

Global Transboundary E-waste Flows Monitor 2022

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E-waste is one of the fastest-growing waste streams. In 2019, the world generated 53.6 Mt of e-waste – an average of 7.3 kg per capita. E waste generation is expected to increase to 74.7 Mt in 2030 and reach as much as 110 Mt in 2050, unless we modify our practices.

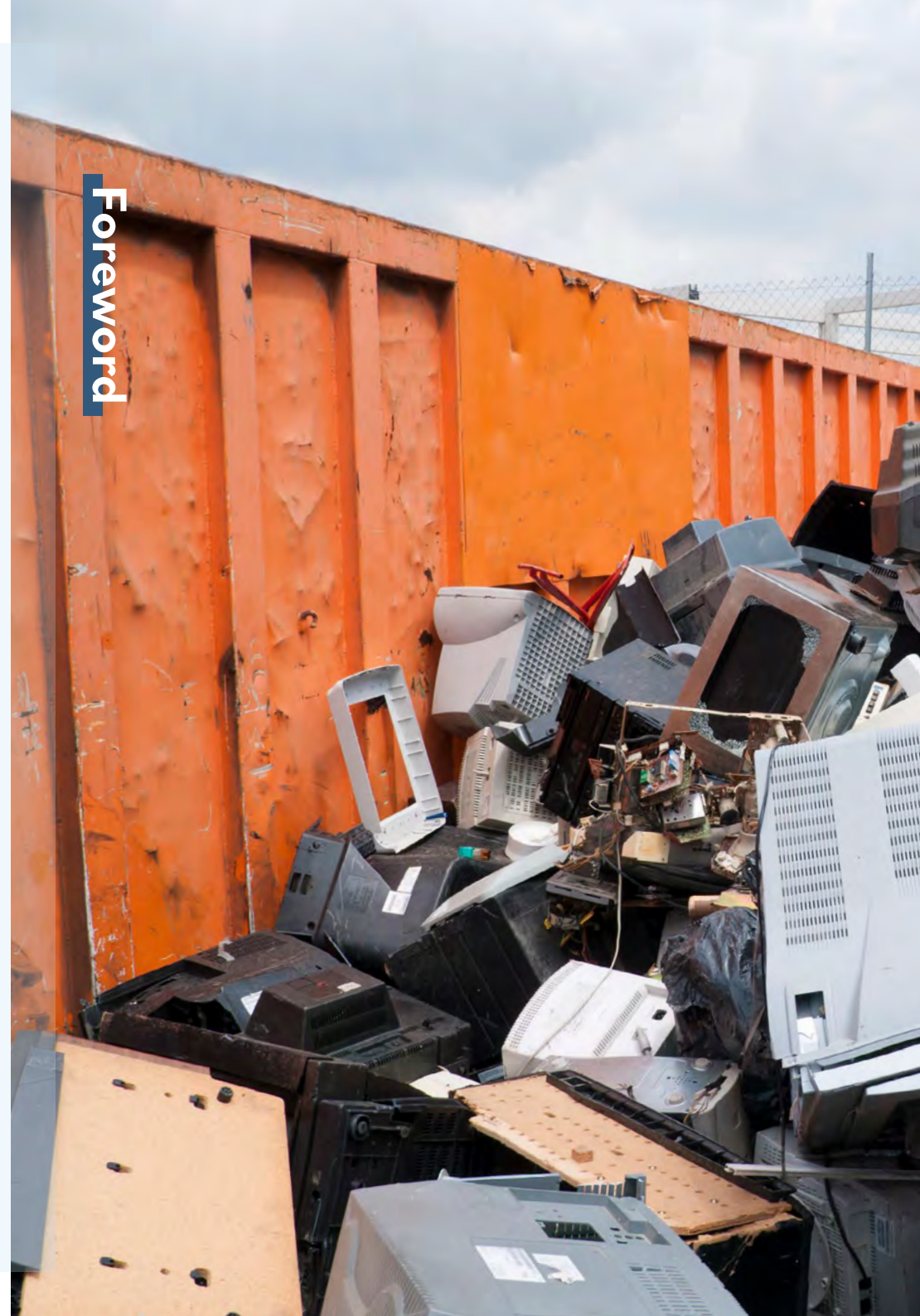
The e-waste topic found its way into the public perception via alarming reports – e.g. a report by the Basel Action Network in the early 2000s (BAN 2005) – accompanied by initial studies illustrating the need for more thorough data gathering and research, including a study produced by United Nations University. Documentaries also showed the primitive harvesting of some valuable components, such as gold or copper, from printed circuit boards or cables through open acid baths or burning. Workers obscured in toxic smoke leave us with no doubts regarding the environmental and health impacts of such practices. The global South has been called by the international community the graveyard of the global North's luxury products, assuming that most e-waste generated is shipped there, supported by some reports noting that 80% of total e-waste is shipped across country borders.

Quantifying these shipments is difficult, as a number of studies have illustrated, due to a grey-zone in business when non-functional used electronics are shipped for reuse (with individuals claiming that the

electronics can still be repaired) or even in illegal situations when non-repairable and non-reusable equipment is shipped, only to prevent recycling costs in countries with strict e-waste legislations. Therefore, the real magnitude of this issue remains unclear, though the impacts of informal treatment in some recipient countries are unquestionably significant. As well, most of these countries contribute to the issue of environmental and health harm through informal treatment by domestically generating mountains of e-waste.

This study is part of the E-waste Monitors series (ewastemonitor.info), which has been developed since 2014 by the Sustainable Cycles (SCYCLE) Programme – which has just completed its transition from UNU to UNITAR. SCYCLE and its closest partners, such as ITU, UNIDO, and UNEP, follow international guidelines on e-waste statistics, containing the most applied classifications as well as correspondence tables of those classifications.

Foreword





Unfortunately, accurately estimating transboundary movement of e-waste is currently difficult, due to several reasons linked to limited and un-harmonised data at the global level. Monitoring such flows is critical for countries to become better prepared at controlling transboundary movements of hazardous wastes and advancing in the environmentally sound management of such wastes.

The Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their disposal, with its 189 parties, is the only global treaty on transboundary movement. Nonetheless, data stemming from national reporting is insufficient for a comprehensive analysis of e-waste's transboundary movements, due to incomplete reporting, ambiguous definitions, and incorrect categorisations. Also, there is no reporting obligation for transboundary movements of used electric and electronic equipment (EEE). The amendment proposal of the Basel Convention, presented by Ghana and Switzerland and focused on controlling all e-waste moved across boundaries under the Prior Informed Consent Procedure, is an important new development in this regard.

By harvesting and harmonising all datasets and applying estimation routines, the herein study represents an initial, important starting point for global, regional, and national monitoring of transboundary movement of e-waste. Such monitoring will require a repeated effort to ensure constant monitoring for improving understanding of the flows, routes, trends, etc. and will ultimately help to limit uncontrolled transboundary movements.

To that end, the routes and quantities reported in this study will need to continuously be improved, via regular updates at the global and regional level, to help further explore emerging phenomena such as the increasing intra-regional waste trade (e.g. in Asia and Europe). Improved data quality would also allow a better understanding of the situation in certain regions and countries. For this reason, countries should be all the more encouraged to submit national reporting to the Basel Convention. Also, availability and analysis of data from inspection authorities at the global level, relating to seizures of illicit shipments of used-EEE and e-waste, should also be improved to further develop a methodology for estimating the overall illicit trafficking of e-waste.

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EEE	Electrical and Electronic Equipment
Used-EEE	Used Electrical and Electronic Equipment
WEEE	Waste Electrical and Electronic Equipment
E-waste	Electronic waste
Mt	Metric ton
kt	kiloton
USD	United States Dollar
HS	Harmonized Commodity Description and Coding System
POM	Placed On the Market
PIC	Prior Informed Consent
UN	United Nations
IT	Information Technology
OECD	Organization for Economic Co-operation and Development
kg/inh	kilograms per inhabitant
UNITAR	United Nations Institute for Training and Research
SCYCLE	Sustainable Cycles

Abbreviations

This study estimates that **5.1 Mt (just below 10 percent of the total amount of global e-waste, 53.6 Mt) crossed country borders in 2019.**¹⁾

To better understand the implication of transboundary movement, this study categorizes transboundary movement of e-waste into *controlled* and *uncontrolled* movements and also considers both the receiving and sending regions. Of the 5.1 Mt:

- **1.8 Mt of the transboundary movement is shipped in a controlled manner.** This refers to movement of material that is reported as hazardous waste (according to the Basel Convention's control regime) or to material that is shipped as separated printed circuit boards (which are fractions of high value) to a few specialised end-processors.
- **3.3 Mt of the transboundary movement is shipped in an uncontrolled manner,** as used-EEE or e-waste.²⁾ Most e-waste movements are currently not controlled, which may favour illegal movements and which poses a threat to managing e-waste: **Only 2 to 17 kt of e-waste is estimated to be seized** as illegal e-waste trade from the European Union, in 2019.³⁾ Such is merely a tip of the iceberg, compared to the megatons of uncontrolled shipments, showing that inspection capacities are limited in comparison to the overall transboundary movement.



Executive Summary



¹⁾ The statistics, comprised of physical quantities and trade routes, are very challenging to map, partly due to estimates and modelling and also due to conservative gap-filling. However, the statistics herein were validated through stakeholder consultations, are consistent with each national mass balance, and make for a significant improvement to the information available before this study was conducted. Still and all, the statistics need to continuously be improved.

²⁾ Trade codes do not distinguish between used and new EEE, so products are mostly shipped as EEE.

³⁾ Data related to seizures were only made available by a limited number of enforcement agencies in the European Union, through the project Shipment of Waste Enforcement Actions Project (SWEAP).

GLOBAL E-WASTE GENERATED
53.6 Mt

9.3 Mt

E-WASTE DOCUMENTED TO BE ENVIRONMENTALLY SOUNDLY MANAGED

44.3 Mt

E-WASTE TREATMENT UNKNOWN

83%

treatment of e-waste is unknown, likely dumped, traded, or recycled in a non-compliant or non-environmentally sound way

\$ 47.6 billion USD

value of raw materials

98 Mt CO₂-eq

emissions of untreated refrigerants

71 kt

brominated flame retardants

50 t

of mercury

17%

of global e-waste is documented to be recycled in environmentally sound facilities

\$ 9.4 billion USD

the raw materials (iron, gold, copper, etc.) contained represent a value of \$9.4 billion USD

5.1 Mt

total transboundary movements

9.5% of global e-waste generation correspond to total transboundary movement of used EEE or e-waste.



1.8 Mt

controlled transboundary movements

35% of documented transboundary movements of hazardous waste with prior informed consent under Basel Convention (1.5 Mt), as well as documented trade of printed circuit boards (0.36 Mt).



3.3 Mt

uncontrolled transboundary movements

65% of transboundary movements are uncontrolled used EEE or e-waste. A common method is mixing e-waste with other legal shipments, including used-EEE, for disguising purposes. Licit and illicit methods may overlap.



2-17 kt

seized illegal e-waste exports across European Union, based on inspection data

The following primary trends could be drawn from the detailed statistics and were confirmed from stakeholder consultations:

- **Of the 1.8 Mt of controlled e-waste shipments, 1.5 Mt is comprised of hazardous e-waste shipments that are shipped for environmentally sound treatment under the Basel Convention regime.** The driving factor is compliance with existing national and global e-waste legislation. High-income global regions have adequate e-waste management infrastructure and, consequently, import most of this controlled e-waste for treatment. Those mostly occur either between high-income regions or into high-income regions. This hazardous e-waste travels relatively short distances; only 9% of it moves between continents.
- **0.36 Mt of printed circuit board waste is imported mainly into East Asia, Western Europe, North America, and Northern Europe, where specialist recyclers for printed circuit board waste are located.** Worldwide, there are only half a dozen prominent smelters who can take care of processing printed circuit boards, and they are based in the abovementioned regions. The driving factor is commercial, as waste printed circuit boards are a high-value component of e-waste that typically contains the highest concentration of platinum group metals, such as gold. Such waste travels long distances; more than half is shipped between continents. Despite printed circuit boards being a high-value part, only 0.4 Mt of the global printed circuit board waste (1.2 Mt) is separated from the e-waste and recycled in specialized, environmentally sound facilities. Due to its high value, printed circuit board waste has higher collection and recycling rates – 34 percent – than normal e-waste (17 percent). The compliant treatment steps in printed circuit board waste treatment pose little risk to the environment and are therefore perceived as controlled movement. However, there is also a high risk of cherry-picking of printed circuit board waste during the e-waste management, leaving the hazardous components unmanaged, and 66 percent of all printed circuit board waste is not separately collected and recycled in environmentally sound facilities but is instead likely to be unmanaged separately or taken care of by the informal sector.





- **3.3 Mt of uncontrolled transboundary movement exists as used-EEE⁴⁾ or e-waste from high-income to middle-and low-income countries, further trickling down regionally toward the poorest within the region.** This movement happens on the continental level (such as from Europe into Africa or from East into Southeast Asia), but also includes intraregional movement from Europe toward Eastern Europe or within regions. Most destination countries are low- and middle-income regions that have inadequate e-waste management infrastructure, which contributes to mismanagement of e-waste. The driving factor is commercial, as there is a demand of used-EEE in recipient countries. However, used-EEE is often mixed with illegal e-waste (e.g. falsely declared). As much as one-third of the appliances can be broken upon arrival.

Primary driving factors for illegal trade of e-waste include the following:

- 1) exportation, as exporting even to remote countries can be less expensive than managing the waste domestically;
- 2) the presence of developed markets for raw materials or recycling facilities (as in the case of printed circuit board waste); and
- 3) the location of manufacturers of electrical and electronic equipment.

As a result, e-waste may end up exported to countries that lack the proper infrastructure to adequately manage hazardous substances existing in e-waste and thus can prevent harm to human health and the environment.

⁴⁾ See also footnote 2. This is an assumption, based on the authors' knowledge of the phenomenon, as, per the shipping documents, they cannot be declared as such and must be declared as new EEE products or e-waste.

In focusing in on the continents and regions, the following additional observations can be made:

- **Europe, East Asia, and North America have capacity to manage hazardous waste and printed circuit board waste, and these regions import hazardous e-waste and printed circuit board waste.** However, the capacity for environmentally sound management of printed circuit board waste in those regions⁵⁾ is estimated to be approximately 0.5 Mt and thus is by far not sufficient to manage the 1.2 Mt of printed circuit board waste embedded in e-waste. The recycling capacity for hazardous e-waste is unknown, but due to the incomplete collection and recycling rates for e-waste in those regions, it is evident that despite having recycling infrastructure, not all e-waste ends up in those facilities.
- **Europe, East Asia, and North America are also primary exporters of uncontrolled used-EEE and e-waste exports,** mainly to Africa, Southeast Asia, Central America, and South America.
- **Recipient countries in Africa, Southeast Asia, Central America, and South America have low recycling rates and a high presence of informal workers in the domestic sector.** North Africa and West Africa are the primary importing hubs for uncontrolled used-EEE and e-waste exports, mainly coming from Europe and to a lesser extent from West Asia. This places a large burden on the environment and informal workers. For instance, Africa exports 13 percent of their printed circuit board waste to Western Europe, with a high risk for cherry-picking leaving the hazardous components unmanaged.
- **Eastern Europe** faces imports of uncontrolled used-EEE or e-waste exports from other European countries.
- **Southern Asia** shows little transboundary movement and probably has a strong, informal local market for managing e-waste.

- **West Asia** is an import and export hub for both controlled and uncontrolled transboundary movement of e-waste.
- **Central Asia and the Caribbean** do not record controlled hazardous waste movements, but do import significant shares of uncontrolled used-EEE and e-waste, placing a risk on non-environmentally sound management.
- **Oceania's** reporting on transboundary e-waste flows from/to is limited⁶⁾, but New Zealand and Australia export e-waste generated mainly to Asia.

⁵⁾ In 2019, Europe had a recycling rate of e-waste of 42.5%, East Asia had a rate of 20%, and North America had a rate of 15%. Source: Forti et al 2020.

⁶⁾ The local capacity for recycling e-waste is limited in Oceania. From an assessment in Micronesia and Melanesia (PacWaste 2014), items such as used lead-acid batteries from solar power and mobile phones are increasingly entering the waste stream. Specifically concerning hazardous waste, not all countries (eg. Vanuatu, Solomon Islands) in the region are parties to the Basel Convention.

Global Import and Export Flows*



➤ **Uncontrolled e-waste used-EEE**



➤ **Movement of hazardous e-waste with prior informed consent under Basel Convention**



➤ **Printed Circuit Board Waste**



➤ **Flow within the region**

* The flows do not specifically point to individual countries, but point to the regions. These flows are based on the available data. Regions or countries with higher level of reporting may result as having higher levels of import/export.

1

Introduction

1.1 What is EEE and E-Waste?

E-waste refers to all electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of reuse (Step Initiative, 2014).⁷⁾ E-waste includes a wide range of products, including nearly all household or business items with circuitry or with electrical components that have a power or battery supply. There are many types of EEE products on the market. E-waste needs to be grouped into sensible and practically useful categories for comparison and international benchmarking of the e-waste management performance of the country. The UNU-KEYS are a product categorisation comprised of 54 products, which are listed in ANNEX 1 and which can be further aggregated into following six e-waste categories, as derived from the European Union WEEE Directive.



Category 1: Temperature exchange equipment

More commonly referred to as cooling and freezing equipment. Typical equipment includes refrigerators, freezers and air conditioners, and heat pumps.



Category 2: Screens, monitors, and equipment containing screens

Typical equipment includes televisions, monitors, laptops, and tablets.



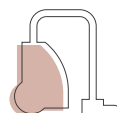
Category 3: Lamps

Typical equipment includes fluorescent lamps and LED lamps.



Category 4: Large equipment

Typical equipment includes washing machines and dryers, dishwashing machines, large printing devices, and photovoltaic panels.



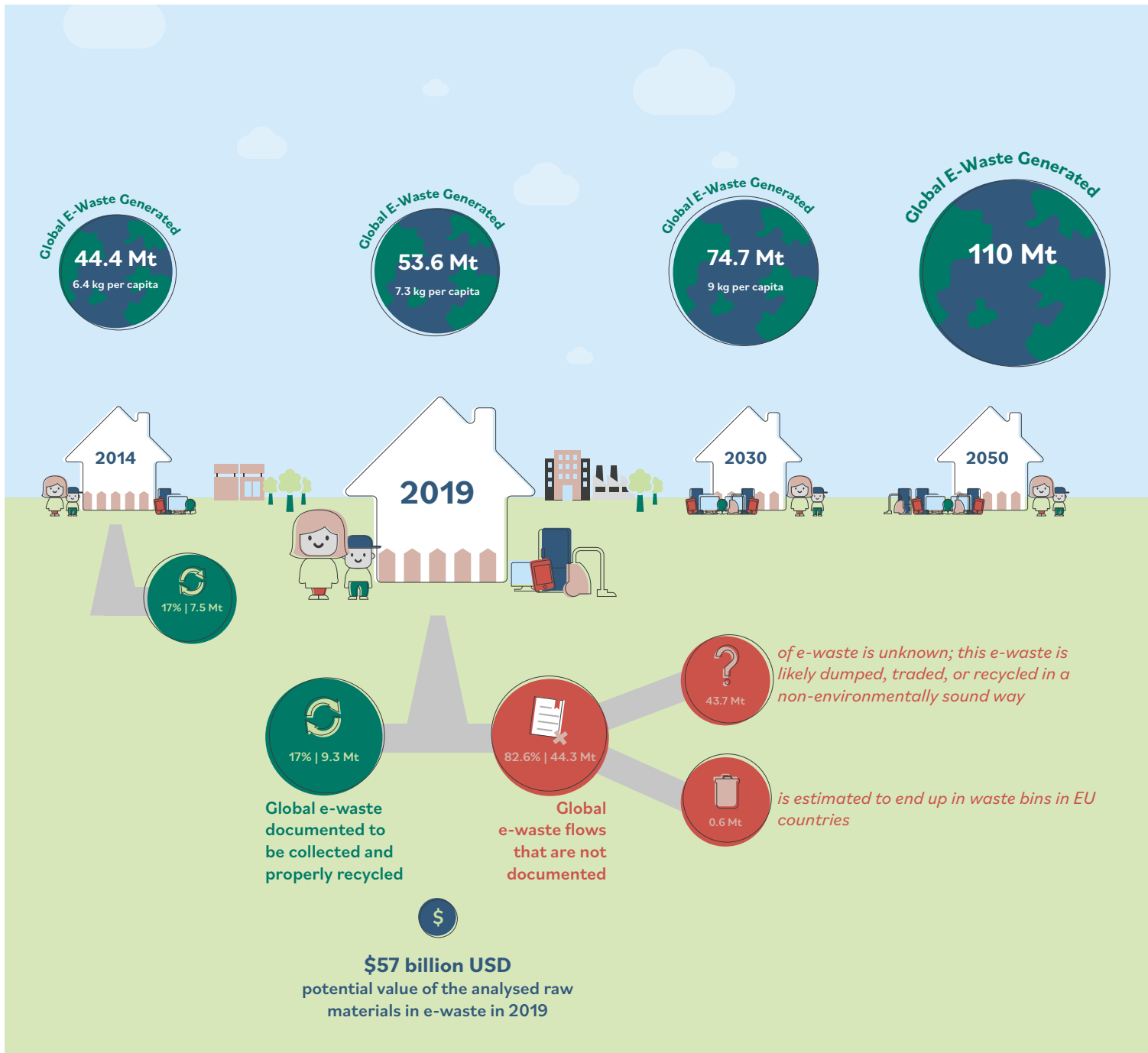
Category 5: Small equipment

Typical equipment includes vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, electric toys, small medical devices, and control instruments.



Category 6: Small IT and telecommunication equipment

Typical equipment includes mobile phones, personal computers, printers, game consoles, calculators, and other small IT equipment.

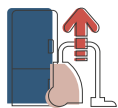


1.2 Global E-Waste Flows and Reasons

In 2019, the world generated 53.6 Mt of e-waste – an average of 7.3 kg per capita. E-waste generation is expected to increase by an average of 2 Mt annually to 74.7 Mt in 2030 (Forti et al 2020), and as much as 110 Mt is expected in 2050 (Parajuly et al 2019). Economic development and rapid change in technology render EEE obsolete, making e-waste the fastest growing waste stream globally. The growing amount of e-waste poses a threat to the environment, while simultaneously providing a business opportunity for extracting common, precious, and critical raw materials embedded in e-waste.

Only 17 percent of 2019’s e-waste generated was reported as collected and recycled, which means that other high-value, recoverable materials such as gold, silver, copper, and platinum, conservatively valued at \$57 billion USD, were substantially dumped or burned as opposed to being collected for formal treatment or reuse. And of the remaining 44.3 Mt of global e-waste flows not documented, the great majority is likely dumped, traded, or even (partially) recycled in a non-environmentally sound way, and it is estimated that 0.6 Mt ends up in waste bins in European Union countries.

The main reasons for the increasing amount of unmanaged e-waste flows can be summarised as follows:



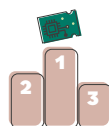
Increasing volumes of e-waste. It is estimated that the amount of e-waste generated will exceed 74 Mt in 2030, and as much as 110 Mt is expected by 2050 (Forti et al 2020, Parajuly et al 2019).



Absence of e-waste-specific legislation. As of October 2019, still 29% of the population was not covered by a national e-waste policy, legislation, or regulation. Thus, less than half of all countries in the world – 78 of the totals 193 (UN member states) – currently have a policy, legislation, or regulation in place. Sometimes legislation does not cover all types of e-waste (Forti et al 2020),⁸⁾ and in some countries with e-waste policy, legislation, or regulation actually in place, there is too little enforcement to argue that matters are under control and that e-waste is environmentally soundly managed.



Limitations of e-waste management infrastructure. In most countries, the organisational, financial, or technical capacities needed for e-waste management are not yet fully developed or, in some cases, are entirely absent. In high-income countries, e-waste can be mixed with other types of waste and may not undergo the required specific treatment steps, or the waste can be exported to low-and middle-income countries. Both cases lead to lower resource and environmental efficiencies. In low-and middle-income countries, e-waste is managed mostly by the informal sector, where e-waste is often handled under inferior conditions and not according to state-of-the-art processes.



Competition between formal and informal sectors for valuable e-waste parts. The informal sector nowadays plays a key role in low- and middle-income countries and regions, including in countries in Africa, Asia, and Central and South America with no developed (e-)waste management infrastructure (Wagner et al 2022; Baldé et al 2021; Iattoni et al 2021; Honda et al 2014). The informal sector plays a crucial role in the collection of e-waste and recycling of valuable materials from its components even though some materials are only partially recycled, and other materials are not recycled at all.⁹⁾

These informal treatment operations are sources of adverse health and environmental impacts in the informal sector, including the occupational exposure; community exposure; environmental contaminations and possible effects on children's health, mainly by pollutants not disposed of in an environmentally sound manner; and exploitation of child labour.



Legal and illegal import and export issues. A significant share of both the e-waste documented as being collected or recycled and undocumented e-waste is moved across borders as second-hand products or e-waste. Transboundary flows of e-waste have become a major concern for both exporter and importer countries. While the importing and exporting of e-waste is only regulated for hazardous waste by both national and international policies, laws, and regulations, the uncontrolled trade of e-waste often mixed with used-EEE can also favor corporate or organised crime. E-waste is one of the top three waste categories (Van Den Brink et al 2020) illicitly traded from 2018-2020, mainly as undeclared or falsely declared as used-EEE, new EEE, household goods, personal belongings, or other type of waste, as opposed to e-waste.



Mixing of e-waste with other waste streams such as metal scrap. This has mostly been studied within the European Union, but the situation is quite similar in other high-income countries, including the United States, Australia, Japan, etc. These countries possess a well-developed compliant e-waste management infrastructure for collecting e-waste in shops and municipalities, as well as for recovering recyclable components of the collected e-waste and disposing of residuals in a compliant and environmentally sound manner. However, according to target studies performed in the Netherlands (Baldé et al 2020), Romania (Magalini et al 2019), and for the European Union, United Kingdom, Norway, Switzerland, and Iceland (Baldé et al 2020b), significant portions of e-waste generated are still managed apart from compliant recycling sectors. Part of the waste is exported for reuse or is non-compliantly recycled with metal scrap. In fact, the largest uncompliant flow of e-waste is managed together with metal scrap but without proper depollution steps in place (Forti et al 2020), primarily for economic reasons, such as cutting costs.

⁸⁾ According to the **Regional E-waste Monitors**: - All 12 countries in the Commonwealth of Independent (CIS) region + Georgia have well-developed legal and regulatory frameworks in the field of waste management, but six countries have no specific legislations or EPR systems focused on regulating e-waste (Baldé et al 2021) - All 13 countries in the LATAM REM have well-developed legal and regulatory frameworks for waste management, but most do not have specific legislations for e-waste or EPR systems focused on the regulation of e-waste (Wagner M et al. 2022) - In the 11 countries part of the Arab REM, there are no specific e-waste laws yet in place. Consequently, e-waste can only be managed via existing legislation on general waste (Iattoni et al 2021)

⁹⁾ Formal recycling of e-waste does not always recover all materials, as in the case of informal recycling.

1.3 Transboundary Movement of EEE and E-waste

Transboundary movements of hazardous and other wastes, including EEE and e-waste, have represented a long-standing global concern for the negative impacts on human health and the environment when such wastes end up in countries without capacities for managing the waste in an environmentally sound way. The Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their disposal, adopted in 1989 and entered into force in 1992, is one of the main outcomes of the global efforts taken by governments to control transboundary movements of waste characterised as hazardous under the Convention. This multilateral treaty ratified by 189 countries/parties¹⁰⁾ is focused on preventing environmentally and socially detrimental hazardous waste-trading patterns, including those relating to e-waste, which, due to its constitution, often contains hazardous elements. Subsequent addenda to the Basel Convention on electric and electronic waste were introduced in 2006 (Nairobi Declaration) and 2011 (Cartagena Decisions)¹¹⁾.

The Basel Convention classifies hazardous waste in terms of the substances in the waste materials exhibiting a hazardous characteristic (e.g. ecotoxicity). Therefore, the Convention does not list, for example, computers as hazardous and keyboards as non-hazardous. Instead, it classifies wastes depending on their chemical properties and intrinsic hazardous characteristics.

This implies that the Convention does not have a specific rule for all forms of used and end-of-life electronics (Shalebadi, 2013). However, the most significant international guidelines addressing the management and transboundary movements of e-waste are the ad interim adopted technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, specifically regarding the distinction between waste and non-waste under the Basel Convention.

Basel Convention in-focus 1: Hazardous vs non-hazardous waste

*The Basel Convention is the main international regulatory instrument for regulating and controlling the transboundary movements of hazardous waste, defined under Article 1 – paragraph 1 of the Convention. The technical guideline on transboundary movements of e-waste and used-EEE details criteria for better **distinguishing** between **hazardous waste and non-hazardous waste** (the main distinction between entry A1180 and B1110).*

While the Convention remains a key instrument for controlling and preventing unsound management and illicit trafficking of hazardous waste, including e-waste characterised as hazardous under the Convention, there is not such level of control relevant to non-hazardous waste that can be traded across countries without being subject to the Prior Informed Consent (PIC) procedure. Nonetheless, if treated in an environmentally unsound manner, non-hazardous waste can still pose a threat to humans and environmental safety, thus potentially posing a burden on the primary receiving countries.

¹⁰⁾ C.f. <http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.aspx>.

¹¹⁾ The Nairobi Declaration on the Environmentally Sound Management of Electronic and Electrical Waste was adopted by the 8th meeting of the Conference of the Parties of the Basel Convention on the Control of Transboundary Movements of Hazardous Waste, held in Nairobi (Kenya) on 1 December 2006. The Cartagena Declaration on the prevention, minimisation, and recovery of hazardous wastes and other wastes was adopted at the 10th meeting of the Conference of the Parties to the Basel Convention, held in Cartagena, Colombia on October 2011.

Data stemming by the Parties to the Basel Convention mandated under Article 13 provide some information for analyzing flows and amounts of transboundary movement of e-waste (Forti et al 2020; Workshop Basel Convention Center Southeast Asia 2012; Ministry of Environment Japan 2013), but the information is insufficient for conducting a comprehensive analysis for the following reasons:



Incomplete reporting: Many Parties do not submit a national report, or do not submit a report every year, with less than 50 percent submitting their reports in 2019¹²⁾.



Ambiguous definitions: Interpretation of definitions is different among the Parties, which results in irregularities that impede aggregating and analyzing data.



Incorrect categorisation: The categorisations of wastes as hazardous waste is different among the Parties, due to diverging interpretations of Annex I, Annex VIII, and Annex IX of the Basel Convention, which provide the categories of wastes to be controlled, the list of hazardous wastes to be controlled, and the list of non-hazardous wastes, respectively.



Discrepancies in reporting: The amount of transboundary movement of hazardous wastes in the national reports may be inexact because the amounts described in notification and movement documents are usually different. This is because the amount described in a notification is a maximum amount of expected transboundary movement of hazardous wastes.



Data inaccuracies: The same transboundary shipment may be described by exporting and importing countries and may contain different amounts of hazardous waste, or sometimes the code and description of items may not match.

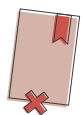
Basel Convention in-focus 2: Challenges of controlling transboundary movement of e-waste

According to the Basel Convention, EEE becomes e-waste if its holder discards it or intends (or is required) to discard it. Different definitions, or different interpretations, of the definition of waste implemented at the national level (e.g. non-reusable products) may pose challenges in controlling and monitoring the transboundary movements of waste, including e-waste. In general, to make a judgement as to whether or not an EEE product is waste, it may be necessary to examine all circumstances, including the history of an item, on a case-by-case basis, or via testing.

When inspecting a container carrying e-waste, often mixed with used-EEE and other products, distinguishing between e-waste and used-EEE often represents one of the main challenges because exporters sometimes provide false declarations or provide falsified functioning tests. The Basel Convention technical guidelines on e-waste offer in-depth guidance as to which characteristics should be considered for EEE to qualify as waste. The ad interim adopted Basel Convention technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, specifically regarding the distinction between waste and non-waste under the Basel Convention, offer in-depth guidance as to which characteristics should be considered for EEE to be waste. However, these are only guidelines and not a mandatory document in their nature. As well, some items (e.g. a laptop) may still technically be in good shape or workable, but there might not be interest in it or a market for it. If it is then disposed of by its owner, it automatically becomes waste.

The Harmonized Commodity Description and Coding System, also known as the Harmonized System (HS) of tariff nomenclature, is an internationally standardised system of names and numbers for classifying traded products. As of reporting year 2022, the harmonised system of 8549 heading in the HS includes the battery scrap descriptions in the prior schedule, but now it also covers ‘electrical and electronic waste and scrap’. E-waste is covered under codes ‘of a kind used principally for the recovery of precious metal (HS 854921)’, or ‘other electrical and electronic assemblies and printed circuit boards’, (HS 854931) and ‘other’ e-waste (HS codes 854929, 854939, 854991, 854999). This code could not yet be analysed for this study, and it is expected that due to the illegal nature of some e-waste shipments, the code might not be used to map all shipments.

Transboundary movement of e-waste is not easy to monitor for several reasons:



There is no global registry. E-waste is not comprehensively recorded by the Basel Convention. As well, there is no reporting obligation for used-EEE transboundary movement, and e-waste movements are often illegal in nature, which makes them very hard to track.



Global mapping efforts reveal trade routes but include no quantities. In 2010, the first mapping of trade routes was undertaken using trade statistics of waste batteries and accumulators (Lepawsky et al. 2010). It was assumed that the trade routes would reveal similarities with e-waste movement. Also, recent mapping of the Basel Action Network revealed routes of illegal shipments of e-waste, but, due to the small sample size, could not produce statistics (BAN 2016, BAN 2019).



Limited or unharmonised geographical scopes of studies. Some studies were carried out for a single country from only the importer’s or exporter’s perspective (Baldé et al 2020, Odeyingbo et al 2017), or perhaps for only a few products (Baldé et al 2016). The most comprehensive statistics were produced for the United States and the European Union. The United States used a mass balance method and price analysis of trade statistics and concluded that 8.5 percent of e-waste generated was exported as used-EEE. The Countering WEEE Illegal Trade study revealed that 15.8 percent of e-waste and used-EEE generated (1.5 Mt) was shipped out of the European Union. The reasons for exportation related to repair and reuse, but 30 percent of the shipments’ weight was still illegal e-waste. Those studies could not easily generate a global total, as many countries are missing or were using a variety of methodologies and scoping.

As a consequence to the mentioned points, to date only rough global estimates can be made. Based on all literature, the *Global E-waste Monitor* of 2020 estimated that the quantities of used-EEE and e-waste that were moved across boundaries ranged from 7 to 20 percent of e-waste generated (Forti et al 2020, Baldé et al 2016).

THIS STUDY

improves the statistics on transboundary movement of e-waste by:



Harvesting all possible datasets from the Basel Convention, trade statistics, and literature.

Harmonising the datasets.



Applying estimation routines based on mass balances and similarities across countries to estimate for missing data.

Distinguishing between controlled and uncontrolled movements of types of e-waste between countries:



controlled movement meaning

- e-waste movement declared under the prior informed consent procedure under auspices of the Basel Convention
- printed circuit board waste transports to specialist recyclers



uncontrolled movement meaning

- used-EEE and illegal e-waste



Creating one detailed harmonised dataset covering the entire world, with:

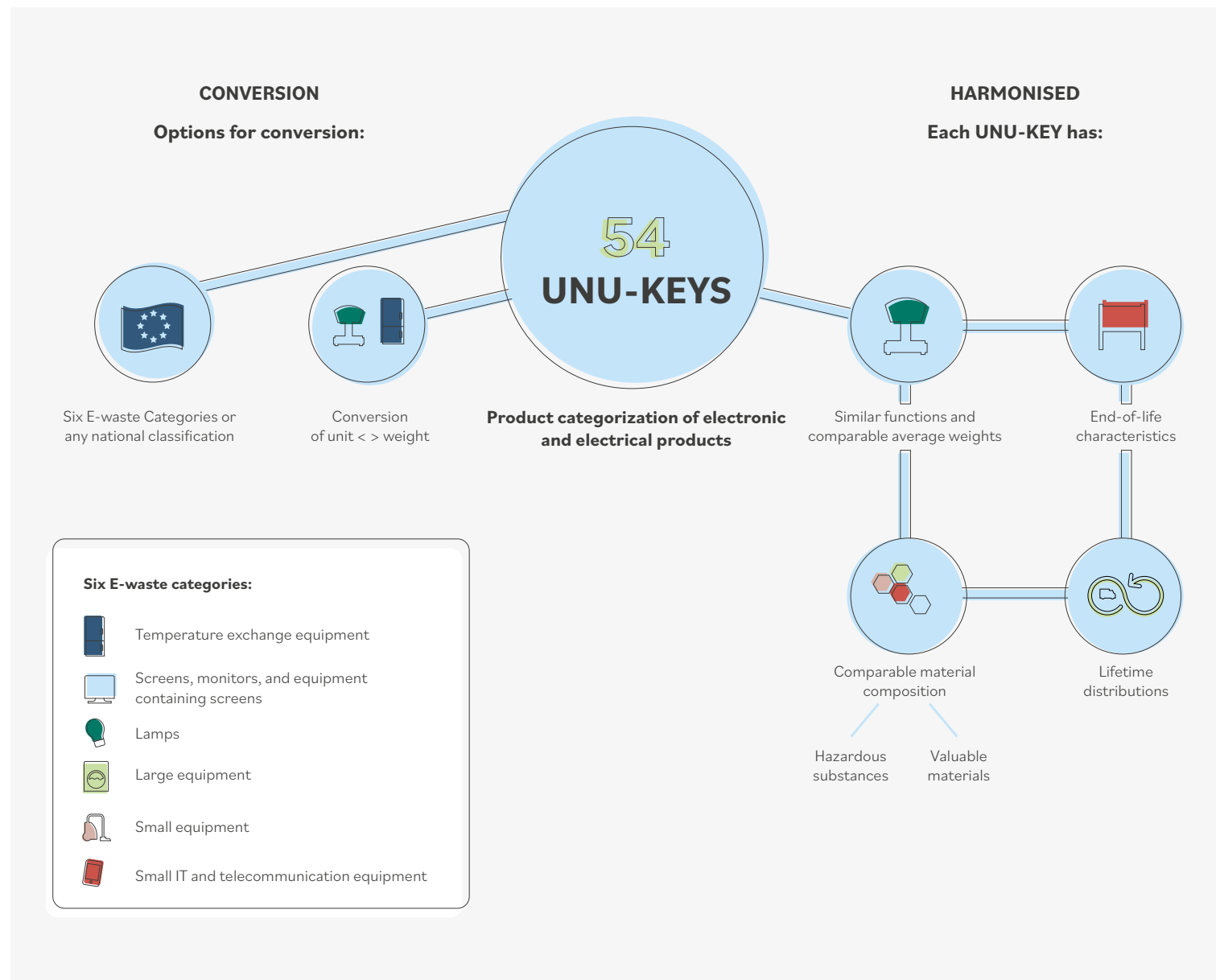
- trade routes of e-waste from importer and exporter perspective per country
- statistics in weight
- disaggregation in controlled and uncontrolled and, where possible, detailed into the type of e-waste

2 Methodology

The study follows the international guidelines on e-waste statistics (Forti et al 2018), which contain the most applied classifications on e-waste, as well as correspondence tables of those classifications. Conceptually, the classifications cover the entire mass balance from products that are placed on the market and the waste treatment per country. The mass balances per country are constructed in such a way that they can be aggregated to regional and global totals.

2.1 Classification

There are many types of EEE on the market. The UNU-KEYS are used to group them into categories that facilitate developments over time and international benchmarking of the e-waste management performance for each country or region. The UNU-KEYS are comprised of 54 products that are constructed in such a way that product groups share comparable average weights, material compositions, end-of-life characteristics, and lifetime



distributions. All data has been gathered, and calculations have been performed at the detailed level of the UNU-KEYS.

For better illustration, the results were grouped into the six e-waste categories mentioned in ‘Section 1.1 What is EEE and

E-waste?’. The UNU-KEY classification descriptions and the corresponding tables for the six categories are listed in ANNEX 1.

The measurement starts with electronic and electrical equipment placed on the market, which is then in use by consumers, businesses, or the government sector ('Stock').

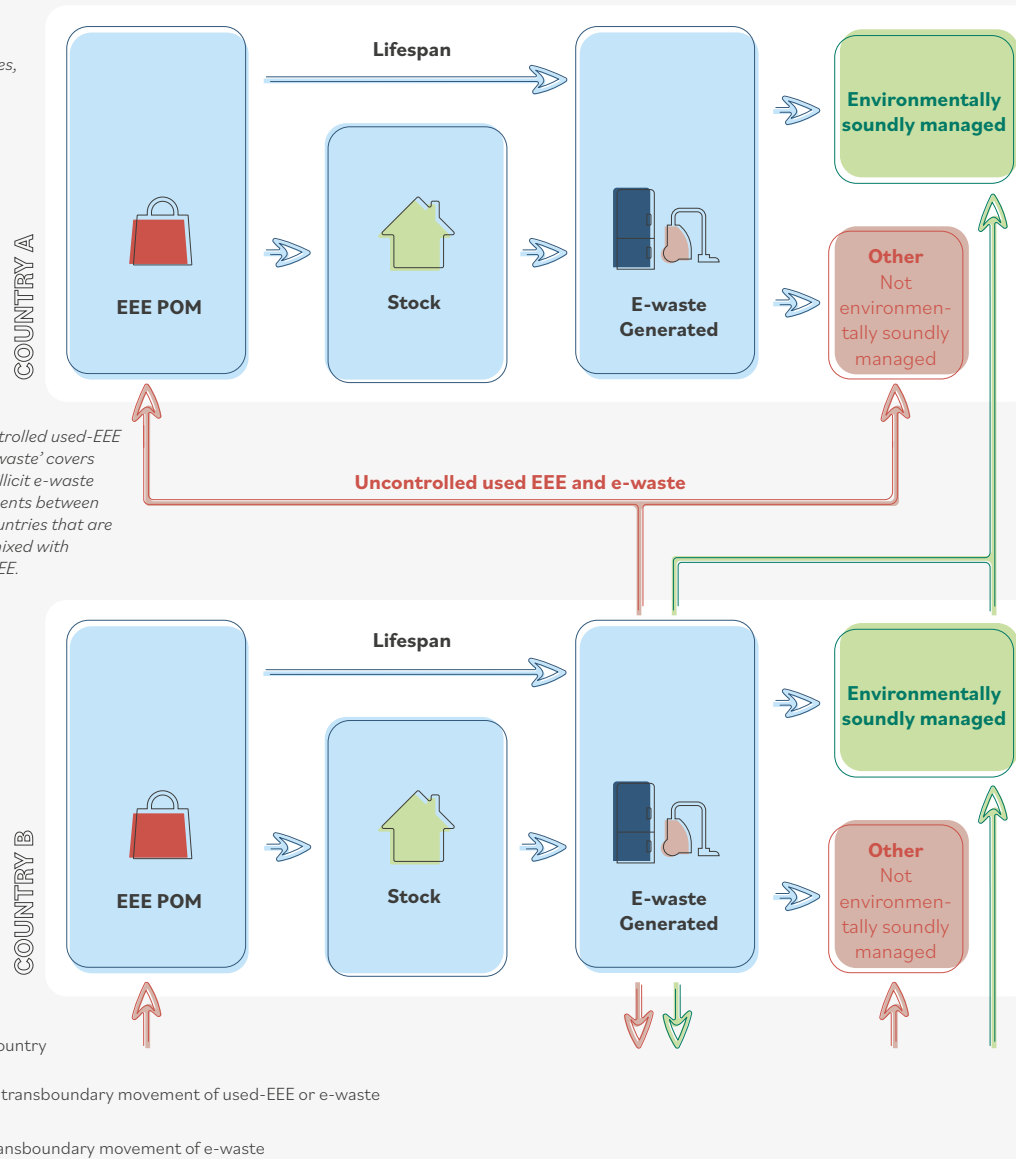
After the product-specific lifespan, the EEE is discarded and become 'E-waste generated', the total amount of e-waste prior to collection or any waste management activity. The lifespan includes second-hand reuse and repair within the country.

A share of the total amount of e-waste generated is 'Environmentally soundly managed', i.e. collected by formal, designated organisations, producers, or the public sector, and treated in dismantling and treatment facilities as regulated under national e-waste legislation.

'Other waste management routes' addresses e-waste disposed of in waste bins, going to landfills or incineration facilities, as well as e-waste collection outside of the formal systems. This could involve handling of e-waste by informal actors that obtain or buy e-waste door-to-door or by mixing e-waste with other waste streams, such as metal scrap.

After dismantling, specific parts of collected e-waste may be sent to other countries for environmentally sound treatment ("Controlled e-waste"). This is subjected to notification, such as notification under the prior informed consent procedure in the Basel Convention for hazardous e-waste parts, or transboundary movement of e-waste that poses little risk to the environment, such as printed circuit board waste going to smelters.

'Uncontrolled used-EEE and e-waste' covers illegal/illicit e-waste movements between two countries that are often mixed with used-EEE.



2.2 Assessment of E-Waste Flows

The assessments of the e-waste flows are based on mass balances at the country level, which are also used to quantify imports and exports between countries. The mass balance includes electronic and electrical equipment (EEE) that is placed on the market (POM), the stock of EEE already on the market, the calculation of e-waste generation by lifespan applied to EEE POM and stock, and the identification of whether e-waste is managed environmentally soundly or otherwise. The data are harmonised and balanced, which means that data from all sources have the same product coverage, are consistent (for instance that importation from country A to B is the same as an exportation from country B to A), and that the mass balances do not show negative quantities (e.g. e-waste treatment equals e-waste generation in a given year and is mathematically consistent with EEE POM and lifespans), for all e-waste flows in and across countries. This study distinguishes between the controlled transboundary movement and the uncontrolled transboundary movement of EEE for reuse (used-EEE) - or items that are broken, with specific dismantled parts - both of which are e-waste.

2.3 Data Sources and Calculation Steps

The datasets of EEE POM, EEE stock, e-waste generated, and environmentally soundly managed e-waste are obtained from *The Global E-waste Monitor* per UNU-KEY, aggregated to the six categories, and the totals for each country (Forti et al 2020). The reference year of the data presented is 2019. The national recycling rates are computed as the totals of annual environmentally soundly managed e-waste divided by the annual e-waste generated per country. The other waste management routes are calculated through the mass balance of the environmentally soundly managed e-waste subtracted from the e-waste generated.

The quantities of transboundary movement have been researched by integrating various datasets and methodologies and distinguished into controlled and uncontrolled movement. Controlled transboundary movements were assessed using data of such movements reported to the Basel Convention Secretariat, the office responsible for the European Union-Waste Shipment Regulation, and the movement of printed circuit board waste by using in the global trade statistics. Uncontrolled transboundary movements were quantified by analysing whether prices of EEE commodities recorded in the trade statistics are in ranges that are more reasonable for used-EEE or e-waste than for new EEE. The methods are described below in more detail.

Controlled movement

Quantities of hazardous e-waste and hazardous parts thereof should be reported by the Parties of the Basel Convention to the Secretariat and to the competent European Union authority for the Waste Shipment Regulation under the Prior Informed Consent procedure. These reported data were analysed based on the combination of the A/B and Y codes that are relevant for e-waste and a description using the method developed in the *Regional E-waste Monitor* series (Baldé et al 2021, Iattoni et al 2021, Wagner et al 2022). In 2019, less than 50% of the State Parties to the Basel Convention did submit relevant information on hazardous e-waste through the national reports. It is not assumed that the other countries simply did not encounter such exports. Therefore, data on controlled transboundary movements under the Prior Informed Consent procedure only reflect the situation of the reported hazardous e-waste imports/exports, which may largely differ from the actual situation. Missing data was conservatively estimated based on regional averages from reported amounts from the Parties to the Basel Convention. For instance, missing export data from one country in East Asia were estimated by first computing the total exports from other countries in East Asia where these data were available. The ratio of those total exports and the e-waste generation of those countries was used as a proxy to calculate the missing export data in proportion to the e-waste generation in this country.

Waste of printed circuit boards was analysed using HS code 711299 (waste and precious metal scrap or of metal clad with precious metals) extracted from the UN Comtrade database for all bilateral imports and exports between countries. The record of each country contains the HS code; reporter country; partner country; flows to and from the partner country in terms of import, export, re-import, and re-export, expressed as monetary value in USD; and the physical amount in mass. In theory, each flow is thus covered by two records: reporter country A and partner country B for the export flow, and vice versa for the same flow reported by country B with partner country A for the import flow. In order to create consistent datasets, the records with exports are primarily considered and supplemented with data that was recorded through imports. As a next step, the prices per mass are calculated per record. Prices between \$1 to \$15 USD/kg are typical for printed circuit board waste. The related flows were thus selected and marked as transboundary movement of printed circuit board waste. These results can be further aggregated to regional and global totals.

Uncontrolled movement

Uncontrolled transboundary movements of used-EEE/e-waste were estimated with analyses as described above for printed circuit boards, but with of prices adapted to the assessed goods. Similar methods have been conducted for quantifying exports from the United States (Duan et al 2013) and globally (Baldé et al 2016), though only for a few products. The Comtrade database was extracted for all bilateral trade for all relevant HS codes, using the list from the e-waste statistics guidelines (Forti et al 2018). The HS codes related to the category of lamps were not analysed, as there are, to date, no indications that uncontrolled transboundary movement of lamps takes place. Small equipment is produced in various qualities and sizes, which makes it very complex, if not impossible, to discriminate used EEE from new EEE for the HS codes for this category. Therefore, the outcomes from small equipment are not included. The 75 HS codes for the categories of temperature exchange equipment, screens and monitors, large equipment, and small IT equipment are analysed and presented in this report.

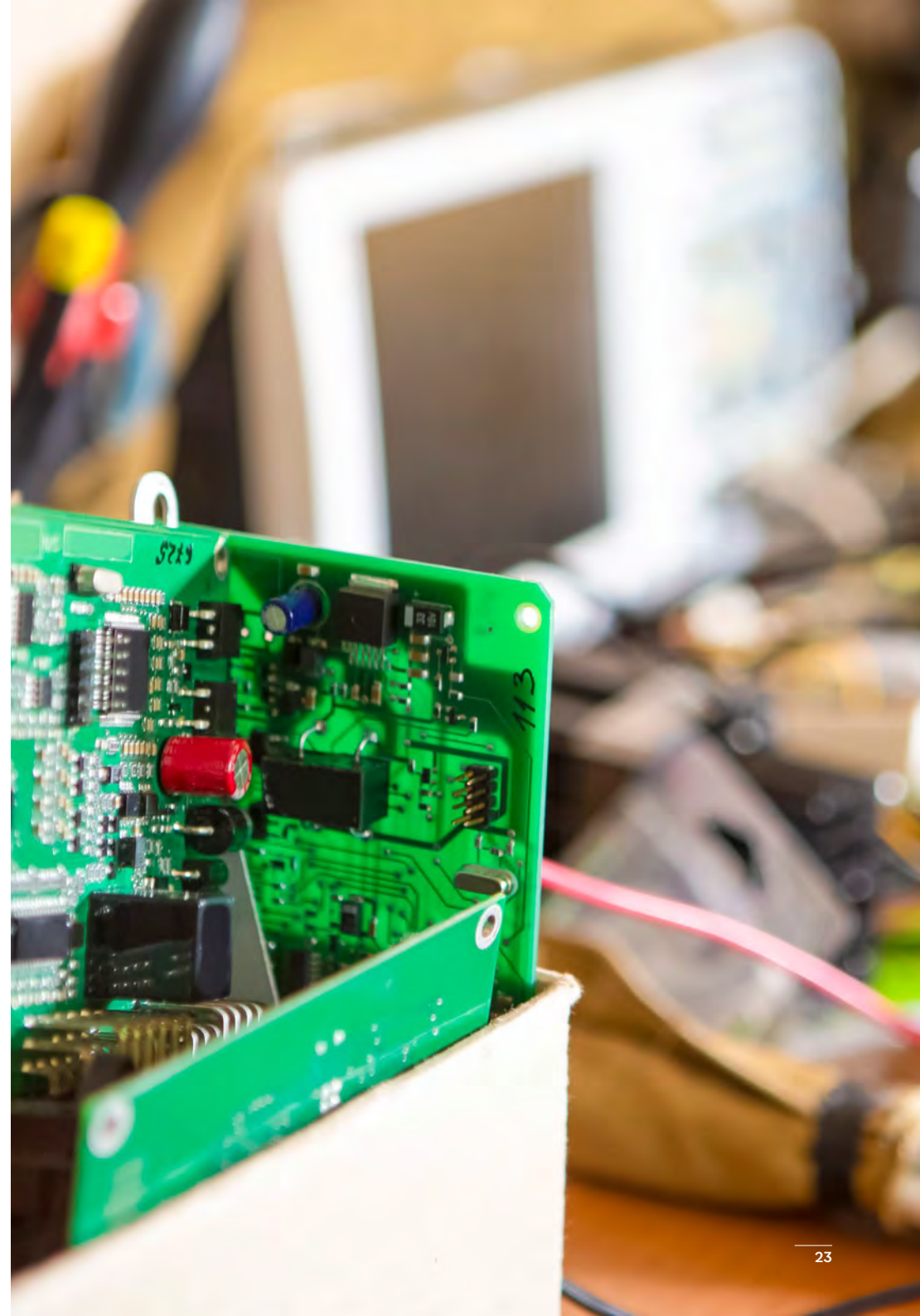
As described above for trade statistics on printed circuit board waste, one record contains the Harmonized Commodity Description and Coding System (HS code), reporter country, partner country, flow (import, export, re-import, re-export) monetary value in USD, and the physical amount. Only the records labelled as exports are considered. As a next step, the price per record is calculated. The distinction between the transboundary movement between used-EEE and new-EEE is done using a price analysis. First, the median price per HS code is calculated from the dataset of all bilateral trade. It was assumed that prices of an individual record below 30 percent of the median price refer to second-hand goods or waste.

For small IT, 10 percent of the median price has been used. The prices were compared with external data sources, such as prices on Amazon, and prices of used-EEE in the Person in the Port report (Odeyingbo et al 2017). Furthermore, since the analysis focuses on used-EEE and e-waste's transboundary movement, imports into wealthy countries (such as the OECD and countries in the gulf area) were excluded as well. A manual analysis of the largest exporting or importing records per UNU-KEY was done to ensure that accidental reporting errors in the trade statistics that occur at HS reporting level are either excluded from the datasets or imputed with another datapoint. Following those steps, a dataset was available that contained used-EEE or e-waste exports and imports from the entire world. Since many datapoints were discarded in the process, the entire dataset was extrapolated with a factor to match the quantities from the Countering WEEE Illegal trade datasets (Huisman et al 2015).

Beyond these limitations of national reports to the Basel Convention Secretariat, only legal shipments of hazardous e-waste are notified under the Basel Convention. Trade of second-hand EEE and illegal shipments are not reported. It is also difficult to reach an accurate estimate of the transboundary flows due to the illicit nature of the illegal shipments. Estimates on such quantities have been extrapolated from customs data on export violations or by identifying data gaps in national material flow analyses, which may be related to uncontrolled exports.

Printed circuit board waste generation and collection rates

The amounts of printed circuit boards generated was calculated per country from the *Global E-waste Monitor* dataset for e-waste arising in tonnage by multiplying it with the mass fraction of printed circuit boards per UNU-KEY from the internal datasets of the ProSUM project (Huisman et al 2017). The total amount of environmentally soundly recycled printed circuit board waste was calculated by multiplying the amounts of printed circuit board waste generated by the national recycling rate. The share of printed circuit board waste that is treated in an environmentally sound way was calculated to be at least the same percentage as the national recycling rate of the country of export. In cases where the share of exports was higher than the national recycling rate, the share of the exports was taken as the share of printed circuit board waste that is recycled in an environmentally sound way.



2.4 Stakeholder Consultations

To validate the main findings, the preliminary results of the analysis, a set of selected stakeholders have been contacted for in-depth online interviews. The stakeholders were mainly representatives of the enforcement sector and international experts with field experience and operational knowledge on the topic of transboundary movements, including of e-waste and used-EEE.

The key stakeholders from the enforcement sector operate in the main exporting hotspots – such as Belgium, Germany, Netherlands, and the United Kingdom – and have ground experience in main importing hubs in Asia and Africa. They provided targeted comments or additional knowledge on the specific regional conditions. Representatives from relevant international organisations were also interviewed to validate the results and the main trade routes emerging from the analysis.

2.5 Limitations to the Analysis

Mapping transboundary routes and simultaneously quantifying them has not been done at the global level, nor is the matter straightforward. Due to the absence of high-quality registers and clear classifications, the methodologies are more complex than simply querying and adding up the values in databases. This leads to uncertainty in the presented data. The reasons are as follows:

- First, the statistical datasets of hazardous e-waste in Basel Convention National Reports showed many data gaps. The data gaps were conservatively estimated based on reported statistics in the Basel Convention National Reports.
- Second, movements of e-waste are often illegal, and the involved actors avoid formal recording, often falsifying records or making no notifications at all. Those misreported flows are not reported and thus are hardly identifiable. As well, stricter enforcement in one country could also cause changes of trade routes to other countries, which aggravates the difficulties of interpretations and extrapolations.
- Third, shipments of e-waste mixed with other waste streams are not captured. Such can include, e.g., shipments of e-waste being classified as metal scrap. Such mixed shipments are often intentional and illegal. These flows were impossible to assess in this study, but could be significant, as was researched for the Netherlands (Huisman et al 2012).





- Fourth, global trade hubs cause further limitations. Often, shipments to a trading hub such as Hong Kong or Dubai are not representative of the final destination and could lead to double counting, as the same load is recorded twice in the statistics. Where it was suspected that the load was recorded twice, it was excluded from the analysis to correct for potential double counting. This report presents regions, instead of individual countries, due to the uncertainty of intraregional local trade from the trade hubs and to be more robust for changing routes. Additionally, the quantity and quality of data from, e.g., Europe is higher, so the overall results may be influenced by the amount of data available for different continents.
- Another limitation is related to the price analyses of the detailed records in the trade statistics, which had to be applied to distinguish used-EEE from new-EEE. Some records are of a low quality, as errors are often made by the data providers. Typical errors include entering kg data instead of tonnages, or vice versa. Such errors clearly limit analyses. Mistakes in the physical units can lead to dubious prices such that the price approach could lead to incorrect conclusions. Therefore, strict selection criteria for data records were applied in this study to prevent such incorrect conclusions, which, however, causes a tradeoff. While preventing inaccurate conclusions, this approach also resulted in a lot of discarded records that weakened the database by reducing the data that could be used for the analysis. Additionally, in movements between countries where the majority of traded goods was new electrical and electronic equipment, the trade of second-hand equipment is undetectable, since the high prices of the new equipment dominate the data analysed. So, the applied price-based approach can thus be assumed to result in significant underestimates of the real totals. This effect was corrected by an extrapolation step with known quantities in the literature for a few trade routes that were applied to other trade routes as well.

Despite these uncertainties, the quantities presented are harmonised and consistent with each national mass balance considered in this study and contain an unprecedented set of detailed information with a degree of accuracy that should allow insights and for drawing conclusions regarding the magnitude and trade routes. This allows for better understanding and control of transboundary e-waste flows and equates to a significant improvement to the knowledge from before the study was conducted, though the data needs to continuously be updated. Besides further methodical adaptations, above all the data quantities and qualities of transboundary movement of e-waste can always be improved at national and international levels to allow for more accurate and comprehensive assessments. The trade routes presented in this study are confirmed through the stakeholder consultations and are considered representative.

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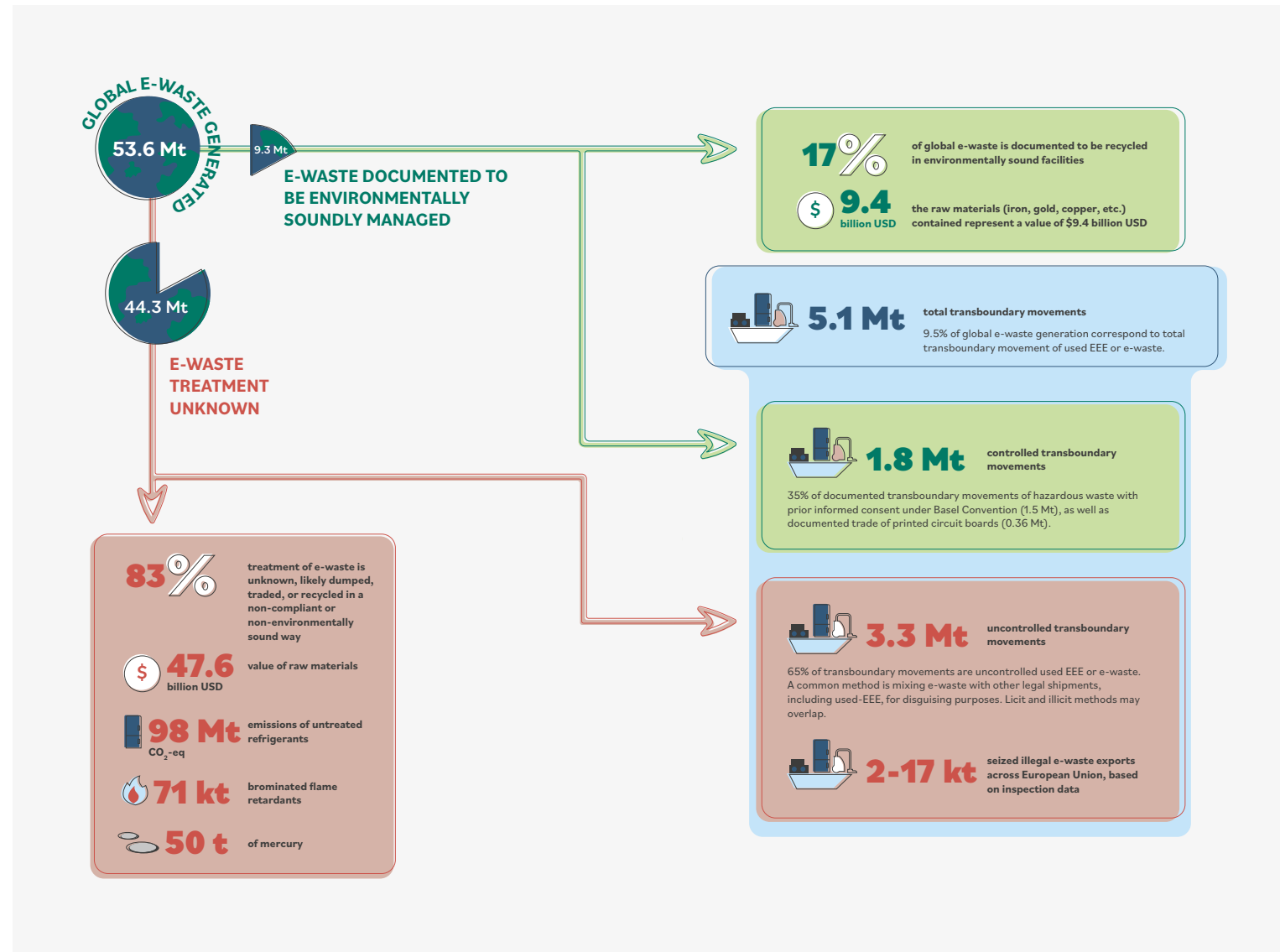
Global statistics

3.1 Global E-Waste Flows of Transboundary Movements

53.6 Mt Global e-waste generation is 53.6 Mt, only 17 percent of which is documented as having been managed in an environmentally sound manner.

In 2019, a total of 53.6 Mt of e-waste was generated globally. Only 17 percent thereof were documented as having been managed in an environmentally sound manner, thus allowing for the recycling of \$9.4 billion USD gross value in iron, gold, copper and other valuable raw materials. The fate of about 83 percent (44.3 Mt) of e-waste generated is thus unknown or unaccounted for. The waste might be treated and recycled in an undocumented way or it is sometimes dumped, burned, traded, or even recycled in inappropriate or uncompliant manners, with a potential loss in gross value of \$47.6 billion USD of precious metals.

Only 17 percent of total e-waste generated is managed in an environmentally sound manner, while the fate of approximately 44.3 Mt is unknown or unaccounted for, with a potential loss in value of precious metals of \$47.6 billion USD.



5.1 Mt Globally, 5.1 Mt of e-waste are moved across countries, of which 3.3 Mt is uncontrolled and 1.8 Mt is controlled.

Just below 10 percent of the total e-waste is moved across countries (5.1 Mt), of which only 1.8 Mt is controlled movement of e-waste. This involves reported movements according to the Basel Convention control regime (prior informed content procedure) and printed circuit board waste that is shipped into countries that have specialised environmentally sound printed circuit board waste treatment facilities. The share of controlled movements accounts for 35 percent of all transboundary movements. Roughly 3.3 Mt (65 percent) of annual transboundary movements are uncontrolled. This uncontrolled waste consists of a variety of types of trade, ranging from entirely legal trade, such as used-EEE for reuse in recipient countries, to e-waste that is illegally moved to other countries because of the countries' lower treatment costs.

2-17 kt Merely 2-17 kt of e-waste are seized as illegally traded from the European Union, and the actual numbers are likely much higher.

Even though it is challenging to accurately estimate the illegal waste exports, only roughly 2 to 17 kt of e-waste were seized as having been illegally traded across national borders in 2019 from the European Union.¹³⁾ This is still at the same order of magnitude found during the Countering WEEE Illegal trade project. In that report, at least 2 kt were reported as seized illegal shipments in 2010, leading to some form of sentencing and/or administrative fines or civil penalties. Thus, the problem of illegal e-waste shipments still exists, and the seized amounts likely represent only the tip of the iceberg, as the total amount of uncontrolled e-waste movement (3.3 Mt) is drastically larger.

A common method used to circumvent controls is mixing e-waste with legal shipments, especially used-EEE but also stuffed within transboundary movements of used or end-of-life vehicles. Misclassification, misdeclaration, and fraud are in fact the most reported modus operandi for illegal transboundary movements of waste in general, including e-waste, specifically. Illegal trade in e-waste is due to several factors: in certain cases, exports to remote countries are less expensive than managing the waste domestically; the presence of developed markets for raw materials; and the location of manufacturers of electrical and electronic equipment.

Illegal trade of e-waste is due to several factors: in most cases, exports are less expensive than managing waste domestically; presence of developed markets for raw materials; and the location of manufacturers of electrical and electronic equipment.

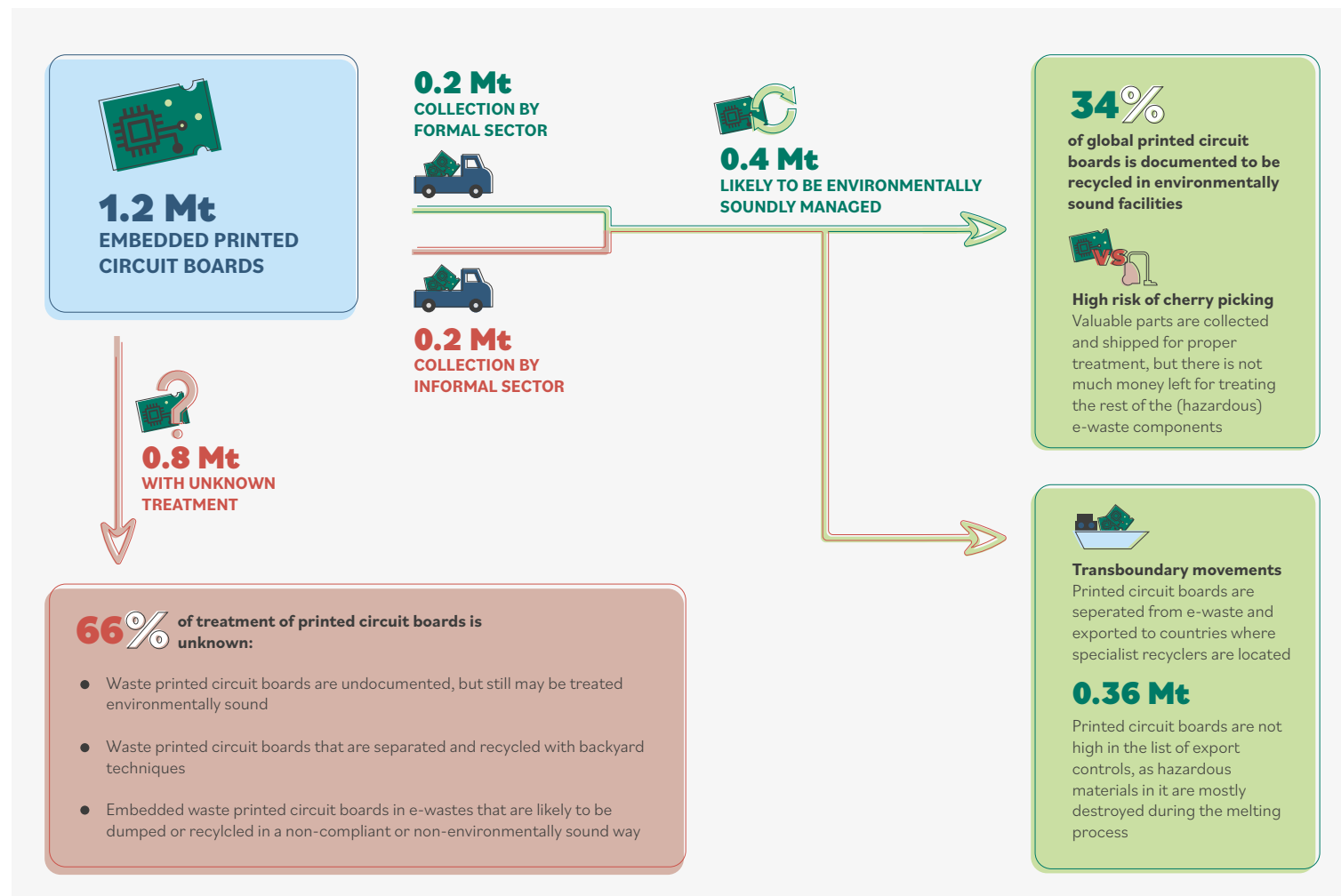
¹³⁾ This was estimated by extrapolating inspection data from the European Union.

3.2 Global Statistics of Printed Circuit Board Waste

34% 34 percent of global printed circuit board waste is recycled in environmentally sound facilities, a higher percentage than e-waste overall (17 percent).

Printed circuit board waste represents a high-value fraction of e-waste, as such waste can contain high concentrations of precious metals as gold, silver, palladium, and copper. 1.2 Mt of printed circuit board waste are in the total annual e-waste amounts. The management of the printed circuit board waste depends largely on the existence of specific legislation for managing e-waste and the existence of e-waste management infrastructure. It is estimated from the global collection and recycling rates of e-waste and the mapped transboundary flows of separated printed circuit board waste that approximately 0.4 Mt of printed circuit board waste is separated from e-waste and recycled in specialised environmentally sound primary and secondary (or similar) smelters, as in, e.g., the European Union, North America, Korea, or Japan.¹⁴⁾ From the 0.4 Mt, it is estimated that 0.36 Mt of printed circuit board waste is moved across borders to reach the facilities. This data matches the total maximum capacity of the main printed circuit board waste smelters of 0.5 Mt found in online sources.¹⁵⁾

The 0.4 Mt of soundly recycled printed circuit board waste comprises 34% of



printed circuit boards contained in e-waste generated. This is a substantially higher percentage than the global documented e-waste collection rate of 17 percent in the formal sector. The difference could come from informal dismantled e-waste, assuming that the formal collection rates of general e-waste is the same for printed circuit board waste.

Compared to 17% of e-waste collected and treated formally, due to its high value, 34% of printed circuit board waste is documented to undergo formal, sound recycling. So, roughly half of these printed circuit boards come from informal collection and pre-treatment, while 66 percent are not documented to be recycled in environmentally sound facilities.

¹⁴⁾ Waste printed circuit board treatment in China is a factor of uncertainty. There appear to be smelters, some of which are modern while others are less so, but quantitative data is lacking.

¹⁵⁾ See Chapter 5 References's full list of consulted websites: Glencore; Boliden; Escrap news; Aurubis, Umicore.



There is a high risk of cherry-picking of printed circuit boards waste while remaining hazardous components and the fate of 66 percent depends on e-waste management infrastructure. The better developed the country – typically in high-income countries – the higher the chance for better management.

After the separation of the printed circuit board waste, the remaining e-waste loses most of its value, specifically in cases of IT equipment waste, but still contains hazardous materials. The fate of the e-waste parts without the printed circuit board, depends largely on the country where the dismantling occurs. If the separation happened in countries with developed e-waste management infrastructures and functioning e-waste legislation, all remaining parts are treated by mostly local or regional e-waste treatment facilities in an environmentally sound manner. They produce secondary raw materials, and hazardous and other parts that can't be recycled are disposed of adequately. If the dismantling occurred in countries without legislation or any e-waste management infrastructure, the chances are very high that the discarded printed circuit boards are dismantled, and the remaining non-valuable e-waste parts are simply burned or dumped at inadequate landfills.

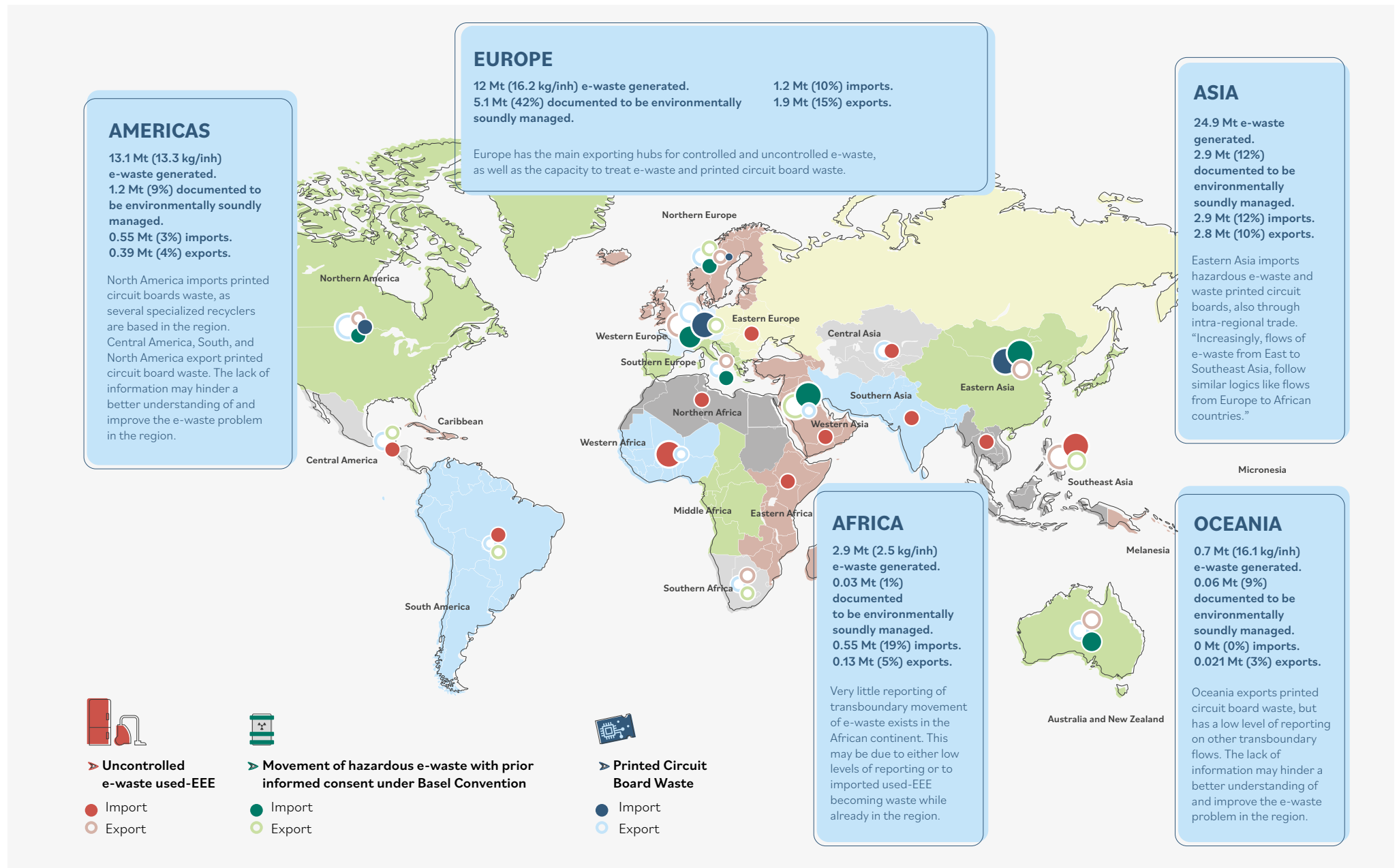


The fate of most discarded printed circuit boards is unknown

The fate of 0.8 Mt (66%) of printed circuit board waste is unknown. It may be that these flows are undocumented, but still are separated and end up in sound treatment facilities – a notion which is supported by the finding that approximately half of documented formally recycled printed circuit boards comes from informal collected flows of e-waste. It can also be that separated printed circuit board waste is treated in backyard recycling techniques, causing environmental damage or risks to human health. Finally, the discarded printed circuit boards may be shredded with the products, i.e. without separating the printed circuit boards, especially if the printed circuit boards are of low value while the product contains a high share of metals. Washing machines are one such example of this type of products.



3.3 Global Import and Export Hotspots*



High-income regions possess an e-waste management infrastructure and import some e-waste for environmentally sound treatment.

High-income countries – typically found in the North America, Europe, and East Asia – have the highest documented collection and recycling rates. In Europe, 42 percent is documented as being environmentally soundly managed, followed by Asia (12 percent), then Oceania and the Americas (both 9 percent). This indicates that those high-income countries have e-waste management infrastructure developed, despite not being sufficient to manage all e-waste generated. This is, e.g., related to their higher smelting capacities for printed circuit board waste and their ability to manage hazardous parts managed under the Basel Convention.

Low- and middle-income regions are subjected to imports of e-waste and have inadequate infrastructure for managing e-waste.

The African continent receives significant imports of used-EEE and/or e-waste, an impressive 0.55 Mt as compared to 2.9 Mt of domestic e-waste generation. E-waste is usually traded to the continent through mixed shipments of used-EEE and e-waste in containers, but is also stuffed in end-of-life or used vehicles. Africa exports limited e-waste to other regions with treatment facilities or smelting capacities, and the lowest formal and documented collection and recycling rates globally are found in Africa. Only 1 percent is documented to be environmentally soundly managed¹⁶⁾. Thus, the e-waste management infrastructure and legislation is inadequate for managing the e-waste arising from new and imported used-EEE, and the e-waste imported. Imported e-waste thus adds to the significant burden on the continent from domestic e-waste. Similar dynamics are also found in other receiving regions, such as Central and South America and Southern and Southeast Asia.

High-income regions export uncontrolled used-EEE and e-waste to low- and middle-income regions, causing damage to human health and the environment.

The uncontrolled movements of e-waste and used-EEE from high-income areas to countries that do not have the proper infrastructure to adequately manage hazardous substances existing in e-waste results in damage to both human health and the environment. The techniques employed by the informal sector often perform modestly in terms of environment, health and safety, and in some cases possibly also in recovering valuable resources. In certain regions, most non-valuable and hazardous e-waste parts end up in (often unauthorised) landfills, ill-equipped recycling facilities, and open-air burning. The waste is dumped in areas where residents and workers – without proper equipment or adequate training – manually disassemble the units and collect valuable material that can be sold, reused, or recycled. What is not reusable is then dumped – unmanaged in uncontrolled facilities or in open dumping sites – causing severe health and safety issues

for local environments and contributing to environmental degradation. Collecting from the waste stream or scavenging materials from waste and recycling is an important economic activity that generates income in low-income countries.

The reasons behind exports of untested used-EEE that in part is e-waste are the demand for used-EEE in lower income countries and thus achievable good prices for reuse of such equipment. E-waste can still be sold to obtain spare parts for repair or recycling. Illegal exports on a commercial and larger scale may also be motivated by escaping the higher costs of e-waste treatment for some types of e-waste in higher income areas. As widely recognised, this may increase the risks for receiving countries to experience severe environmental and health damages, as well as becoming opportunity for criminals to exploit these trade routes for illicit shipments or other related crimes.

¹⁶⁾ It is important to note that these figures by definition exclude the important and strong role of informal collection and subsequent treatment, which results in very high collection and treatment rates, even though conducted under substandard conditions. Additionally, the rates of reuse and repair are high, thus contributing to avoidance of e-waste. Also see Balthasar Groscurth: *Extended Product Lifespan Abroad - Assessing Repair Sector in Ghana*, https://online.electronicsgoesgreen.org/wp-content/uploads/2020/10/Proceedings_EGG2020_v2.pdf

Low reporting under the Basel Convention may favor illegal movements and pose a threat to managing e-waste.

Many countries do not keep records and statistics on the transboundary movement of hazardous e-waste, specifically in the Americas, Asia, Oceania, and Africa. The lack of reporting, the general low quality of data, and the lack of control of transboundary movements of e-waste (through the Basel Convention) pose a threat to the environmentally sound management of e-waste and may favor illegal movements from/to the region (Baldé et al 2021, Iattoni et al 2021, Wagner et al 2022).

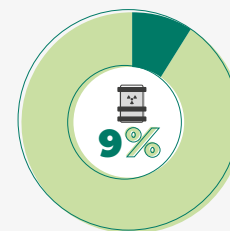
Transboundary movement occurs both intercontinentally and within continents. The higher the e-waste’s value per mass, the further it can be transported.

The high-income countries in North America, Europe, and Oceania are net exporters with intercontinental destinations such as Africa, Asia, and Southern or Central America, which are net importers. Similar patterns, however, seem to be expanding within continents as well. Increasing flows of e-waste are documented as reaching Eastern Europe (mainly coming from Western Europe) and Southeast Asia (mainly coming from East Asia). These flows follow the same logic as the intercontinental trades. Asia is both an importing and exporting hub since it is a manufacturing site for EEE and with a certain level of intra-regional e-waste trade. Similarly to what is happening for other waste streams (e.g. plastics), one reason likely relates to the increased number of facilities able to treat e-waste at the regional level.

Controlled transboundary movements of hazardous e-waste possesses the lowest value per unit of mass, as it costs to depollute and manage it in an environmentally sound way. Only 9 weight percent of all movements are between continents. Printed circuit board waste represents the highest value fraction of e-waste. 51 weight percent of all movements occur between continents¹⁸⁾. Movements of used-EEE and illegal e-waste are in between, accounting for 38 weight percent of all movements across continents. So, generally speaking, the higher the value, the higher the probability of intercontinental transboundary movement.

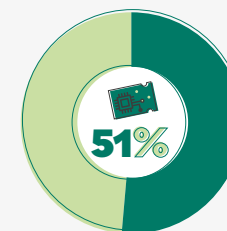
Continent	Countries reporting under the Basel Convention	Total countries
Americas	18	35
Europe ¹⁷⁾	36	42
Africa	10	53
Asia	27	47
Oceania	3	13

Share that is traded across continents



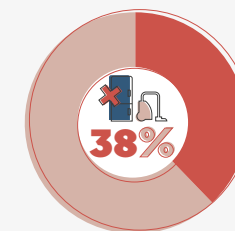
Hazardous e-waste with prior informed consent

Controlled e-waste



Waste printed circuit boards

Controlled e-waste



Used EEE and illegal e-waste

Uncontrolled e-waste



“In the current world, post-pandemic and with the geo-political escalations and the increasing prices of energy, we might expect even more intra-regional waste trade taking place”.

¹⁷⁾ For European Union Member States, reporting is mandatory under the Waste Shipment Regulation – which corresponds to the actual transposition of the Basel Convention. For this reason, the reporting rate in Europe might be higher overall than in other regions, where reporting is not mandatory.

¹⁸⁾ But this number can be higher, due to low reporting under the Basel Convention.



In focus - exporting used-EEE mixed with e-waste in used vehicles.

Both the enforcement sector and the academic community agree on the fact that a common method of illegal disposal appears to be exporting e-waste with other, legal shipments – specifically, second-hand vehicles and end of life vehicles. However, little in-depth research exists on this aspect and is often limited to specific trafficking routes (Bisschop 2012; Odeyingbo et al. 2017; McMahon et al. 2021).

By applying a methodology to quantify transboundary movements of used-EEE and e-waste hidden in used-vehicles previously tested on the Dutch scenario (Baldé et al. 2020), the herein study confirms that Western and North Africa are the top receiving regions – respectively receiving 62.5 kt and 47.8 kt of mixed e-waste and used-EEE charged on used vehicles. As reported by the interviewed stakeholders, Eastern Europe can, to some extent, be regarded as an emerging importer (37.6 kt), where e-waste and used-EEE are sent through transporters on roads and often resold at flea markets. Top exporters are Western Europe (113 kt), Northern Europe (30.4 kt), and North America (30.3 kt). One modus operandi reported by enforcement officers is often linked to migrated groups that initiate this type of (licit) trade to send money and products to their origin countries. However, this can also turn into an illicit activity, such as, e.g., using false declarations or forging declarations altogether.

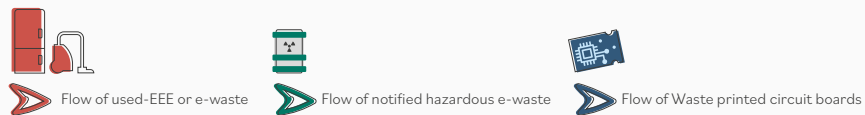
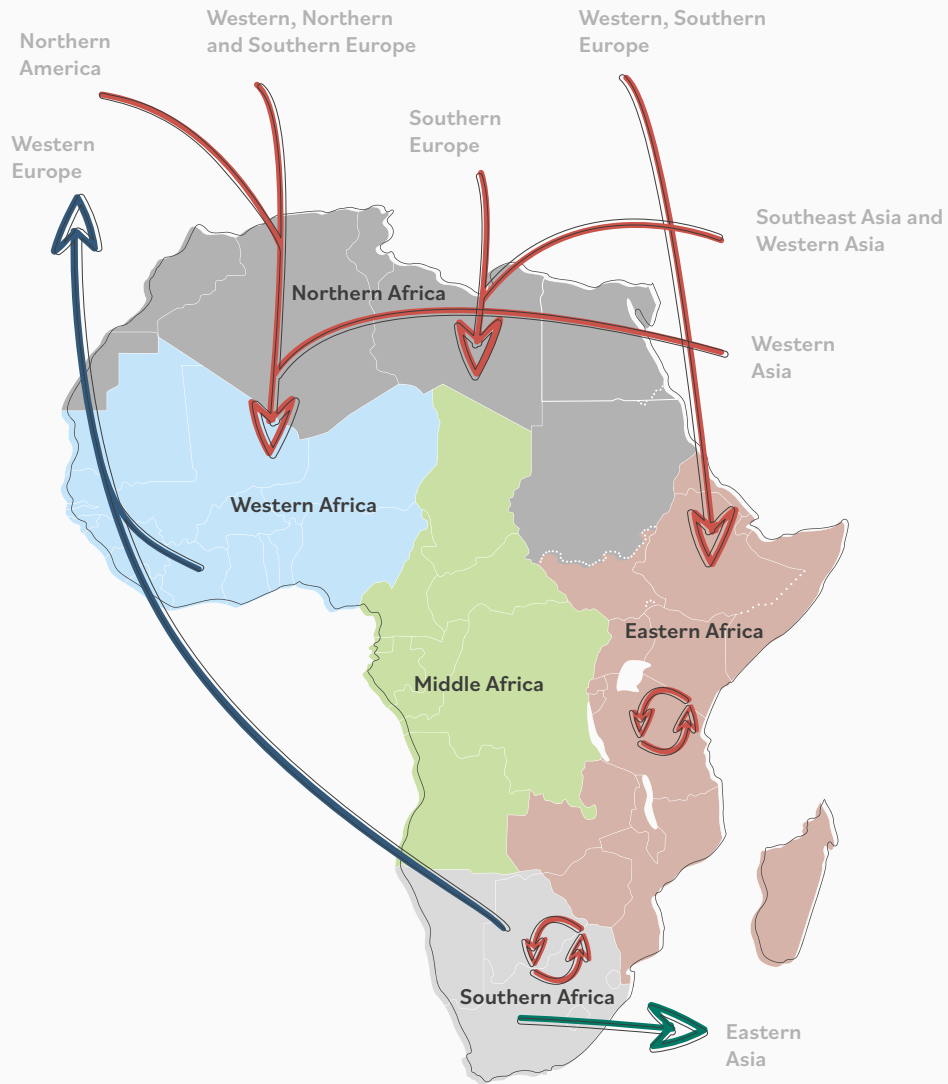
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Regional overviews¹⁹⁾



¹⁹⁾ The regions in this chapter, and in the overall analysis, are considered according to UN regional division. In the regional maps, the most relevant flows are highlighted, from the perspective of the region in the continent.

Africa



INDICATORS AFRICA

Waste generation (Mt)

Total e-waste	2.9
Embedded Waste Printed Circuit Board	0.1

Environmental sound collection and recycling (Mt)

Total e-waste	0.03
Printed Circuit Board Waste	0.01

Not environmental sound managed e-waste (Mt)

Total e-waste	2.9
Embedded and Printed Circuit Board Waste	0.1

Environmental sound collection and recycling rates

Total e-waste	1%
Printed Circuit Board Waste	13%

Not environmental sound managed rates

Total e-waste	99%
Printed Circuit Board Waste	87%

TRANSBOUNDARY MOVEMENT BETWEEN COUNTRIES (kt)

Total Exports	132
<i>Controlled</i>	
E-waste reported as hazardous	12
Printed Circuit Board Waste	7
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	113
Total Imports	546
<i>Controlled</i>	
E-waste reported as hazardous	19
Printed Circuit Board Waste	0
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	527

INHABITANTS (MILLION)

1 152

In Africa, only 0.03 Mt of the 2.9 Mt of total e-waste are documented as being treated in environmentally sound facilities, indicating that Africa cannot manage the 546 kt of additional imports it received, resulting in massive health and environmental damages, as well as lost resources.

In 2019, Africa generated 2.9 Mt e-waste, which has 0.1 Mt printed circuit boards embedded. Only 0.03 Mt of these 2.9 Mt of e-waste are documented as being treated in environmentally sound facilities. Almost none of the e-waste is environmentally soundly managed, due to the absence of proper e-waste management and recycling infrastructure and capacities. The continent is characterised by a widespread and strong informal sector presence, whose actors are engaged in collection and cherry-picking of valuable parts, while the remainder ends up in open dumpsites or is burned in the open air, with massive health and environmental damages.

Imports into Africa total 546 kt, with the main importing areas being North Africa (230 kt) and West Africa (216 kt). The total exports are 132 kt, which makes Africa a net importer. If compared to e-waste generated in the continent, imports amount to 19 percent of the total e-waste generated on the continent – the world’s highest percentage. Since Africa has very little e-waste management infrastructure, it is incapable of managing such large quantities of imports in formal sectors. The lack of proper legislation (or relevant enforcement when it is in place) and adequate financing structures do not enable conditions for the domestic and imported e-waste to be managed in an appropriate manner. Thus, imports of e-waste lead to more e-waste that is inadequately managed.

North, East, and West Africa are the main importing hubs for uncontrolled used-EEE and e-waste exports, coming primarily from Europe and to a lesser extent from West Asia. This places a big burden on the environment and on informal workers.

With respect to imports, the large majority is uncontrolled used-EEE and e-waste. A large market for second-hand electrical and electronic products exist across all African countries. To avoid detection, illegal e-waste is thus often mixed with or mis-declared as used-EEE. Part of this used-EEE becomes e-waste either during transport, when products are not appropriately stored or protected during transport, or shortly after arriving in the destination country.

The African continent and especially North and West Africa, still receive most e-waste from Europe.





West Africa is the most impacted region in the continent, with an additional one-third of imported adding to the e-waste generated – some of which, according to one interviewed stakeholder, is then further shipped to neighbouring countries and beyond. This region is also the main hub for e-waste and used-EEE imported mainly from Europe, and subsequently traded further to other African regions or, to some extent, to neighbouring regions with treatment facilities, such as Southern Africa. In addition, West Africa witnesses a significant amount of e-waste and used-EEE imports linked to other shipments, especially end-of-life and used vehicles mainly originating from Western Europe, Northern Europe, and North America.

Imports in East and North Africa cause an additional one-fifth of e-waste to be managed (compared to e-waste generated). North Africa is also impacted by imports of e-waste and used-EEE mixed with end-of-life vehicles and used vehicles from Western Europe (Germany, especially, see Ayetor et al 2021) and, to a lesser extent, from North America. Specifically, Nigeria and Libya are hotspots of used vehicles imports, especially considering the fact that African governments have not been very successful in attracting manufacturers to invest in assembly plants on the continent (Ayetor et al 2021).

Middle Africa shows relatively little transboundary movement of e-waste, suggesting mostly informal processing of domestic e-waste.

Middle Africa is the only region that appears to receive relatively low amounts of transboundary traded e-waste or used-EEE. This might be probably due to the location of the countries, which are relatively distant from normal trading routes. Also, no notable movement of printed circuit board waste or hazardous e-waste was detected, suggesting that the local informal e-waste sector manages the e-waste²⁰⁾.

“I’ve seen countries importing items as used-EEE, performing checks only afterward and finding out they were waste. Importing/exporting mixed used-EEE and e-waste is a regular modus operandi.”

Interviewed stakeholder

²⁰⁾ This is based on the knowledge and interpretation of the authors.

Africa reports very little to the Basel Convention, indicating a low capacity for environmentally sound treatment of e-waste and the presence of domestic sector of informal workers.

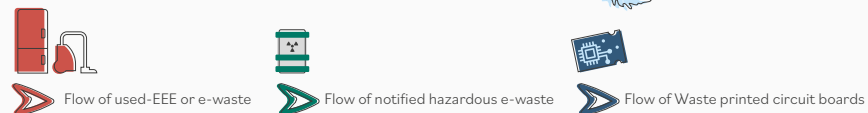
Africa imports 19 kt of hazardous e-waste under the Basel Convention and exports 12 kt – very little importation in total in relation to the total amount of 2.9 Mt of e-waste. This indicates that Africa has very little capacity to manage e-waste environmentally soundly and that it has a strong domestic sector of informal workers. There are some documented exports from Southern Africa to East Asia, as well as some imports into North Africa from East Asia. This may be due to low reporting levels as well as to the fact that imported used-EEE is actually near end-of-life equipment, which quickly becomes waste upon arrival in the region. Also, the fact that very few treatment and recycling facilities exist in the region for handling e-waste in an environmentally sound manner hinders the possibility of starting the notification process. The notification process itself represents a challenge for both authorities and recyclers, for lack of experience, or limited knowledge of the Prior Informed Consent Procedure roles and steps (Prevent Waste Alliance and StEP 2021).

Africa exports 13 percent of their printed circuit board waste to Western Europe, with a high risk for cherry-picking leaving the hazardous components and parts unmanaged.

All regions show dismantled printed circuit boards, which are exported to Western Europe. Those occur mostly from Southern and West Africa to treatment facilities in other continents, especially in Western Europe, where some of the world's main recycling plants for printed circuit board waste are based. With the presence of the informal sector, this comes with a high risk for cherry-picking of only the valuable parts, neglecting other e-waste parts that can end up untreated, dumped, or burned in the open air in Africa.

Very little reporting of transboundary movement of e-waste occurs in the African continent. This could be related to low levels of reporting as well as to imported used-EEE becoming waste while already in the region.

Americas



INDICATORS AMERICAS

Waste generation (Mt)

Total e-waste	13.1
Embedded Waste Printed Circuit Board	0.3

Environmental sound collection and recycling (Mt)

Total e-waste	1.2
Printed Circuit Board Waste	0.1

Not environmental sound managed e-waste (Mt)

Total e-waste	11.9
Embedded and Printed Circuit Board Waste	0.2

Environmental sound collection and recycling rates

Total e-waste	9%
Printed Circuit Board Waste	44%

Not environmental sound managed rates

Total e-waste	91%
Printed Circuit Board Waste	56%

TRANSBOUNDARY MOVEMENT BETWEEN COUNTRIES (kt)

Total Exports	547
<i>Controlled</i>	
E-waste reported as hazardous	31
Printed Circuit Board Waste	128
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	388
Total Imports	393
<i>Controlled</i>	
E-waste reported as hazardous	24
Printed Circuit Board Waste	65
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	305

INHABITANTS (MILLION)

984

In the Americas, only 1.2 Mt of the 13.1 Mt of total e-waste are documented as being treated in environmentally sound facilities. The informal sector has a strong presence in Central and South America.

In 2019, the Americas generated 13.1 Mt of e-waste, which has 0.3 Mt of printed circuit boards embedded. However, only 1.2 Mt of e-waste are documented as being treated in environmentally sound facilities. A distinction in the data can be made between North American import/export rates, the ones in Central and Latin America, and the Caribbean.

North America is a main exporting hub for uncontrolled used-EEE and e-waste exports, mainly to East/Southeast Asia and Central/South America, placing a burden on importing countries.

North America is a main exporting region, with an estimated of 430 kt of e-waste exported in 2019 as opposed to 88 kt imported. The largest transboundary flow in North America is uncontrolled used-EEE and e-waste. This was estimated to be 325 kt, which are mostly exported from North America to East Asia, Southeast Asia, Central America, and South America. The trade routes to Asia correspond with previous studies. In a very small-scale study, 43 GPS trackers were deployed in e-waste exports from Canada (BAN 2018). The study shows that 7 of the trackers deployed at Canadian electronics recyclers and collection sites were exported out of Canada, and 4 were shipped illegally toward developing countries in Asia. An earlier study conducted for the United States, Canada, and Mexico revealed that roughly 5 percent of desktops, 14 percent of laptops, 9 percent of Cathode Ray Tube screens, and 7 percent of flat panel displays were exported (Duan et al 2013). This is in the same order of magnitude as the underlying data found in this study. The uncontrolled exports of used-EEE and e-waste are exported to countries with hardly any e-waste management infrastructure and low collection rates, thus placing a burden on the environment and leading to a potential loss of resources.

North America has the capacity to manage hazardous waste and printed circuit board waste, and it imports 88 kt in total.

North America is the only region in the continent that imports hazardous waste under the Basel Convention, indicating that it has capacity to treat such e-waste. This e-waste comes primarily from Central America and, to a lesser extent, from other countries within the North American region. North America is, to some extent, an importer of printed circuit board waste, which is transported intra-regionally but which is also imported from Western and Eastern Europe, as well as from Central and South America. This is due to the presence of recycling companies in the region that can process printed circuit board waste. However, North America also exports a certain amount of printed circuit board waste to East Asia and Western Europe, where recycling facilities capable of treating them adequately are located.





The United States signed the Basel Convention in 1990, and the U.S. Senate provided its advice and consent to ratification in 1992. However, the United States has not ratified the Convention because, according to the Department of State, it does not have sufficient domestic statutory authority to implement all of its provisions. The United States' lack of participation in the Basel Convention creates a considerable gap in the main goal of the international treaty. Instead, its support for what is considered a crucial treaty, protecting the international ecosystem, would result in a major commitment to the Basel Convention's mission.

Central and South America import primarily uncontrolled used-EEE and e-waste and have insufficient e-waste management infrastructure for managing it. Controlling the transboundary movements of e-waste within and outside the region is still very challenging, as partly expressed by low reporting rates to the Basel Convention. The region also exports printed circuit board waste.

Central and South America import 300 kt and export 114 kt. All imports are uncontrolled used-EEE and e-waste. These imports place a sizable burden on the countries, as the regions generally have insufficient formal e-waste collection and drop-off points for separately collecting e-waste; consequently, the informal sector is very strong, and environmental sound management of e-waste is rare (roughly 1 percent). One of the main driving factors, as previously mentioned, is the competition between formal and informal sectors for valuable e-waste parts (Wagner et al 2022).

Central America has an intraregional trade of uncontrolled e-waste and used-EEE, but it also imports from East and Southeast Asia. South America, similarly, has an intra-regional trade of e-waste and used-EEE and imports from Southeast Asia. South America also exports hazardous waste (4.4 kt) and printed circuit boards (10.2 kt) to Western Europe, where main recyclers are located. Even though all countries in the study have ratified the Basel Convention, its enforcement remains a significant challenge, which makes monitoring and controlling transboundary movements of e-waste within and outside the region very challenging.

In Central and South America, one of the driving factors for increasing unmanaged e-waste flows is the competition between the formal and informal sectors for valuable components of e-waste

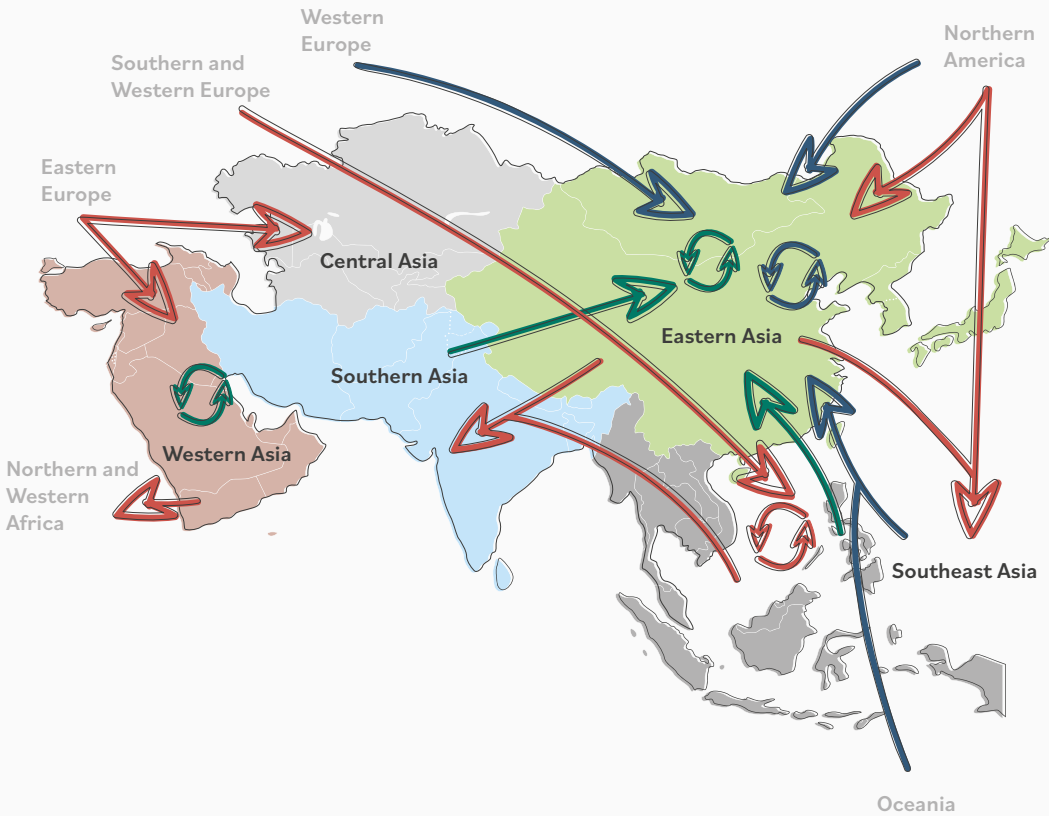
It is estimated that 26 kt of waste printed circuit boards are exported from South and Central America to specialist recyclers in Western Europe, North America, and East Asia. This is confirmed by the sources analysed in the study of Wagner et al (2022). E-waste operators in Honduras, for example, export valuable parts, including dismantled printed circuit boards, to Panama, Mexico, Canada, and the United States – but these are not documented in official reporting. The implication is that hazardous materials, including those embedded in e-waste, can be exported to countries where environmentally unsound management is most likely taking place. This can also encourage illegal shipments of e-waste (Wagner et al 2022).

The Caribbean mainly imports used-EEE and e-waste, and it exports hazardous e-waste.

The Caribbean generates 125 kt of e-waste, but has very little formal capacity for collecting and treating the waste. Consequently, it exports 2 kt of e-waste mostly to controlled hazardous waste treatment facilities in Europe and imports 8 kt of uncontrolled used-EEE and e-waste, primarily from North America. Unlike the other regions, no significant movement of printed circuit board waste was found.

Some countries developed good practices, an example being El Salvador, which implemented an electronic tracking system of imports and exports of hazardous waste, including e-waste. This platform could be linked to other countries in Central America to improve regional cooperation and exchange.

Asia



INDICATORS ASIA

Waste generation (Mt)

Total e-waste	24.9
Embedded Waste Printed Circuit Board	0.6

Environmental sound collection and recycling (Mt)

Total e-waste	2.9
Printed Circuit Board Waste	0.1

Not environmental sound managed e-waste (Mt)

Total e-waste	22.0
Embedded and Printed Circuit Board Waste	0.5

Environmental sound collection and recycling rates

Total e-waste	12%
Printed Circuit Board Waste	17%

Not environmental sound managed rates

Total e-waste	88%
Printed Circuit Board Waste	83%

TRANSBOUNDARY MOVEMENT BETWEEN COUNTRIES (kt)

Total Exports	2 537
<i>Controlled</i>	
E-waste reported as hazardous	1 038
Printed Circuit Board Waste	36
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	1 463
Total Imports	2 889
<i>Controlled</i>	
E-waste reported as hazardous	964
Printed Circuit Board Waste	111
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	1 814

INHABITANTS (MILLION)

4 445



Flow of used-EEE or e-waste



Flow of notified hazardous e-waste



Flow of Waste printed circuit boards

In Asia, 2.9 Mt of 24.9 Mt total e-waste are documented as being treated in environmentally sound facilities. The informal sector has a strong presence in all areas except for in high-income countries.

Asia generated 24.9 Mt of e-waste annually, with 561 kt printed circuit boards embedded. Only 2.9 Mt of e-waste are documented as being treated in environmentally sound facilities. The remaining 22.0 Mt of e-waste generated are not managed in an environmentally sound manner. This is mainly due to the lack of e-waste management and infrastructure and the presence of the informal sector, which is in competition with the formal one for valuable components, and most e-waste is at risk of ending up in uncontrolled dumping sites. Most transboundary movement can be observed around East Asia and Southeast Asia. East Asia and Southeast Asia have become hubs for the manufacture of electronics, not only for consumption within Asian markets, but globally as well (Honda S et al, 2016). The high rate of EEE production on the continent²¹⁾ is linked especially to East Asia, namely Japan and Korea, as well as to countries within the region in Southeast Asia, where production costs less.

Southeast Asia and East Asia are primary import and export hubs. Southern Asia probably has strong informal local markets for e-waste and show little transboundary movement.

Within Asia, most e-waste is imported and exported in Southeast Asia and East Asia. East Asia imports roughly 1 Mt and exports 0.9 Mt. Southeast Asia imports 1.1 Mt and exports 1.0 Mt. It is remarkable that Southern Asia imports and exports very little e-waste – only 0.2 Mt are exported and 0.3 Mt are imported – since the region generates 4.8 Mt. of e-waste. The formal collection and recycling rates for Southern Asia are minimal (one percent). Both are strong indications that there is a strong domestic informal market for e-waste management in Southern Asia, leading to little imports and exports.

Data reveal an emerging phenomenon of intra-regional trade of e-waste in the Asian continent.





East Asia has environmentally sound e-waste management infrastructure, and most e-waste imports are controlled. However, exports of uncontrolled used-EEE and e-waste is placing a burden on other countries. Southeast Asia mostly imports uncontrolled used-EEE and e-waste and has no capacity for treating it. The effects of the Chinese ban on e-waste imports have consequences on the e-waste trade shift.

East Asia has treatment capacity for hazardous waste and printed circuit board waste, and it imports 0.7 Mt of hazardous waste and 0.1 Mt of printed circuit board waste for environmentally sound processing. On the other hand, East Asia exports uncontrolled e-waste to Southeast Asia and Southern Asia. The recipient countries do not have the treatment capacities to treat the waste environmentally soundly when it becomes e-waste, and those imports place a significant burden on the environment and may lead to the losses of valuable resources. Moreover, flows from East Asia to Southeast Asia follow the same driving factors as from Europe to West Africa, namely demand for second-hand electronics; lower costs for processing, disposing, dismantling; etc.

The effects of the Chinese ban on plastics also have consequences on e-waste. The main operations have shifted from China to countries in Southeast Asia, such as Malaysia, Vietnam, and Thailand.

As well, Southeast Asia, e.g. Singapore, similarly to North Africa (e.g. Egypt), is an emerging hub for re-exporting e-waste. And besides e-waste, there is possible intra-regional trade of low quality or counterfeit EEE (IP KEY Southeast Asia, 2021). Finally, a similar phenomenon can be observed with plastic waste. As some countries within the region are developing capacities for dealing with, e.g., PVC plastic, there might be a similar trend for e-waste recycling sites. The installation of these capacities may reduce the trade because each country starts treating its own waste, including e-waste, internally. The effects of the so-called Chinese ban on plastics (Uhm Y. 2021) also affect e-waste, as the main imports have shifted from China to Malaysia, Vietnam, and Thailand.

Vice versa, Southeast Asia sends the most valuable parts (printed circuit board waste) back to manufacturing countries in East Asia for recycling of mainly precious metals and copper as secondary raw materials. Treatment facilities in East Asia also receive printed circuit board waste from Western Europe and North America.

West Asia is an import and export hub for controlled and uncontrolled transboundary movement of e-waste.

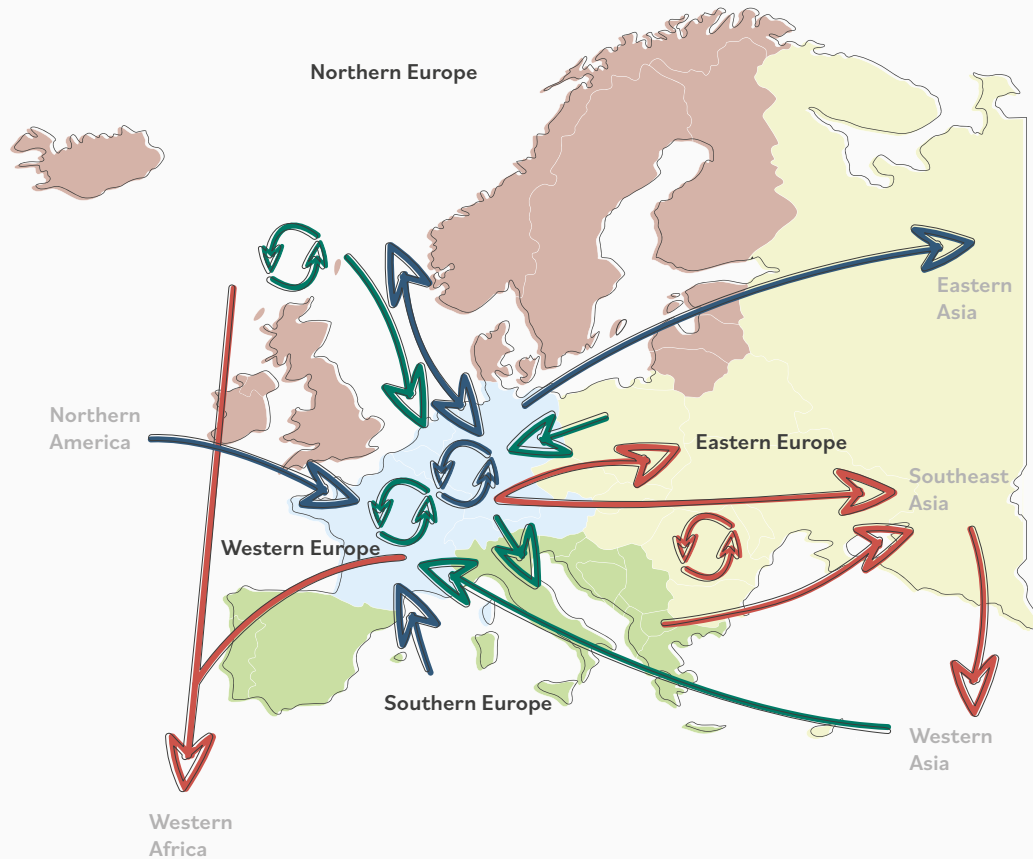
West Asia imports 443 kt of e-waste and exports 455 kt. The imports and exports are also roughly the same for the imports and exports of controlled and uncontrolled e-waste movements. Controlled hazardous e-waste is moved within the region for processing. Uncontrolled e-waste or used-EEE is moved within the region and shipped into North and West Africa. This is probably due to the large income differences within West Asia. The uncontrolled e-waste and used-EEE moves from high-income to middle- and low-income countries, where it trickles down to the poorest countries in the region.

No controlled hazardous waste movements are reported in Central Asia. Potentially, significant quantities of uncontrolled transboundary movements of used-EEE and e-waste is imported, causing a risk for non-environmentally sound management of the imports.

Central Asia does not report any controlled hazardous e-waste movements to the Basel Convention. Thus, it is unclear whether this occurs in practice. However, the e-waste management infrastructure in Central Asia is incapable of formally managing e-waste, leading to most e-waste being disposed of at landfills or handled by the informal sector (Baldé 2021). There is a surplus of uncontrolled e-waste and used-EEE movement (31 kt imports vs. 13 kt exports), which is significant in comparison to e-waste generation of 220 kt. Around 3 kt of printed circuit board waste are dismantled and exported to recyclers in Europe.



Europe



INDICATORS EUROPE

Waste generation (Mt)

Total e-waste	12.0
Embedded Waste Printed Circuit Board	0.3

Environmental sound collection and recycling (Mt)

Total e-waste	5.1
Printed Circuit Board Waste	0.2

Not environmental sound managed e-waste (Mt)

Total e-waste	6.9
Embedded and Printed Circuit Board Waste	0.1

Environmental sound collection and recycling rates

Total e-waste	42%
Printed Circuit Board Waste	61%

Not environmental sound managed rates

Total e-waste	58%
Printed Circuit Board Waste	39%

TRANSBOUNDARY MOVEMENT BETWEEN COUNTRIES (kt)

Total Exports

<i>Controlled</i>	1850
E-waste reported as hazardous	375
Printed Circuit Board Waste	184
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	1290

Total Imports

<i>Controlled</i>	1248
E-waste reported as hazardous	457
Printed Circuit Board Waste	172
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	619

INHABITANTS (MILLION)

740



Flow of used-EEE or e-waste



Flow of notified hazardous e-waste



Flow of Waste printed circuit boards

Europe generated 12 Mt of e-waste, of which 42 percent is documented as being formally collected and recycled. 1.8 Mt are exported, as compared to 1.2 Mt of imports, rendering Europe a net exporter.

Europe generated 12 Mt of e-waste in 2019, ranking third after Asia and the Americas, but with 16.2 kg per capita (Forti et al 2020), Europe has the highest e-waste generation per capita. This region is nonetheless leading in the environmentally sound formal management of e-waste generated (around 42 percent of 12 Mt), with a peak of 61 percent of collection and recycling of printed circuit boards, while the collection rate for e-waste is lower (the aforementioned 42%). This is the result of the advanced policy and regulatory framework in the European Union.

In 2006, the European Union transposed the Basel Convention and the OECD Council Decision concerning transboundary movements of recyclable waste into European regulation with the European Waste Shipment Regulation. The Waste Shipment Regulation implements the international obligations of these two regulations and includes the internationally agreed-upon objective that wastes shall be disposed of in an environmentally sound manner. The WEEE Directive (2012/19/European Union) sets collection, recovery, recycling, and reuse²²⁾ targets for the six categories of e-waste described in section 1.1. Other countries in the region – including Iceland, Switzerland, and the Balkan countries, such as Serbia, Bosnia, and Herzegovina – have similar laws (Forti et al 2020), but other countries in the European part of the commonwealth of independent states are mostly still in development of legislation or have inadequate e-waste management infrastructure (Baldé et al 2021). Europe is both an export and import hotspot for controlled e-waste and uncontrolled used-EEE and e-waste movements. The total movements amount to 1.9 Mt of exports and 1.2 Mt of imports.

Most regions in Europe have the capacity to manage hazardous waste, leading to 457 kt imports of hazardous waste, and Western and Northern Europe have the capacity to manage printed circuit board waste imports, totaling 172 kt.

A very well-developed e-waste management infrastructure exists in the European Union for collecting e-waste in municipalities, shops, and via private operators. There are also well-developed standards for pre-processing and end-processing of e-waste to ensure that materials in e-waste are recycled to secondary raw materials and that non-recyclable and, especially, hazardous components are safely disposed of. Most regions in Europe have the capacity to treat hazardous wastes, and consequently there is intra-regional and cross-continental movements of these wastes. Most controlled hazardous e-waste movements occur around Western Europe (175 kt exports and 262 kt imports) and Northern Europe (130 kt exports and 89 kt imports).

A well-developed e-waste management infrastructure exists in the European Union, but costs for compliant e-waste collection, treatment, and disposal in the formal sector in Europe are substantially higher than a non-compliant treatment and recycling, which can lead to exports of e-waste.



Western and Northern Europe treat printed circuit board waste and attract such waste primarily from Europe and the Americas.

Western and Northern Europe have treatment capacity to treat discarded printed circuit boards and attract imports from Southern and Northern Europe and from North, Central, and South America. In total, 137 kt of printed circuit board waste were imported in countries in Western Europe, as well as 26 kt into Northern Europe.

All regions in Europe have uncontrolled used-EEE and e-waste exports via routes to the global South (into West Africa and Southeast Asia). This burdens the receiving countries with insufficient e-waste management capacities and with additional hazardous waste.

All regions in Europe show exports of used-EEE or e-waste. A total of 1.3 Mt is estimated to be exported. This is also largely documented in literature, such as the Countering WEEE Illegal Trade Study (Huisman et al 2015), the Person in the Port report (Odeyingbo et al 2017), a more recent tracking study from Basel Action Network (BAN, 2018), and the study by the European Court of Auditors related to European Union actions and challenges on electronic waste (ECA, 2021). In the Basel Action Network study, 134 trackers were secretly deployed in e-waste in 10 European Union countries²³⁾ for, most frequently, government-approved takeback stations.

Eastern Europe is an emerging importing hotspot, though the current geopolitical situation might have a significant impact on the current flows and could change the balances.

²³⁾ Austria, Belgium, Denmark, Germany, Hungary, Ireland, Italy, Poland, Spain, and the United Kingdom.

They found that 19 (6 percent) of the tracked scrap equipment was exported, including 11 very likely illegal shipments to Ghana, Hong Kong, Nigeria, Pakistan, Tanzania, Thailand, and Ukraine.

This study found that Western Europe is one of the main exporters of uncontrolled used-EEE or e-waste (together with East and Southeast Asia). Western Europe exports roughly 0.6 Mt of used-EEE and e-waste, primarily to West Africa, Eastern Europe, Southeast Asia, and North Africa. However, Eastern Europe, Northern Europe, and Southern Europe also export 0.2 Mt of uncontrolled used-EEE or e-waste each.

The driving factor for such uncontrolled movements is the demand for used-EEE and potentially cheaper treatment costs in recipient regions. The modalities of such transports range from simply stacking untested used-EEE, part of which may actually be e-waste in containers, where typically the quality worsens as one goes deeper into the container and used-EEE and e-waste transported via used or near end-of-life vehicles. As confirmed by the interviewed stakeholders, the main route for trading e-waste or used-EEE transported in used vehicles is still from Western Europe to West Africa, primarily to Nigeria and its neighbouring countries. E-waste in vehicles is rarely declared and thus is difficult to detect. One modus operandi by exporters is to provide falsified reports of functionality tests performed on used-EEE carried in vehicles that would need to be checked by inspectors (INTERPOL 2009).

The most common modality adopted for illegal transboundary movements is to unlawfully label e-waste as used-EEE for export, which confirms the importance of proper testing of equipment destined for export (Huisman et al, 2015). Untested used-EEE may also be exported and declared as 'household goods' or 'personal effects' in containers with mixed contents (Odeyingbo et al. 2017). A new modus operandi recently identified by the law enforcement community is that e-waste exported from the charity sector actors is collected by textile recyclers and declared as second-hand household goods (van Den Brink et al 2020). The importing regions often lack e-waste management infrastructure, and after the usage as used-EEE (or directly when e-waste), it is most likely managed by the informal sector, and non-valuable materials (including hazardous ones) are disposed of in landfills or elsewhere.

Accurately estimating illegal e-waste exports is a challenge. However, through the extrapolation of seized inspections (only) from the European Union, it is estimated that roughly 2 to 17 kt of e-waste are seized as illegally traded across national borders. These estimates are based only on data from actual seizures reported by a limited number of European Union countries. In consideration of the overall uncontrolled shipments in the region, inspection capacities appear to be rather limited.

Uncontrolled used-EEE or e-waste exports are also happening within Europe to Eastern European countries.

Recent trends also show regional e-waste shipments (e.g. from Western/Northern Europe to Eastern Europe) rather than a strict 'North-South' route (Forti et al 2020). This trend is confirmed by this study: Eastern Europe imports more than half of its uncontrolled used-EEE or e-waste from Western Europe (316 kt), but also imports such materials across borders within Eastern Europe, itself. Eastern Europe is actually an emerging import hotspot, though the current geopolitical situation might have a significant impact on the current flows and change the balances.

Oceania



INDICATORS OCEANIA

Waste generation (Mt)

Total e-waste	0.7
Embedded Waste Printed Circuit Board	0.01

Environmental sound collection and recycling (Mt)

Total e-waste	0.06
Printed Circuit Board Waste	0.005

Not environmental sound managed e-waste (Mt)

Total e-waste	0.6
Embedded and Printed Circuit Board Waste	0.01

Environmental sound collection and recycling rates

Total e-waste	9%
Printed Circuit Board Waste	31%

Not environmental sound managed rates

Total e-waste	91%
Printed Circuit Board Waste	69%

TRANSBOUNDARY MOVEMENT BETWEEN COUNTRIES (kt)

Total Exports

<i>Controlled</i>	21
E-waste reported as hazardous	8
Printed Circuit Board Waste	4
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	10

Total Imports

<i>Controlled</i>	0
E-waste reported as hazardous	0
Printed Circuit Board Waste	0
<i>Uncontrolled</i>	
Undocumented exports of mixed used EEE and e-waste	0

INHABITANTS (MILLION)

42



Flow of used-EEE or e-waste



Flow of notified hazardous e-waste



Flow of Waste printed circuit boards

In Oceania, 0.06 Mt of 0.7 Mt total e-waste are documented to be formally treated in environmentally sound facilities, most of which are in Australia.

Oceania ranked second worldwide in terms of e-waste generation per capita, with 16.1 kg per capita and with a total of 0.7 Mt of e-waste generated in 2019. However, only 9 percent of this waste is collected and recycled in an environmentally sound manner (0.06 Mt); the fate of the remainder is unknown or ends up in landfills. However, printed circuit boards from e-waste are collected and recycled three times more commonly, and 27 percent of the printed circuit boards contained in the generated e-waste. Australia and New Zealand account for almost all e-waste generated (665 kt), followed by Melanesia (15 kt), Polynesia (1 kt), and Micronesia, with 0.5 kt of e-waste generated.

Challenges for sound e-waste management include the spread-out geography of the region and the notable differences in terms of economy and population between the two larger countries, Australia and New Zealand, and the smaller islands in Melanesia, Micronesia, and Polynesia. The Australian Government has funded a National Television and Recycling Scheme (NTRS), offering collection and recycling services for televisions and computers, with a recycling target of 80 percent to be reached by 2026-2027. The country has also banned landfilling of e-waste (Forti et al 2020). New Zealand is still considering a mandatory national plan for dealing with the e-waste issue. Recycling of e-waste is currently limited in New Zealand and is carried out mostly manually, making it more labor-intensive and less economically viable. In the other countries/areas of the region, the limited availability of suitable land on small islands and atolls for constructing landfills, the islands' remoteness, and the islands' relatively small populations represent key challenges to proper treatment and disposal of such e-waste and parts.

Reporting on transboundary e-waste flows from/to Australia and New Zealand is limited, and exports of 21 kt of e-waste mainly to Asia are documented.

Due to the remoteness of the Oceanian region, transboundary e-waste flows from and to Oceania are limited. Overall, Oceania appears as an exporting region, with 21 kt of e-waste and used-EEE (3 percent of e-waste generated) exported in 2019. Roughly half of the exports are controlled e-waste exports.

Oceania is second worldwide in terms of e-waste generation per capita, but only 9 percent of the waste is recycled in an environmentally sound manner.





Australia and New Zealand report 12 kt of controlled shipments to Asia and Western Europe. Oceania exports relatively large quantities of printed circuit board waste to East Asia, Southeast Asia, and Western Europe.

From all controlled e-waste exports (12 kt) out of Oceania, 8 kt are reported as hazardous wastes under the prior informed consent procedure in the Basel Convention, from which 80 percent are moved to Southern Asia. The other 20 percent of hazardous e-wastes are documented to be exported to Japan, Korea, and Singapore. Additionally, hazardous e-wastes are moved regionally from New Zealand to Australia for processing. Approximately 4 kt of printed circuit board waste is exported and published in four reports (ANZRP 2021, EPSA 2021, Ecycle Solutions 2021, MRI 2021). These are not reported under the prior informed consent procedure in the Basel Convention. Only one of the above reports indicates the destination of the discarded printed circuit boards (Japan and Singapore). The shipments to Singapore are likely further traded and shipped to other countries. The analysis of the printed circuit board waste conducted in this study indicates that discarded printed circuit boards are exported to East Asia and Western Europe.

10 kt of uncontrolled e-waste shipments from Australia and New Zealand to Southeast Asia are occurring.

Oceania exports approximately 8 kt of uncontrolled e-waste to Southeast Asia, where recycling infrastructure is limited. Finally, an interesting yet still small flow is recorded from the same region to West Africa (2 kt). No information was available regarding e-waste and used-EEE inside traded second-hand or near end-of-life vehicles in this region.

Melanesia, Micronesia, and Polynesia do not have any notable activity on transboundary movement of e-waste or used-EEE.

Melanesia, Micronesia, and Polynesia generated 17 kt of e-waste in 2019. They have no e-waste management infrastructure. Moreover, they do not report to import or export either printed circuit board waste or hazardous waste, and no indications of uncontrolled e-waste or used-EEE movements were found in the datasets.

5

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About the authors



Dr. Cornelis Peter Baldé is a Senior Scientific Specialist at the Sustainable Cycles Programme, which is hosted by the United Nations Institute for Training and Research. He received his PhD in hydrogen storage at Utrecht University. Kees is the initiator of the Global E-waste Monitor series, a researcher holding an H-factor of 17, co-founder of the Global E-waste Statistics Partnership, author of various national e-waste and battery studies, and manager of research projects. He

is also a member of global expert groups on circular economy, waste, and sustainable development goals. He frequently provides policy advice to governments and is the chair of the board of the Dutch National (W)EEE Register. He frequently provides policy advice to governments and is the chair of the board of the Dutch National (W)EEE Register and public speaker to television, media, scholars, and policy makers.



Elena D'Angelo is a consultant at the Sustainable Cycles Programme of UNITAR. Since she joined the team in 2016, she has been mainly involved in the coordination and research activities of EU funded projects dealing with transnational waste crimes, as well as in research activities dealing with environmental crime, mercury waste and circular economy. Working with the UN since more than 12 years, she has developed an in-depth knowledge of the phenomena related

to the illicit transboundary movement and management of waste, including e-waste, also thanks to the involvement in the preparation and development of the EC-funded projects CWIT, Dotcom Waste, Waste Force and STRIKE. She is also involved in the development of the e-waste academies for managers and scientists, as well as in the overall SCYCLE training strategy.



Vittoria Luda di Cortemiglia works as a consultant for the Sustainable Cycles Program of UNITAR. She graduated in law at the University of Turin and completed a Master of Arts (MA) in International Relations at St. John's University in New York. Vittoria leads analysis and training programs related to waste crime, transboundary waste shipments, and environmentally sound management of waste.



Dr. Otmar Deubzer is environmental engineer. Since 2008, he has been working with the Sustainable Cycles Programme among others on the development of standards for e-waste collection, transport, treatment and disposal. Otmar has also been involved in e-waste-related projects in Africa and is working on projects related to circular economy and CRMs. Otmar is also active as international consultant for industry for European legislation, mainly the RoHS-, WEEE- and REACH Directives at Fraunhofer IZM, and he is working in projects related to recycling of critical materials from electrical and electronic equipment. Since 2006, he has been reviewing the exemptions from the substance regulations of the RoHS Directive and the End-of-Life Vehicles Directive for the European Commission.

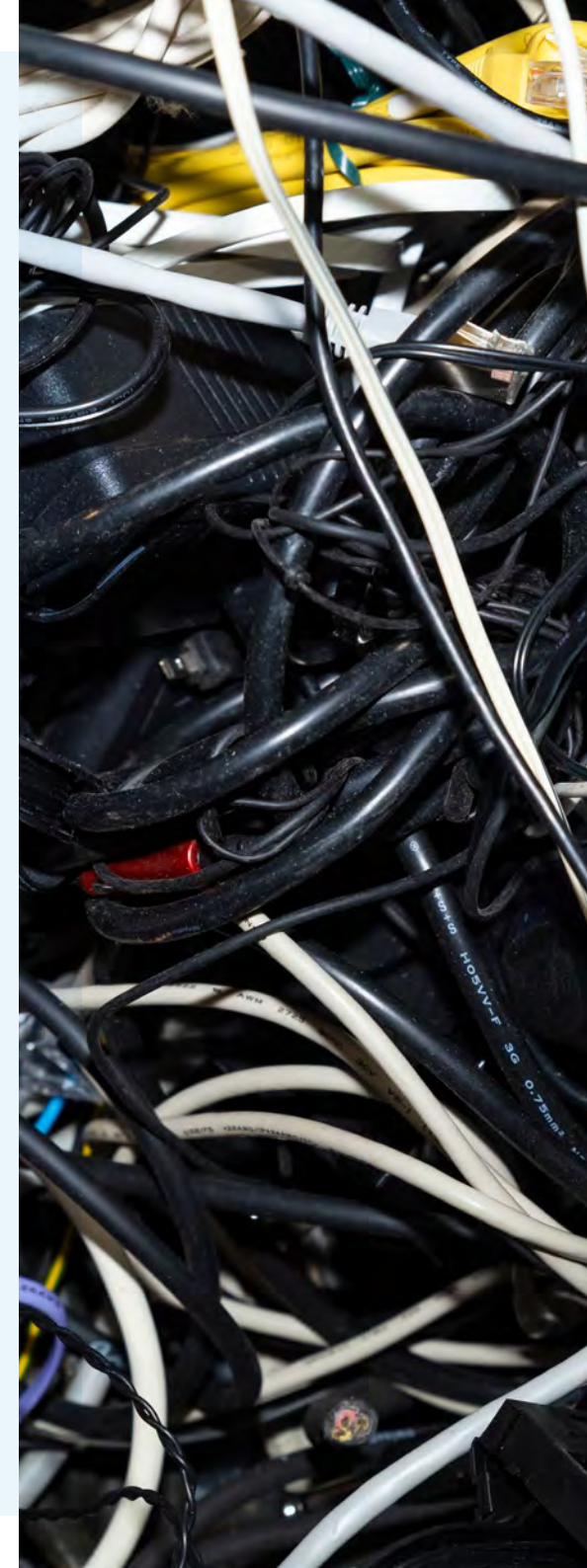


Dr. Ruediger Kuehr is the Manager of Sustainable Cycles (SCYCLE) Programme and Head of the recently established UNITAR Bonn Office. As a political and social scientist by education, Ruediger has worked for more than twenty years on the e-waste challenge. He co-founded the StEP Initiative, co-initiated the development of an e-waste coalition among the various UN organisations and the SCYCLE Programme, and initiated the permanent E-waste Academies and E-waste Monitors at the global, regional, and national levels. But the foundation of Ruediger's work is in establishing strategic approaches to sustainability, which renders life-cycle thinking indispensable in his activities; as such, he is also a frequent speaker for forward-thinking at conferences and in media appearances.

ANNEX 1 UNU-KEYS

UNU key	Description	EU-6
0001	Central Heating (household-installed)	4
0002	Photovoltaic Panels (incl. inverters)	4
0101	Professional Heating & Ventilation (excl. cooling equipment)	4
0102	Dishwashers	4
0103	Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)	4
0104	Washing Machines (incl. combined dryers)	4
0105	Dryers (wash dryers, centrifuges)	4
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	4
0108	Fridges (incl. combi-fridges)	1
0109	Freezers	1
0111	Air Conditioners (household-installed and portable)	1
0112	Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)	1
0113	Professional Cooling equipment (e.g. large air conditioners, cooling displays)	1
0114	Microwaves (incl. combined, excl. grills)	5
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	5
0202	Equipment for food preparation (e.g. toaster, grills, food processing, frying pans)	5
0203	Small household equipment for hot water preparation (e.g. coffee, tea, water cookers)	5
0204	Vacuum Cleaners (excl. professional)	5
0205	Personal Care equipment (e.g. toothbrushes, hair dryers, razors)	5
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	6
0302	Desktop PCs (excl. monitors, accessories)	6
0303	Laptops (incl. tablets)	2
0304	Printers (e.g. scanners, multi-functionals, faxes)	6

UNU key	Description	EU-6
0305	Telecommunication equipment (e.g. [cordless] phones, answering machines)	6
0306	Mobile Phones (incl. smartphones, pagers)	6
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	4
0308	Cathode Ray Tube Monitors	2
0309	Flat Panel Display Monitors (LCD, LED)	2
0401	Small Consumer Electronics (e.g. headphones, remote controls)	5
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	5
0403	Music Instruments, Radio, Hi-Fi (incl. audio sets)	5
0404	Video (e.g. Video recorders, DVD, Blu-Ray, set-top boxes) and projectors	5
0405	Speakers	5
0406	Cameras (e.g. camcorders, photo & digital still cameras)	5
0407	Cathode Ray Tube TVs	2
0408	Flat Panel Display TVs (LCD, LED, Plasma)	2
0501	Small lighting equipment (excl. LED & incandescent)	3
0502	Compact Fluorescent Lamps (incl. retrofit & non-retrofit)	3
0503	Straight Tube Fluorescent Lamps	3
0504	Special Lamps (e.g. professional mercury, high & low pressure sodium)	3
0505	LED Lamps (incl. retrofit LED lamps)	3
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	5
0507	Professional Luminaires (offices, public space, industry)	5
0601	Household Tools (e.g. drills, saws, high-pressure cleaners, lawnmowers)	5
0602	Professional Tools (e.g. for welding, soldering, milling)	4





UNU key	Description	EU-6
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	5
0702	Game Consoles	6
0703	Leisure equipment (e.g. sports equipment, electric bikes, jukeboxes)	4
0801	Household Medical equipment (e.g. thermometers, blood pressure meters)	5
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	4
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	5
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	4
1001	Non-cooled Dispensers (e.g. for vending, hot drinks, tickets, money)	4
1002	Cooled Dispensers (e.g. for vending, cold drinks)	1

Six e-waste categories Description

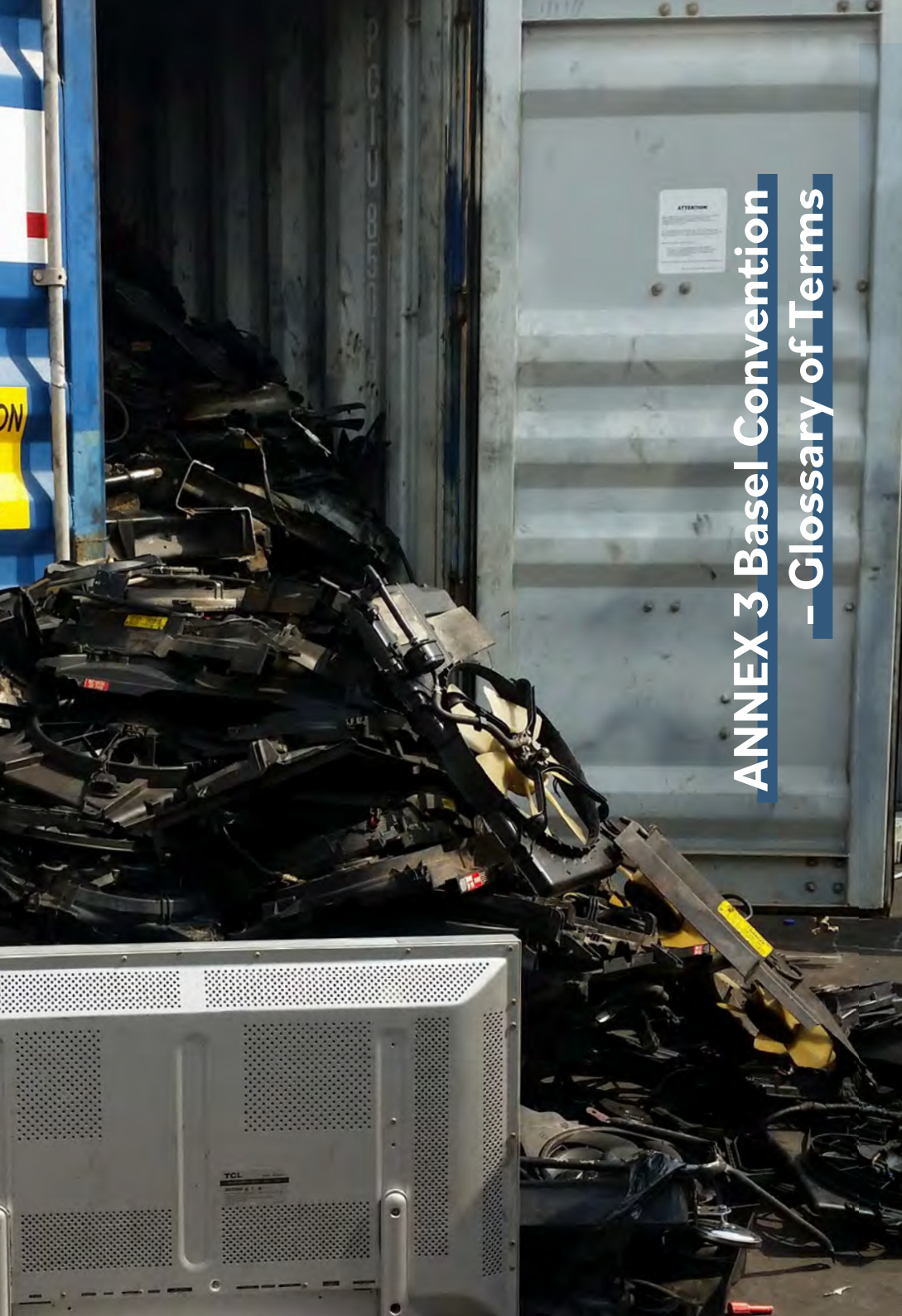
Full name	
1	Temperature exchange equipment
2	Screens, monitors, and equipment containing screens
3	Lamps
4	Large equipment
5	Small equipment
6	Small IT and telecommunication equipment

INDICATOR	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	GLOBAL	FOOTNOTE
Waste generation (Mt)							
Total e-waste	2.9	13.1	24.9	12.0	0.7	53.6	
Embedded Waste Printed Circuit Board	0.1	0.3	0.6	0.3	0.01	1.2	
Environmental sound collection and recycling (Mt)							
Total e-waste	0.03	1.2	2.9	5.1	0.06	9.3	
Printed Circuit Board Waste	0.01	0.1	0.1	0.2	0.005	0.4	1), 4)
Not environmental sound managed e-waste (Mt)							
Total e-waste	2.9	11.9	22.0	6.9	0.6	44.3	
Embedded and Printed Circuit Board Waste	0.1	0.2	0.5	0.1	0.01	0.8	
Environmental sound collection and recycling rates							
Total e-waste	1%	9%	12%	42%	9%	17%	
Printed Circuit Board Waste	13%	44%	17%	61%	31%	34%	
Not environmental sound managed rates							
Total e-waste	99%	91%	88%	58%	91%	83%	
Printed Circuit Board Waste	87%	56%	83%	39%	69%	66%	
TRANSBOUNDARY MOVEMENT BETWEEN COUNTRIES (kt)							
Total Exports	132	547	2 537	1 850	21	5 086	5)
<i>Controlled</i>							
E-waste reported as hazardous	12	31	1 038	375	8	1 464	2)
Printed Circuit Board Waste	7	128	36	184	4	358	1)
<i>Uncontrolled</i>							
Undocumented exports of mixed used EEE and e-waste	113	388	1 463	1 290	10	3 264	3)
Total Imports	546	393	2 889	1 248	0	5 076	5)
<i>Controlled</i>							
E-waste reported as hazardous	19	24	964	457	0	1 464	2)
Printed Circuit Board Waste	0	65	111	172	0	348	1)
<i>Uncontrolled</i>							
Undocumented exports of mixed used EEE and e-waste	527	305	1 814	619	0	3 264	3)
INHABITANTS (MILLION)	1 152	984	4 445	740	42	7 363	

Footnotes

- 1) Export, collection, and recycling of printed circuit boards in Australia unknown. Collection and recycling estimated at 30%; exports are adjusted for this estimation.
- 2) This is a conservative estimate, as exports from Africa (excluding Southern Africa) and its destinations could not be assessed, and reporting under the Basel Convention is limited in many countries, which made it difficult to fill the datagaps.
- 3) Estimated; the division between used EEE and illegal e-waste is unclear and could vary per region.
- 4) Estimated by sum of exported printed circuit board waste and domestic recycling rate in the country (assuming that the domestic recycling rate in country is the same for printed circuit boards) and removing for potential double counting.
- 5) Regions or countries with higher level of reporting may result as having higher levels of import/export.





ANNEX 3 Basel Convention -- Glossary of Terms

Waste:

(see Article 2, Paragraph 1 of the Basel Convention)

Substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law.

Hazardous waste:

(see Article 1, Paragraph 1 of the Basel Convention)

- a) Wastes that belong to any category contained in Annex I to the Convention, unless they do not possess any of the characteristics contained in Annex III; and
- b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the Party of export, import, or transit.

In addition, Article IV, Section B of the Technical Guidelines on transboundary movements of e-waste and used-EEE more clearly specifies the **distinction** between **hazardous waste and non-hazardous waste**.

46. Entry A1180 (hazardous waste):

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

47. Entry B1110 (non-hazardous waste):

Electrical and electronic assemblies:

- Electronic assemblies consisting only of metals or alloys.
- Waste electrical and electronic assemblies or scrap (including printed circuit boards) not containing components such as accumulators and other batteries.
- Electrical and electronic assemblies ... destined for direct reuse.

48. Equipment will often contain hazardous components or substances. However, the presence of such a component or substance in equipment should not necessarily cause the equipment as a whole to be deemed hazardous waste under the Convention.

49. E-waste should therefore be presumed to be hazardous waste unless it can be shown either that it does not exhibit hazardous characteristics or that it does not contain hazardous components or substances, specifically:

- a) Lead-containing glass from cathode ray tubes (CRTs).
- b) Nickel-cadmium batteries and batteries containing mercury.
- c) Selenium drums.
- d) Printed circuit boards.
- e) Fluorescent tubes and backlight lamps.
- f) Plastic components containing brominated flame retardants (BFRs).
- g) Other components containing or contaminated with mercury, such as mercury switches, contacts, and thermometers.
- h) Oils/liquids.
- i) Components containing asbestos, such as wires, cooking stoves, and heaters.

Used-EEE:

The Technical Guidelines on transboundary movements of e-waste and used-EEE, in its Article V, also provides guidance on the enforcement of provisions regarding transboundary movements of e-waste and used equipment.

52. Persons who arrange the transport of used equipment should ensure that the equipment is accompanied by appropriate documentation.

54. In the absence of proof that an item is used equipment and not e-waste through appropriate documentation issued in accordance with paragraph 32, 33, 41, 42, and 53 of the present guidelines and appropriate protection against damage during transportation, loading and unloading in particular through sufficient packaging and appropriate stacking of the load by the person who arranges the transport, the relevant State authorities (e.g., customs, police, or environmental inspectors) should consider the item to be potentially hazardous e-waste and, in the absence of consent provided in accordance with the requirements of the Basel Convention, should presume that the export constitutes a case of illegal traffic under Article 9 of the Convention.

Illegal trafficking:

Under the Basel Convention, illegal traffic is defined as a transboundary movement of hazardous wastes:

- without notification pursuant to the provisions of the Convention to all States concerned;
- without the consent of a State concerned;
- through consent obtained by falsification, misrepresentation, or fraud;
- that does not conform in a material way with the documents; or
- that results in deliberate disposal (eg. dumping) of hazardous wastes in contravention of the Convention and of general principles of international law.

Common methods of illegal traffic include making false declarations; the concealment, mixture, or double layering of the materials in a shipment; and the mislabeling of individual containers. Such methods seek to misrepresent the actual contents of a shipment, and as such, the meticulous and thorough scrutiny of national enforcement officers is required to detect instances of illegal traffic.



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