the issue and has started to work on developing regulations, but progress has been slow. As a result, there is no system in place to track the amount of e-waste being generated or to ensure its proper disposal.[175] In 2023, Myanmar began planning to introduce EPR schemes for EEE. However, the lack of infrastructure for e-waste management remains a significant challenge. There are very few recycling facilities in the country and the informal sector is responsible for most e-waste recycling activities. This often involves the dismantling and sorting of EEE without proper safety and health measures, leading to environmental and health risks.[176]

There is a lack of awareness among the general public and stakeholders regarding the impact of e-waste on the environment and human health. This has resulted in a low level of participation in e-waste collection drives and recycling programmes.[177] Moreover, most EEE is imported from neighbouring countries, which makes it challenging to regulate product quality. This likely also contributes to the generation of e-waste in Myanmar.

rizalfaridz71 / Shutterstock.com

Philippines

The primary types of e-waste in the Philippines are consumer electronics such as televisions, refrigerators, washing machines and mobile phones. These devices are often imported from other countries and regulating their quality can be challenging, likely leading to a high rate of product obsolescence and premature disposal. This is a common theme across the region. The country has a mixed approach of formal and informal e-waste management. The formal sector comprises government and private sector initiatives that focus on the proper disposal, treatment and recycling of e-waste. The informal sector, on the other hand, comprises scavengers and waste pickers who collect and extract valuable components from discarded electronics.

In response to the growing e-waste challenge, the Philippine Government has enacted overarching laws and regulations that refer to e-waste management. The Ecological Solid Waste Management Act of 2000 (Republic Act No. 9003) mandates the proper handling and disposal of solid waste, including e-waste. Additionally, the Department of Environment and Natural Resources issued Administrative Order No. 2013-22, which outlines guidelines for the environmentally sound management of e-waste in the country.[178] The department also released the Revised National Solid Waste Management Strategy in 2021, which includes provisions for e-waste management. Under the revised strategy, e-waste is defined as end-of-life EEE and its parts that have ceased to be of value to their users or become unusable due to wear and tear, damage or obsolescence. The definition also includes equipment that is intended for reuse, resale or disposal.[179]

One key challenge in the Philippines is the lack of access to proper e-waste disposal facilities and infrastructure, especially in rural areas. This limits the collection and disposal of e-waste in these areas, and often results in the illegal dumping of e-waste in rivers, landfills and other areas. There is also a lack of proper regulation and enforcement of existing laws and regulations related to e-waste management. This results in the illegal export of e-waste to other countries. There is growing recognition of the importance of proper e-waste management in the Philippines. The Revised National Solid Waste Management Strategy and the various programmes and initiatives launched by local governments, NGOs and private companies are all steps in the right direction. There is also a growing trend to adopt circular economy principles, which prioritize resource efficiency and the reuse and recycling of materials. This could lead to the development of a more sustainable e-waste management system in the Philippines.[180]

Singapore

The National Environment Agency is responsible for managing e-waste in Singapore, where the e-waste management system is based on a 3-pronged approach of reduce, reuse and recycle. The agency aims to reduce the amount of e-waste being generated by implementing a national EPR scheme, encouraging the reuse of EEE through repair and refurbishment programmes, and increasing the recycling of e-waste through collection and processing programmes. Under this framework, manufacturers and importers of EEE are responsible for the management of their products at the end of their useful life. This includes the collection, transportation and disposal of e-waste, and the development of strategies to reduce the environmental impact of their products.[181]

To facilitate the collection and disposal of e-waste, Singapore has established a network of e-waste recycling points and programmes. The programmes are designed to encourage the proper disposal and recycling of electronic products, and to heighten the public awareness of the environmental and health risks associated with improper e-waste disposal. Despite these efforts, challenges remain, principally the country's limited capacity for e-waste recycling and processing. This has led to a significant amount of e-waste being exported to other countries, where it may be processed under less environmentally friendly conditions. Another challenge is the lack of public awareness and participation in e-waste recycling programmes. While the government has worked to promote these programmes and raise awareness about e-waste management, there is a need for greater engagement with the public and a greater emphasis on education and outreach.[182]

Despite these challenges, Singapore's e-waste management system has made significant progress in recent years. The National Environment Agency has set a target of recycling 30 per cent of waste generated in Singapore by 2030 and is working with stakeholders to achieve this goal.[183]

Heng Lim / Shutterstock.com

Thailand

One of Thailand's key policy initiatives addressing the e-waste challenge is the National E-waste Management Plan, launched in 2018 by the Pollution Control Department of the Ministry of Natural Resources and Environment. The plan aims to establish a more sustainable and effective system for managing e-waste in the country. To achieve this goal, it outlines a series of strategies and actions that focus on reducing e-waste generation, promoting recycling and proper disposal, and improving overall management practices. One of the main goals of the National E-waste Management Plan is to establish a more efficient and effective system for collecting and transporting e-waste. This includes the development of e-waste collection points and the implementation of regulations to ensure that e-waste is properly handled and transported. By improving collection and transportation, the plan aims to ensure that e-waste is properly disposed of and that valuable materials are recovered and recycled.[184]

In 2021, the Strategic Plan on Integrated E-waste Management in Thailand (2022-2026) was launched to follow up on the 2018 National E-waste Management Plan. The latter establishes a long-term framework for the management of e-waste in Thailand, while the former aims to achieve short- and medium-term goals by 2026. The strategic plan focuses on the implementation of the national plan objectives and targets, including strengthening the e-waste management system, promoting the circular economy and enhancing public awareness and participation.[185]

The National E-waste Management Plan also recognizes the importance of educating the public about the proper handling and disposal of e-waste. It includes campaigns to heighten awareness of the environmental and health risks associated with improper e-waste disposal, and efforts to promote more responsible consumption and product design. By raising public awareness, the plan aims to encourage more responsible behavior among consumers and reduce the amount of e-waste generated. It is important to note that Thailand is one of the largest manufacturers of temperature exchange equipment, which includes air conditioners and refrigerators. This means that there are domestic producers of EEE in the country, making it even more important for the country to address e-waste management.

One key challenge facing e-waste management in Thailand is the lack of a comprehensive regulatory framework. While regulations exist for hazardous and solid waste management, there is currently no specific regulation governing e-waste management. A draft WEEE act developed by the Pollution Control Department on the basis of the EPR concept is currently being revised following consultation with national stakeholders, including producers. However, in the absence of a consensus on the draft act - especially the model through which the e-waste management system would be financed - and with no enforceable e-waste regulation in place, e-waste management continues to suffer from a fragmented approach, with different agencies being responsible for different aspects. Another challenge is the prevalence of the informal sector, which plays a significant role in e-waste recycling in Thailand. While informal recyclers provide an important service, they often work in unsafe conditions and without proper training or equipment. This can lead to environmental and health risks, and to suboptimal recovery rates for valuable materials.[186]

According to a material flow accounts study of e-waste management in Thailand for refrigerators (UNU-KEY 0108), air conditioners (UNU-KEY 0111), personal computers (UNU-KEY 0302), cathode-ray tube televisions (0308), LCD televisions (UNU-KEY 0309), phones (UNU-KEY 0305) and mobile phones (UNU-KEY 0306), an estimated 218 million kg of e-waste were dismantled using manual processes in 2023.[187] Of those amounts, around 80 per cent were recyclable materials and around 20 per cent were non-valuable materials. The recyclable parts are normally recycled, whereas non-sellable parts ended up in landfill or were incinerated. According to another study by the same authors, of the 417 million kg of e-waste generated by households, 125 million kg are hoarded by the households, 263 million kg are managed by informal sector workers and 29 million kg are managed by a formalized sector.[188]

Vietnam

The Vietnamese Government has taken steps to address e-waste management. In 2020, the Ministry of Natural Resources and Environment issued the National Action Plan on management of waste from electronic products in Viet Nam for the period of 2020-2025. The plan aims to improve e-waste management across the country by promoting the 3Rs (reduce, reuse, and recycle) approach and strengthening the relevant legal framework. It also sets a target to collect and treat 70 per cent of the e-waste generated in the country by 2025.[189] The government has also implemented various regulations to control the import and export of e-waste. In 2020, it issued Decree No. 31/2020/ND-CP, which covers the management of used EEE and components. The decree aims to control the import and export of e-waste by requiring that importers of used EEE and components have an environmental protection commitment in accordance with the law and ensure that the imports/exports are not hazardous waste.[190]

The private sector has also taken initiatives to improve e-waste management in Viet Nam.[191] For example, the Vietnam E-waste Solutions Joint Stock Company was established in 2020 to promote a circular economy for e-waste in Viet Nam. The Vietnam Environment and Sustainable Development Institute provides expertise on e-waste management, including collection, transportation and recycling services, to businesses and individuals in Viet Nam.

Viet Nam faces challenges in implementing and enforcing e-waste management regulations effectively. One of the main challenges is the lack of awareness among the general public and businesses regarding the importance of proper e-waste disposal. As a result, e-waste is sometimes mixed with general waste, leading to improper disposal. To address these challenges, collaborative initiatives have been undertaken involving government agencies, private sector entities and NGOs. These efforts aim to raise awareness about e-waste issues, improve recycling practices and establish a more sustainable e-waste management system.

Heng Li Hanoi Photography / Adobe Stock

Central Asia

The countries of Central Asia are party to several multilateral environmental agreements aimed at environmental conservation and minimizing the negative impact of hazardous chemicals on the environment and human health. These agreements have been adopted and ratified by some countries in the region, while other countries have expressed their commitment to complying with them. All Central Asian countries, together with Armenia, Azerbaijan and Georgia, are party to the Basel Convention.[192] At the time of writing, Turkmenistan had taken steps to incorporate the country's international obligations under the Basel Convention into domestic law by developing procedures for the import, export and transboundary movement of hazardous and other wastes.

The member countries of the Eurasian Economic Union have adopted several important legal documents aimed at regulating the management of e-waste. One of these, the Technical Regulation on the Restriction of Hazardous Substances in Electrical and Electronic Products (TR EAEU 037/2016), came into effect in 2018 and applies to all Eurasian Economic Union countries, including Armenia, Belarus, Kazakhstan, Kyrgyzstan and the Russian Federation. The Technical Regulation sets forth requirements for the design and production of EEE with restrictions on the presence of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ethers. During the manufacturing process, the concentration of these substances in the homogeneous materials used should not exceed 0.1 per cent by weight, and hexavalent chromium should not exceed 0.01 per cent.[193]

Another important regional document related to e-waste, the Agreement on Cooperation on the Management of Waste Electronic and Electrical Equipment[194], was signed in 2018 by representatives of Member States of the Commonwealth of Independent States, including Uzbekistan, Armenia, Belarus, Kazakhstan, Kyrgyzstan, the Russian Federation and Tajikistan. The main objective of the agreement is to promote the establishment of a regional system for the management of e-waste. This includes maximizing the utilization of such waste as a source of secondary materials thanks to the development and implementation of the best available technologies.

There are few differences in the way e-waste is handled and the level of infrastructure development among Central Asian countries. E-waste recyclers are located in the region, but they usually collect e-waste from legal entities. A common practice of e-waste management is the reuse and repair of used EEE. Another practice is buy-back or free-of-charge removal of household appliances by service organizations that repair and resell used EEE. Public awareness of the negative impact of e-waste and the need for its collection and recycling remains low. Only some countries, e.g. Kazakhstan and Uzbekistan, run occasional public awareness campaigns and collect household e-waste.

Some countries of Central Asia and the Commonwealth of Independent States are developing and implementing projects aimed at improving the e-waste collection and recycling system. For example, with the support of ITU and UNEP, proposals have been drawn up for the implementation of EPR for e-waste and a series of seminars and training sessions on e-waste management organized. With the support of UNITAR, a project on national monitoring of e-waste is being implemented in Kazakhstan, Kyrgyzstan, Uzbekistan and Tajikistan. One of the results of the project will be the development of national roadmaps to improve the e-waste collection and recycling system.

Kazakhstan stands out as a leader in the region regarding e-waste management regulation, as the country has specific regulations in place. Developing a robust waste management system is a priority for Kazakhstan. The main legal act governing waste management is the Environmental Code[195], which was adopted in 2021. The code contains provisions for the separate collection of e-waste, mercury-containing waste, batteries and other hazardous components. It makes the transfer of such waste to recycling facilities mandatory. Since 2017, EPR has been applicable to EEE in Kazakhstan. The responsibilities of the EPR operator have currently been assigned to a State organization, but the country is exploring the possibility of introducing its own EPR system for manufacturers and importers of EEE.[196]

Western Asia

The Western Asia subregion encompasses the United Arab Emirates, Bahrain, Cyprus, Israel, Kuwait, Oman, Qatar, Saudi Arabia, the Syrian Arab Republic, Yemen, Lebanon, Armenia, Azerbaijan, Georgia, Iraq, Jordan, the State of Palestine and Türkiye.

In Bahrain, Iraq, Jordan, Kuwait, Israel, Lebanon, Oman, the State of Palestine, Qatar, Saudi Arabia, the Syrian Arab Republic, the United Arab Emirates and Yemen, e-waste management is characterized by inadequate practices regardless of the income level of the country concered: 99.9 per cent of e-waste is currently unmanaged or mismanaged (except in Israel and Türkiye). The e-waste ends up in landfills and/or is managed by the informal sector, with severe health and environmental repercussions owing to the release of hazardous substances, greenhouse gas emissions and loss of critical material resources. Because of the lack of specific legislation, e-waste in those countries can only be managed through existing legislation on general or hazardous waste. Some countries (e.g. Jordan, Lebanon, Oman, Qatar, the State of Palestine, Saudi Arabia, Sudan and the United Arab Emirates) have well-developed legal and regulatory frameworks on waste management and/or, more specifically, on hazardous waste, which should also apply to e-waste.

With regard to the existing legal framework, no country in the region has specific e-waste laws, with the exception of Israel and its Electrical and Electronic Equipment and Batteries (or E-waste) Law[197], and Türkiye and its Regulation on the Management of Waste Electrical and Electronic Equipment.[198] The Israeli law requires manufacturers and importers to either treat their e-waste and battery waste directly or to sign a contract with companies accredited to treat them. The Ministry of Environmental Protection is responsible for ensuring that this equipment – which includes mobile phones, computers, television sets and refrigerators – is properly disposed of once it can no longer be used or that it is recycled whenever possible.

The Turkish Regulation came into force on 1 February 2023. It introduces a framework for the implementation of EPR for manufacturers of EEE and regulates the relevant strategies, policies and administrative, legal and technical procedures and principles. The Regulation prioritizes the use of recycled materials, wherever technically feasible and especially in newly designed products. E-waste and e-waste fractions that cannot be sent for reuse or recycling are disposed of in facilities with the appropriate environmental permits and licences. The Regulation sets specific targets for the collection of EEE, namely: 40 per cent in 2025; and from 2025 onwards, a yearly increase of 5 per cent up to 65 per cent by 2030. After 2030, the collection target is 65 per cent unless the Ministry establishes otherwise.

Qatar's comprehensive law on the treatment and disposal of hazardous waste (Executive By-Law of the Environment Protection Act, issued via Decree-Law No. 30, 2002) prohibits the treatment and disposal of such waste in facilities not properly designed for that purpose.[199] Similarly, the United Arab Emirates adopted an integrated waste management law in 2018.[200] Lebanon adopted Decree No. 5606/2019, detailing the fundamentals of hazardous waste management and listing e-waste as a type of hazardous waste, in addition to a number of ministerial decisions that regulate the collection, transport and storage of hazardous waste. In the State of Palestine, e-waste is mentioned in the 1999 Environmental Act[201] as a component of hazardous waste, but there is no specific strategy, law or technical specification on e-waste management.

Only Israel, Türkiye and the United Arab Emirates have introduced the EPR principle for e-waste and batteries, but Jordan and Lebanon are in the process of establishing EPR regulations. No other country or territory in the region has implemented or drafted legislation on an EPR system for e-waste.

Several countries in Western Asia have adopted, or are in the process of adopting, environmentally sound management standards or policies for waste in general. Jordan and Bahrain have issued policies on e-waste management specifically, while Qatar is in the drafting phase. In Israel, companies need to apply for accreditation to treat e-waste for importers and manufacturers. At the moment, 2 companies are accredited until 2024.[202]


OVKNHR / Shutterstock.com

All countries in the region have ratified the Basel and Stockholm Conventions (Israel has only signed the Stockholm Convention) and all have ratified the Rotterdam Convention. The regulation of the import and export of e-waste is essentially based on the provisions of the Basel Convention. Kuwait, Lebanon, the State of Palestine, Qatar and the United Arab Emirates have also enacted national laws on the import and export of hazardous waste, including e-waste.

Several countries, such as Jordan, Kuwait, Lebanon, Qatar, Saudi Arabia and the United Arab Emirates, prohibit the import of hazardous waste and materials but permit their export under the Basel Convention. More specifically, Jordan and Lebanon allow the export of hazardous wastes (including e-waste) under specific licensing conditions and with the authorization of the supervising ministry. Kuwait and Qatar allow the export of such wastes under Basel Convention conditions only where no plant for recycling or treating them exists in the exporting country.

In Georgia, e-waste is regulated as a specific waste stream at the legislative level and managed within the framework of the Waste Management Code.[203] The code defines “specific wastes” as those generated from products that require special management measures and careful handling after being transformed into waste. This category includes packaging, oil, tires, motor vehicles, batteries, accumulators and EEE. Furthermore, the Government of Georgia has approved several regulations specifically addressing e-waste management. One of the key regulations is the Technical Regulation on the Management of Waste Electronic and Electrical Equipment[204], which establishes rules for the management of e-waste, including provisions related to EPR, promoting waste prevention and ensuring reuse. The classification of EEE outlined in the Technical Regulation is harmonized with the EU and international classification of e-waste.

Armenia’s Comprehensive and Enhanced Partnership Agreement with the European Union includes provisions for strengthening environmental cooperation.[205] Under the agreement, Armenia is obliged to implement the polluter pays principle and plans to introduce an EPR system. The regulation of waste in the country is governed by the Law on Wastes[206], which establishes the legal principles and rules governing waste management, including collection, processing, recycling and transportation. However, except for specific types of e-waste such as mercury and fluorescent lamps, e-waste is not explicitly included in the list of regulated wastes.

In Azerbaijan, the National Strategy for Improving Solid Waste Management provides for the implementation of relevant plans and measures. However, its implementation is focused on the construction of landfills and it does not regulate e-waste.

Formal environmentally sound e-waste collection exists in a few of the region’s States, namely Jordan, Qatar, the United Arab Emirates and Türkiye. In Qatar, for instance, e-waste is collected from residential areas through announced plans organized in coordination with the competent authorities, such as the Ministry of Municipalities and the Environment. E-waste from government offices, industrial and commercial facilities and other sectors is collected through agreements between a licensed private collector and the generator of the e-waste concerned. In the United Arab Emirates, e-waste is collected by the municipal authorities and through voluntary disposal at formal collection points (known as United Arab Emirates waste collection centres). In addition, the country is home to the only e-waste recycling and processing facility in Africa and the Middle East: the facility has the capacity to process 40 million kg of all types of e-waste per year. In 2019 and 2020, the Ministry of the Environment in Jordan started licensing companies for e-waste collection and recycling: 7 companies are currently licensed to collect (including from informal collectors) and dismantle e-waste for export in accordance with the Basel Convention rules.[207]

In Türkiye, the e-waste recycling rate is low, despite the current legal framework. Although Türkiye is currently one of the largest manufacturers of small household appliances in Europe, shortcomings in its current policies prevent it from achieving its targets for reusing and recycling such appliances.[208] Moreover, there are 3 associations in Türkiye that have been licensed by the Ministry of Environment and Urbanization for the production of electrical and electronic devices (ELDAY, AGID and TÜBİSAD). TÜBİSAD, for example, was appointed by the ministry in 2015 as the authorized institution for the collection of televisions/monitors and ITC consumer equipment waste. It continues to carry out various training, consultancy and campaign activities, and its website lists the addresses of 294 e-waste collection centres.[209]

In Lebanon, all e-waste is managed under a general hazardous waste decree and the country is in the process of establishing EPR, which is referenced in its 2019 national strategy for integrated solid waste management.[210] The proposed targets for e-waste are as follows: a minimum of 2 kg per capita per year for recovery, and a minimum of 4 kg per capita per year for separate collection within 5 years of its introduction. The strategy is currently being revised, which might result in a change in the targets.[211] According to a 2019 UNIDO assessment, e-waste management infrastructure in Lebanon falls short on several counts: it is limited, including by high energy costs; the sector has many informal participants working in the absence of health and environmental safety measures; there is no specific e-waste legislation; awareness is limited; and there are no e-waste statistics.[212]

SOUTHERN ASIA

India

India, one of the world's largest generators of e-waste, is also a forerunner in the region when it comes to e-waste legislation and infrastructure for collection and recycling. The first E-waste (Management and Handling) Rules[213] were notified in 2011 by the Ministry of Environment, Forests and Climate Change, which is responsible for waste-related legislation; they have been regularly updated and amended since then, with the latest amendment having come into force in April 2023. The E-waste Rules[214] also include a schedule, similar to the EU RoHS Directive, restricting the use of certain hazardous substances in EEE if safer alternatives exist.

The E-waste Rules 2011 had 21 product categories, mainly IT devices and a few consumer appliances. They introduced the concept of EPR for e-waste management, including of producers, dismantlers, recyclers and regulators. They also contained requirements aimed at reducing the amount of hazardous substances from products, in line with the EU RoHS Directive. Guidelines for the Implementation of E-waste Rules 2011 were issued by the Central Pollution Control Board, the federal body for environmental regulation. The rules were revised in 2016, with the new rules coming into force the same year.[215] The revised rules further strengthened the EPR framework and introduced the concept of producer responsibility organizations. Although the product scope remained the same, the applicability of the rules was extended to include components, consumables, and parts and spares of the electronic equipment covered under the rules, to provide clarity on the scope. Most importantly, the 2016 rules introduced phased collection targets for e-waste, starting with a 30 per cent target in the first year and going up to 70 per cent.

The 2016 rules were amended in 2018 with a view to bringing new entrants to the Indian electronics market under the ambit of the E-waste Rules and thus leveling the playing field. The amended version also rationalized collection targets, to give industry more time to evolve and establish the system. It introduced the requirements to be met by producer responsibility organizations wishing to register with the Central Pollution Control Board, and signaled a conscious decision to shift to a centralized, nationally regulated EPR authorization regime for e-waste, to ensure seamless pan-India compliance. The 2016 rules and subsequent amendments have given the entire stakeholder value chain the impetus to initiate systemic improvements and investment in infrastructure and heightened awareness. As a result, there has been a rapid increase in recycling capacity, from 89 billion kg in 2010 to over 1 billion kg in 2021, with 400 authorized recyclers operating in the country today, compared to only 23 in 2010.[216]

The E-waste Rules attempt to simplify the regulatory and reporting requirements, mainly focusing on producers, manufacturers and recyclers. The revised rules also focus on recycling, introducing recycling targets, as compared to collection targets previously. Importantly, they also expand the scope of mandatory products to over 100, including solar panels, medical devices, tools, toys and lab equipment. The recycling targets slowly ratchet up from 60 per cent of EEE POM (based on average lifespan of the product) in fiscal 2023-2024 to 80 per cent of EEE POM by fiscal 2027-2028. The Central Pollution Control Board has also notified the draft average lifespan of each product included.[217]

The Government of India has also identified the need for, and opportunities offered by, a shift to a circular economy. The National Institution for Transforming India (NITI Aayog) has published several strategy papers on the broader policy direction to be implemented by the government to mainstream a resource-efficient and circular Indian economy. The Ministry of Electronics and Information Technology specifically released a strategy paper on the circular economy and EEE, in which it identified key areas for intervention, particularly in respect of end-of-life management of electronics, and proposed a comprehensive action agenda to enhance resource efficiency and the circular economy in the sector.

The overall circular economy strategy also encourages repairs, with the Ministry of Consumer Affairs setting up a committee to come up with a right-to-repair framework. Initially, the framework will focus on mobile phones, tablets and consumer durables. The Right to Repair Portal India[218] of the Department of Consumer Affairs, Ministry of Consumer Affairs, Food & Public Distribution, provides warranty and post-sales information, by consumer brand, to consumers in India.

Muntaka Chasant for Fondation Carmignac

Afghanistan

Afghanistan generates the lowest amounts of e-waste per capita in the region (0.8 kg), for a total of approximately 32 4 kg in 2022. It currently has no specific legislation on e-waste management. According to a 2017 government report on the country's progress towards the Ha Noi 3R Declaration (Sustainable 3R Goals for Asia and the Pacific 2013-2023), Afghanistan had a poor recycling and recovery rate for e-waste and other recyclables. Goal 13 (ensuring environmentally sound management of e-waste), Goal 14 (effective enforcement to prevent illegal transboundary movements of e-waste) and Goal 15 (implementation of EPR) were identified as not relevant for the country.[219]

Bangladesh

Bangladesh is one of the largest generators of e-waste in the region (over 350 million kg annually at a rate of 2.2 kg per capita), yet it has few licensed e-waste dismantlers and they use basic resource recovery practices that are polluting and unsafe. In the absence of formal e-waste infrastructure or enforcement of e-waste legislation, the e-waste is mainly handled by the informal sector.

Rapid growth in the amount of e-waste generated in the country nevertheless resulted in regulatory and enforcement pressure from civil society[220] and from international development partners and multilateral organizations. The Ministry of Environment, Forest, and Climate Change, which is responsible for the coordination of all matters related to the environment, including e-waste management, issued the E-waste Management Rules in 2021, after nearly 10 years of talks.[221] The rules introduce the EPR framework for e-waste management, requiring producers of almost all EEE to register with the Department of Environment, have an approved e-waste management plan and reach collection targets of 10 per cent in 2022, increasing annually by 10 percentage points to 50 per cent in 2026. The restrictions related to hazardous substances are aligned with those of the European Union.

Despite the progress made, the Government of Bangladesh has been unable to implement the rules, which contain reduced standards for lead and are therefore blocked by the World Trade Organization. In 2022, the Bangladesh Telecommunication Regulatory Commission, which is responsible for regulating and approving the import, installation and use of telecom equipment, approved the Guideline on E-Waste Management and Recycling System[222] following a stakeholder process that had commenced in June 2021. Several development partners have shown an interest in helping Bangladesh establish an effective e-waste management system. An ongoing World Bank initiative[223] includes e-waste management infrastructure as a specific component, with financing to the tune of USD 71 million committed to support the piloting of an effective private-public partnership to attract private investment in e-waste facilities that ensure environmentally sound treatment, provide technical assistance on certification standards and incentives, etc.

Matyas Rehak / Shutterstock.com

In the meantime, the handful of formal e-waste recyclers established by local entrepreneurs often struggle to access e-waste. The dominant informal sector has extensive networks with buyers, including from outside Bangladesh, who are able to offer much higher prices than local entrepreneurs. This can be seen in the price escalation observed on the market, where prices for e-waste have gone up three- or tenfold as informal dismantlers become more aware of the value of e-waste and are able to better sort and separate in order to gain added value.

Bhutan

Statistical estimates indicate that Bhutan generates 5.2 million kg of e-waste per year. The Waste Prevention and Management Act, 2009[224] sets out the direction and objectives of the Government of Bhutan on waste management. It establishes key agencies and monitoring authorities to effectively implement the act, which covers various types of waste, including e-waste. It defines e-waste as "discarded, obsolete or recyclable electrical or electronic equipment including all components, subassemblies and consumables at the time of discarding". The National Environment Commission is the apex monitoring body responsible for coordinating and overseeing the performance of designated implementing agencies. The Department of Information Technology and Telecom is mandated to ensure prevention and management of e-waste, also as per the National Waste Management Strategy, 2019.[225]

Under the umbrella of the Waste Prevention and Management Act, the Waste Prevention and Management Regulation, 2012, came into effect on 18 April 2012. The regulation includes provisions on e-waste management, with guidelines for producers, exporters and consumers, and creates an e-waste fund to support implementation efforts. Chapter VII, on e-waste, lays out the scope of application, the functions of stakeholders, and reporting and disclosure requirements. The e-waste fund is managed by the Department of Information Technology and Telecom in consultation with the National Environment Commission; it finances implementation of the e-waste management system. The Department of Revenue and Customs and the Department of National Properties are also stakeholders in the system, with responsibilities for collecting all EEE and for auctioning government IT devices, respectively.

Despite the progress made, poor knowledge about e-waste, the lack of e-waste management entities to collect, transport, sort and recycle e-waste in an environmentally sound way, and inadequate facilities have all resulted in the improper handling and disposal of e-waste remaining a common practice. The Thimpu Waste Management plan also highlights these issues, indicating that even though Bhutan is a signatory to the Basel Convention, the e-waste generated within the country is mostly sold to scrap dealers across the country's borders.[226]

Maldives

The Maldives Ministry of Environment, Climate Change and Technology published the E-waste Management Guidelines in March 2022.[227] The guidelines acknowledge that Maldives has limited options for hazardous waste management and no formal mechanism or infrastructure for separate collection. They suggest that bringing e-waste management under an EPR framework would make recycling more efficient and also lead to job creation. The Maldives Environment Protection Agency and the Waste Management Department are important stakeholders for the development and implementation of the regulatory framework for e-waste management in the country.

Nepal

Nepal generates 41.5 million kg of e-waste every year; its per capita rate of 1.4 kg is one of the lowest in the region. According to an e-waste inventory commissioned by the Department of Environment, the Kathmandu

Muntaka Chasant for Fondation Carmignac

Valley alone generated approximately 18 million kg of e-waste in 2017. The inventory also found that the average lifespan was two years for mobile phones, 4 years for laptops, 8 years for televisions and computers, and 10 years for refrigerators and washing machines.[228] The inventory included a field survey that polled the public about the main causes of e-waste generation, with most fingers pointing to new technology/advanced models. Physical damage, limited awareness and the high cost of repairs were also cited as reasons for discarding EEE. However, a report commissioned by the National Telecommunications Authority found that repair and reuse of EEE is very common in Nepal.[229]

The Government of Nepal has yet to finalize and publish any policy or legislation related to e-waste. The Ministry of Science and Technology has commissioned the Nepal Telecommunications Authority to publish a draft framework for e-waste legislation by 2023.

The Ministry of Federal Affairs and General Administration is addressing e-waste as a waste category in its revision of the Solid Waste Management Act 2011, but details on this have not yet been published. Neither the Ministry of Forest and Environment nor the Department of Environment has been as active on the topic as the other government agencies, although they are potentially major stakeholders. The lack of coordination and collaboration across stakeholders in the e-waste value chain is also reflected in the various dialogues and public consultations that have taken place, with few concrete outcomes. Moreover, in the absence of an EPR system, most producers are unaware of the need for solutions for safe collection and recycling of end-of-life EEE. A nascent recycling industry does exist, with formal e-waste recycling facilities being set up that are offering voluntary take-back and recycling services.

Driven by regional and global commitments, some producers are starting to take proactive steps voluntarily to take back e-waste and are working with recyclers for its safe disposal. It is nevertheless a challenge for a landlocked country like Nepal to find suitable downstream treatment options for fractions that cannot be treated or recycled in the country and that are often shipped across multiple borders, making the process more time-consuming and expensive.

Pakistan

Pakistan, as the second most populous country in the region, is a large generator of e-waste, estimated at 556 million kg in 2022, albeit with a rate of 2.4 kg/capita. It is also a destination for e-waste exported from other countries, with a study published in 2017 estimating that approximately 95.4 million kg of e-waste were imported into Pakistan annually. Of this, the large majority of imports were personal computers and power cables (37 per cent each), followed by monitors (15 per cent). The study also found that 89 per cent of e-waste imports enter the country in Karachi. Similar to most countries in the region, Pakistan's current regulations (as of June 2023) at both provincial and federal level lack specific provisions on e-waste management. The National Hazardous Waste Management Policy 2022, published by the Ministry of Climate Change, identifies e-waste as one of the waste streams to be included in a regulatory framework to be developed following the policy approval.[230]

The Ministry had previously published the Environmental Guidelines for Sound Disposal Management of Mercury in Compact Fluorescent Light Bulbs.[231] However, the guidelines only indicate the method of handling and disposing of the light bulbs; it deems the disposal of end-of-life bulbs to be the corporate social responsibility of manufacturers. A study commissioned by the Asian Development Bank on the solid waste management sector in Pakistan in 2022 highlighted the need for an action plan to set up an effective e-waste management system. It also called for collaboration among stakeholders such as the Ministry of Climate Change, the Ministry of Industries and Production and original equipment manufacturers. The recycling sector in Pakistan is dominated by informal operators. While Karachi is the main hub for e-waste dismantling and recycling, secondary markets have also emerged in Lahore, Faisalabad, Gujranwala and Peshawar.[232]

Sri Lanka

Sri Lanka, as an island country with little manufacturing of EEE, imports all the equipment consumed domestically. Like most countries in the region, Sri Lanka does not, as yet, have a legal framework governing e-waste management. Responsibility for the management of e-waste lies with the Central Environmental Authority,[233] which has developed a draft e-waste policy that supports implementation of the polluter pays principle and lays the ground for legislation based on the EPR framework. The policy suggests that ways be explored of applying the polluter pays principle to generate revenue from efficient and effective e-waste management and that financial instruments be found to generate revenue and promote efficient use.

Notwithstanding the lack of an e-waste regulation, the Central Environmental Authority has initiated on-site projects to collect and manage e-waste. As part of the 2014 National E-waste Programme, which aims to recycle all forms of "mobile" waste generated by customers around the country, the authority signed memoranda of understanding with 14 partner organizations from the telecommunication and appliance industry on the voluntary collection of e-waste. Another memorandum of understanding concerned collaboration with a network of 5000 schools in Sri Lanka that proved not only to be an effective collection mechanism but also created awareness among children and their parents of the importance of managing e-waste. The Central Environmental Authority also publishes a list of licensed e-waste collectors in Sri Lanka indicating (as of June 2023) 13 organizations that are involved in e-waste management.[234] There are limited downstream options for final treatment and recovery, for which transboundary shipments are necessary. As a signatory to the Basel Convention, Sri Lanka requires Prior Informed Consent from the importing country, and lists the related procedure and costs online.[235]

Muntaka Chasant for Fondation Carmignac

E-waste Status in Europe in 2022

KEY E-WASTE STATISTICS

14 billion kg
EEE POM

13 billion kg | 17.6 kg per capita
E-waste generated

5.6 billion kg | 42.8%
E-waste documented as formally collected and recycled rate

LEGISLATION

39 countries
have a national e-waste policy, legislation or regulation

37 countries
use the EPR principle

34 countries
have collection targets in place

31 countries
have recycling targets in place

ENVIRONMENTAL IMPACT

16.6 billion kg CO_2 equivalents
Greenhouse gas emissions (GHG)

4.7 million kg
Emissions of mercury

6 million kg
Plastics containing brominated flame retardants, unmanaged

GENERAL INFO

742 million
population

40 countries
analyzed

E-WASTE TRANSBOUNDARY MOVEMENT (2019)

1.2 billion kg imports

Controlled, 0.6 Uncontrolled, 0.6

1.9 billion kg exports

Controlled, 0.6 Uncontrolled, 1.3

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION PER SUB-REGION

Eastern Europe — 290 million
3,700 1,000 | 27% *E-waste (million kg)*

1. Russian Federation ... 1,900
2. Poland ... 520
3. Ukraine ... 390

Northern Europe — 100 million
2,500 1,000 | 42% *E-waste (million kg)*

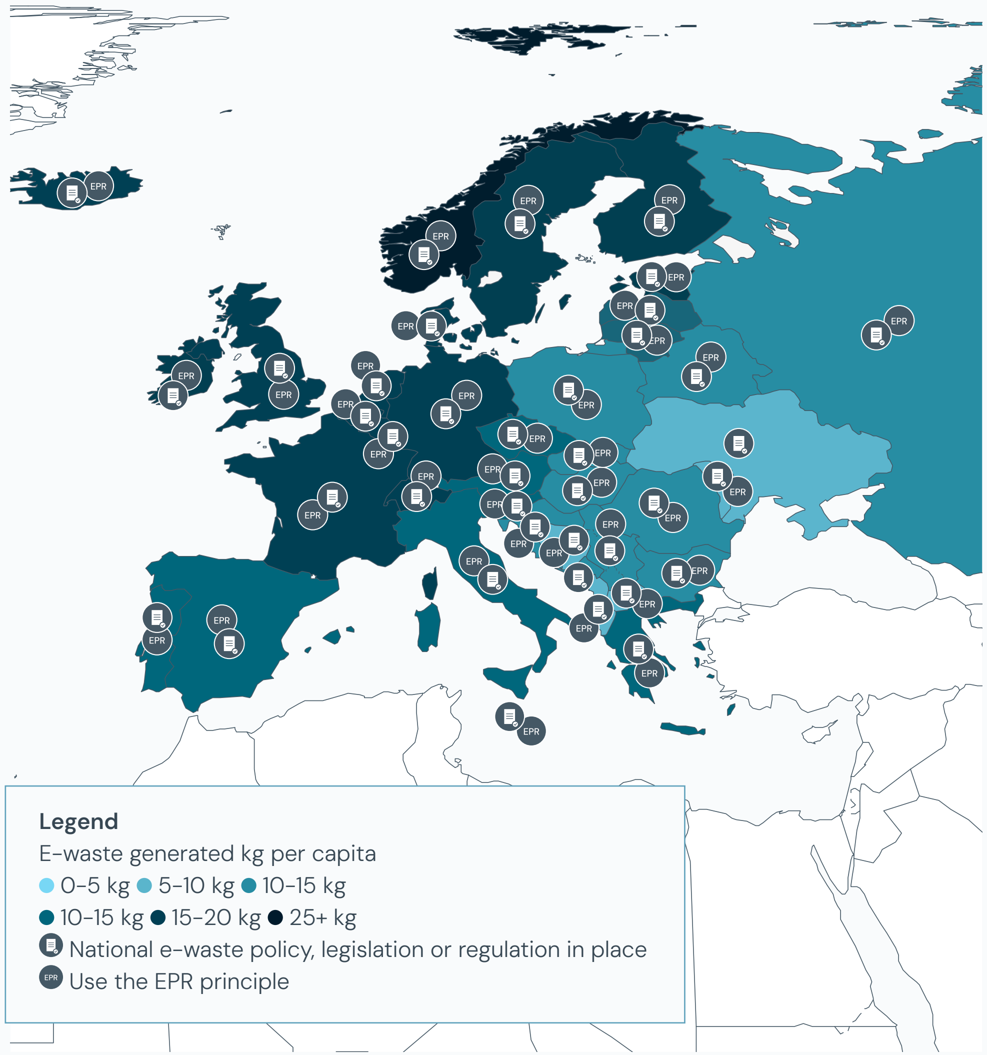
1. United Kingdom ... 1,700
2. Sweden ... 220
3. Norway ... 140

Southern Europe — 150 million
2,700 1,100 | 40% *E-waste (million kg)*

1. Italy ... 1,100
2. Spain ... 930
3. Greece ... 190

Western Europe — 200 million
4,200 2,500 | 58% *E-waste (million kg)*

1. Germany ... 1,800
2. France ... 1,400
3. Netherlands ... 390



Source: The Global E-waste Monitor 2024 *UN Clear Map*

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION IN THE REGION

Total million kg

1. Russian Federation ... 1,900
2. Germany ... 1,800
3. United Kingdom of Great Britain and Northern Ireland ... 1,700
4. France ... 1,400
5. Italy ... 1,100

kg per capita

1. Norway ... 27
2. United Kingdom of Great Britain and Northern Ireland ... 24
3. Switzerland ... 23
4. France ... 22
5. Iceland ... 22

Europe

NORTHERN EUROPE, WESTERN EUROPE, AND EUROPEAN UNION MEMBERS FROM SOUTHERN AND EASTERN EUROPE.

European countries, especially those in the European Union, are considered good examples in terms of the way they legislate and manage e-waste. The legislation, policies and systems in place in the 27 EU Member States (plus Norway) are based on the EU WEEE and RoHS Directives. Non-member States, including Iceland and Switzerland, have implemented laws aligned with the WEEE Directive. In addition to recognizing the importance of properly managing e-waste to ensure environmental sustainability, the European Union has also recognized the need to ensure that valuable resources are recovered from EEE. In March 2023, the European Commission published the Critical Raw Materials Act, which recognizes the need to strengthen the Union's autonomy in the supply of key raw materials. The main objective of the act is to ensure the "supply of critical raw materials..., indispensable for a wide set of strategic sectors including the net zero industry, the digital industry, aerospace, and defence sectors".[236]

The EU WEEE Directive sets criteria for the collection, treatment and recovery of WEEE. The European Commission is currently reviewing the directive to assess whether it remains fit for purpose, to simplify the text and to determine whether a further review is needed. The EU RoHS Directive aims to prevent the risks posed to human health and the environment by the management of electronic and electrical waste. It does this by restricting the use of certain hazardous substances in EEE for which there are safer alternatives. These restricted substances include heavy metals, flame retardants and plasticizers. The RoHS Directive promotes the recyclability of EEE, as EEE and its components will contain fewer hazardous substances. The findings of a public consultation on the review of the RoHS Directive in mid-2022 helped to identify possible changes needed. This includes amending the provisions on recovered spare parts, which could have a positive impact on CO_2 emissions and resource efficiency, and assuming that a substitute is available when it has been demonstrated that such is the case for a majority of manufacturers in the EU market.[237]

The EU WEEE Directive describes two methods for calculating the collection rate in EU Member States. The WEEE generated method involves dividing the mass of e-waste collected by the mass of e-waste generated in the same year. Based on this method, the collection rate increased from 40 per cent in 2014 to 54 per cent in 2021. Increases are mainly driven by the higher e-waste collection rates compared to e-waste generation. The other calculation method is the EEE POM method, whereby the mass of e-waste collected is divided by the average amount of EEE POM in the 3 preceding years. The collection rate using the EEE POM method increased from 39 to 50 per cent between 2013 and 2016. From 2016 to 2020, the collection rate dropped to 44 per cent, the result of even larger amounts of EEE being put on the market.

Every year, EU Member States can choose either method to calculate their collection rate and track progress on e-waste collection targets. For the WEEE generated method, the EU target is 85 per cent, and for EEE POM, the target has been 65 per cent since 2019. Only 3 of the 27 EU Member States (Croatia, Bulgaria and Poland) have reached the collection target set out in the WEEE Directive, according to the latest available dataset. This means that 24 EU Member States are presently not reaching the target; the majority of those are below the 50 per cent target using the EEE POM method.

Alexanderstock23 / Shutterstock.com

Only one country (Poland) has surpassed the 85 per cent collection rate and met the more ambitious target of 85 per cent collection rate for e-waste collection under the WEEE-generated method. 19 countries had rates in the 50 to 85 per cent range, while 11 countries remained below 50 per cent. Switzerland does not have any such targets in place but would meet the EU target calculated using the EEE POM method.

E-waste treatment in the United Kingdom is based on the Waste Electrical and Electronic Waste Regulation 2013, which is in line with the EU WEEE Directive, even though the United Kingdom is no longer an EU member. The government has started to review this statutory instrument. In both the United Kingdom and the European Union, the focus is very much on setting up schemes for the collection of single-use devices such as vaporizers, because they are also e-waste, and their numbers are growing.

The countries that reach the targets seem to contradict both the overall trend and the underlying factors observed across the rest of the European Union, and the quality of the data produced by some countries has been called into question. Besides official government statistics, there are no public reports or research available that allow for a better understanding of collection rates.[238] Understandably, the objective is to substantially increase collection in the European Union so as to meet the self-set targets and avoid penalties.

A recent study found that EU households are home to an average 74 electrical and electronic items each (excluding lamps and luminaires), for a total mass of 90 billion kg.[239] Of those 74 items, 61 are in use, while an estimated 4 items per household are hoarded and not working (and thus have not yet been discarded). This is equal to 3 billion kg of broken appliances that could be repaired or handed over to WEEE collection schemes, increasing collection rates considerably if consumers were convinced or incentivized.

Government trials in, for example, Austria and Germany are monetarily supporting the repair of EEE and thus extending product lifetimes. Deposits on EEE continue to be discussed as a way to secure higher return rates but have yet to be widely applied, also because of substantive administrative costs. Governments are also trying to supplement existing data and raise the relatively low collection rates by, for instance, including data on transboundary movements (equipment leaving the country), plastic components, etc. Interestingly, relatively few efforts are apparently being made to make sure that consumers return equipment, either by providing incentives or by simplifying take-back systems. Contrary to other waste streams, such as packaging, biomass or paper, the consumer is expected to return e-waste over an extensive delivery system to collection points of municipalities and retailers. The use of e-waste collection containers for small equipment, while not widespread, is rising in the European Union.

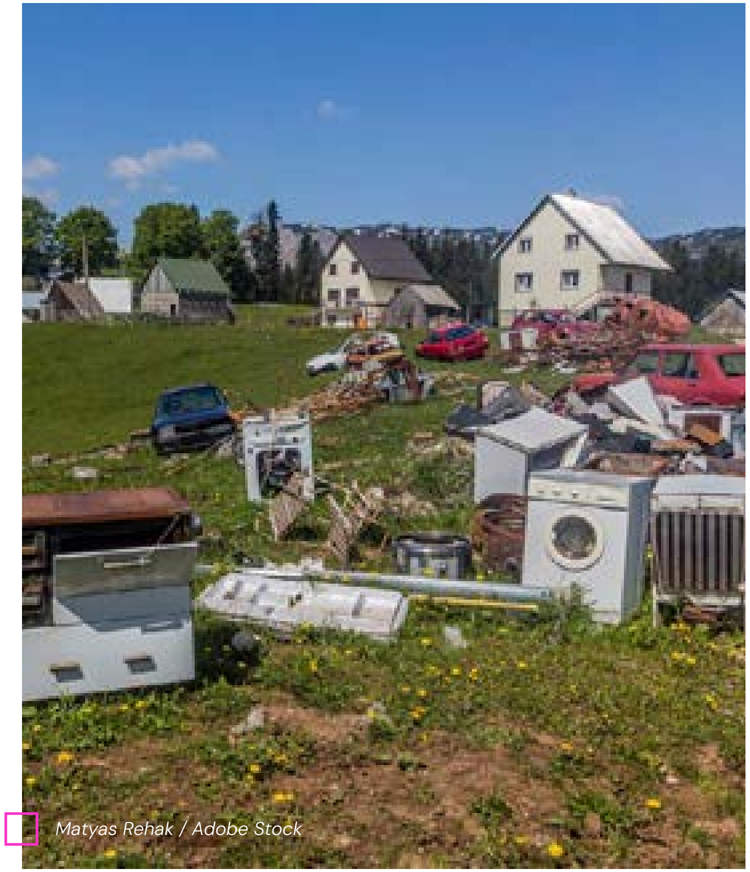
UNITAR

SOUTHERN EUROPE (NON-EUROPEAN UNION MEMBERS)

The non-EU member States of Serbia, Bosnia and Herzegovina, Montenegro, Albania and North Macedonia are commonly referred to as the Western Balkans. The countries in the Western Balkans are slowly aligning their e-waste management approaches with the EU WEEE Directive, which includes introducing the EPR principle in their related legislation. However, not all countries in the Western Balkans have fully implemented an EPR system. Most have provisions for ambitious e-waste collection and treatment targets, which in a few cases have expired and need to be renewed, but measures to enforce and track them through a comprehensive monitoring framework are lacking. Additionally, some of the countries are gathering and publishing data on the amount of e-waste being collected and recycled. However, a clear reporting framework for the amount of EEE being put on the market and for the amount of e-waste being generated is missing. This makes it challenging to set appropriate targets.

While all the countries in the Western Balkans have e-waste collection and treatment infrastructure, the maturity levels vary and in most cases the infrastructure remains limited, particularly in Albania and Montenegro. Most countries have the capacity to pre-treat e-waste before it is sent abroad. One major challenge is that consumers are not discarding e-waste in the receptacles provided specifically for that purpose. As a result, most of the e-waste is picked up by the informal sector and sold as scrap metal in the Western Balkans.[240] In addition, even when reporting systems are in place, EEE producers are not always fully aware of their legal obligations. Informal sector participants operating e-waste management activities in the Western Balkans collect the waste door-to-door, which often leads to cherry-picking - they collect only high-value waste products and components.

Informal participants often dismantle and sort e-waste before the recovered fractions are sold to local recyclers or exported. There are many licensed e-waste collectors in the Western Balkans but only a few are active[241], and some only cover business-to-business products. Although all countries in the Western Balkans are signatories to the Basel, Rotterdam and Stockholm Conventions, e-waste continues to be moved across borders within the region because some countries have no specific laws banning e-waste imports and exports. The import of used EEE is not specifically regulated in all countries in the region but at the same time there is a huge demand from consumers. The region has a strong culture of reuse and EEE is often repaired by consumers instead of being immediately disposed of. In fact, EEE is sometimes donated or sold to companies (local reuse centres), or individuals involved in the trade of second-hand devices in the Western Balkans.[242]



Matyas Rehak / Adobe Stock

EASTERN EUROPE (NON-EUROPEAN UNION MEMBERS)

The Eastern European subregion encompasses the EU Member States of Bulgaria, the Czech Republic, Hungary, Poland, Romania and Slovakia (see *Northern Europe, Western Europe and EU Member States from Southern and Eastern Europe* above). It also includes the non-EU members Belarus, Ukraine, the Republic of Moldova and the Russian Federation, of which only Belarus, Ukraine and Moldova presently have e-waste-specific legislation.

Belarus classifies e-waste as hazardous waste and is in the process of adopting specific e-waste management regulations and standards. Currently, e-waste is covered by the legal framework on general waste management. Similarly, the Russian Federation regulates e-waste using bylaws. In Moldova, e-waste is regulated in accordance with the requirements of the Law on Waste No. 209, dated 29 July 2016, and the Provisions on WEEE approved by Government Resolution No. 212 in March 2018. Other legal instruments related to waste management are also relevant for e-waste.

As regards Ukraine, the main regulatory document governing waste management is Law No. 187/98-BP(66), on waste, of 5 March 1998, as amended and supplemented. The legal framework covers the full list of existing waste, including e-waste. In addition, a number of ministerial resolutions and orders are dedicated to e-waste management. Belarus, Georgia, Moldova, the Russian Federation and Ukraine have recently adopted or are in the process of adopting specific e-waste management standards. The management of waste, including hazardous waste, is regulated by several national laws and rules in all countries in the subregion.

An EPR system covering e-waste has already been established in Belarus, Georgia, Moldova and the Russian Federation. Ukraine is currently drafting a text on EPR for e-waste. These countries apply EPR to the waste streams arising from several products, such as packaging, batteries and accumulators, EEE, vehicles and oils. In Belarus, the EPR system has been in place since August 2012. The range of goods covered includes different type of packaging, computers and mobile phones. The system is State-owned and has only one producer responsibility organization. EEE producers in Belarus are mandated to collect and recycle or neutralize the waste from their products by one of the following channels applied singly or in combination: (a) their own waste collection systems (buy-back centres or containers), production lines and repair shops; they must ensure the recycling/neutralization of waste either directly or by a third party, and producers and suppliers have to collect not less than 30 per cent of EEE placed on the market annually; (b) a contract with the waste management operator. Producers and suppliers in the country tend to use the second option. Retailers and trade organizations are also engaged in the collection of WEEE in Belarus (through shops and places of repair or maintenance).[243]

In Moldova, Article 12 of Law No. 209/2016 on waste provides for implementation of the EPR scheme in the country to boost reuse, prevention, collection and recycling. The scheme involves individuals or legal entities that are in the business of developing, manufacturing, processing, treating, selling and/or importing products subject to EPR. The main responsibility of producers is to ensure achievement, individually or via collective systems, of the collection and recycling targets set by the government. Several producer responsibility organizations have been established in Moldova for different waste streams (e-waste, WEEE, batteries and packaging), but not all are fully compliant with EPR principles all of the time, also due to the complexity of the new approaches introduced by the EU Waste Framework Directive, to limited recycling and treatment capacities within the country and to poor understanding of their roles.[244]

FotograFFF / Shutterstock.com

The subregion's countries have signed or ratified several international agreements related to e-waste. These range from multilateral environmental agreements to agreements restricting the use of hazardous substances in manufacturing or promoting the circular economy.[245] More specifically, all countries are party to the Basel and Stockholm Conventions, and all countries except Belarus are party to the Rotterdam Convention. Following its ratification of the Basel Convention, Belarus amended Article 27 of Law No. 271-3 of 20 July 2007, on waste management, to regulate the transboundary movement of waste; in Moldova, Chapter VIII of Waste Law 209/2016 establishes rules for the import and export of waste. Moreover, Moldova ratified the Minamata Convention on Mercury in 2017, while Belarus and the Russian Federation have signed it but have yet to complete the ratification process.

In 2020, TR EAEU 041/2017, a technical regulation adopted by the Eurasian Economic Union, which includes Belarus and the Russian Federation among its Member States, entered into force. The regulation, which is based on the EU RoHS Directive, restricts the substances that can be used to manufacture electrotechnical and electronic products.[246]

In terms of industrial recyclers, in Moldova treatment companies are active in sorting, dismantling and ensuring the primary treatment and recycling of e-waste before it is exported abroad for further treatment (e.g. to EU Member States). In 2021, Belarus had 10 e-waste treatment companies able to process all types of e-waste: the materials obtained from disassembling are processed in compliance with the legislation, although valuable components are sometime sent to the Russian Federation or the European Union for further treatment. In Ukraine, of 115 organizations licensed for e-waste management, about 80 per cent have licences for e-waste recycling. Waste printed circuit boards, specifically, are dismantled in the e-waste management process in Belarus, Moldova and the Russian Federation, but treated/recycled mainly in the Russian Federation, where a processing plant was opened in 2020. Belarus also accepts printed circuit boards for final treatment and recycling. Informal operators still play a central role, especially those that travel from door to door collecting e-waste. One reason is the lower cost when e-waste is not delivered to formal collectors; the informal collectors also give cash incentives. In terms of consumers, in Belarus and Ukraine they pay for the collection and treatment/recycling of e-waste and batteries when purchasing new equipment and batteries: the cost of these services is included in the price of the goods by the producers, but it is not visible.

E-waste Status in Oceania in 2022

KEY E-WASTE STATISTICS

750 million kg
EEE POM

707 million kg | 16.1 kg per capita
E-waste generated

292 million kg | 41.4%
E-waste documented as formally collected and recycled rate

LEGISLATION

1 country
has a national e-waste policy, legislation or regulation

1 country
uses the EPR principle

1 country
has collection targets in place

1 country
has recycling targets in place

ENVIRONMENTAL IMPACT

359 million kg CO_2 equivalents
Greenhouse gas emissions (GHG)

542 kg
Emissions of mercury

389 thousand kg
Plastics containing brominated flame retardants, unmanaged

GENERAL INFO

44 million
population

14 countries
analyzed

E-WASTE TRANSBOUNDARY MOVEMENT (2019)

0 million kg imports

22 million kg exports

Controlled, 12 Uncontrolled, 10

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION PER SUB-REGION

Australia and New Zealand — 31 million
680 | 290 | 43% — *E-waste (million kg)*

1. Australia ... 580
2. New Zealand ... 100

Melanesia — 12 million
21 | 0 | 0% — *E-waste (million kg)*

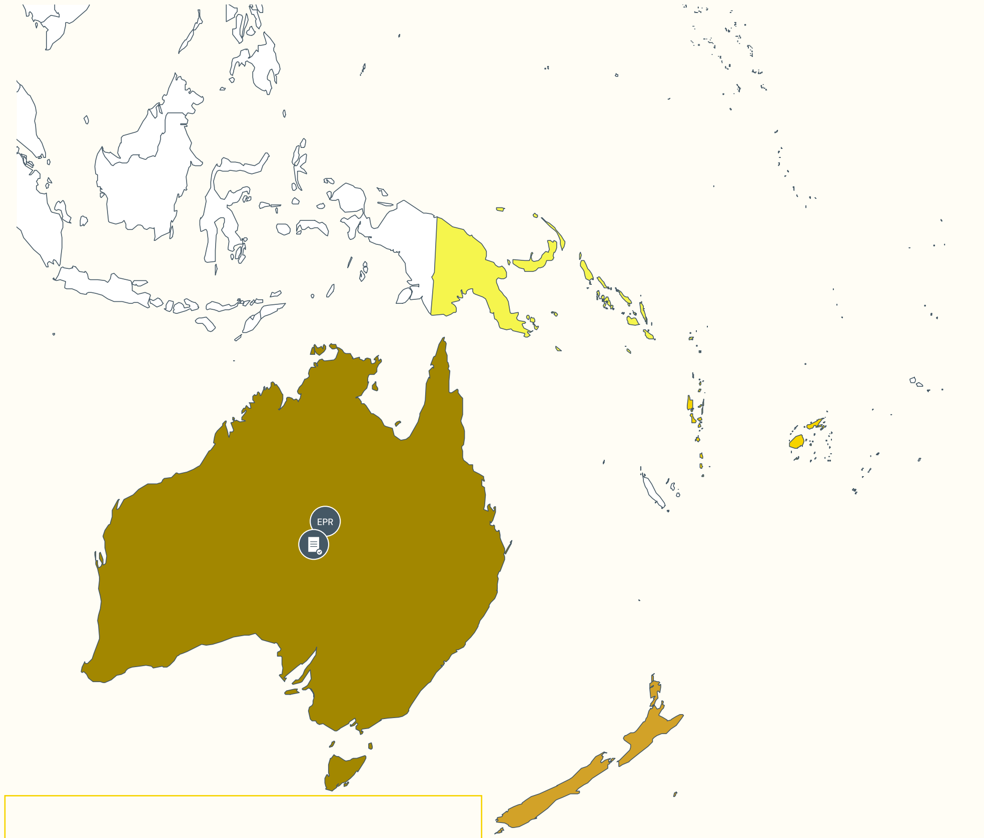
1. Papua New Guinea ... 13
2. Fiji ... 6.7
3. Solomon Islands ... 0.8

Micronesia — 0.3 million
0.8 | 0 | 0% — *E-waste (million kg)*

1. Micronesia, Federated States of ... 0.2
2. Palau ... 0.2
3. Kiribati ... 0.2

Polynesia — 0.3 million
1.1 | 0 | 0% — *E-waste (million kg)*

1. Samoa ... 0.7
2. Tonga ... 0.4
3. Tuvalu ... 0.03



Legend
E-waste generated kg per capita
0-5 kg, 5-10 kg, 10-15 kg, 15-20 kg, 20-25 kg
National e-waste policy, legislation or regulation in place
EPR Use the EPR principle

Source: The Global E-waste Monitor 2024

UN Clear Map

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION IN THE REGION

Total million kg

1. Australia ... 580
2. New Zealand ... 100
3. Papua New Guinea ... 13
4. Fiji ... 7
5. Solomon Islands ... 0.8

kg per capita

1. Australia ... 22
2. New Zealand ... 20
3. Palau ... 12
4. Fiji ... 7
5. Nauru ... 6

Oceania

AUSTRALIA AND NEW ZEALAND

Australia

Australia is the only country in the South Pacific with specific legislation covering e-waste management.[247] The Australian Government established the first National Waste Policy in 2009, providing directions for enhancing waste and resource management and facilitating national reporting of waste and resource recovery data.[248] In 2018, an updated version of the policy was published to guide the country towards a circular economy by defining 5 principles aligned with 14 strategies specific to waste, recycling and resource recovery.[249]

The National Television and Computer Recycling Scheme is one of the most significant producer responsibility schemes to be implemented in Australia under the government Product Stewardship Act 2011, which came into effect on 8 August 2011. The related Product Stewardship (Televisions and Computers) Regulations 2011 came into effect on 8 November 2011. This scheme provides Australian households and small businesses with access to industry-funded collection and recycling services for televisions and computers. The Australian Government reports that to date over 1 800 collection services have been made available to consumers, resulting in over 130 million kg of television and computer waste collected and recycled. An estimated total of 122 million kg of televisions and computers reached end of life in Australia in 2014-2015, of which around 43 million kg were recycled (35 per cent) under this scheme. This a significant improvement from the recycling rate of only 9 per cent in 2008.

The National Television and Computer Recycling Scheme is Australia's sole co-regulatory framework. 5 approved organizations currently operate under this co-regulatory arrangement. In the financial year 2020-2021, the framework collected 50.5 million kg of televisions and computers, achieving a maximum recovery rate of 96.7 per cent.[250,251] The scheme target for the overall amount of e-waste to be recycled rose from 50 to 70 per cent between 2015 and 2022, and the aim is to reach 80 per cent by 2035.[252] The scheme covers national e-waste collection locations in urban and remote areas. With more than 697 permanent drop-off sites and one-off collection events, the Australian population has convenient access to e-waste drop-off services.[253,254,255]

ymgerman / Shutterstock.com

In terms of voluntary product stewardship, EEE product schemes are industry-led and can operate autonomously or with Australian Government accreditation. Accreditation ensures that the scheme human well-being and environmental results have been validated, contributing to Australia's recycling and waste reduction goals. Currently, there are 2 government-accredited industry-led voluntary schemes: MobileMuster and B-cycle. MobileMuster, the industry recycling programme for mobile phones, obtained accreditation in 2014. The programme aims to divert mobile phone products from landfills and recycle them in a safe, secure and ethical manner. It is administered on behalf of the mobile phone industry by the Australian Mobile Telecommunications Association, which expanded the stewardship programme in July 2022 by adding 3 more product categories: network connectivity, smarthome technology, and wearables and peripherals. Members of the scheme include mobile handset manufacturers, network carriers, modem manufacturers, and accessory manufacturers and distributors.

The Australian mobile recycling programme, MobileMuster, operates 3 000 public drop-off points, ensuring convenient access for 96 per cent of the country's population within a 10-kilometre radius. By 2022, it had successfully collected 109 thousand kg of mobile phones and components, achieving a 99.3 per cent recycling recovery rate.[256] MobileMuster has actively promoted recycling through various campaigns since its launch, including the nationwide campaign Go for Zero 2023, which aims to stop broken mobile phones from being sent to landfills by encouraging households to recycle old, non-functional devices and accessories.[257] Despite Australia's advances in e-waste management, discussions with stakeholders and state/territory governments have highlighted several challenges. All states support the principle of banning e-waste from landfills nationwide. However, regions with remote communities, like the Northern Territory, are concerned about the viability of landfill bans until they have guaranteed access to the National Television and Computer Recycling Scheme.[258]

To protect the environment and provide social, economic and cultural benefits, the New Zealand Government introduced the Waste Minimisation Act (2008), promoting waste minimization and a reduction in disposal. Compared to Australia, New Zealand is still in the process of developing a national scheme to deal with the e-waste issue. Unconfirmed reports estimate that around 80 million kg of e-waste are produced in New Zealand annually, with less than 1 per cent being sent for recycling and the remainder going into landfills. In 2014, the Ministry of Environment contracted a private organization to develop a product stewardship framework for managing e-waste in New Zealand. This organization undertook a comprehensive stakeholder engagement and consultation; it also collected and analysed e-waste data to develop recommendations for an e-waste stewardship option for New Zealand.[259] It is understood that the New Zealand Government is still considering these various options. It is also closely monitoring the success of the Australian scheme.

The Ministry for Environment recognizes that e-waste recycling is currently limited. Many recycling activities involve processing e-waste into individual components, which are then shipped outside the country for further processing and materials recovery. Manual processes make disassembly activities economically challenging owing to high labour costs, high disposal fees and high prices for disassembled e-waste components. While white goods and IT equipment are frequently remanufactured or recycled for their valuable internal components, disassembly processes by companies in New Zealand may not be economically viable.[260] New Zealand's Waste Minimisation Fund, with a budget of over USD 75 million, supports projects that facilitate the country's transition towards a low-emission and circular economy.[261] In alignment with the New Zealand Waste Strategy 2023, the government has acknowledged the importance of a mandatory product stewardship scheme for EEE, including large batteries. With this goal in mind, it aims to launch a regulated electrical and electronic product stewardship plan by 2025.[262]

MICRONESIA (FEDERATED STATES OF), MELANESIA AND POLYNESIA

Micronesia (Federated States of), Melanesia and Polynesia consist of 22 countries and territories that face unique challenges owing to their geographical spread. Furthermore, the limited availability of suitable land on small islands and atolls for constructing facilities, combined with the islands' remoteness and relatively small populations, raises issues of economies of scale for waste management. These challenges are compounded by changing weather patterns and rising sea levels. Waste management overall in the Pacific is governed by the recently adopted Pacific Regional Waste Pollution Management Strategy 2016-2025 (Cleaner Pacific 2025), which details the current situation and the future strategy for managing all waste streams, including e-waste.[263]

The entities in charge of e-waste management vary among Pacific Island countries, with some managed by national governments (Cook Islands, Samoa and Tonga), state governments (Micronesia) or local governments (Fiji, Vanuatu and Solomon Islands), and some sharing the responsibility (Kiribati and the Marshall Islands). Moreover, socioeconomic factors across the subregion result in varying levels of e-waste management, with private recycling companies in charge of e-waste management in countries such as Palau, while other countries have underdeveloped recycling services.[264]

Audreycmk / Shutterstock.com

Currently, a significant amount of e-waste is stockpiled on Pacific islands and awaiting further handling. Efforts to deal with these stockpiles are hamstrung by economic and logistical challenges, limited access to disposal points and recycling markets, and the high cost of transporting e-waste out of the region. To find a sustainable solution for the management of e-waste and other hazardous waste streams, a 4-year EU-funded project, referred to as the PacWaste (Pacific Hazardous Waste) project and managed by the Secretariat of the Pacific Regional Environment Programme in Samoa, aims to collect information on current e-waste management practices and stockpiles in 5 Pacific island countries, in order to prioritize future actions to assist other countries in the Pacific to manage e-waste. Additionally, the Pacific islands have received support from the GEF-funded Implementing Sustainable Low and Non-chemical Development in Small Island Developing States (ISLANDS) programme, which is helping 14 countries in the Pacific transition to a cleaner Pacific by 2025. The ISLANDS programme helps control the import of hazardous materials and to dispose of hazardous wastes in an environmentally responsible manner.[265]

The Samoa Ministry of Natural Resources and Environment, with support from PacWastePlus (a follow-up to the PacWaste project), has deemed e-waste a priority waste stream. Currently, e-waste in Samoa is improperly disposed of, ending up in landfills or being burned or unlawfully discarded, leading to environmental contamination and health risks for residents. The Samoa PacWastePlus project aims to establish the E-waste Product Stewardship Scheme to support long-term e-waste management. It also aims to develop a dismantling and storage facility for e-waste and its components, to be located in Tafaigata. The scheme's design is expected to be completed by September 2023.[266,267,268] In Niue, the accumulation of e- and other waste is a challenge in the absence of proper storage facilities, training and financing. In December 2022, an e-waste clean-up effort resulted in the collection of 6 containers of e-waste. To address the lack of infrastructure, the Niue Department of Environment, in partnership with the PacWastePlus project, is constructing a new recycling transfer facility to collect and manage e-waste and household recyclables.[269,270]

Global E-waste Statistics Partnership

Initially formed in 2017, and today run by UNITAR-SCYCLE and ITU, the Global E-waste Statistics Partnership has 3 key objectives: to collect global e-waste data using an internationally adopted methodology; to enhance stakeholder understanding of the e-waste challenge through data; and to improve statistics quality through capacity building. Its website (www.globalewaste.org) continues to provide an open-source portal for the e-waste data it compiles. The Global E-waste Monitor is now in its fourth edition, with previous editions published in 2020, 2017 and 2014, and is the GESP flagship publication.[271] It enhances understanding and interpretation of global e-waste data in relation to the Sustainable Development Goals, providing valuable insights for policy-makers, industries, academia, the media and the public.

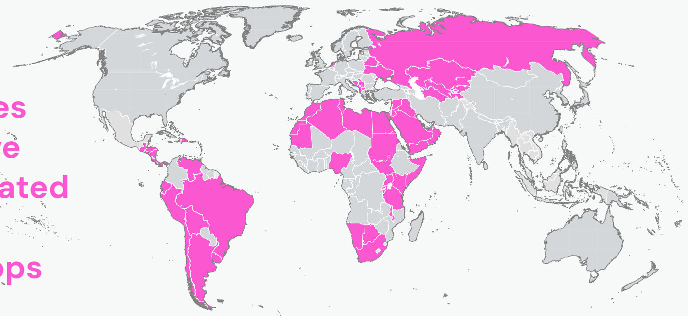
The GESP has conducted national and regional workshops, training participants from more than 80 countries, and facilitated the adoption of a harmonized measurement framework. Since 2020, 62 countries have participated in e-waste statistics workshops, including from the following regions: East Africa, Latin America, Eastern Europe and the Arab States. In addition, 4 countries have successfully compiled national e-waste statistics. As a result of these workshops, the GESP has produced a series of national e-waste monitors for Malawi, Namibia, Botswana, Bahrain, Kazakhstan, Tanzania, Lebanon and the Netherlands. It has strived to establish the foundation for quantitative assessment models and in so doing has helped identify critical e-waste challenges, uncover avenues for improvement and promote collaboration among stakeholders on a national scale towards data harmonization. Regional e-waste monitors have been developed for East and South-east Asia (2016), Latin America (2022), the Arab States (2021) and the Commonwealth of Independent States/Georgia (2021), and an edition of Outlooks to 2050 for West Asia (2023).[272]

In 2022, ITU and UNITAR-SCYCLE collaborated with the East Africa Communications Authority to improve e-waste data in East Africa (Rwanda, United Republic of Tanzania, Uganda, Burundi, Kenya and South Sudan). E-waste data and statistics play a crucial role in decision-making, target setting and improving e-waste collection rates. Accurate and up-to-date e-waste data provide decision-makers with valuable insights into the scale and impact of e-waste, enabling them to develop informed policies and strategies.

By understanding the volume, composition and trends of EEE POM and e-waste generation, decision-makers can identify areas of concern, allocate resources effectively and prioritize interventions to address e-waste management challenges.

E-waste data help set realistic and achievable recycling targets. By analysing the amount of e-waste generated and current recycling rates, policy-makers can establish appropriate goals for recycling and recovery. These targets can guide the development of recycling infrastructure, investment in technology and the implementation of collection and recycling programmes to meet recycling objectives.

E-waste data enable the identification of gaps and bottlenecks in e-waste collection systems. By analysing collection rates and identifying regions or EEE with low collection rates, decision-makers can develop targeted strategies to improve collection mechanisms and raise awareness among consumers. This can involve setting up convenient collection points, establishing EPR schemes, promoting take-back programmes or incentivizing proper e-waste disposal (see Box 6).



Box 6. Prime Minister Modi Stresses Proper E-waste Disposal in India

India's Prime Minister Narendra Modi discussed e-waste during his monthly Mann Ki Baat radio programme in January 2023. Emphasizing the need to properly dispose of e-waste, he said that "today's latest devices are also the future's e-waste" and "devices like mobile phones, laptops and tablets have become common in every household. Their number will be in billions across the country. Whenever someone buys a new device or replaces one's old device, it becomes necessary to keep in mind whether it is discarded properly or not. If e-waste is not discarded properly, it can also harm our environment." Citing the Global E-waste Monitor 2020, Modi added, "50 million tonnes of e-waste are thrown every year. Can you guess how much? Even if the weight of all the commercial planes that have been built in the history of mankind is combined, it will not equal the amount of e-waste being released. It is like every second 800 laptops are being thrown away." In August 2021, Modi also announced a Waste-to-Wealth mission focused on making better use of waste.

To hear part of the recording of the Prime Minister's statement, go to https://ewasteindia.com/2023/01/31/mann-ki-baat-e-waste-handling/.

About
the Authors

Dr. Cornelis P. Baldé
Senior Scientific Specialist,
UNITAR, SCYCLE Programme

Professor Ruediger Kuehr
Senior Manager SCYCLE Programme &
Adjunct Professor, Department of Electronics
& Computer Engineering,
University of Limerick (Ireland)

Tales Yamamoto
Individual Contractor,
UNITAR, SCYCLE Programme

Dr. Rosie McDonald
Climate Change Officer,
ITU

Elena D'Angelo
Individual Contractor,
UNITAR, SCYCLE Programme

Dr. Shahana Althaf
Sustainability Scientist,
Aligned Incentives

Garam Bel
Circular Economy Coordinator,
ITU

Dr. Otmar Deubzer
Senior Scientific Specialist,
UNITAR, SCYCLE Programme &
Fraunhofer IZM

Elena Fernandez-Cubillo
Individual Contractor,
UNITAR, SCYCLE Programme

Vanessa Forti
Associate Officer,
UNITAR, SCYCLE Programme

Vanessa Gray
Head, Environment and
Emergency Telecommunications
Division, BDT, ITU

Professor Sunil Herat
Professor,
Griffith University

Dr. Shunichi Honda
Programme Management Officer,
International Environmental Technology
Centre (IETC), UNEP

Giulia Iattoni
Assistant Programme Officer,
UNITAR, SCYCLE Programme

Dr. Deepali S. Khetriwal
International E-waste Expert

Vittoria Luda di Cortemiglia
Project Manager/Consultant,
UNITAR, SCYCLE Programme

Yuliya Lobuntsova
Director of the Department of Waste
and Chemical Safety,
CSD Center

Professor Innocent Nnorom
Professor,
Abia State University

Noémie Pralat
E-waste Policy Support,
ITU

Michelle Wagner
Technical Project Coordinator,
WEEE Forum

Annex 1.
Methodology Details

Table A.1.1 UNU-KEYS and link to 6 e-waste categories

UNU KEY	DESCRIPTION	EU-6	EU-6PV
0001	Central Heating (household installed)	4	4a
0002	Photovoltaic Panels (incl. inverters)	4	4b
0101	Professional Heating & Ventilation (excl. cooling equipment)	4	4a
0102	Dishwashers	4	4a
0103	Kitchen Equipment (e.g., large furnaces, ovens, cooking equipment)	4	4a
0104	Washing Machines (incl. combined dryers)	4	4a
0105	Dryers (wash dryers, centrifuges)	4	4a
0106	Household Heating & Ventilation (e.g., hoods, ventilators, space heaters)	4	4a
0108	Fridges (incl. combi-fridges)	1	1
0109	Freezers	1	1
0111	Air Conditioners (household installed and portable)	1	1
0112	Other Cooling Equipment (e.g., dehumidifiers, heat pump dryers)	1	1
0113	Professional Cooling Equipment (e.g., large air conditioners, cooling displays)	1	1
0114	Microwaves (incl. combined, excl. grills)	5	5
0201	Other Small Household Equipment (e.g., small ventilators, irons, clocks, adapters)	5	5
0202	Equipment for Food Preparation (e.g. toaster, grills, food processing, frying pans)	5	5
0203	Small Household Equipment for Hot Water Preparation (e.g., coffee, tea, water cookers)	5	5
0204	Vacuum Cleaners (excl. professional)	5	5
0205	Personal Care Equipment (e.g. tooth brushes, hair dryers, razors)	5	5
0301	Small IT Equipment (e.g., routers, mice, keyboards, external drives & accessories)	6	6
0302	Desktop PCs (excl. monitors, accessories)	6	6
0303	Laptops (incl. tablets)	2	2
0304	Printers (e.g., scanners, multi functionals, faxes)	6	6
0305	Telecommunication Equipment (e.g. (cordless) phones, answering machines)	6	6
0306	Mobile Phones (incl. smartphones, pagers)	6	6
0307	Professional IT Equipment (e.g., servers, routers, data storage, copiers)	4	4a
0308	Cathode Ray Tube Monitors	2	2
0309	Flat Display Panel Monitors (LCD, LED)	2	2
0401	Small Consumer Electronics (e.g., headphones, remote controls)	5	5
0402	Portable Audio & Video (e.g., MP3, e-readers, car navigation)	5	5

UNU KEY	DESCRIPTION	EU-6	EU-6PV
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	5	5
0404	Video (e.g., Video recorders, DVD, Blue Ray, set-top boxes) and projectors	5	5
0405	Speakers	5	5
0406	Cameras (e.g., camcorders, photo & digital still cameras)	5	5
0407	Cathode Ray Tube TVs	2	2
0408	Flat Display Panel TVs (LCD, LED, Plasma)	2	2
0501	Small Lighting Equipment (excl. LED & incandescent)	3	3
0502	Compact Fluorescent Lamps (incl. retrofit & non-retrofit)	3	3
0503	Straight Tube Fluorescent Lamps	3	3
0504	Special Lamps (e.g., professional mercury, high & low pressure sodium)	3	3
0505	LED Lamps (incl. retrofit LED lamps)	3	3
0506	Household Luminaires (incl. Household Incandescent Fittings & Household LED Luminaires)	5	5
0507	Professional Luminaires (offices, public space, industry)	5	5
0601	Household Tools (e.g., drills, saws, high pressure cleaners, lawn mowers)	5	5
0602	Professional Tools (e.g., for welding, soldering, milling)	4	4a
0701	Toys (e.g., car racing sets, electric trains, music toys, biking computers, drones)	5	5
0702	Game Consoles	6	6
0703	Leisure Equipment (e.g., sports equipment, electric bikes, juke boxes)	4	4a
0801	Household Medical Equipment (e.g. thermometers, blood pressure meters)	5	5
0802	Professional Medical Equipment (e.g., hospital, dentist, diagnostics)	4	4a
0901	Household Monitoring & Control Equipment (alarm, heat, smoke, excl. screens)	5	5
0902	Professional Monitoring & Control Equipment (e.g., laboratory, control panels)	4	4a
1001	Non-cooled Dispensers (e.g., for vending, hot drinks, tickets, money)	4	4a
1002	Cooled Dispensers (e.g., for vending, cold drinks)	1	1

Table A.1.2 6 e-waste categories

	FULL NAME
1	Temperature Exchange Equipment
2	Screens, Monitors, and Equipment Containing Screens
3	Lamps
4a	Large Equipment (excluding photovoltaic panels)
4b	Photovoltaic Panels (including converters)
5	Small Equipment
6	Small IT and Telecommunication Equipment

Table A.1.3 Indicator framework used in the Global E-waste Monitor 2024

THEME	INDICATOR	INTERPRETATION
EEE Placed on Market	1. Total EEE Placed on the Market (POM) (measured in unit kg per capita or tonnage).	*This represents the size of the national EEE goods market, or consumption by households, economic units.*
E-waste generation	2. Total e-waste generated (measured in unit kg per capita or tonnage).	This indicator is defined as the amount of discarded electrical and electronic products (e-waste) resulting from consumption within a national territory during a given reporting year, prior to any collection, reuse, treatment, or export. *This represents the amount of e-waste generated nationally.*
E-waste management	3a. E-waste formally collected and managed (measured in unit kg per capita or tonnage).	*This represents the amount of e-waste documented to be separately collected and managed through formal waste management systems.*
	3b. E-waste disposed of in residual waste (measured in unit kg per capita or tonnage).	*This represents the amount of e-waste disposed of with the mixed residual waste.*
	3c. E-waste collected and managed by companies outside of formal systems (measured in unit kg per capita or tonnage).	*This represents the amount of e-waste that is collected and recycled outside the compliant system. It may be mixed metal scrap and shredded. It typically has lower environmental health and safety standards as it does not undergo depollution steps, and hence is not compliant with specific e-waste legislation.*
	3d. E-waste collected and managed by informal recyclers (measured in unit kg per capita or tonnage).	*This represents the amount of e-waste that is managed by the informal sector, focusing on valuable parts and does not undergo depollution steps.*
	4. E-waste collection rate (measured as unit per cent).*	*This indicator assesses the performance of the formal collection systems.* It is calculated as follow: total e-waste formally collected x 100 per cent / total e-waste generated.
Transboundary movements	5. Total imports and exports of e-waste, disaggregated into controlled (5a) and not controlled (5b) (measured in unit kg per capita or tonnage).	*This represents the amount of e-waste that is imported or exported into a country.*
Environmental impact	6. Greenhouse gas emissions (unit: billion kg of CO_2-eq).	The direct emissions are calculated from improper management of refrigerants due to activities of indicator 3b to 3d.
	7. Greenhouse gas emissions avoided.	This covers the direct and indirect emissions avoided thanks to e-waste management. The avoided direct emissions are calculated assuming that the gasses in the refrigerants are not released when cooling and freezing equipment are compliantly managed (indicator 3a). The indirect avoided emissions are calculated from saved emissions due to less mining or primary raw materials assuming that recovered secondary raw materials from e-waste can be used for the production of new EEE.
	8. Release of hazardous substances disaggregated into mercury (8a), lead (8b) and Plastics containing brominated flame retardants (8c).	These are the modelled direct releases of the substances into the environment if they are not treated under environmentally sound conditions in activities under indicator 3b to 3d.
	9. Ore excavation avoided (unit: billion kg).	The amount of ore not excavated is calculated from the amount of viable resources recovered from e-waste and therefore not mined as primary raw materials.

THEME	INDICATOR	INTERPRETATION
Resources in e-waste	10. Total metals in e-waste. This is disaggregated into viable recovery (10a) and non-viable recovery (10b).	This is calculated by tracing individual metals in the e-waste types. For each e-waste category, the recycling effectiveness for 3 components (printed circuit boards, cables and the rest) and per e-waste management route (3a to 3d) was determined from the literature, stakeholder interviews and expert judgement.
Innovations for e-waste treatment technology	11. Share of patent applications on e-waste recycling, disaggregated into several keywords.	Technological development and innovation are not only adding to the constantly growing mountain of e-waste, they are also essential for improving recycling rates and the overall efficiency of e-waste management, particularly in the context of recycling technologies. Patent data serves as a valuable indicator of inventiveness, where e-waste patents reflect the capacity of innovators to foresee new technological and economic opportunities in the e-waste management domain.
Economic impact	12. Total value of metals in e-waste. Disaggregated into viable recovered metals (12a) and non-viable (12b) (unit: USD).	The quantities from indicator 10 are calculated with using the commodity prices of the individual metals.
	13. Value of greenhouse gas emissions avoided (unit: USD).	This is the monetized value of long-term benefits of the greenhouse gas emissions avoided from indicator 7.
	14. Treatment costs of e-waste management. Disaggregated into environmentally sound (compliant) treatment costs (14a), treatment of e-waste in residual waste (14b), treatment costs of e-waste mixed with metal waste (14c), and treatment costs of informal sector (14d) (unit: USD).	These are the costs involved to manage e-waste.
	15. Externalized costs to society (unit: USD).	Emissions to the environment lead to costs elsewhere in society and are not included in the usual pricing mechanisms. These hidden costs are called 'externalized costs', and are estimated based on the environmental and health damage due to emissions of mercury, lead, plastics and greenhouse gases in indicators 6 and 8, mostly stemming from activities in indicators 3b to 3d.
	Net economic impact (unit: USD).	This is calculated by adding the value of viable recovery (12b) of greenhouse gas emissions avoided (13) and then subtracting treatment costs (14) and externalized costs (15).
Legislation	Number of countries having legislation	Legislation and regulations on e-waste are crucial in stimulating environmentally sound e-waste management and the construction of e-waste management infrastructure.

** The indicator for SDG target 12.5.1 (national recycling rate and tonnes of material recycled) is defined as total e-waste recycled/total e-waste generated. The "total e-waste recycled" is equivalent to the formal collection of e-waste documented using the method and datasets of the Global E-waste Monitor. To report on the indicator, the custodian agencies UNEP and the United Nations Statistics Division use the datasets and methodologies developed by SCYCLE, the Global E-waste Statistics Partnership and the UN Partnership on Measuring ICT for Development. The relevant data sources may be found in Annex 1.*

Calculation of EEE POM and E-waste Generated

The amount of e-waste generated is calculated using both empirical data from the apparent consumption method for calculating EEE POM and a sales-lifespan model. In this model, lifespan data for each product are subjected to the EEE POM (using a Weibull function) to calculate the amount of e-waste generated. The data in this report were obtained and processed as set out below.

Step 1
The relevant codes describing EEE in the Harmonized Commodity Description and Coding System (HS) were selected.

Step 2
For the European Union, the international trade statistical data were extracted from Eurostat as 8-digit combined nomenclature codes. Domestic production data were also extracted from Eurostat, in the PRODCOM classification. For the other countries, statistical data on imports and exports were extracted from the United Nations Commodity Trade Statistics database. This was done for 193 countries and approximately 220 8-digit HS codes for the years 1995-2022. For countries other than the 27 EU Member States, data on domestic production were retrieved from the Eurostat PRODCOM database in CPC1.1(39)[273], while for China and Viet Nam, data on domestic production were retrieved from national registries. For some countries, no data on production were available, and this was corrected for in the outlier detection routines. Data are given as the number of units. Countries were then classified into 5 groups according to the purchasing power parity (PPP) for the business-as-usual scenario.[274] This procedure was repeated for each year, as each country's PPP changes over the years, especially in low-xin countries. This process was useful to make statistics comparable between countries and to calculate trends between groups.

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

Step 3
The units were converted to weight using the average weight data per appliance type. The average weights are published in the E-waste Statistics Guidelines.[275]

Step 4
The POM weight was calculated for the 54 UNU-KEYS by using the apparent consumption approach: POM = Domestic Production + Import - Export (this equation applies to the 28 EU Member States). When data on domestic production were not available, the following approach was used: POM = Import - Export. Undercounting as a result of no domestic production data was subsequently corrected for in the outlier detection steps in step 6.

Step 5
The numbers presented in this report for UNU-KEY 0002 (photovoltaic panels) use the annual installed capacity of panels expressed in megawatts as a basis for the calculation of the amount of panels placed on the market. This is estimated as the annual change in installed capacity in the year. The source used to calculate the historical annual installed capacity of photovoltaic panels and its future projection was data from the International Renewable Energy Agency.[276] By applying annual conversion factors (kg photovoltaic panels/megawatts installed) obtained from the PV Cycle Association[277], it was possible to estimate the annual amount of panels placed on the market expressed in kilograms.

Step 6
The POM data were automatically corrected for outliers, in order to detect values that were too low (due to the lack of domestic production data in some countries where domestic production is relatively large) or too high (due to misreporting of codes or units). The entries detected were replaced with more realistic sales values either from the time series of the origin country or from comparable countries. These statistical routines resulted in a harmonized dataset with a similar scope and consistent sales for a country based on its own trade statistics.

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

Step 8
The POM time series was extended. Past POM were calculated back to 1980 based on trends in the available data and the appliance date of market entry. Future POM were predicted to 2030 using sophisticated extrapolation methods. The principle considers the ratio between the POM and PPP per county and uses that ratio to estimate POM with the forecast PPP from the Shared Socioeconomic Pathways database.[278]

Step 9
The amount of e-waste generated by country was determined using the POM and lifetime distributions. Lifetime data were obtained from the 28 EU Member States using the Weibull distribution. Ideally, the lifetime of each product is determined empirically per product and per type. At this stage, only harmonized European residence times of EEE were available from extensive studies performed for the European Union; they were found to be quite homogeneous across Europe, leading to a 10 per cent deviation in final outcomes.[279] Due to the absence of data, it was assumed that the higher residence times per product in the European Union were approximately applicable for non-EU countries as well. In some cases, this would lead to an overestimate, as a product could last longer in low-income countries than in high-income countries because residents of low-income countries are more likely to repair products. However, it can also lead to an underestimate, as the quality of products is often lower in low-income countries because reused equipment or more cheaply produced versions that do not last as long might enter the domestic market. In general, however, it is assumed that this process leads to relatively accurate estimates. It should be noted that

POM are much more sensitive for the amount of e-waste generated than lifespans.

Vapes (e-cigarettes)
Waste from e-cigarettes was calculated separately in this edition due to recent interest. The 2022 POM were calculated by analysing world trade statistics for the HS code 854340 (electronic cigarettes and similar personal electric vaporizing devices). Trade data from China were taken as a reference because evidence was found that 80 per cent of all disposable vapes are produced in China.[280] The data were validated by comparing the results with those of other estimation methods reviewed. This include a comparison with estimates of the global number of vapers (82 million in 2021)[281] in combination with the average number of single-use vapes consumed in a year.[282] The results were also validated by calculating the amount of lithium present in each vape (0.15g)[283] and comparing that to global statistics on lithium consumption for the production of vapes worldwide (90 kg).[284]

E-waste documented as formally collected and recycled
For the European Union, total e-waste formally collected and recycled was extracted from the Eurostat database. For other countries, it was collected from questionnaires produced by SCYCLE, the OECD and the United Nations Statistics Division, or downloaded from the websites of national institutes dealing with e-waste. If no data were available, searches were conducted in peer-reviewed academic literature and in grey literature. The longest possible time series was downloaded and split into the e-waste categories where possible. This was the basis for the construction of time series for 2010 to 2022. The unavailable data were extrapolated using the e-waste collection rates of the closest available years and multiplying them by the e-waste generated during the extrapolated year. The calculations were made for countries for which there was at least one data point available.

Used EEE and e-waste imported or exported
The quantities of uncontrolled e-waste imports and exports were taken from the estimates contained in the Global Transboundary Flows E-waste Monitor 2022[285],which can be consulted for more information.

E-waste in residual waste and e-waste collected outside formal systems in countries with developed recycling outside a compliant system
The data on e-waste disposed of in residual waste and on collection and recycling outside the compliant system in the European Union were collected from 2 studies conducted in Europe.[286] For the remaining countries, the data were estimated based on the gap between e-waste generated, on the one hand, and e-waste documented as formally collected and recycled in the country and e-waste exported, on the other. For high-income and upper-middle-income countries, the gap was allocated half to e-waste collected outside formal systems in countries with developed e-waste management infrastructure. This is comparable to the shares found in the European Union.

E-waste managed outside formal systems in countries with no developed waste management infrastructure
Most of the countries with no developed e-waste management infrastructure had zero or close to zero e-waste documented as formally collected and recycled. The e-waste managed by low- and lower-middle-income countries was allocated here.

Population covered by national policies and legislation
The development of national e-waste policies and legislation was evaluated in this report to assess whether a country had such policies and/or legislation in effect through 2023. Population data were obtained from the United Nations Department of Economic and Social Affairs Population Division.

Quantification of raw materials found in e-waste
The amount of raw materials found in e-waste was calculated by linking the composition data from ProSUM to the estimated amount of e-waste generated.[287] The following elements were considered: aluminium, copper, lead, tin, nickel, zinc, gold, platinum, silver, bismuth, cobalt, iron, germanium, indium, iridium, osmium, palladium, rhodium, ruthenium and antimony. The viable and non-viable recovery of secondary raw materials was calculated using a model where recovery as secondary raw materials was assessed by considering e-waste management, type of e-waste and the components in the e-waste. A detailed matrix was established for the following quantities:

1. documented as formally collected and recycled;
2. e-waste in residual waste;
3. e-waste collected outside formal collection systems in countries with developed waste management systems;
4. e-waste collected outside formal collection systems in countries with no developed waste management systems.

The e-waste types are:

1. temperature exchange equipment;
2. screens and monitors;
3. lamps;
4. large equipment, excluding photovoltaic panels;
5. photovoltaic panels;
6. small equipment;
7. small IT and telecommunication equipment.

The components were printed circuit boards, cables and others.

The assessment involved evaluating the literature for each combination to determine dismantling rates per component, recovery efficiency per element and recovery efficiency per e-waste category (temperature exchange equipment, screens and monitors, lamps, large equipment excluding photovoltaic panels, photovoltaic panels, small equipment and small IT equipment). A variety of data sources were used[288], alongside internal datasets from UNITAR, particularly from recyclability studies. Where there were no data, expert judgment from the authors was used.


Muntaka Chasant for Fondation Carmignac

Table A.1.4 Use of rare earth elements table

SOURCE COMPONENT	KEY EEE	RARE EARTH ELEMENTS	SOURCE
Fluorescent powders	Fluorescent lamps	Europium, terbium, yttrium, cerium, lanthanum	CEWASTE project[a]
	Cathode-ray tube monitors and TVs	Yttrium, terbium, europium, gadolinium, lanthanum, cerium	CEWASTE project[a]
Neodymium magnets	Speakers (e.g. in mobile phones); hard disc drives in laptops, desktop computers, professional IT (data centres); electrical motors in drones	Neodymium, praseodymium, dysprosium, gadolinium, terbium	CEWASTE project, Bobba et al., 2020.[b]
Displays, LEDs, lasers, printed circuit board	Other electrical and electronic equipment and components thereof	Neodymium, dysprosium	Bobba et al., 2020.[b]
Alloys and non-structural parts	3D-printers	Neodymium, scandium	Bobba et al., 2020.[b]

[a] *Council of Europe. 2007. Management of municipal solid waste in Europe. Document 1173, 5 February;*
[b] *Bobba et al. 2020, note 303. For information on the CEWASTE project, see https://cewaste.eu/about-the-project/.*

Additional data on the use of rare earth elements were obtained from the CEWASTE project and a 2020 study.[289] This is summarized in Table A1.4.

Plastics containing brominated flame retardants and mercury in e-waste

The literature was searched for composition data relating to brominated flame retardant plastics.[290] Similarly to the raw materials found in e-waste, composition data on brominated flame retardants were linked to the estimated amount of e-waste generated. The amount of mercury in e-waste was calculated using internal UNITAR datasets on the amount of mercury per UNU-KEY and from a variety of studies.[291] Emissions of plastics containing brominated flame retardants and mercury were assessed in the light of the quantities managed outside the documented formal compliant management system.

Rock excavations during mining

The amount of rock waste from excavations was calculated using the rock-to-metal ratio from the 2022 UG Geological Survey[292] for the potential recovery quantities of aluminium, copper, lead, tin, nickel, zinc, gold, platinum, silver, cobalt, iron, iridium, palladium, rhodium and ruthenium and. For bismuth, germanium, indium, osmium, and antimony an averaged “rock to metal ratio” was used.

Greenhouse gas emissions arising from e-waste management

The greenhouse gas emissions arising from e-waste management were assessed by measuring the direct emissions of refrigerants that contribute to global warming and potential avoided emissions from secondary raw material recovery. The scope of this research is to estimate the amount of CO_2 equivalents that could potentially be released into the atmosphere if cooling and freezing equipment (and thus the refrigerants it contains) was not recycled and treated in an environmentally sound way and if all used materials were primary materials instead of partly secondary ones.

The literature was reviewed to assess the amount and type of refrigerants used in cooling and freezing equipment. Relevant information was found for refrigerators and air conditioners.[293] Subsequently, the amount of refrigerants was linked to the estimated amount of waste refrigerators and air conditioners generated by each of the 193 countries analysed, by year. Lastly, the global warming potential was researched for each type of refrigerant and linked to the amount of refrigerants found in refrigerators and air conditioners. In refrigerators, the refrigerants R-11 and R-12 were used until 1994; they were then substituted with R-134a and R-22 until 2017. Since 2017, only R-152a and R1234yf have been used. In air conditioners, R-410a, R-134a and R-22 were used until 2017, and R-32 and R-1234yf have been used since. The potential avoided emissions from secondary raw materials were calculated using the net greenhouse gas emissions between primary and secondary raw material production. Various sources were utilized to derive the net greenhouse gas emissions.[294]

Muntaka Chasant for Fondation Carmignac

The calculations were performed for iron, aluminium, copper, zinc, lead, nickel, silver, platinum, rhodium, palladium and gold.

E-waste patents

Patents on e-waste recycling are patents for technology concerning management of e-waste found in Cooperative Patent Classification YO2W30/82. Patents in these technology areas were selected based on the international patent classification code. Data were downloaded from the PATSTAT database of the World Intellectual Property Organization and from Espacenet, which have global coverage.[295]

Economic assessment

The overall economic assessment of global e-waste management was estimated by assessing the viable recovery of metals, the monetized value of greenhouse gas emissions and avoided greenhouse gas emissions, and externalized costs, plus the costs of e-waste management systems with a recent developed methodology.[296] Projections were made using a 2 per cent yearly inflation rate, and all data found in euros were converted into US dollars using the exchange rates of that year.

The value of viable recovery was assessed per type of metal for aluminium, copper, lead, tin, nickel, zinc, gold, platinum, silver, bismuth, cobalt, iron, germanium, indium, iridium, osmium, palladium, rhodium, ruthenium and antimony by multiplying the quantities under viable recovery by the metal prices. These metal prices were sourced from either the World Bank commodity price database[297] or multiple online sources.[298,299,300,301,302]

The compliant system was assessed using the revenues derived from extracted secondary resources, the costs for depollution of e-waste and the externalized (hidden) economic damages to human health and the environment of unmanaged mercury, lead, plastic waste/greenhouse gases.

The treatment costs were taken from the UNU-European Energy Research Alliance study on treatment costs, supplemented with internal UNITAR datasets per type of waste.[303] The average amount for compliant treatment of 1 thousand kg of e-waste was USD 372. The treatment costs for disposal in mixed residual waste were not readily available and could be found in only one study, where it was EUR 67 per thousand kg in 2 000 in European countries for landfilling. After correcting for inflation, this amounted to around EUR 100 per thousand kg in 2022. A European Commission document on municipal solid waste management also indicated around EUR 100 per thousand kg. This was converted to USD using the average EUR/USD exchange rate in 2022. The costs for mixing waste with scrap metal were taken from the UNU- European Energy Research Alliance study on metal rich bulky e-waste without deducting depollution and compliance costs and amounted to EUR 38 per thousand kg in 2017.

The informal sector was assessed using a study conducted in 2021 in Pakistan[304], which found that the costs were between twice and almost 5 times as high as the economic benefits. The economic benefits were assessed in the light of the viable recovery of e-waste managed outside formal systems in countries with no developed waste management infrastructure (USD 12 billion), and the costs obtained were divided by an average of 3.65, leading to roughly USD 270 per thousand kg. Collection was included in the costs, but not included in compliantly managed e-waste, as this varied widely by country and was usually paid through municipal collection costs, costs for retailers, etc.

The externalized average long term socio-economic cost of unmanaged mercury, lead, plastics and CO_2 emissions was taken from several publications.[305,306,307,308,309,310,311] The values used in this publication are USD 712 thousand per kg of mercury, USD 20 per kg of lead, USD 8.5 per kg plastics in small equipment, and USD 250 USD per tonne of CO_2 equivalent emissions.

E-waste outlook to 2030

In the business-as-usual scenario, documented formal e-waste collection and recycling follows the same trend as the 2010 to 2022 time series. For the 3 other scenarios, documented formal e-waste recycling and collection is set according to a matrix depending on whether the country has legislation and e-waste management infrastructure, and whether it manages imports for reuse. These parameters increase with the level of ambition. The data are summarized in Table A1.5. The e-waste managed outside the formal collection and recycling systems was allocated using the same methodology as for the 2022 data.

Table A.1.5 Overview on Grouping and Calculation Parameters of 2030 Outlook on E-waste Management

GROUP	STATUS OF LEGISLATION	DOCUMENTED COLLECTION AND RECYCLING RATE IN LATEST YEAR	INCOME LEVEL	DOCUMENTED COLLECTION AND RECYCLING RATE IN LATEST YEAR (IN %)			SHARE OF USED EEE IMPORTS THAT ARE MANAGED (IN %)		
				PROGRESSIVE	AMBITIOUS	ASPIRATIONAL	PROGRESSIVE	AMBITIOUS	ASPIRATIONAL
1a	No legislation	< 10%	Low- and lower-middle	10	20	40	0	25	50
1b	No legislation	< 10%	Upper-middle and high	10	20	40	0	25	50
2a	Draft and in force	< 10%	Low- and lower-middle	15	25	50	0	25	50
2b	Draft and in force	< 10%	Upper-middle and high	15	25	50	0	25	50
3	Draft and in force	10% < x < 20%	All	30	50	60	0	25	50
4	Draft and in force	20% < x < 30%	All	50	65	75	0	25	50
5	Draft and in force	30% < x < 40%	All	65	75	85	0	25	50
6	Draft and in force	> 40%	All	85	85	85	0	25	50

Legislation Methodology

This part provides a comprehensive overview of the methodology used to calculate the headline indicator for tracking global progress on e-waste policy, legislation and regulation. It aims to provide a stepwise approach for making the process as transparent as possible while establishing an indicator that respects the criteria previously explained. It is important to note that the methodology has been improved for this version following some discrepancies found in the Global E-waste Monitor 2020 regarding the coverage of countries with an e-waste policy, legislation or regulation. There is therefore a break in data comparability. Thus, despite a continued upward trend, represented by an increase in the headline indicator from 81 to 80 between the 2020 edition and this one, there are differences in the results per country displayed in their entirety in Annex 2.

The information was collected, analysed and reviewed as described below.[i]

First, the data were collected from the Compliance to Product (C2P)[312] dataset, which is a global compliance knowledge management system for regulations, standards and management relating to various areas, including e-waste. The C2P dataset includes detailed information on legislative measures (policies, regulations, legislation, guidelines, standards) at national and state/provincial level and on items such as status, dates and web reference. It currently has 645 records for e-waste policy, legislation and regulation, with each record describing the territory in which the instruments are in force. The C2P registry does not include guidelines and standards for e-waste recyclers, however, only national legally and non-legally binding instruments. The subsequent analysis stage involves a systematic review of each record in the dataset, following the stepwise approach described below.

Step 1
The geographical scope of the measure recorded was checked in the "Territory Covered" column. Only those implemented at the national level were included in the next step; those at state or provincial level were excluded. For the United States of America and Canada, a state/provincial analysis was done.

Step 2
The "Status" of the measure in the record was analysed. Only records with the indication "In force" were included in the next steps; those marked "Archived" were excluded. Records marked "Proposed" were not immediately excluded but instead considered for the Review and Validation stage (see next paragraph).

Step 3
The record was analysed to determine the type of measure. If the measure qualified as a policy, regulation or law related to e-waste, WEEE or specific categories or products within the definition of e-waste, then it was considered for the Review and Validation stage. Other measures, including recycling standards, certification programmes and technical guidelines, were excluded, as were those that did not cover e-waste.

Step 4
After the C2P dataset had been analysed, the intermediate outcomes were further validated based on the information collected from other

[i] For more information, see ITU and UNITAR, Consultation on the Methodology for Measuring the Global Progress of E-waste Legislation.

data sources, such as the outcomes of questionnaires received from the United Nations Statistics Division[313], the OECD[314] and ITU (through its annual World Telecommunication/ICT Regulatory Survey).[315] The goal was twofold: to validate or correct the outcomes of the analysis of the C2P dataset, given the potential lack of clarity arising from the translation of the title of the recorded measures. The record was validated against the national responses received to the OECD questionnaire and the ITU Regulatory Survey.

The OECD questionnaire was co-developed by the SCYCLE team as part of the international initiative to document e-waste-related information and sent by the OECD to its member countries. It contains a specific question on existing national e-waste legislation, its content and scope, and the custodian entity. These details were compared with the outcome of the analysis for each OECD country. At the same time, the ITU Regulatory Survey was used to compare with the outcome of the analysis. The survey covers a wide range of ICT policy and regulatory issues and serves to track the latest ICT trends and evolutions, including some key aspects of the regulatory environment of e-waste management. It includes a specific question on existing national e-waste legislation.

Step 5

The previous step validates the records only for OECD countries. For the rest, the records were reviewed and validated based on the responses received to a questionnaire sent out by the United Nations Statistics Division that is similar to the OECD questionnaire and the environmental part of the ITU survey, and was developed for documenting e-waste-related information for non-OECD countries.

Step 6

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

Step 7

Once each record had been carefully reviewed against these three sets of supplementary information, the final decision was made on whether to include it to calculate the indicator. If validated, the record was included in the calculation of the indicator; otherwise it was excluded.

The outcome of the data-collection, analysis, review and validation process is the consolidated database, in which the data for each country are stored.

The definitions set out[316] were used when analysing the datasets. Typically, a financial mechanism would cover anything from waste collection, separation and transfer, treatment, recycling and final disposal to monitoring and control, public information and awareness, and the delivery of training programmes.[317] And, typically, the producers (manufacturers, distributors, importers, resellers) of EEE, either individually or collectively, through some form of organizational structure, would cover the costs of these activities.

- Strategy: Often a high-level and not legally binding document, the strategy is designed to inform stakeholders how the country will reach its objectives for the e-waste management system and achieve its vision. A national e-waste management strategy often spells out the priority areas for e-waste management as a whole but can equally be developed to explore a particular approach for specific sectors within the electronics value chain. As it is a high-level document, a strategy is also well suited for use in the context of a regional approach, where there may be more uncertainty about the future of e-waste management.

- Policy: Often a statement of intent by the government to tackle a particular issue, in this case e-waste management, a policy is not legally binding. Policy documents normally contain specific policy objectives, strategies and an action plan for attaining them, and in some cases preliminary definitions and targets. A national e-waste management policy is often a plan or course of action set out by a government at, for instance, the municipal, provincial or national level.

- Legislation: Legislation often sets out the overarching principles for a particular topic; in the case at hand, the overarching legislation usually covers the environment at large and often contains provisions on waste in general. From these, regulations can be developed to help with the enforcement of specific aspects. National legislation may authorize a particular ministry to develop regulations for legislation enforcement by regulators.

- Regulation: Often national legislation empowers a particular ministry to develop regulation, which may govern the enforcement of e-waste management in a particular way, unlike a strategy or policy developed to explore a change in direction, vision or strategy of the existing legal framework.

Muntaka Chasant for Fondation Carmignac

Annex 2.
Datasets

Table A2.1. Average number of items in stock (households, businesses and public sector) disaggregated by income group and e-waste category and normalized per capita (2022)

Income level >	HIGH-INCOME	UPPER-MIDDLE-INCOME	LOWER-MIDDLE-INCOME	LOW-INCOME
Total	**145**	**56**	**41**	**19**
Total excl. lamps	**109**	**30**	**17**	**4**
Total excl. lamps and small equipment	**12.1**	**3.3**	**1.4**	**0.4**
Temperature exchange equipment	1.4	0.7	0.3	0.1
Screens and monitors	3.5	0.9	0.4	0.1
Lamps	36.2	26.4	23.3	14.3
Large equipment	3.7	1.3	0.3	3.9
Small equipment	97.1	26.6	15.8	3.9
Small IT and telecommunication equipment	3.5	0.5	0.3	0.1

Muntaka Chasant for Fondation Carmignac

Table A2.2. Regional e-waste key statistics

REGION	SUB REGION	NUMBER OF COUNTRIES IN REGION	INHABITANTS		E-WASTE GENERATED				E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED			
			MILLIONS IN 2010	MILLIONS IN 2022	KG PER CAPITA IN 2010	KG PER CAPITA IN 2022	MILLION KG IN 2010	MILLION KG IN 2022	MILLION KG IN 2020	MILLION KG IN 2022	COLLECTION RATE 2010 (%)	COLLECTION RATE 2022 (%)
Africa	ALL	54	1,040	1,408	1.6	2.5	1,640	3,551	1.9	25	0.1	0.7
	Eastern Africa	18	337	466	0.5	0.9	154	431	1.9	2.4	1.2	0.5
	Central Africa	9	131	193	1	1.6	131	307	0	0.1	0.0	0.0
	Northern Africa	6	205	257	3.7	5.8	763	1,484	0	0	0.0	0.0
	Southern Africa	5	59	68	5.4	8.5	317	578	0	23	0.0	4.0
	Western Africa	16	308	424	0.9	1.8	275	752	0	0	0.0	0.0
Americas	ALL	36	918	1,021	9.9	14.1	9,068	14,427	3,149	4,328	34.7	30.0
	Caribbean	14	29	32	5.1	7.6	148	241	0	0.1	0.0	0.0
	Central America	8	155	178	6.1	10.2	940	1,811	31	60.3	3.3	3.3
	Northern America	2	344	376	16.6	21.2	5,695	7,963	3,118	4,151	54.8	52.1
	South America	12	391	435	5.8	10.1	2,285	4,413	0	117.1	0.0	2.7
Asia	ALL	49	4,168	4,677	3.2	6.4	13,259	30,147	1,030	3,568	7.8	11.8
	Central Asia	5	63	77	2.5	5.2	161	396	0	12.8	0.0	3.2
	Eastern Asia	7	1,554	1,638	4.9	9.9	7,672	16,292	1,027	3,225	13.4	19.8
	South-Eastern Asia	11	596	678	3.4	6.4	2,045	4,362	0	0	0.0	0.0
	Southern Asia	9	1,723	1,999	1.1	3.1	1,883	6,140	unknown	60.1	unknown	1.0
	Western Asia	17	232	286	6.5	10.3	1,498	2,957	2.6	270.1	0.2t	9.1

REGION	SUB REGION	NUMBER OF COUNTRIES IN REGION	INHABITANTS		E-WASTE GENERATED				E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED			
			MILLIONS IN 2010	MILLIONS IN 2022	KG PER CAPITA IN 2010	KG PER CAPITA IN 2022	MILLION KG IN 2010	MILLION KG IN 2022	MILLION KG IN 2020	MILLION KG IN 2022	COLLECTION RATE 2010 (%)	COLLECTION RATE 2022 (%)
Europe	ALL	40	733	742	13.3	17.6	9,739	13,076	3,780	5,593	38.8	42.8
	Eastern Europe	10	295	291	7.4	12.7	2,177	3,678	355	1,005	16.3	27.3
	Northern Europe	10	99	106	18.4	23.2	1,824	2,456	940	1,042	51.5	42.4
	Southern Europe	13	152	150	15.5	18	2,349	2,700	844	1,069	35.9	39.6
	Western Europe	7	188	196	18.1	21.7	3,389	4,243	1,641	2,478	48.4	58.4
Oceania	ALL	14	36	44	12.6	16.1	452	707	unknown	292	unknown	41.4
	Australia and New Zealand	2	26	31	16.8	21.9	441	684	unknown	292	unknown	42.8
	Melanesia	4	9	12	1.1	1.8	10	21	0	0	0.0	0.0
	Micronesia	5	0.3	0.3	1.4	2.6	0.4	0.8	0	0	0.0	0.0
	Polynesia	3	0.3	0.3	2.7	3.3	0.8	1.1	0	0	0.0	0.0
World	ALL	193	6,896	7,893	5	7.8	34,157	61,908	7,961	13,807	23.3	22.3

Table A2.3. Country groupings used in the report

REGION	SUB REGION	NUMBER OF COUNTRIES IN REGION
Africa	Eastern Africa	Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, United Republic of Tanzania, Uganda, Zimbabwe
	Central Africa	Central African Republic, Angola, Cameroon, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sao Tomé and Príncipe
	Northern Africa	Algeria, Egypt, Libya, Morocco, Sudan, Tunisia
	Southern Africa	Botswana, Lesotho, Namibia, South Africa, Swaziland
	Western Africa	Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo
Americas	Caribbean	Aruba, Antigua and Barbuda, Bahamas, Barbados, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago
	Central America	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama
	Northern America	United States of America, Canada
	South America	Argentina, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Uruguay, Peru, Suriname, Venezuela
Asia	Central Asia	Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
	Eastern Asia	China, Hong Kong (China), Japan, Macao (China), Mongolia, Republic of Korea, Taiwan (Province of China)
	South-Eastern Asia	Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam
	Southern Asia	Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Sri Lanka, Nepal, Pakistan, Thailand
	Western Asia	Arabia, Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi, Syrian Arab Republic, Türkiye, United Arab Emirates, Yemen
Europe	Eastern Europe	Belarus, Bulgaria, Czech Republic, Hungary, Moldova, Poland, Romania, Russian Federation, Slovakia, Ukraine
	Northern Europe	Denmark, Estonia, Finland, United Kingdom, Ireland, Iceland, Latvia, Lithuania, Norway, Sweden
	Southern Europe	Albania, Bosnia and Herzegovina, Croatia, Spain, Greece, Italy, Malta, Montenegro, North Macedonia, Portugal, San Marino, Serbia, Slovenia
	Western Europe	Austria, Belgium, France, Germany, Luxembourg, Netherlands, Switzerland
Oceania	Australia and New Zealand	Australia, New Zealand
	Melanesia	Fiji, Papua New Guinea, Solomon Islands, Vanuatu
	Micronesia	Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, Palau
	Polynesia	Samoa, Tonga, Tuvalu

Table A2.4. Key e-waste statistics, by country or territory (2022)

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Afghanistan	Asia	32	0,8	N/A		No	No	No	No
Albania	Europe	24	8,3	N/A		Yes	Yes	No	No
Algeria	Africa	333	7,5	N/A		No	No	No	No
Angola	Africa	148	4,2	N/A		No	No	No	No
Antigua and Barbuda	Americas	1	13,3	N/A		No	No	No	No
Argentina	Americas	517	11,4	14,4	Communication with Ministry of Environment and Sustainable Development in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	Yes	Yes	No	No
Armenia	Asia	22	7,8	N/A*	Questionnaires conducted by UNSD, OECD and UNECE in 2014/2015. Data point is added to the global totals, but data is not published.	No	No	No	No
Aruba	Americas	2	20,7	N/A		No	No	No	No
Australia	Oceania	583	22,4	292,4	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE – e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	Yes	Yes	Yes
Austria	Europe	175	19,6	133,2	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Azerbaijan	Asia	90	8,7	0,01	Communication with JSC "Tamiz Schahar" in the context of this report: C.P. Baldé, G. Iattoni, V. Luda, I.C Nnorom, O. Pecheniuk, R. Kuehr, Regional E-waste Monitor for the CIS + Georgia – 2021, 2021, United Nations University (UNU) / United Nations Institute for Training and Research (UNITAR) – co-hosting the SCYCLE Programme, Bonn, Germany. https://ewastemonitor.info/wp-content/uploads/2021/11/REM_2021_CISGEORGIA_WEB_final_nov_11_spreads.pdf	No	No	No	No
Bahamas	Americas	7	17,7	N/A		No	No	No	No
Bahrain	Asia	26	17,8	N/A		Yes	No	No	No
Bangladesh	Asia	367	2,2	N/A		Yes	Yes	Yes	No
Barbados	Americas	4	14,7	N/A		No	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Belarus	Europe	111	11,6	31	Communication with Ministry of Housing and Utilities in the context of this report: C.P. Baldé, G. Iattoni, V. Luda, I.C Nnorom, O. Pecheniuk, R. Kuehr, Regional E-waste Monitor for the CIS + Georgia - 2021, 2021, United Nations University (UNU) / United Nations Institute for Training and Research (UNITAR) - co-hosting the SCYCLE Programme, Bonn, Germany. https://ewastemonitor.info/wp-content/uploads/2021/11/REM_2021_CISGEORGIA_WEB_final_nov_11_spreads.pdf	Yes	Yes	No	No
Belgium	Europe	252	21,7	162,8	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/data-browser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Belize	Americas	3	7,1	N/A		No	No	No	No
Benin	Africa	14	1,1	N/A		No	No	No	No
Bhutan	Asia	5	6,7	0,5	UNSD — Environment Statistics. Retrieved August 1, 2023, from https://unstats.un.org/unsd/envstats/qindicators	No	No	No	No
Bolivia (Plurinational State of)	Americas	89	7,3	2,4	Communication with Ministry of Environment and Water of the Plurinational State of Bolivia in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-moni-tor-latin-america-2021/	Yes	Yes	No	No
Bosnia and Herzegovina	Europe	33	10,1	4,9	Communication with BHAS 2022/Zeos/Kim/Tec 2022 in the context of this report: G. Iattoni, I.C Nnorom, D. Toppenberg, R. Kuehr, C.P. Baldé. Regional E-waste Monitor for the Western Balkans - 2023. International Telecommunication Union (ITU), United Nations Environment Programme (UNEP) and United Nations Institute for Training and Research (UNITAR) - SCYCLE Programme. https://www.scycle.info/wp-content/uploads/2023/12/Regional-E-waste-Monitor-Balkan-2023.pdf	Yes	Yes	Yes	Yes
Botswana	Africa	23	8,7	N/A		No	No	No	No
Brazil	Americas	2443	11,4	79	P. Dias, J. Palomero, M.Pilotto Cenci, T. Scarazzato, A. Moura Bernardes. Electronic waste in Brazil: Generation, collection, recy-cling and the covid pandemic, Cleaner Waste Systems. Volume 3, 2022, ISSN 2772-9125, https://doi.org/10.1016/j.clwas.2022.100022. (https://www.sciencedirect.com/science/article/pii/S2772912522000227)	Yes	Yes	Yes	No
Brunei Darussalam	Asia	9	19,9	N/A		No	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Bulgaria	Europe	90	13,2	75,5	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Burkina Faso	Africa	17	0,8	N/A		No	No	No	No
Burundi	Africa	8	0,6	N/A		No	No	No	No
Cambodia	Asia	25	1,5	N/A		Yes	No	No	No
Cameroon	Africa	33	1,2	0,1	Communication with Solidarite Technologique in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	Yes	Yes	No	No
Canada	Americas	774	20,2	98	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE – e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	No	No	No
Cape Verde	Africa	3	5,3	N/A		No	No	No	No
Central African Republic	Africa	3	0,6	N/A		No	No	No	No
Chad	Africa	12	0,7	N/A		No	No	No	No
Chile	Americas	230	11,7	7,3	Communication with Ministry of Environment of Chile in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	Yes	Yes	No	No
China	Asia	12066	8,5	1951,7	Communication with Ministry of Environment in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	Yes	Yes	No	Yes

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
China, Hong Kong Special Adminis-trative Region	Asia	161	21,6	71,6	Communication with Hong Kong Environmental Protection Department in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/ United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/ Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	No	No	No	No
China, Macao Special Adminis-trative Region	Asia	13	18,5	N/A		No	No	No	No
Colombia	Americas	388	7,5	4,9	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE - e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	Yes	No	No
Comoros	Africa	1	1,5	N/A		No	No	No	No
Congo	Africa	16	2,7	N/A		No	No	No	No
Costa Rica	Americas	66	12,7	5,8	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE - e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	Yes	No	No
Croatia	Europe	54	13,3	35,3	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en"	Yes	Yes	Yes	Yes
Cyprus	Asia	16	13	3,5	C.P. Baldé, G. Iattoni, C. Xu, T. Yamamoto, Update of WEEE Collection Rates, Targets, Flows, and Hoarding - 2021 in the EU-27, United Kingdom, Norway, Switzerland, and Iceland, 2022, SCYCLE Programme, United Nations Institute for Training and Research (UNITAR), Bonn, Germany. https://www.scycle.info/new-study-update-of-weee-collection-rates-targets-flows-and-hoarding/ Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Czech Republic	Europe	173	16,5	118,9	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Côte d'Ivoire	Africa	42	1,5	N/A		Yes	Yes	No	No
Democratic Republic of the Congo	Africa	56	0,6	N/A		No	No	No	No
Denmark	Europe	131	22,3	79	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Djibouti	Africa	2	1,7	N/A		No	No	No	No
Dominica	Americas	1	8,9	N/A		No	No	No	No
Dominican Republic	Americas	99	8,8	N/A		Yes	Yes	No	No
Ecuador	Americas	108	6	3,3	Communication with Ecuadorian Ministry of Environment, Water and Ecological Transition (MAATE) in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	Yes	Yes	Yes	No
Egypt	Africa	692	6,3	N/A		Yes	Yes	No	No
El Salvador	Americas	41	6,4	0,5	Communication with Ministry of Environment and Natural Resources from El Salvador in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	No	No	No	No
Equatorial Guinea	Africa	18	10,6	N/A		No	No	No	No
Eritrea	Africa	3	0,7	N/A		No	No	No	No
Estonia	Europe	19	14,2	12,4	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Ethiopia	Africa	88	0,7	N/A		No	No	No	No
Fiji	Oceania	7	7,2	N/A		No	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Finland	Europe	118	21,3	89,6	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
France	Europe	1445	22,4	860,7	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Gabon	Africa	21	8,7	N/A		No	No	No	No
Gambia	Africa	4	1,4	N/A		No	No	No	No
Georgia	Asia	34	8,9	N/A		Yes	Yes	Yes	No
Germany	Europe	1767	21,2	956,6	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Ghana	Africa	72	2,2	N/A		Yes	Yes	No	No
Greece	Europe	194	18,6	58,6	C.P. Baldé, G. Iattoni, C. Xu, T. Yamamoto, Update of WEEE Collection Rates, Targets, Flows, and Hoarding - 2021 in the EU-27, United Kingdom, Norway, Switzerland, and Iceland, 2022, SCYCLE Programme, United Nations Institute for Training and Research (UNITAR), Bonn, Germany. https://www.scycle.info/new-study-update-of-weee-collection-rates-targets-flows-and-hoarding/ Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Grenada	Americas	1	10,4	N/A		No	No	No	No
Guatemala	Americas	92	5,2	1,1	Communication with Ministry of Environment and Natural Resources in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	No	No	No	No
Guinea	Africa	14	1	N/A		No	No	No	No
Guinea-Bissau	Africa	1	0,6	N/A		No	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Guyana	Americas	7	8,1	N/A		No	No	No	No
Haiti	Americas	12	1,1	N/A		No	No	No	No
Honduras	Americas	36	3,5	0,1	Communication with Secretariat of Natural Resources and Environment in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	No	No	No	No
Hungary	Europe	138	14,3	90,4	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Iceland	Europe	8	22,4	4,8	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
India	Asia	4137	2,9	59,6	Communication with Assocham India in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	Yes	Yes	Yes	No
Indonesia	Asia	1886	6,9	N/A		No	No	No	No
Iran (Islamic Republic of)	Asia	817	9,3	N/A		Yes	No	No	No
Iraq	Asia	267	6,1	N/A		No	No	No	No
Ireland	Europe	103	20,6	67,4	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Israel	Asia	148	16,5	72,4	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE – e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	Yes	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Italy	Europe	1124	19	461,6	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Jamaica	Americas	21	7,4	0,1	Communication with National Solid Waste Management Authority in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/ United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/ Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	No	No	No	No
Japan	Asia	2638	21,2	613,4	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE – e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	No	No	Yes
Jordan	Asia	69	6,1	1,6	Communication with National Statistics Office in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	Yes	No	No	No
Kazakhstan	Asia	196	10,2	12,4	UNSD Questionnaire (UNSD 2019).	Yes	Yes	Yes	No
Kenya	Africa	88	1,6	N/A		No	No	No	No
Kiribati	Oceania	0	1,3	N/A		No	No	No	No
Kuwait	Asia	71	16,7	N/A		No	No	No	No
Kyrgyzstan	Asia	14	2,2	N/A		No	No	No	No
Lao People's Democratic Republic	Asia	27	3,6	N/A		No	No	No	No
Latvia	Europe	22	11,9	11,6	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Lebanon	Asia	60	10,7	0,1	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	No	No	No	No
Lesotho	Africa	3	1,3	N/A		No	No	No	No
Liberia	Africa	3	0,6	N/A		No	No	No	No
Libya	Africa	94	13,8	N/A		No	No	No	No
Lithuania	Europe	37	13,4	16,7	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Luxembourg	Europe	13	20,9	6,8	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Madagascar	Africa	19	0,6	N/A		Yes	No	No	No
Malawi	Africa	11	0,5	N/A		No	No	No	No
Malaysia	Asia	411	12,2	N/A		Yes	No	No	No
Maldives	Asia	5	10	N/A		No	No	No	No
Mali	Africa	20	0,9	N/A		No	No	No	No
Malta	Europe	8	14,1	3,2	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Marshall Islands	Oceania	0	3	N/A		No	No	No	No
Mauritania	Africa	12	2,7	N/A		No	No	No	No
Mauritius	Africa	16	12,1	0,1	Business Mauritius, UNDP Mauritius (2021). Circular Economy: Optimising private sector investment in Mauritius. https://www.undp.org/sites/g/files/zskgke326/files/migration/mu/Circular-Economy--Optimising-private-sector-investment-in-Mauritius.pdf	No	No	No	No
Mexico	Americas	1499	11,8	52,6	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE - e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Micronesia (Federated States of)	Oceania	0	1,9	N/A		No	No	No	No
Mongolia	Asia	20	5,9	N/A		No	No	No	No
Montenegro	Europe	8	13	0,2	Communication with Western Balkans NGO in the context of this report: G. Iattoni, I.C Nnorom, D. Toppenberg, R. Kuehr, C.P. Baldé. Regional E-waste Monitor for the Western Balkans - 2023. International Telecommunication Union (ITU), United Nations Environment Programme (UNEP) and United Nations Institute for Training and Research (UNITAR) - SCYCLE Programme. https://www.scycle.info/wp-content/uploads/2023/12/Regional-E-waste-Monitor-Balkan-2023.pdf	Yes	No	No	No
Morocco	Africa	177	4,8	N/A		No	No	No	No
Mozambique	Africa	20	0,6	N/A		No	No	No	No
Myanmar	Asia	76	1,4	N/A		No	No	No	No
Namibia	Africa	17	6,8	0,03	Communication with Namigreen in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) - co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	No	No	No	No
Nauru	Oceania	0	6,3	N/A		No	No	No	No
Nepal	Asia	42	1,4	N/A		No	No	No	No
Netherlands	Europe	387	22,1	228,5	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
New Zealand	Oceania	101	19,6	N/A		No	No	No	No
Nicaragua	Americas	21	3	0,1	Communication with Ministry of Environment in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	No	No	No	No
Niger	Africa	14	0,5	N/A		No	No	No	No
Nigeria	Africa	497	2,3	N/A		Yes	Yes	Yes	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Norway	Europe	145	26,8	107,2	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Oman	Asia	71	15,7	N/A		No	No	No	No
Pakistan	Asia	559	2,4	N/A		No	No	No	No
Palau	Oceania	0	12,2	N/A		No	No	No	No
Panama	Americas	54	12,4	0,1	Communication with Ministry of Health in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	No	No	No	No
Papua New Guinea	Oceania	13	1,3	N/A		No	No	No	No
Paraguay	Americas	57	8,4	N/A		No	No	No	No
Peru	Americas	221	6,5	3,4	Communication with Ministry of Environment in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	Yes	Yes	Yes	No
Philippines	Asia	537	4,7	N/A		No	No	No	No
Poland	Europe	517	13,5	417,8	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Portugal	Europe	183	17,8	60,3	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Puerto Rico	Americas	65	20	N/A		No	No	No	No
Qatar	Asia	44	16,2	0,2	Communication with Ministry of Municipality and Environment in the context of this report: Ministry of Municipality and Environment, 2019.	No	No	No	No
Republic of Korea	Asia	930	17,9	443,1	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE - e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	Yes	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Republic of Moldova	Europe	21	6,8	0,2	Communication with Ministry of Agriculture, Regional Development and Environment in the context of this report: C.P. Baldé, G. Iattoni, V. Luda, I.C Nnorom, O. Pecheniuk, R. Kuehr, Regional E-waste Monitor for the CIS + Georgia - 2021, 2021, United Nations University (UNU) / United Nations Institute for Training and Research (UNITAR) - co-hosting the SCYCLE Programme, Bonn, Germany. https://ewastemonitor.info/wp-content/uploads/2021/11/REM_2021_CISGEORGIA_WEB_final_nov_11_spreads.pdf	Yes	Yes	Yes	No
Romania	Europe	250	13	71,5	C.P. Baldé, G. Iattoni, C. Xu, T. Yamamoto, Update of WEEE Collection Rates, Targets, Flows, and Hoarding - 2021 in the EU-27, United Kingdom, Norway, Switzerland, and Iceland, 2022, SCYCLE Programme, United Nations Institute for Training and Research (UNITAR), Bonn, Germany. https://www.scycle.info/new-study-update-of-weee-collection-rates-targets-flows-and-hoarding/ Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Russian Federation	Europe	1910	13,2	120,8	Communication with Analytical Center for the Government of Russian Federation in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) - co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	Yes	Yes	No	No
Rwanda	Africa	10	0,7	2	Nations Institute for Training and Research (UNITAR) - co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	Yes	Yes	No	No
Saint Kitts and Nevis	Americas	1	15	N/A		No	No	No	No
Saint Lucia	Americas	2	11,4	0,03	Roldan M. 2017. "E-waste management policy and regulatory framework for Saint Lu-cia". Telecommunication Management Group, Inc	No	No	No	No
Saint Vincent and the Grenadines	Americas	1	10,6	N/A		No	No	No	No
Samoa	Oceania	1	3,1	N/A		No	No	No	No
San Marino	Europe	1	22,1	N/A		No	No	No	No
Sao Tomé and Príncipe	Africa	0	1,9	N/A		No	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Saudi Arabia	Asia	617	17,1	N/A		No	No	No	No
Senegal	Africa	25	1,5	N/A		No	No	No	No
Serbia	Europe	81	11,1	31,2	Communication with IENE in the context of this report: G. Iattoni, I.C Nnorom, D. Toppenberg, R. Kuehr, C.P. Baldé. Regional E-waste Monitor for the Western Balkans - 2023. International Telecommunication Union (ITU), United Nations Environment Programme (UNEP) and United Nations Institute for Training and Research (UNITAR) - SCYCLE Programme. https://www.scycle.info/wp-content/uploads/2023/12/Regional-E-waste-Monitor-Balkan-2023.pdf	Yes	Yes	Yes	No
Seychelles	Africa	1	13,5	N/A		No	No	No	No
Sierra Leone	Africa	6	0,7	N/A		No	No	No	No
Singapore	Asia	121	20,3	N/A		Yes	No	Yes	No
Slovakia	Europe	84	15,4	47,3	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Slovenia	Europe	36	17	15,1	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Solomon Islands	Oceania	1	1,1	N/A		No	No	No	No
Somalia	Africa	9	0,5	N/A		No	No	No	No
South Africa	Africa	527	8,8	22,9	Lydall M, Nyanjowa W, and James Y. 2017. “Mapping South Africa’s Waste Electrical and Electronic Equipment (WEEE) Dismantling, Pre-Processing and Processing Technology Landscape", Mintek	Yes	Yes	No	No
South Sudan	Africa	15	1,4	N/A		No	No	No	No
Spain	Europe	935	19,6	395,2	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Sri Lanka	Asia	175	8	N/A		No	No	No	No
Sudan	Africa	103	2,2	N/A		No	No	No	No
Suriname	Americas	7	11,1	N/A		No	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Swaziland	Africa	7	6,2	N/A		No	No	No	No
Sweden	Europe	221	21	151,2	Eurostat, 2022. Waste electrical and electronic equipment (WEEE) by waste management operations (env_waselee), Metadata in Euro SDMX Metadata Structure (ESMS). Eurostat, the statistical office of the European Union. https://ec.europa.eu/eurostat/databrowser/view/env_waseleeos/default/table?lang=en	Yes	Yes	Yes	Yes
Switzerland	Europe	204	23,4	129	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE – e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	Yes	Yes	Yes
Syrian Arab Republic	Asia	121	5,6	N/A		No	No	No	No
Taiwan (Province of China)	Asia	463	19,4	145,4	Communication with EPA Taiwan (Province of China) in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	No	No	No	No
Tajikistan	Asia	12	1,2	0,11	Communication with Isfara waste plant in the context of this report: C.P. Baldé, G. Iattoni, V. Luda, I.C Nnorom, O. Pecheniuk, R. Kuehr, Regional E-waste Monitor for the CIS + Georgia – 2021, 2021, United Nations University (UNU) / United Nations Institute for Training and Research (UNITAR) – co-hosting the SCYCLE Programme, Bonn, Germany. https://ewastemonitor.info/wp-content/uploads/2021/11/REM_2021_CISGEORGIA_WEB_final_nov_11_spreads.pdf	No	No	No	No
Thailand	Asia	753	10,5	29	Borrirukwisitsak, S., Khwamsawat, K. & Leewattananukul, S. The use of relative potential risk as a prioritization tool for household WEEE management in Thailand. J Mater Cycles Waste Manag 23, 480–488 (2021). https://doi.org/10.1007/s10163-021-01175-x	No	No	No	No
The former Yugoslav Republic of Macedonia	Europe	21	10	3,4	Communication with SSO 2022/MoEPP 2022 in the context of this report: G. Iattoni, I.C Nnorom, D. Toppenberg, R. Kuehr, C.P. Baldé. Regional E-waste Monitor for the Western Balkans – 2023. International Telecommunication Union (ITU), United Nations Environment Programme (UNEP) and United Nations Institute for Training and Research (UNITAR) – SCYCLE Programme. https://www.scycle.info/wp-content/uploads/2023/12/Regional-E-waste-Monitor-Balkan-2023.pdf	Yes	Yes	Yes	No
Timor-Leste	Asia	2	1,6	N/A		No	No	No	No
Togo	Africa	8	0,9	N/A		No	No	No	No
Tonga	Oceania	0	4	N/A		No	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Trinidad and Tobago	Americas	24	15,4	N/A		No	No	No	No
Tunisia	Africa	85	6,9	N/A		No	No	No	No
Turkey	Asia	1077	12,7	186,9	Communication with Exitcom in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	Yes	Yes	Yes	Yes
Turkmenistan	Asia	46	7,1	N/A		No	No	No	No
Tuvalu	Oceania	0	2,4	N/A		No	No	No	No
Uganda	Africa	41	0,9	0,2	Communication with Computers for School Uganda in the context of this report: Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. https://www.scycle.info/global-e-waste-monitor-2020/	Yes	No	No	No
Ukraine	Europe	385	8,9	31,2	UNSD — Environment Statistics. Retrieved August 1, 2023, from https://unstats.un.org/unsd/envstats/qindicators	Yes	No	No	No
United Arab Emirates	Asia	178	18,9	5,4	UNSD — Environment Statistics. Retrieved August 1, 2023, from https://unstats.un.org/unsd/envstats/qindicators	Yes	Yes	No	No
United Kingdom of Great Britain and Northern Ireland	Europe	1652	24,5	501,9	UK Environment Agency, 2022. WEEE collected in the UK. https://www.gov.uk/government/statistical-data-sets/waste-electrical-and-electronic-equipment-weee-in-the-uk	Yes	Yes	Yes	Yes
United Republic of Tanzania	Africa	61	0,9	N/A		Yes	Yes	No	No
United States of America	Americas	7188	21,3	4052,8	OECD Statistics, 2022. Waste from electrical and electronic equipment (WEEE – e-waste). https://stats.oecd.org/Index.aspx?DataSetCode=EWASTE	Yes	No	No	No
Uruguay	Americas	44	12,9	1,3	Communication with Ministry of Environment in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	No	No	No	No

COUNTRY	REGION	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	REFERENCE FOR E-WASTE COLLECTION AND RECYCLING DATA	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Uzbekistan	Asia	128	3,7	N/A*	Internal data from UNITAR that is confidential. Data point is added to the global totals.	No	No	No	No
Vanuatu	Oceania	0	1,2	N/A		No	No	No	No
Venezuela (Bolivarian Republic of)	Americas	303	10,8	1	Communication with Ministry of the People's Power for Eco-socialism (MINEC) in the context of this report: M. Wagner, C.P. Baldé, V. Luda, I. C Nnorom, R. Kuehr, G. Iattoni. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554, Bonn (Germany), 2022. https://www.scycle.info/regional-e-waste-monitor-latin-america-2021/	No	No	No	No
Viet Nam	Asia	516	5,3	N/A		Yes	Yes	No	No
Yemen	Asia	49	1,5	N/A		No	No	No	No
Zambia	Africa	23	1,1	N/A		Yes	Yes	No	No
Zimbabwe	Africa	17	1,1	0,03	UNSD — Environment Statistics. Retrieved August 1, 2023, from https://unstats.un.org/unsd/envstats/qindicators	No	No	No	No

N/A* = These data points are considered in the total but due to confidentiality cannot be disclosed as single values

Table A.2.5. Overview of e-waste flows for 2030 scenarios and viable recovery of metals

SCENARIO	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (SDG INDICATOR 12.5.1)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (SDG 12.5.1)	ESTIMATED E-WASTE IN WASTE BIN	ESTIMATED E-WASTE IN SCRAP METAL	INFORMAL SECTOR	TOTAL	IRON	COPPER	GOLD	NICKEL	ALUMI-NIUM
Unit	*per cent*	*billion kg*	*billion kg*	*billion kg*	*billion kg*	*billion kg*	*billion kg*	*billion kg*	*thousand kg*	*million kg*	*billion kg*
2022 – current practice	22	14	14	16	18	19	16	1.1	47	1.9	1.1
2030 – business as usual	20	16	20	22	24	25	21	1.4	50	2.1	1.4
2030 – progressive	38	31	13	14	24	28	24	1.6	78	4.3	2.2
2030 – ambitious	44	37	12	13	21	29	24	1.6	79	4.5	2.4
2030 – aspirational	66	50	10	10	13	30	25	1.7	79	4.9	2.9

Bénédicte Kurzen / NOOR for Fondation Carmignac

Table A.2.6 Overview of environmental/economic impact of the 2030 scenarios

SCENARIO	AVOIDED MERCURY EMISSIONS	MERCURY EMISSIONS	AVOIDED GREENHOUSE GAS EMISSIONS (DIRECT AND INDIRECT)	GREENHOUSE GAS EMISSIONS CAUSED BY ENVIRONMENTALLY UNSOUND MANAGEMENT OF REFRIGERANTS	OVERALL ECONOMIC COST	VALUE OF RECOVERED METALS E-WASTE	VALUE OF AVOIDED GREENHOUSE GAS EMISSIONS	TREATMENT COSTS	EXTERNALIZED COSTS ARISING FROM LEAD/ MERCURY EMISSIONS, PLASTIC LEAKAGES AND GLOBAL WARMING CONTRIBUTION
Unit	*1000 kg*	*1000 kg*	*Mt CO_2 equivalent*	*Mt CO_2 equivalent*	*billion USD*	*billion USD*	*billion USD*	*billion USD*	*billion USD*
2022 – current practice			94	145	-36	28	23	-10	-78
2030 – business as usual	11	46	105	149	-40	42	26	-15	-93
2030 – progressive	21	36	155	116	-4	52	39	-20	-75
2030 – ambitious	25	32	171	103	9	54	43	-21	-66
2030 – aspirational	34	23	209	74	38	57	52	-24	-47


PradeepGaurs / Shutterstock.com

References

1] StEP Initiative. 2014. One Global Definition of E-Waste. Solving the E-Waste Problem (Step) White Paper, UNU 3576 (June), 08.
2] ITU. 2022. Facts and Figures 2022. ITU Subscriptions.
3] Forti V, Baldé CP and Kuehr R. 2018. E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. UNU, ViE – SCYCLE, Bonn, Germany.
4] StEP Initiative. 2014, note 1.
5] Forti V et al. 2018, note 2.
6] European Space Agency. 2022. Recycling in space: wannabe or reality? ESA Blogs, 10 January 2022.
7] European Commission. 2023. Critical Raw Materials: ensuring secure and sustainable supply chains for EU's green and digital future. European Commission, 16 March 2023, Brussels, Belgium.
8] Baldé CP, Kuehr R, Blumenthal K, Fondeur Gill S, Kern M, Micheli P, Magpantay E and Huisman J. 2015. E-Waste Statistics Guidelines on Classification, Reporting and Indicators. UNU, IAS – SCYCLE, Bonn, Germany.
9] Forti V et al. 2018, note 2.
10] UN Statistics. 2023. SDG indicator metadata. UN Statistics, 31 March 2023.
11] Munro PG, Samarakoon S, Hansen UE, Kearnes M, Bruce A, Cross J, Walker S and Zalengera C. 2023. Towards a repair research agenda for off-grid solar e-waste in the Global South. Nature Energy 8, 123-128 (2023).
12] Baldé CP, Iattoni G, Xu C and Yamamoto T. 2022. Update of WEEE Collection Rates, Targets, Flows, and Hoarding – 2021 in the EU-27, United Kingdom, Norway, Switzer-land, and Iceland. SCYCLE Programme, UNITAR, Bonn, Germany.
13] Grigoropoulos CJ, Doulos LT, Zerefos SC, Tsangrassoulis A and Bhusal P. 2020. Estimating the benefits of increasing the recycling rate of lamps from the domestic sector: Methodology, opportunities and case study. Waste Management, vol. 101, 2020, pp. 188-199.
14] Baldé CP, D'Angelo E, Luda V, Deubzer O and Kuehr R. 2022. Global Transboundary E-waste Flows Monitor – 2022. UNITAR, Bonn, Germany.
15] Ibid.
16] Odeyingbo O, Nnorom I and Deubzer O. 2017. Person in the Port Project – Assessing Import of Used Electrical and Electronic Equipment into Nigeria. UNU-ViE SCYCLE and BCCC Africa, Bonn, Germany.
17] Prevent Waste Alliance. 2022. Controlling E-waste Imports in Tanzania.
18] Baldé CP, Wagner M, Iattoni G, and Kuehr R. n.d. In-depth Review of the WEEE Collection Rates and Targets in the EU-28, Norway, Switzerland, and Iceland, 2020. UNU/UNITAR, Bonn, Germany.
19] Calboli I. 2023. The Right to Repair: Recent Developments in the USA. WIPO Magazine, Geneva, Switzerland.
20] De Meneses AA and Molyneux CG. 2023. European Commission Publishes Directive on the Right of Repair Proposal. Global Policy Watch, Covington's Public Policy and Government Affairs Group.
21] European Commission. 2023. Ecodesign for Sustainable Products Regulation. Brussels, Belgium.
22] OECD. 2016. Extended Producer Responsibility: Guidance for efficient waste management. Policy Highlights. OECD Publishing, Paris, France.
23] UNU and StEP. 2019. Developing Legislative Principles for e-waste policy in developing and emerging countries. StEP White Paper, Bonn, Germany.
24] ITU. 2021. Policy Practices for E-waste Management. ITU and the World Economic Forum, Geneva, Switzerland.
25] Reuter MA, van Schaik A, Gutzmer J, Bartie N and Abadías Llamas A. 2019. Challenges of the Circular Economy – A material, metallurgical and product design perspective. Annual Review of Materials Research, Issue 49, 2019, pp. 253-274.
26] European Commission. 2022. EU Critical Raw Materials Act. Brussels, Belgium.
27] Hagelüken C, Lee-Shin JU, Carpentier A and Heron C. 2016. The EU circular economy and its relevance to metal recycling. Recycling, 2016, 1(2), pp. 242-253.
28] Deubzer O, Herreras L, Hajosi E, Hilbert I, Buchert M, Wuisan L and Zonneveld, N. 2019. Baseline and Gap/Obstacle Analysis of Standards and Regulations. CEWASTE Project, UNU, Bonn, Germany; SCRREEN. 2020. Factsheet updates based on the EU Factsheets 2020: Rare Earth Elements. Solutions for Critical Raw materials – a European Expert Network (SCRREEN). Tables 25 and 26.
29] CEWASTE. 2023. About the Project.
30] Baum ZJ, Bird RE, Yu X and Ma J. 2022. Lithium-Ion Battery Recycling – Overview of Techniques and Trends. ACS Energy Lett. 2022, 7/2, pp. 712-719.
31] UNDP and UNEP. 2018. Managing mining for sustainable development: A sourcebook. UNDP, Bangkok, Thailand.
32] Chepkemoi J. 2017. What is the environmental impact of the mining industry? WorldAtlas, 25 April 2017.
33] McWhorter WB. 2017. Exploring the potential health and safety issues of artisanal and small-scale gold mining in Ghana: a case study. Tuscaloosa, Alabama.
34] Intergovernmental Panel on Climate Change. 2023. Summary for Policymakers. Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34.

35] Williams M, Gower R, Green J, Whitebread E, Lenkiewicz Z and Schröder DP. 2019. No Time to Waste: Tackling the Plastic Pollution Crisis before It's Too Late. Tearfund, Teddington, UK; World Health Organization. 2019. Ambient (outdoor) air pollution: Key Facts. Geneva, Switzerland.

36] Velis C, Cook E. 2021. Mismanagement of plastic waste through open burning with emphasis on the global south: a systematic review of risks to occupational and public health. Environmental Science Technology, June, Vol 1;55(11), pp. 7186-7202.

37] UNEP. 2019. Minamata Convention on Mercury – Text and Annexes. Nairobi, Kenya.

38] Secretariat of the Minamata Convention on Mercury. 2023. Minamata Convention in 2022: Progress report on activities. UNEP, Geneva, Switzerland.

39] Magalini F and Huisman J. 2018. WEEE Recycling Economics – The shortcomings of the current business model. UNU and European Energy Research Alliance.

40] Silpa K, Yao L, Bhada-Tata P and Van Woerden F. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Overview booklet. World Bank, Washington, DC.

41] ITU. 2021. Policy practices for e-waste management: Tools for fair and economically viable extended producer responsibility – Examples from African countries. ITU and the World Economic Forum, Geneva, Switzerland.

42] Merdassi N. 2023. An Interview with Ines Temimi, Collectun D3E Recyclage, a Woman-Owned Recycling Business in Tunisia. Women's Council on Energy and the Environment (WCEE), Washington, DC.

43] Yahya M. 2022. Voucher incentive, phone app promote e-waste recycling among Egyptians. Xinhua, 16 March 2023.

44] Merdassi N. 2023, note 44.

45] Magoum I. 2022. Senegal: Towards the regulation of electronic waste management. Afrik 21, 20 October.

46] ITU. 2023. E-waste Policy Development and Data Collection: Examples from African countries.

47] Bergeron JR. n.d. Initiatives to tackle e-waste in Ivory Coast. Borgen Project.

48] EEP Africa and Nordic Development Fund. 2020. Solar E-waste Management Innovations in Sub-Saharan Africa, webinar, 26 May 2020.

49] Global LEAP Awards. 2020. WEEE Centre Creates an Economically Viable E-waste Management Model. The Global Leap Awards Spotlight.

50] GOGLA 2019. E-waste Toolkit: Module 4 Briefing Note – E-waste Regulation and Compliance. November. Contributors: Drew Corbyn, Juliana Martínez, Rebecca Cooke.

51] Skrdlik, J. 2023. Spain Nabs Europe-Africa Electronic Waste Smugglers. Oganized Crime and Corruption Reporting Project, 6 January.

52] McMahon K, Uchendu C, Fitzpatrick C. 2021. Quantifying used electrical and electronic equipment exported from Ireland to West Africa in roll-on roll-off vehicles. Resources, Conservation & Recycling 164 (2021), 105177.

53] ITU. 2021, note 48.

54] Luyeye P. 2023. Case study – Benelux Afro Center: Innovative relay stations involving young people in the proper recycling of e-waste in the DRC.

55] ITU. 2021, note 48.

56] Onianwa PC. 2020. Achieving Sustainable and Sound E-waste Management in African Cities through EPR Schemes. Basel Convention Coordinating Centre for the African Region, Ibadan, Nigeria.

57] World Wild Fund for Nature. 2022. Extended producer Responsibility for Single-use Plastics and Packaging Waste Streams: An Assessment for Kenya. Gland, Switzerland.

58] Njathi I. 2022. Kenya's E- Waste Management strategy. Tharuma Trevisan Advocates, 4 March.

59] ITU and UNITAR. 2023. EACO Regional E-waste Data Harmonization. Geneva and Bonn.

60] Government of Tanzania, National Bureau of Statistics and UNU, ViE – SCYCLE. 2019. National E-Waste Statistics Report 2019. Dodoma, Tanzania, and Bonn, Germany.

61] Africa Clean Energy 2021. Stand Alone Solar (SAS): Market Update Zambia. ACE Tetra Tech International Development, March.

62] Green Crossroads. 2017. Green Crossroads and "Green Mauritius" project. 20 February.

63] ITU. 2021, note 48.

64] Electronics Recycling Coordination Clearinghouse. 2023. Maps.

65] New Jersey Department of Environmental Protection. 2017. E-waste Frequently Asked Questions. Trenton, New Jersey.

66] Electronics Recycling Coordination Clearinghouse. 2023. Product Scope Map.

67] Electronics Recycling Coordination Clearinghouse. 2023. Covered Entities by State.

68] Lee D, Offenhuber D, Duarte F, Biderman A and Ratti C. 2018. Monitour: Tracking global routes of electronic waste. Waste Management, 72, pp. 362-370.

69] Electronics Recycling Coordination Clearinghouse. 2020. Per Capita Collection 2018-2020.

70] Connecticut Department of Energy and Environmental Protection. 2022. 2022 Status Report on Connecticut's State-wide Consumer Electronics Recycling Program.

71] Althaf S, Babbitt CW and Chen R. 2019. Forecasting electronic waste flows for effective circular economy planning. Resources, Conservation & Recycling, 151, pp. 1-10.

72] Dell Technologies. n.d. State by State Recycling.

73] Paben J. 2023. State program revamp proposal advances in Oregon. Resource Recycling, 5 April.

74] Department of Environmental Quality. 2023. Oregon E-cycles Collections Determination for 2024. State of Oregon, 1 May.

75] Moloney S. 2023. NY Becomes First State to Enact "Right to Repair" Law for Consumers of Digital Electronic Devices. Norwood News, 1 January.

76] Xavier LH, Ottoni M and Lepawsky J. 2021. Circular economy and e-waste management in the Americas: Brazilian and Canadian frameworks. Journal of Cleaner Pro-duction, 297, 126570.

77] Dell Technologies. 2023. Canada's Recycling Laws.

78] Resource Productivity & Recovery Authority. 2023. Information Technology, Telecommunications, Audio-visual.

79] Habib K, Mohammadi E and Withanage SV. 2023. A first comprehensive estimate of electronic waste in Canada. Journal of Hazardous Materials, vol. 448.

80] Wagner M, Baldé CP, Luda V, Nnorom IC, Kuehr R and Iattoni G. 2022. Regional E-waste Monitor for Latin America: Results for the 13 countries participating in project UNIDO-GEF 5554. Bonn, Germany.

81] International Trade Administration. 2022. Environmental Technologies, Mexico – Country Commercial Guide.

82] Denogean JI. 2016. Electronic Waste Treatment in Mexico: Viability and Obstacles. MS thesis, Department of Earth and Environmental Engineering, Columbia University.

83] Government of Mexico. 2003. General Law for the Prevention and Integral Management of Wastes. Official Journal of the Federation, 8 October.

84] Grupo Briffault. 2021. Environmental Standard for the Federal District NADF-019-AMBT-2018. 26 April.

85] UNDP and GEF. 2020. Management of POPs Containing Waste in Mexico. Project Implementation Review (PIR)

86] UNDP. 2019. Sound Management of POPs containing waste in Mexico (EvMT). Independent Evaluation Office.

87] Environmental Protection Agency and Secretaría de Medio Ambiente y Recursos Naturales. 2020. Border 2025: United States – Mexico Environmental Program.

88] Government of Belize. 2020. Belize – Nationally Determined Contribution under the United Nations Framework Convention on Climate Change.

89] Wagner et al. 2022, note 82.

90] 90 UNSD. 2022. The United Nations Statistics Division. 2022. https://unstats.un.org/UNSDWebsite/.

91] United Nations Statistics Division. 2022. United Nations Statistics Division – Commodity Trade Statistics Database (COMTRADE). 8 May.

92] **Basel Convention. 2016**. Basel Convention National Reports - Year 2016. Secretariat of the Basel Convention. Geneva, Switzerland. https://www.basel.int/Countries/NationalReporting/NationalReports/BC2016Reports/tabid/6145/Default.aspx.

93] **Basel Convention. 2017**. Basel Convention National Reports - Year 2017. Secretariat of the Basel Convention. Geneva, Switzerland. http://www.basel.int/Countries/NationalReporting/NationalReports/BC2017Reports/tabid/7749/Default.aspx.

94] **Basel Convention. 2018**. Basel Convention National Reports - Year 2018. Secretariat of the Basel Convention. Geneva, Switzerland. https://www.basel.int/Countries/NationalReporting/NationalReports/BC2018Reports/tabid/8202/Default.aspx.

95] **Basel Convention. 2019**. Basel Convention National Reports - Year 2019. Secretariat of the Basel Convention. Geneva, Switzerland. http://www.basel.int/Countries/NationalReporting/NationalReports/BC2019Reports/tabid/8645/Default.aspx.

96] **Basel Convention. 2020**. Basel Convention National Reports - Year 2020. Secretariat of the Basel Convention. Geneva, Switzerland. http://www.basel.int/Countries/NationalReporting/NationalReports/BC2020Reports/tabid/8989/Default.aspx.

97] **Basel Convention. 2021**. Basel Convention National Reports - Year 2021. Secretariat of the Basel Convention. Geneva, Switzerland. http://www.basel.int/Countries/NationalReporting/NationalReports/BC2021Reports/tabid/9379/Default.aspx.

98] Government of Jamaica, Ministry of Local Government and Community Development. 2022. National Solid Waste Management Authority - Jamaica.

99] Loop News. 2018. Watch: Electronic Waste Recycling Project Helps Unemployed. Trinidad & Tobago.

100] Mihai FC, Grazie M-G, Meidiana C, Chukwunonye E and Elia V. 2019. Waste Electrical and Electronic Equipment (WEEE): Flows, Quantities, and Management-a Global Scenario. In: Electronic Waste Management and Treatment Technology, pp. 1-34. Elsevier, San Diego.

101] Wagner et al. 2022, note 82.

102] Government of Colombia, Ministry of Commerce, Industry and Tourism. 2023. Resolución-0479-de-2023. 27 April.

103] PREAL. 2022. Ecuador [PREAL blog]; Miranda GM. 2022. República del Ecuador Ministerio del Ambiente, Agua y Transición Ecológica.

104] Miranda GM. 2022. República del Ecuador Ministerio del Ambiente, Agua y Transición Ecológica.

105] Ibid.

106] Cueva A, Carlos A, Hernández S, Alhilali S, Ives-Keeler K and Casanas B. 2023. Promoting Circular Economy through Resource-Efficient Electronic Recycling across Latin America. Going Green CARE Innovation 2023, Vienna, May.

107] Government of Peru, Ministry of the Environment. 2021. Disposiciones complementarias al Decreto supremo No 009-2019-MINAM, que aprueba el régimen especial de gestión y manejo de residuos de aparatos eléctricos y electrónicos.

108] Sustainable Recycling Industries. 2023. Peruvian Minister to Promote the Creation of a Public-Private Group to Strengthen e-Waste Management during the Closing Ceremony of the Sustainable Recycling Industries Project [blog]. 15 June.

109] Basel Convention. 2019. Basel Convention National Reports - Year 2019. 2019. http://www.basel.int/Countries/NationalReporting/NationalReports/BC2019Reports/tabid/8645/Default.aspx.

110] Basel Convention. 2020. Basel Convention National Reports - Year 2020. 2020. http://www.basel.int/Countries/NationalReporting/NationalReports/BC2020Reports/tabid/8989/Default.aspx.

111] Basel Convention. 2021. Basel Convention National Reports - Year 2021. 2021. http://www.basel.int/Countries/NationalReporting/NationalReports/BC2021Reports/tabid/9379/Default.aspx.

112] StEP Initiative. 2019. Partnership Models between the Informal and the Formal Sector.

113] Wagner et al. 2022, note 82.
114] Cueva et al. 2023, note 108.
115] Basel Convention Regional Centre for Training and Technology Transfer for the Caribbean. 2020. The Problem - E-waste Management in the Caribbean. 2 August.
116] Alabate J, Maricel González JT, Sosa C, Laviosa L and Grenada A. 2018. Reciclaje de Electrónicos en Paraguay. Universidad Católica Nuestra Señora de la Asunción, Gestión Ambiental para el Desarrollo Sustentable, Asunción, December.
117] Xavier LH, Ottoni M, Gomes CF, de Araújo RA, Bicov N, Nogueira M, Espinosa D and Tenório J. 2020. Guia de desmontagem de resíduos de equipamentos eletroeletrônicos. Centro de Technologia Mineral/Ministry of Science, Technology and Innovation.
118] Xavier LH, Ottoni M and Sierpe R. 2021. Project Datare: Final Report, November 2021. Centro de Technologia Mineral/ Ministry of Science Technology and Innovation.
119] Xavier LH, Silva R, Ottoni M and Cugula J. 2021. Método Para a Categorização e a Estimativa da Geração de Resíduos Eletroeletrônicos no Brasil. Revista Brasileira de Gestão Ambiental e Sustentabilidade 8 (January), pp. 1533-51.
120] Xavier LH, Contador L, Freitas E, Sierpe R, Marelli Mofati L, Laio de Oliveira M and Vianna Fontes A. 2023. Diagnostico da mineração urbana dos resíduos eletroeletrônicos no Brasil: Projeto MINARE: relatório final. Centro de Technologia Mineral/Ministry of Science, Technology and Innovation.
121] Xavier LH et al. 2021, note 122; Xavier LH et al. 2023, note 123.
122] Xavier, Lúcia Helena da Silva Maciel, Luciana Contador, Emmanuelle Freitas, Ricardo Sierpe, Luciana Marelli Mofati, Mariano Laio de Oliveira, and Ariella Vianna Fontes. 2023. Diagnostico da mineração urbana dos resíduos eletroeletrônicos no Brasil: Projeto MINARE: relatório final. CETEM/MCTI. http://mineralis.cetem.gov.br/handle/cetem/2632.
123] Mohammadi E, Singh SJ and Habib K. 2021. Electronic Waste in the Caribbean: An Impending Environmental Disaster or an Opportunity for a Circular Economy? Resources, Conservation and Recycling 164 (January): 105106; Congress of Paraguay, Chamber of Deputies. 2022. Buscan Crear un Marco Regulatorio para la Disposición Final de Residuos Eléctricos y Electrónicos. November; Basel Convention Regional Centre for Training and Technology Transfer for the Caribbean. 2020, note 119.
124] Cámara de Diputados del Paraguay. 2022. 'H. Cámara de Diputados Del Paraguay'. November 2022. http://diputados.gov.py/index.php/noticias/buscan-crear-un-marco-regulatorio-para-la-disposicion-final-de-residuos-electricos-y-electronicos.
125] BCRC Caribbean. 2020. Waste Electrical and Electronic Equipment - BCRC Caribbean. Basel Convention Regional Centre for Training and Technology Transfer for the Caribbean, 2 August 2020. https://www.bcrc-caribbean.org/our-projects/waste-electrical-and-electronic-equipment/.
126] Arya S and Kumar S. 2023. Global E-Waste Management Strategies and Future Implications, 1st edition. Elsevier, Amsterdam.
127] Wagner M et al. 2022, note 82.
128] Cueva et al. 2023, note 108.
129] Congress of Uruguay, House of Representatives. 2019. Law No. 19.829 on Integrated Waste Management.
130] Wagner M et al. 2022, note 82; Government of Argentina, Ministry of Environment and Sustainable Development. 2023. Resolución 27/2023. Boletín Oficial.
131] Wagner M et al. 2022, note 82.
132] WEEE Forum. 2019. Argentina.
133] Maffei L and Burucua A. 2020. E-Waste and Employment in Argentina, Executive Summary (abstract). International Labour Organization.
134] StEP Initiative. 2019, note 115.
135] Liu YC. 2021. **E-waste management in China: Status, challenges, and future outlook**. Waste Management, pp. 12-22.
136] Junming Zhu, Chengming Fan, Haijia Shi and Lei Shi. 2018. Efforts for a Circular Econ-omy in China: A Comprehensive Review of Policies. Journal of Industrial Ecology, Yale University, vol. 23(1), February, pp. 110-118.
137] Zhen Wang and Jiazhen Huo. 2023. Do government intervention measures promote e-waste recycling in China? Journal of Environmental Management, vol. 342, 118138.
138] Wang Qixiang, Linghui Kong, Jin Li, Bangyi Li and Fan Wang. 2020. Behavioral Evolutionary Analysis between the Government and Uncertified Recycler in China's E-Waste Recycling Management. International Journal of Environmental Research and Public Health 17, No. 19.
139] Bakhdi M. 2022. Managing e-waste in China: the formal and informal sectors. International Journal of Economic Performance, Vol. 5, Issue 2, pp. 388-399.
140] Lou T, Fang F, Hu Q et al. 2022. Evolution of e-waste resources disposal with propa-ganda education and monetary incentives: the influence mechanism of consumer knowledge level. Journal of Material Cycles and Waste Management 24, pp. 2620-2635.
141] 141 Li W and Achal V. 2020. Environmental and health impacts due to e-waste disposal in China – A review. Science of the Total Environment, October.
142] Han Y, Shevchenko T and Qu D. 2022. Smart E-waste Management in China: A Review. Congress on Intelligent Systems, vol. 111, pp. 515-533.
143] Tsai, W.-T. 2018. Current practice and policy for transforming e-waste into urban mining: case study in Taiwan. International Journal of Environment and Waste Management, pp. 1-15.
144] Ma, H.-K. 2018. Recycling Waste Electrical and Electronic Equipment (WEEE) and the Management of Its Toxic Substances in Taiwan – A Case Study. Toxics, pp. 811-823.
145] Ibitz A. 2020. Assessing Taiwan's endeavors towards a circular economy: the electronics sector. Asia Europe Journal, pp. 493-510.
146] Ibid.
147] Akinaga, K. 2022. Japan's E-waste Management: Current Status and Challenges. Recycling, 17.
148] Basu, A. &. 2021. A review of status, trends, and challenges. Journal of Material Cycles and Waste Management, pp. 261-278.
149] Eco Mark Office. 2023. Eco Mark application. Retrieved from https://www.ecomark.jp/acquire/appli_eng/

150] Industrial Structure Council, C. E. 2022. **Report of Progress on the Home Appliance Recycling Law**. Ministry of Economy, Trade and Industry, Japan.

151] Hong JY. 2021. **Management of E-waste in Korea: Current Status and Challenges**. Journal of Korean Society of Environmental Engineers, pp. 589-595.

152] Hyun S. 2022. Current Status and Challenges of Green Digital Finance in Korea. In: Taghizadeh-Hesary F and Hyun S (eds), Green Digital Finance and Sustainable Development Goals. Springer, pp. 243-261.

153] Kim DK. 2021. **Development and Implementation of E-waste Recycling System in Korea**. Journal of Korean Society of Environmental Engineers, pp. 208-215.

154] Davaasuren N. 2021. **Waste management policy, status and challenges in Mongolia**. In: Anquandah CE, E-waste management in Africa and Asia, pp. 89-103.

155] Davaasuren N. 2021. **Electronic waste management in Mongolia**. The Asia-Pacific Journal of Science, Technology and Sustainable Development, pp. 41-55.

156] Ibid.

157] Science Japan. 2021. Electronic waste recycling system established by NEDO and ARBIZ Corporation. Japan Science and Technology Agency, 4 August.

158] Yeruultsengel B. &. 2021. **Electronic waste management and recycling in Mongolia**. Journal of Environmental Science and Technology, pp. 251-260.

159] Government of Brunei, Ministry of Finance and Economy. 2020. Voluntary National Review Report of Brunei Darussalam for 2020 United Nations High-Level Political Forum on Sustainable Development. Brunei Darussalam.

160] Idris R, Yusof I and Shams S. 2023. Status of e-waste management in Brunei Darussalam. AIP Conference Proceedings, 2643 (1).

161] Ibid.

162] GMS Environment Operations Center. 2018. Cambodia's Road Map for Sustainable Development: The National Environment Strategy and Action Plan. Asian Development Bank, Bangkok.

163] Dek Vimean Pheakdey NV. 2022. Challenges and Priorities of Municipal Solid Waste Management in Cambodia. International Journal of Environmental Research and Public Health, 8458.

164] GIZ. 2019. Partnership Ready Cambodia: Waste management. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Berlin, Germany.

165] Ardi R and Akbar IA. 2022. Development of Integrated Electronic Waste Management System Strategies in Indonesia. Proceedings of the First Australian International Conference on Industrial Engineering and Operations Management, Sydney, Australia, 20-21 December, pp. 2190-2200.

166] Kurniawan Kurniawan MD. 2022. **Current status of the recycling of e-waste in Indonesia**. Geosystem Engineering, 83094.

167] Rimantho D, Syaiful S, Nurfaida and Sulandari U. 2022. Electronic waste bank model as a solution for implementing circular economy: Case study DKI Jakarta-Indonesia. Frontiers in Built Environment.

168] UNEP/GRID-Geneva. 2023. Pollution. Interactive Country Fiches.

169] Government of the Lao PDR, Department of Pollution Control and Monitoring. 2020. Lao PDR: Country Report (in Lao).

170] Government of the Lao PDR, Ministry of Finance. 2023. Draft E-Waste Management Plan.

171] Yusof Y, Ismail W, Mohd N, Noor A and Bakar M. 2023. E-Waste Management toward Environmental Sustainability in Malaysia. In: Sustainable Approaches and Strategies for E-Waste Management and Utilization, IGI Global, pp.239-259.

172] Sofian DD, Hanafiah MM, Woon KS and Hassan FM. 2023. Characteristics of consumer towards development of sustainable e-waste management in Malaysia. IOP Conference Series: Earth and Environmental Science, 1167.

173] Mohamad Razip M, Savita KS, Kalid KS, Ahmad MN, Zaffar M, Rahim EEA, Baleanu D and Ahmadian A. 2022. The development of sustainable IoT e-waste management guideline for households. Chemosphere, vol. 303, Part 1, 134767.

174] Mohamad NS, Ai CT and Hon TH. 2022. The Determinants of Consumers' E-Waste Recycling Behavior through the Lens of Extended Theory of Planned Behavior. Sustainability 14, No. 15: 9031.

175] Gamaralalage Jagath Premakumara D, Hengesbaugh M, Onogawa K and Hlaing OMT. 2017. Waste Management in Myanmar: Current Status, Key Challanges and Recomendations for National and City Waste Management Strategies. UN Environment/IGES Centre Collaborating with UNEP on Environmental Technologies , Japan.

176] World Bank. 2019. Myanmar - Country Environmental Analysis : A Road towards Sustainability, Peace, and Prosperity. Synthesis Report.

177] Htun HH 2019. A Study of Public Awareness Concerned with E-Waste and Management Strategies. Myanmar.

178] Government of the Philippines, Department of Environment and Natural Resources. 2021. EMB: National policy, regulatory framework already in place for e-waste mngt.

179] Ibid.

180] Talavera E. 2022. Case Study: Philippines. Recognising Green Skills for Environmental and Sustainable Development in Four Selected Industries. In M Pavlova and M Singh (eds), Recognizing Green Skills Through Non-formal Learning - A Comparative Study in Asia. Springer.

181] Government of Singapore, National Environment Agency. 2023. Sustainable and Resource Efficient Singapore.

182] Government of Singapore, Ministry of Sustainability and the Environment. 2023. Zero Waste Masterplan in Singapore.

183] Government of Singapore, National Environment Agency. 2023. E-Waste Management.

184] Ammartsena A, Ditthapan S and Leenapaesanan P. 2023. E-waste Management in Communities: Gaps in the Law and a Review of Existing Policies. Thailand.

185] Enviliance ASIA information services. 2023. Thailand, Draft WEEE Action Plan 2022-2026.

186] Duangthong T and Boonmee T. 2022. Interest groups and electronic waste management policy. Corporate & Business Strategy Review, vol. 3, Issue 1, pp. 124-133.

187] Borrirukwisitsak S, Khwamsawat K, Leewattananukul S. et al. 2023. Material flow analysis and life cycle assessment of WEEE dismantling into recycled materials in Thailand. Journal of Material Cycles and Waste Management.

188] Borrirukwisitsak S, Khwamsawat K and Leewattananukul S. 2021. The use of relative potential risk as a prioritization tool for household WEEE management in Thailand. Journal of Material Cycles and Waste Management 23, pp. 480-488.

189] Hoang TK. 2021. **E-waste management in Vietnam: Current status, challenges and solutions**. Environmental Science and Pollution Research, 24039-24050.

190] Le VP. 2023. **E-waste management in Viet Nam: Policies, practices, and challenges**. Journal of Environmental Management.

191] Government of Viet Nam, Ministry of National Resources and Environment, Vietnam Environment Administration. 2020. E-waste management in Vietnam [slide presentation].

192] Basel Convention. 2023. Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal. Geneva.

193] Government of Belarus, Department of Technical Regulation and Accreditation. 2016. Technical regulation TR EEU 037/2016 on Restrictions on the Use of Hazardous Substances in Electrical and Electronic Equipment (in Russian).

194] The text of the agreement is available in Russian at https://cis.minsk.by/reestrv2/doc/5785#text.

195] Government of Kazakhstan. 2021. Environmental Code of the Republic of Kazakhstan, 2 January (in Kazakh).

196] UNITAR, Ministry of Ecology and Natural Resources of the Republic of Kazakhstan and Center Cooperation for Sustainable Development. 2023. National E-waste Monitor 2023 – Kazakhstan. Bonn/Astana/Almaty.

197] Government of Israel. 2012. Environmental Treatment of Electrical and Electronic Equipment and Batteries Law, 5772-2012.

198] Government of Türkiye. 2023. Regulation on the Management of Waste Electrical and Electronic Equipment (in Turkish).

199] Government of Qatar. 2002. Executive By-Law for the Environment Protection Law, Issued vide the Decree Law No. 30 for the Year 2002.

200] Government of the United Arab Emirates. 2018. Federal Law No. 12 of 2018 on Integrated Waste Management.

201] Government of the State of Palestine. 1999. Palestinian Environmental Law.

202] Government of Israel, Ministry of Environmental Protection. n.d. Bottles, Tires, Packaging, Appliances, Plastic Bags: Extended Producer Responsibility.

203] Parliament of Georgia. 2014. The Waste Management Code of the Republic of Georgia, No. 2994.

204] Parliament of Georgia. 2020. Technical Regulations on the Management of Waste Electronic and Electrical Equipment, Resolution No. 226, 25 May 2020 (in Georgian).

205] Government of Armenia, Ministry of Foreign Affairs. 2022. The Comprehensive and Enhanced Partnership Agreement between the Republic of Armenia and the European Union (CEPA).

206] Government of Armenia. 2004. The Law of the Republic of Armenia on Waste, 24 November 2004 (in Armenian).

207] Iattoni G, Vermeersch EM, Baldé CP, Nnorom IC and Kuehr R. 2021. Regional E-waste Monitor for the Arab States 2021. Bonn, Germany.

208] Kemal Konyalioglu A and Bereketli I. 2023. A Decision Support System for small household appliances' waste management in Turkey. Conference paper: Tenth International Conference on Environmental Management, Engineering, Planning & Economics (CEMEPE 2023), Skiathos, Greece.

209] Ozhan Akyuz A and Kumas K. 2022. Electrical and electronic wastes in the world and Türkiye: policies and practices in Türkiye and some recommendations. International Journal of Energy Applications and Technologies 9(3), 2022, pp. 71-80.

210] Iattoni G et al. 2021, note 218.

211] Baldé CP, Panchal R and Forti V. 2022. National E-waste Monitor for Lebanon 2022. Bonn, Germany.

212] Ibid.

213] Government of India, Ministry of Environment and Forests. 2011. E-waste (Management and Handling) Rules, 2011, Notification, 12 May 2011. New Delhi, India.

214] Government of India, Ministry of Environment, Forest and Climate Change. 2022. E-waste Management System. New Delhi, India.

215] Government of India, Ministry of Environment, Forest and Climate Change. 2016. Gazette of India (Extraordinary Part II, Section 3, Sub-section I), Notification, 23 March 2016. New Delhi, India.

216] Government of India, Central Pollution Control Board. 2021. Annual Report 2020 – 2021. New Delhi, India.

217] Government of India, Ministry of Environment, Forest and Climate Change, Central Pollution Control Board. 2022. Draft Average life proposed for the notified Electrical and Electronic Equipment (EEE) items under the E-Waste (Management) Rules, 2022. New Delhi, India.

218] Available at https://righttorepairindia.gov.in/.

219] Government of Afghanistan. 2022. Country Report, Afghanistan (draft). Seventh Regional 3R Forum in Asia and the Pacific, Adelaide, Australia, 2-4 November 2016. United Nations Centre for Regional Development.

220] Hossain S. 2010. Study on E-waste: Bangladesh Situation 2010. Environment and Social Development Organization, Dhaka, Bangladesh.

221] Aziz M. 2022. Bangladesh e-waste rules hang in limbo as electrical goods companies ask for delay. Mongabay News, 21 October 2022.

222] Bangladesh Telecommunication Regulatory Commission. 2022. E-waste Management (in Bengali).

223] World Bank. 2023. Bangladesh Environmental Sustainability and Transformation Project (P172817).
224] Parliament of Bhutan. 2009. Waste Prevention and Management Act.
225] Government of Bhutan, National Environmental Commission. 2019. National Waste Management Strategy 2019.
226] Government of Bhutan, National Environment Commission. 2019. Thimphu Waste Management Plan. Thimphu, Bhutan.
227] Government of Maldives, Ministry of Environment, Climate Change and Technology. 2022. E-Waste Management Guideline for Digital Maldives for Adaptation, Decen-tralization and Diversification Project.
228] PACE Nepal Pvt. Ltd. 2017. Final Report on Inventory Preparation of E-waste and Its Management in Kathmandu Valley. Kathmandu, Nepal.
229] Inclusive-Everest JV. 2023. **To develop national policy/strategy and regulatory framework for an e-waste management in Nepal**.
230] Government of Pakistan, Ministry of Climate Change and Environmental Coordination. 2022. National Hazardous Waste Management Policy, 2022. Islamabad.
231] Government of Pakistan, Ministry of Environment. 1997. Environmental Guidelines for Sound Disposal Management of Mercury in Compact Fluorescent Lights Bulbs (CFLs). Islamabad.
232] Sheikh AT. 2023. Hazardous Waste Challenge. DAWN News, Pakistan, 4 May.
233] Government of Sri Lanka, Auditor General's Department, Performance and Environment Audit Division. 2016. Electronic Waste Management in Sri Lanka, 2016, Report No. PER/2016/EW/0.
234] Government of Sri Lanka, Central Environmental Authority. 2023. Licensed Collectors of Electronic Waste Management in Sri Lanka.
235] Government of Sri Lanka, Central Environmental Authority. 2023. Transit or Transshipment approvals for Hazardous Waste through Sri Lanka under the Basel Convention.
236] European Commission. 2023. Critical Raw Materials: ensuring secure and sustainable supply chains for EU's green and digital future. Press release, 16 March, Brussels, Belgium.
237] European Commission. 2022. Review: Restriction of the use of hazardous substances in electronics. 10 March.
238] Baldé, CP et al. 2022, note 11.
239] Baldé, CP et al. 2022, note 13.
240] 240UNDP. 2020. Rapid Assessment Report on the Benefits of Circular Economy on Mitigation of GHGs Emission in the Waste Sector: Republic of North Macedonia. Ministry of Environment and Physical Planning of North Macedonia, GEF and UNDP.
241] European Commission. 2022. Support in the implementation of the waste management legislation and Extended Producer Responsibility (EPR) scheme, Annex C1: Twinning Fiche. Brussels, Belgium.
242] UNEP. 2015. National Implementation Plan for the Stockholm Convention in Bosnia and Herzegovina. UNEP, UNIDO, GEF and Ministry of Foreign Trade and Economic Relations, Bosnia and Herzegovina.
243] Basel Convention Regional Centre in Bratislava. 2022. **Project: Improving of Environmentally Sound Management of computing equipment and mobile phones in Moldova and Belarus – Activity 1.1 (Belarus)**.
244] Basel Convention Regional Centre in Bratislava. 2022. **Project: Improving of Environmentally Sound Management of computing equipment and mobile phones in Moldova and Belarus – Activity 1.1 (Moldova)**.
245] Baldé CP, Iattoni G, Luda V, Nnorom IC, Pecheniuk O and Kuehr R. 2021. Regional E-waste Monitor for the CIS + Georgia – 2021. UNU/UNITAR, Bonn, Germany.
246] Ibid.
247] Patil RA and Ramakrishna S. 2020. A comprehensive analysis of e-waste legislation worldwide. Environmental Science and Pollution Research, 27, pp. 14412–14431.
248] Government of Australia, Department of Environment, Water, Heritage and the Arts, National Environment Protection Council. 2009. National Waste Policy: Less Waste, More Resources.
249] Government of Australia, Department of Climate Change, Energy, the Environment and Water. 2018. National Waste Policy: Less waste, more resources.
250] ActivGroup. 2023. The Activ Group Co-regulatory Annual Report FY 21/22.
251] Government of Australia, Department of Climate Change, Energy, the Environment and Water, and Blue Environment Pty. Ltd. 2022. National Waste Report 2022.
252] Government of Australia, Department of Climate Change, Energy, the Environment and Water. 2022. Recycling and Waste Reduction (Product Stewardship-Televisions and Computers) Rules 2021. Federal Register of Legislation, Compilation No. 2.
253] ActivGroup. 2023, note 261.
254] Australia New Zealand Recycling Platform. 2023. 2021/22 Annual Report; Ecycle Solutions. 2023. 2021/22 Annual Report.
255] Ecycle Solutions. 2023. **2021/22 Annual Report**. Ecycle solutions E-waste & Polystyrene recycling. https://www.dcceew.gov.au/sites/default/files/documents/ecycle-solutions-annual-report-2021-22.pdf
256] MobileMuster. 2022. Annual Report MobileMuster.
257] MobileMuster. 2023. Go for Zero 2023. Aussies' love affair with mobiles – 25 years of MobileMuster. News.
258] Local Government Association of the Northern Territory. 2022. LGANT Submission to Stewardship for Consumer and Other Electrical and Electronic Products: Discussion Paper. Australia.
259] SLR Consulting NZ Limited. 2015. E-waste Product Stewardship. Framework for New Zealand. Final Report. Ministry for the Environment, Report Number 720.10008, Wellington.
260] Government of New Zealand, Ministry for Environment. 2021. Recycling WEEE. 30 March.

261] Government of New Zealand, Ministry for Environment. 2022. Waste Minimisation Fund. Last updated 18 October 2022.

262] Tech Collect NZ. 2020. E-Waste Product Stewardship – New Zealand.

263] Secretariat of the Pacific Regional Environment Programme. 2016. Cleaner Pacific 2025: Pacific Regional Waste and Pollution Management Strategy 2016-2025. Apia, Samoa.

264] Pacific Reef Savers Ltd. 2014. E-Waste Country Assessments. Summary Report to the PacWaste Technical Advisory Panel, South Pacific Regional Environment Programme.

265] GEF. 2022. Fourteen Pacific Island nations make major strides towards a Cleaner Pacific. Press release, 9 March.

266] PacWastePlus/South Pacific Regional Environment Programme. 2021. Samoa Commits to Enhancing E-Waste Management in Collaboration with The PacWastePlus Programme. News 18 May.

267] South Pacific Regional Environment Programme. 2022. Subject: Request for tenders (RFT): Design of Samoa's E-Waste Product Stewardship Scheme.

268] South Pacific Regional Environment Programme. 2023. Tender Name: 2022/ PWP-103-CON: Design of Samoa's E-Waste Product Stewardship Scheme.

269] PacWastePlus/South Pacific Regional Environment Programme. 2021. Project Snapshot Niue. November.

270] PacWastePlus/ South Pacific Regional Environment Programme. 2022. Niue E-waste Clean-up. 19 December.

271] Available at https://ewastemonitor.info/monitors/.

272] Available at https://ewastemonitor.info/monitors/.

273] Eurostat. 2019. Prodcom – statistics by product.

274] Riahi K et al. 2017. The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. Global Environmental Change, vol. 42, January 2017, pp. 153-168.

275] Forti V, Baldé CP, Kuehr R. 2018. E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. UNU, ViE - SCYCLE, Bonn, Germany.

276] International Renewable Energy Agency. 2023. Country Rankings (accessed on 24 March); International Renewable Energy Agency. 2020. Global Renewables Outlook: Energy transformation 2050. Abu Dhabi, United Arab Emirates.

277] PV Cycle Italy Group. 2023. Recycling Solutions for Every Type of Refuse. Milan, Italy.

278] Riahi K et al. 2017, note 285.

279] Magalini F, Wang F, Huisman J, Kuehr R, Baldé K, Straalen VVS, Hestin M, Lecerf H, Sayman U and Akpulat O. 2014. Study on collection rates of waste electrical and electronic equipment (WEEE). European Commission, Brussels, Belgium.

280] Tom Grill. 2022. Are Disposable Vapes Bad For The Environment? The Ecoexperts, 20 December.

281] Jerzyński T and Stimson GV. 2021. Estimation of the global number of vapers: 82 million worldwide in 2021. Drugs, Habits and Social Policy, vol. 24/2, 2023, pp. 91-103.

282] Glimov A, Leventhal A, Meza L. et al. 2021. Prevalence of disposable pod use and consumer preference for e-cigarette product characteristics among vape shop customers in Southern California: a cross-sectional study. BMJ Open 2021, vol. 11/10.

283] Chapman M. 2022. Rise of single-use vapes sending tonnes of lithium to landfill. The Bureau of Investigative Journalism, 15 July.

284] Barnes O and Heal A. 2023. The environmental cost of single-use vapes. Financial Times, 7 March.

285] Baldé CP et al. 2022, note 13.

286] Baldé CP et al. 2022, note 13, and Baldé CP et al. 2020, note 11.

287] Huisman M, Kern P, Micheli P and Magpantay E. 2015. **E-waste statistics: Guidelines on classifications, reporting and indicators**. Bonn, Germany, United Nations University, IAS - SCYCLE.

288] Tecchio P, Ardente F, Marwede M, Christian C, Dimitrova G and Mathieux F. 2018. Analysis of material efficiency aspects of personal computers product group. EUR 28394, Publications Office of the European Union, Luxembourg; Buchert M, Jenseit W, Merz C and Schüler D. 2011. Ökobilanz zum „Recycling von Lithium-Ionen-Batterien" (LithoRec). Öko-Institut e.V., Final Report, Darmstadt; Huisman J. 2004. QWERTY and eco-efficiency analysis on cellular phone treatment in Sweden. TU Delft, Sweden.

289] Bobba S, Mathieux F and Blengini GA. 2020. How will second-use of batteries affect stocks and flows in the EU? A model for traction Li-ion batteries. Resources, Conservation and Recycling, vol. 145, June 2019, pp. 279-291.

290] Chen et al. 2012 en Y, Jinhui L, Lieqiang C, Shusheng C, and Weihua D. 2012. "Brominated Flame Re[1]tardants (BFRs) in Waste Electrical and Electronic Equipment (WEEE) Plastics and Prin[1]ted Circuit Boards (PCBs)". Procedia Environmental Sciences 16: 552-59. https://doi.org/10.1016/j.proenv.2012.10.076; Abbasi. 2015. "Story of Brominated Flame Retardants: Substance Flow Analysis of PDBEs from Use to Waste, PhD-thesis; Yu et al. 2017. "Charac[1]terization of brominated flame retardants from e-waste components in China". Waste Management 68: 498-507. https://doi.org/10.1016/j.wasman.2017.07.033.

291] Maragkos KG, Hahladakis JN and Gidarakos E. 2013. Qualitative and quantitative determination of heavy metals in waste cellular phones. Waste Management, Vol. 33 (9), pp. 1882-1889; Wäger P, Schluep M and Müller E. 2012. RoHS substances in mixed plastics from waste electrical and electronic equipment. Environmental Science and Technology, Vol. 46 (2), pp. 628-635; Böni H. and Widmer R. 2011. Entsorgung von Flachbildschirmen in der Schweiz. Empa and Swico; Cucchiella F, D'Adamo I, Lenny KSC and Rosa P. 2015. Recycling of WEEEs: An economic assessment of present and future e-waste streams. Renewable and Sustainable Energy Reviews, Elsevier, vol. 51(C), pp. 263-272; Savvilotidou V, Hahladakis JN and Gidarakos, E. 2014. Determination of toxic metals in discarded Liquid Crystal Displays (LCDs). In JN Hahladakis (ed.), Resources, Conservation and Recycling, Vol. 92, pp. 108-115.

292] Nassar NT, Lederer GW, Brainard JL, Padilla AJ and Lessard JD. 2022. Rock-to-Metal Ratio: A Foundational Metric for Understanding Mine Wastes. Environmental Science & Technology 2022 56 (10), 6710-6721.

293] Duan H, Miller TR, Gang L, Xianlai Z, Keli Y, Qifei H and Jian Z. 2018. Chilling Prospect: Climate Change Effects of Mismanaged Refrigerants in China. Environmental Science and Technology, 52 (11).

294] Fritz B, Aichele C and Schmidt M. 2020. Environmental impact of high-value gold scrap recycling. The International Journal of Life Cycle Assessment, 25(10), pp. 1930-1941; Nuss P and Eckelman MJ. 2014. Life cycle assessment of metals: A scientific synthesis. PLoS ONE, 9(7); Usapein P and Tongcumpou C. 2016. Greenhouse gas emission in jewelry industry: A case study of Silver Flat Ring. Applied Environmental Research, pp. 11-18; Van der Voet E, Van Oers L, Verboon M and Kuipers K. 2018. Environmental implications of future demand scenarios for metals: Methodology and application to the case of seven major metals. The Life Cycle Assessment of Platinum Group Metals (PGMs) - Reference Year 2017 & 2022 Update, International Platinum Group Metals Association, Munich - Germany. News.

295] World Intellectual Property Organization (WIPO). 2023. PATSTAT Online; WIPO and European Patent Office; European Patent Office. 2023. Espacenet Patent search.

296] UNITAR et al. 2023, note 203; Yumashev D and Baldé CP. 2022. **Electrical and electronic equipment: A tool for setting targets for e-waste collected**. UNITAR, Bonn, Germany.

297] World Bank. 2023. Latest Commodity Prices Published, Commodity Markets.

298] ISE Metal Quotes. Metal Prices.

299] Daily Metal Prices. 2022. Metal Spot Prices by Date. 1 July 2022.

300] Umicore. 2023. Iridium. Precious Metal Management, Prices.

301] Metalary. 2023. Osmium Price.

302] Daily Metal prices. 2022. Metal Spot Prices by Date. Daily Metal Prices, July 01, 2022.

303] Magalini F and Huisman J. 2018, note 39.

304] Shaikh S. 2021. A critical analysis of e-waste management and recycling in Pakistan: a life cycle assessment. PhD thesis, Victoria University, Melbourne, Australia.

305] Giang A and Selin NE. 2015. Benefits of mercury controls for the United States. PNAS, 113 (2) pp. 286-291.

306] Pain DJ, Dickie I, Green RE, Kanstrup N and Cromie R. 2019. Wildlife, human and envi-ronmental costs of using lead ammunition: An economic review and analysis. Ambio 48, pp. 969-988.

307] Dalberg Advisors. 2021. Plastics: The Costs to Society, the Environment & the Economy. World Wide Fund for Nature, Gland, Switzerland.

308] Pindyck RS. 2016. The Social Cost of Carbon Revisited. National Bureau of Economic Research, Working Paper 22807, Cambridge MA.

309] Ricke K, Drouet L, Calderia K and Tavoni M. 2018. Country-level social cost of carbon. Nature Climate Change 8, pp. 895-900.

310] Kikstra JS, Waodelich P, Rising J, Yumashev D, Hope C and Brierley CM. 2021. The social cost of carbon dioxide under climate-economy feedbacks and temperature variability. Environmental Research Letters, 2021, 16(9):094037.

311] Rennert K, Errickson F and Prest BC, et al. 2022. Comprehensive Evidence Implies a Higher Social Cost of CO_2. Nature 610, pp. 687-692.

312] Compliance and Risks. 2023. CRP Platform Overview.

313] United Nations Statistical Division. 2023. Questionnaire on Environmental Statistics.

314] OECD. 2023. OECD.Stat.

315] ITU. 2019. ITU Telecommunication/ICT Regulatory Survey.

316] Ibid.

317] Wikipedia. 2023. DIKW pyramid.

United Nations Institute for Training and Research (UNITAR)
Sustainable Cycles (SCYCLE) Programme
Platz der Vereinten Nationen 1
53113 Bonn, Germany

International Telecommunication Union (ITU)
Place des Nations, 1211
Geneva 20, Switzerland

Fondation Carmignac
Villa Carmignac, Porquerolles
Île de Porquerolles
La Courtade
83400 Hyères, France

Contact
balde@unitar.org

Maurizio Marcato / Shutterstock.com