The Global E-waste Monitor 2020

Quantities, flows, and the circular economy potential

Authors: Vanessa Forti, Cornelis Peter Baldé, Ruediger Kuehr, Garam Bel

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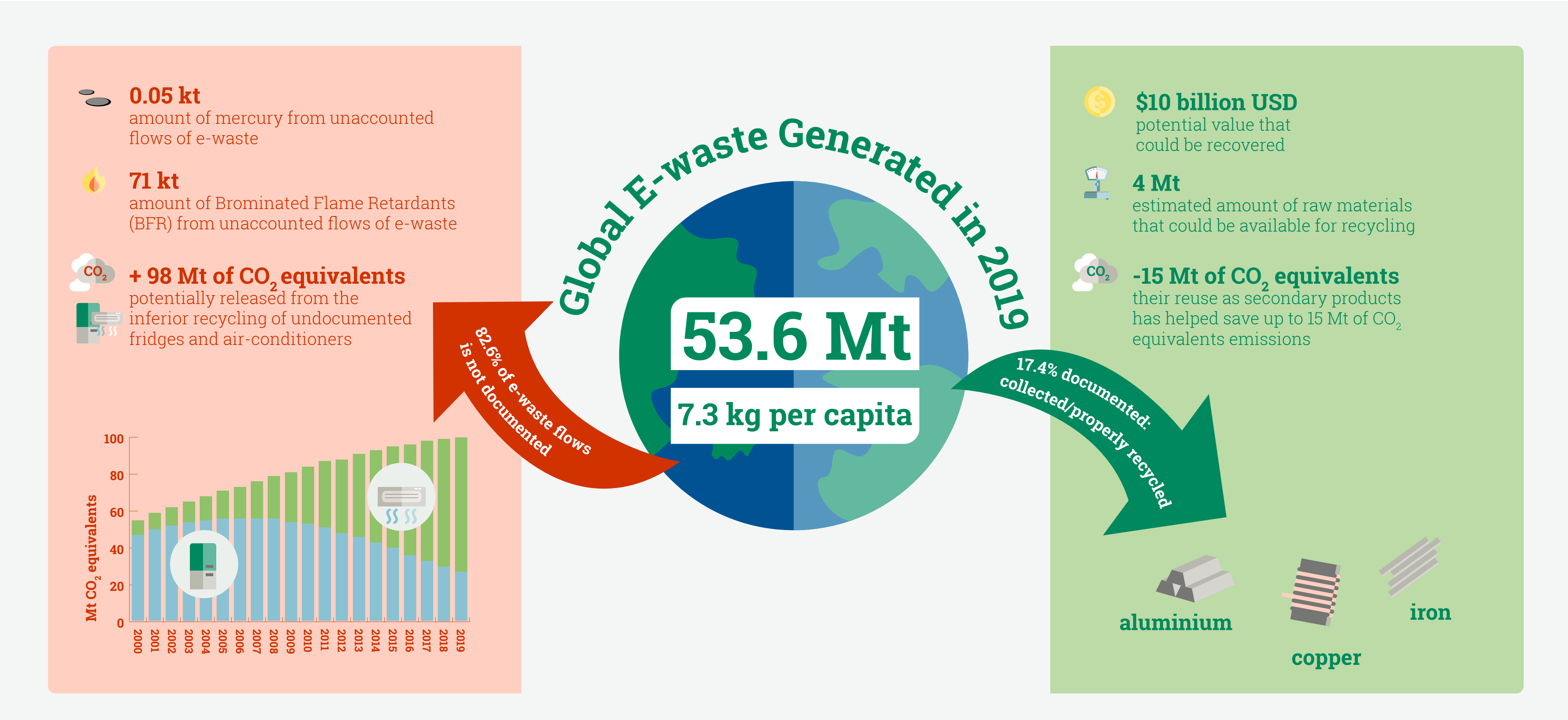
With the current documented formal collection and recycling rate of 17.4%, a potential raw material value of $10 billion USD can be recovered from e-waste, and 4 Mt of secondary raw materials would become available for recycling. Focusing only on iron, aluminium, and copper and comparing emissions resulting from their use as virgin raw materials or secondary raw materials, their recycling has helped save up to 15 Mt of CO_2 equivalent emissions in 2019 (see Annex 2 for details on the methodology).

EEE also contains hazardous substances, usually heavy metalssuch as mercury, cadmium, or lead and chemicals such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and flame retardants. Approximately 71 kt of plastic containing BFR (Brominated Flame Retardants) arise from the unaccounted flows of e-waste generated in 2019 (see Annex 2 for details on the methodology). In particular, BFR are used in appliances to reduce the product's flammability, appearing, for example, in outer casings of computers, printed wiring boards, connectors, relays, wires, and cables (McPherson, Thorpe, and Blake 2004 & Herat 2008). The recycling of plastic containing BFR represents a major challenge for e-waste recycling because of the costs related to the separation of plastic containing PBDEs and PBBs from other plastic. Recycled plastic with PBDE and PBB content higher than 0.1% cannot be used for manufacturing of any products, including EEEs. In most cases, compliant recyclers incinereate plastic containing PBDEs and PBBs under controlled conditions to avoid the release of dioxins and furans. On the other end, if incineration is not carried out in an environmentally sound manner, those substances are likely to pose risks to health or the environment. The use of PBDEs and PBBs have been banned in Europe (European Parliament 2011). Some of these contaminants have been banned in Europe, as risk assessment studies have shown that they are persistent, bioaccumulative, and toxic, and can be responsible for kidney damage, several skin disorders, and nervous and immune systems and effects to the nervous and immune systems.

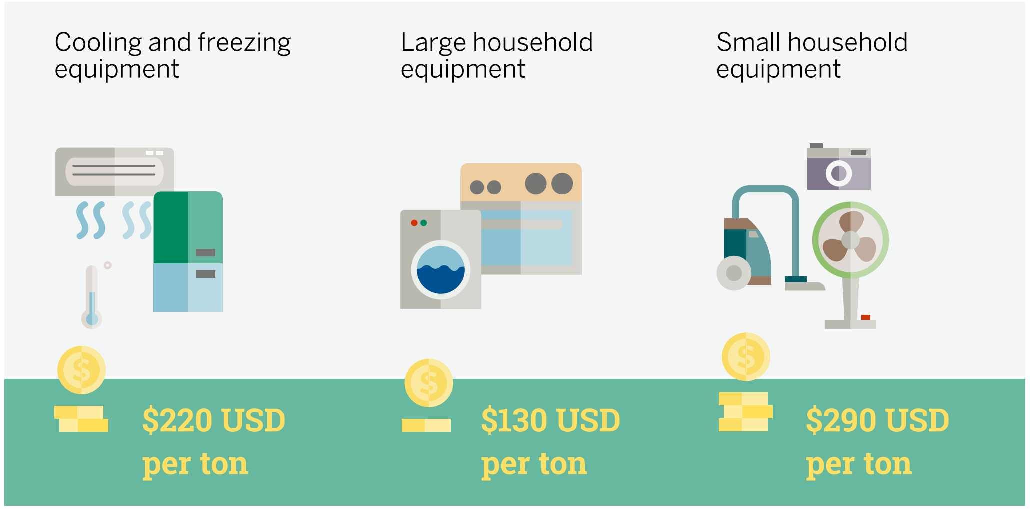


Mercury is used in fluorescent light sources, e.g. in background lights of older flat panel displays and TVs, in compact fluorescent lamps ("energy-saving lamps"), fluorescent lamps, in measure and control equipment, and in old switches. (Baldé et al. 2018). If these appliances are abandoned in open dumpsites as opposed to being properly recycled, mercury can enter the food chain and accumulate in living organisms while bringing damage to the central nervous system, thyroid, kidneys, lungs, immune system, etc (Baldé et al. 2018). A total of 50 t of mercury can be found in the unaccounted flows of e-waste generated in 2019 worldwide.

Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs) are present in refrigerant circuits and insulating foams of older generations of cooling and freezing equipment, such as refrigerators, freezers, and air-conditioning systems. These molecules have a long lfespan in the atmosphere. They react with ozone molecules (O_3), generating molecular oxygen that thins the stratospheric ozone layer (ozone hole). This process leads to an increment of the UV radiation that can pass the stratosphere, likely causing skin cancers, eye-related diseases, and a weakening of the immune system. The Montreal Protocol (adopted in 1987) regulates the production and consumption of manmade chemicals known as ozone-depleting substances, which includes the phasing out of CFCs and HCFCs. These gases have high global warming potential (GWP). If EEE containing these gases is not managed in an environmentally sound manner, refrigerants could be emitted into the atmosphere. Estimations show that a total of 98 Mt of CO_2 equivalents[(11)] were released from the inferior recycling of undocumented fridges and air conditioners (40% in Europe and 82.6% in the rest of the world). Greenhouse gas (GHG) emissions from the improperly managed refrigerants estimated to be found in air conditioners overtook the emissions from fridges in 2013. In 2019, of the total CO_2 equivalents estimated to be released into the atmosphere, 73% were from air conditioners and 27% were from fridges. This is explained by the fact that refrigerants with high global warming potential were used before 1994 (e.g. R-11 and R-12) and until 2017 (R-134a and R-22). Since then, the refrigerants have been substituted by others with a substantially lower GWP (e.g. R-152a and R-124yf). The decrease of CO_2 equivalent emissions, reflecting the recent obligations for replacing the refrigerants, will be observed only in the next decades, when the new products placed on the market will become waste (see Annex 2 for details on the methodology).

The presence of hazardous substances and scarce or valuable materials in e-waste makes it necessary to recycle and treat the e-waste in an environmentally sound manner; doing so helps avoid the release of such substances into the environment and the losses of ecologically and economically valuable materials. Although several pieces of legislation have banned the use of some substances and are pushing for them to be replaced by safer materials, appliances that were produced in the past and still contain those substances must, once discarded, be treated adequately in order to contain the risks that they can pose to the environment and health. In addition, new equipment may also still contain smaller amounts of those banned substances, due to the fact that they technically cannot yet be substituted or eliminated.

It can be assumed that at least most e-waste collection, treatment, and disposal in the formal sector is legally compliant, thus taking care of the environmental, health, and safety aspects. This assumption may not be applicable for treatment and disposal outside the formal sector. Non-compliant recycling proves to be a cheaper option than the compliant recycling. A recent study by the European Electronics Recyclers Association (EERA) and the United Nations University (Magalini and Huisman 2018) shows that a European compliant recycler incurs substantially higher costs than a non-compliant recycler. In detail, the compliant recyclers based in Europe normally incur technical costs such as costs related to treatment, de-pollution, disposal of hazardous fractions, and disposal of non-hazardous fractions, as well as the proof of legal compliance, quality, and service level.

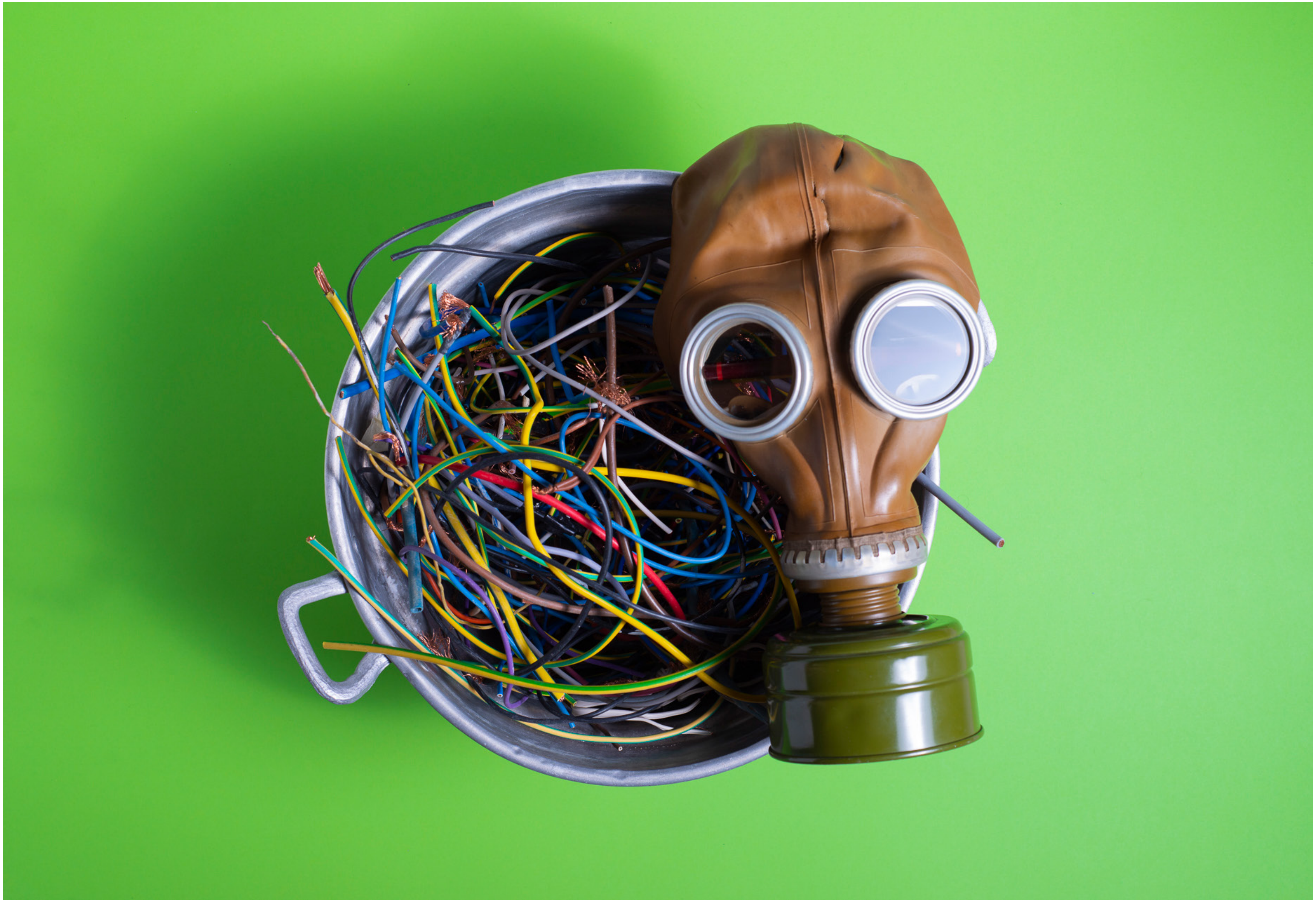


Source: Magalini and Huisman 2018

The study concludes that the potential cost reductions that can be realised by non-compliant treatment exceed the normal economic margins of legitimate recyclers, applying best available technology and ensuring full compliance, which leads to unfair competition.

Chapter 8

E-waste Impact on the Health of Children and Workers

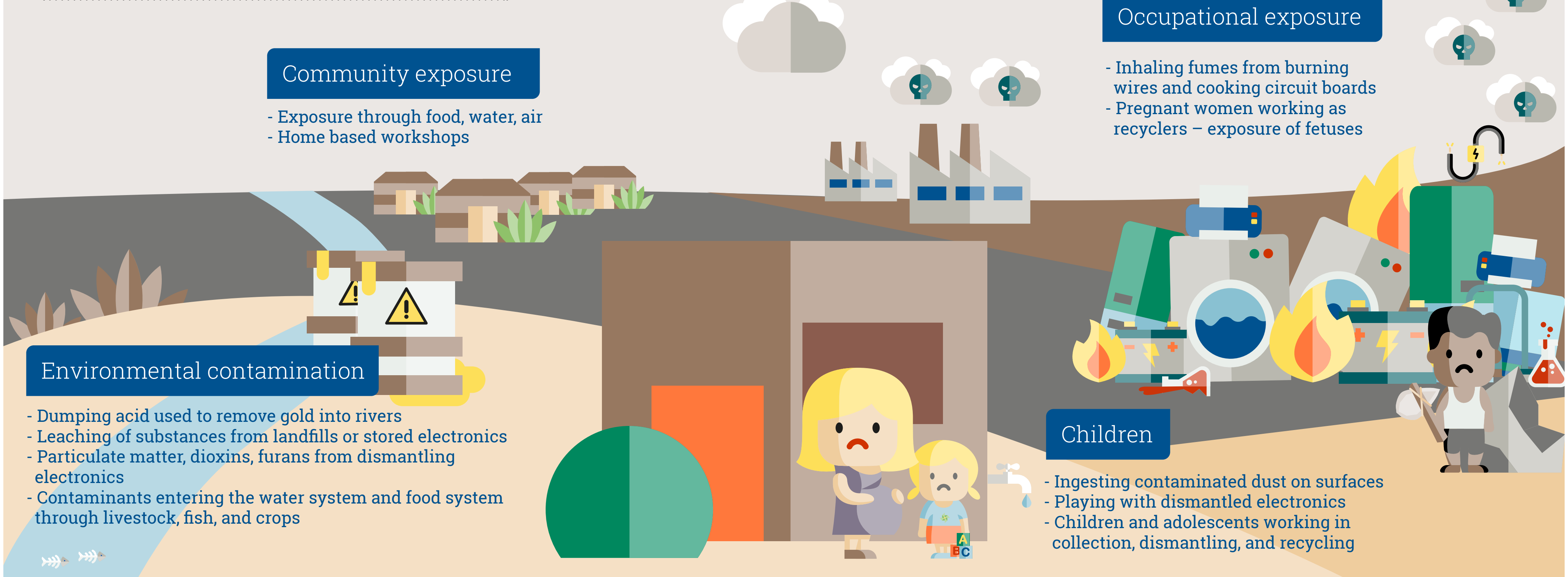


Children live, work, and play in informal e-waste recycling sites. Adults and children can be exposed by inhaling toxic fumes and particulate matter, through skin contact with corrosive agents and chemicals, and by ingesting contaminated food and water. Children are also at risk from additional routes of exposure. Some hazardous chemicals can be passed from mothers to children during pregnancy and breast-feeding. Young children playing outside or in nature frequently put their hands, objects, and soil in their mouths, increasing the risk of exposure. Fetuses, infants, children, and adolescents are particularly vulnerable to damage from exposure to toxicants in e-waste because of their physiology, behaviour, and additional routes of exposure (Landrigan & Goldman 2011; Pronczuk de Garbino 2004).

Adverse health effects recently found to be associated with e-waste

Since the publication of the previous e-waste monitor in 2017, the number of studies on the adverse health effects from e-waste have increased. These studies have continued to highlight the dangers to human health from exposure to well-studied toxins, such as lead. Recently, research has found that unregulated e-waste recycling is associated with increasing numbers of adverse health effects. These include adverse birth outcomes (Zhang Y et al. 2018), altered neurodevelopment (Huo X et al. 2019b), adverse learning outcomes (Soetrisno et al. 2020), DNA damage (Alabi OA et al. 2012.), adverse cardiovascular effects (Cong X et al. 2018), adverse respiratory effects (Amoabeng Nti AA et al. 2020), adverse effects on the immune system (Huo X et al. 2019b), skin diseases (Decharat S et al. 2019; Seith et al. 2019), hearing loss (Xu L et al. 2020), and cancer (Davis JM et al. 2019).

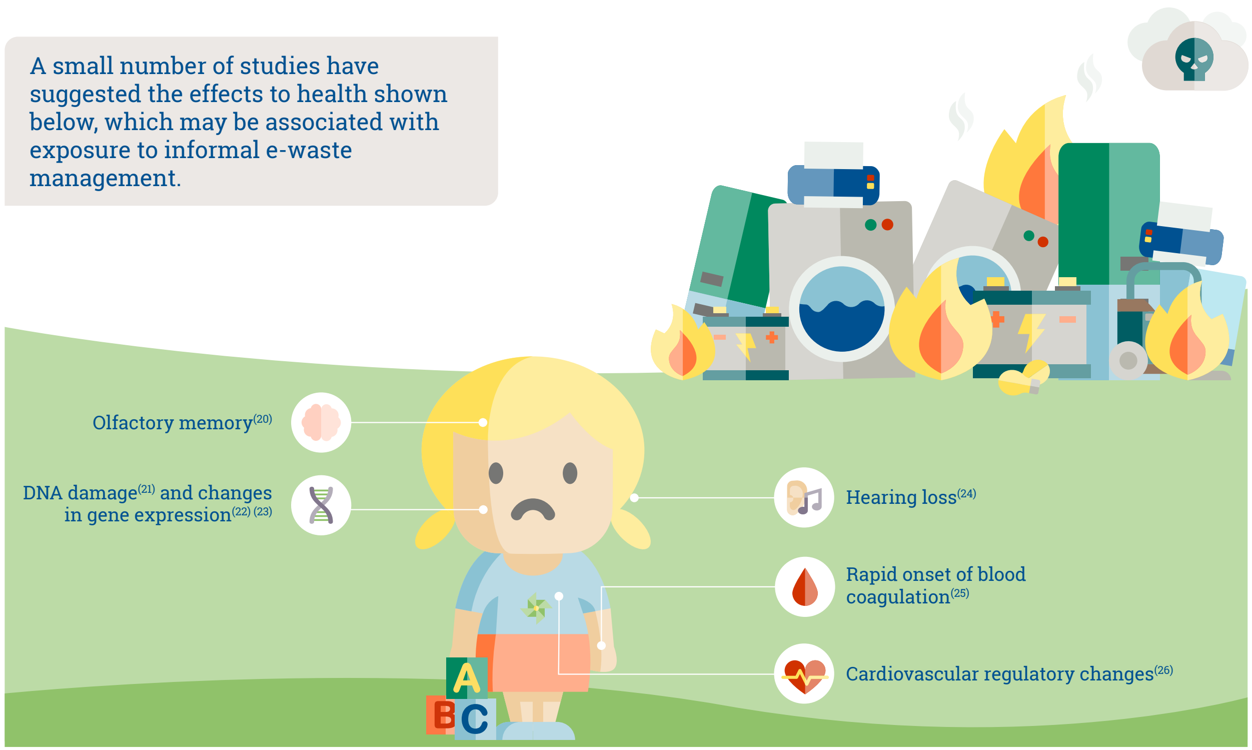
Sources of health or environmental impact caused by informal e-waste recycling



Associations between exposure to informal e-waste recycling and the health of infants and children

Adverse birth outcomes.[12]	Increased or decreased growth.[13]	Altered neurodevelopment, adverse learning, and behavioural outcomes.[14] [15]
Effects on the immune system.[16]	Effects on lung function.[17] [18]	Multiple studies have investigated the impact of e-waste exposure on thyroid function of children but have reported inconsistent results.[19]

A small number of studies have suggested the effects to health shown below, which may be associated with exposure to informal e-waste management.



Because of their unique vulnerability and susceptibility to environmental toxicants, infants and children have been a significant focus of health effects studies.

Since the publication of the previous e-waste monitor in 2017, research on unregulated e-waste recycling and its associations with adverse health outcomes has expanded. These studies have continued to highlight the dangers to human health from exposure to well-studied toxins, such as lead. The following section highlights the most recent findings between e-waste recycling and human health outcomes.

Studies have reported associations between exposure to informal e-waste recycling and adverse birth outcomes (stillbirth, premature birth, lower gestational age, lower birth weight and length, and lower APGAR scores), increased or decreased growth, altered neurodevelopment, adverse learning and behavioral outcomes, immune system function, and lung function. Multiple studies have investigated the impact of e-waste exposure on thyroid function in children but have reported inconsistent results. A small number of studies have also suggested that DNA damage, changes in gene expression, cardiovascular regulatory changes, rapid onset of blood coagulation, hearing loss, and olfactory memory may be associated with exposure to informal e-waste management.

Associations between exposure to informal e-waste recycling and the health of workers

The lack of workplace health and safety regulations leads to an increased risk of injuries for workers in informal e-waste dismantling and recycling.[27] [28]

E-waste workers have also reported stress, headaches, shortness of breath, chest pain, weakness, and dizziness.[29] [30]

As well as

The lack of workplace health and safety regulations leads to an increased risk of injuries for workers in informal e-waste dismantling and recycling.

E-waste workers have also reported stress, headaches, shortness of breath, chest pain, weakness, and dizziness. Among adults involved in informal e-waste management or living in e-waste communities, DNA damage has been associated with exposure to chemicals in e-waste. A small number of studies have also reported effects on liver function, fasting blood glucose levels, male reproductive and genital disorders, and effects on sperm quality from exposure to informal e-waste recycling. There has been a large increase in research into the health impacts of e-waste recycling over the last decade. It is difficult to assess whether exposure to e-waste as a whole causes specific health outcomes because of studies' small populations, the variety of chemical exposures measured, the variety of outcomes measured, and the lack of prospective long-term studies. Yet the body of research suggests there is a significant risk of harm, especially to children who are still growing and developing. Individual chemicals in e-waste such as lead, mercury, cadmium, chromium, PCBs, PBDEs, and PAHs are known to have serious impacts on nearly every organ system (Grant et al. 2013).

Availability of health statistics

In addition to reliable statistics on e-waste collection, processing, and conditions of work, harmonised data on the number of people exposed, exposure to hazardous toxicants, and health effects are critical to understanding the impact of e-waste management. Harmonised statistics are vital for monitoring health impacts, informing decision-makers of the scope of the problem, and evaluating interventions.

Exposure

Limited data are available on the number of people exposed to e-waste. Only rough estimates are available of the number of people involved in informal e-waste management internationally and in impacted countries (EMG 2019; ILO, 2019; Perkins DN 2014; Prakash et al 2010; Xing GH et al. 2009). It is often unclear what methods have been used to produce these estimates. They often do not take into account individuals living in communities but not involved in informal recycling, children, or those exposed to pollutants through environmental contamination.

Large populations in e-waste recycling hotspots may be at risk. But just because a country doesn't have a concentrated neighbourhood of e-waste recycling activity doesn't mean it has no e-waste problem. E-waste is part of a larger waste context and is often collected door-to door or sent to landfills as part of general waste. Waste-pickers, who are among the poorest and most vulnerable, may be exposed in communities around the world (Gutberlet J & Uddin SMN 2017). In Latin America, e-waste is often recycled in small shops across cities, instead of being concentrated in one area (ITU et al. 2016a).

A growing number of studies have measured the daily intake and body burden of single e-waste pollutants, but they have been limited to small numbers of participants (Song & Li 2014). Long-term monitoring of occupational exposure, burdens on the body, environmental levels, and health is needed to quantify the impact of e-waste (Heacock et al. 2018). Experts have recommended that exposure and environmental monitoring include metals, small particulate matter (PM2.5), persistent organic pollutants (POPs), and PAHs (Heacock et al. 2018). Large biomonitoring initiatives are being developed to monitor exposure to chemical hazards (Prüss-Ustün A et al. 2011) and may be a good model for e-waste.

Health effects

Although there is a growing amount of information about the health effects of e-waste exposure, there is limited data available about the number of people suffering from the effects. Academic studies of exposure and health effects have primarily been small studies of 50 to 450 participants (Grant K et al. 2013; Song Q & Li J 2015; Zeng X et al. 2019b; Zeng Z et al. 2018a). Some of these studies have reported contamination of control groups, suggesting the widespread transport of contaminants (Sepúlveda et al. 2010; Song Q & Li J 2015). No large-scale longitudinal studies have been published. There are significant challenges to collecting e-waste-related health statistics, such as the large number of potential health outcomes, the challenges of studying chemical mixtures, the lack of confirmed exposure-outcome relationships, and the long latency periods of some diseases. Internationally harmonised indicators can assist in measuring the number of people at risk of e-waste-related health effects and with monitoring trends over time.

Chapter 9

Regional E-Waste Key Statistics


Oceano Artico
Alaska
Territori del Nord Ovest
Alberta
Ontario
Quebec
Islanda
Scandinavia
Jacuzia
Kamchatka
Giappone
Urali
Ucraina
Cina
Siam
Indonesia
Europa Occidentale
Oceano Atlantico
Africa del Nord
Egitto
Madagascar
Brasile
Perù
Argentina
Oceano Pacifico
Oceano Indiano
Nuova Guinea
Australia Orientale
Global Ewaste Monitor !
2020
America 13,1 Mt
America
Africa 2,9 Mt
Asia 24,9 Mt
Europa 12,0 Mt
Australia 0,7 Mt

E-waste status in Africa in 2019

2.9 Mt | 2.5 kg per capita
e-waste generated

0.9% | 0.03 Mt
e-waste documented to be collected and properly recycled

13 countries
have a national e-waste legislation/policy or regulation in place

1152 population (millions) **49** countries analysed

$3.2 Billion
value of raw materials in e-waste

9.4 Mt CO_2 equivalents
potential release of GHG emissions from undocumented wasted fridges and air conditioners

0.01 kt
amount of mercury from undocumented flows of e-waste

5.6 kt
amount of BFR from undocumented flows of e-waste

Countries with the highest e-waste generation per sub-region

Eastern Africa

0.3 Mt | 0.8 kg per capita | 1.3% | 0.004 Mt | 383

Ethiopia	55.2 kt
Kenya	51.3 kt
Tanzania	50.2 kt

Middle Africa

0.2 Mt | 2.5 kg per capita | 0.03% | 0.0001 Mt | 80

Angola	125.1 kt
Cameroon	26.4 kt
Congo	18.3 kt

Northern Africa

1.3 Mt | 5.4 kg per capita | 0% | 0 Mt | 240

Egypt	585.8 kt
Algeria	308.6 kt
Morocco	164.5 kt

Southern Africa

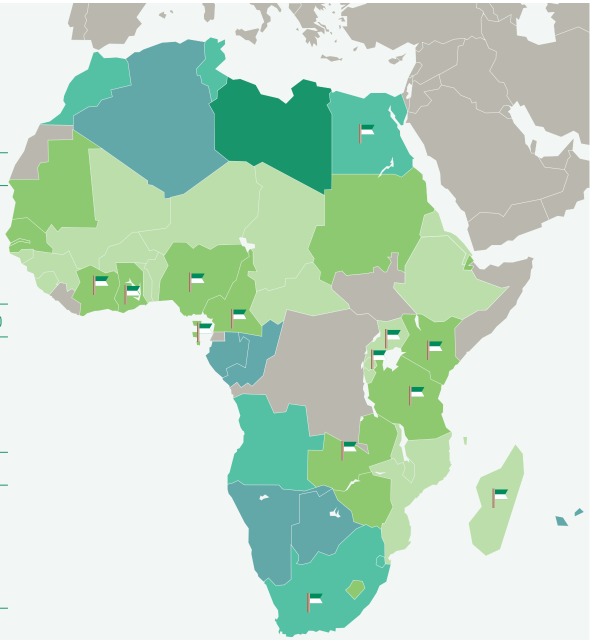
0.5 Mt | 6.9 kg per capita | 4% | 0.02 Mt | 67

South Africa	415.5 kt
Botswana	18.8 kt
Namibia	15.7 kt

Western Africa

0.6 Mt | 1.7 kg per capita | 0.4% | 0.002 Mt | 382

Nigeria	461.3 kt
Ghana	52.9 kt
Côte d'Ivoire	30.0 kt



Legend
E-waste generated (in Mt and kg per capita)
E-waste documented to be collected and properly recycled
Population (in millions)

E-waste generated
0 to 1 kg per capita
1 to 3 kg per capita
3 to 6 kg per capita
6 to 10 kg per capita
10+ kg per capita

Legislation

In past years, there have been some improvements in the legal, institutional, and infrastructural framework for achieving sound management of e-waste in some countries. In Ghana, Technical Guidelines on Environmentally Sound E-Waste Management for Collectors, Collection Centers, Transporters, Treatment Facilities, and Final Disposal have been developed and are being enforced. In Nigeria, the EPR took off with formation of the E-waste Producer Responsibility Organisation of Nigeria (EPRON), a non-profit organization set up by electrical and electronic producers in Nigeria. EPRON is the first Producer Responsibility Organization (PRO) for electronic waste in Nigeria and was founded in March 2018 with such stakeholders as HP, Dell, Phillips, Microsoft, and Deloitte contributing towards its establishment in Nigeria. In East Africa, there are also significant continuing developments, with Rwanda adopting e-waste regulation and other countries looking at adopting future regulations.

Nevertheless, specific e-waste legislation on management of e-waste is still lacking in most African countries. Few countries have e-waste legislation published in Africa (e.g. Egypt, Ghana, Madagascar, Nigeria, Rwanda, South Africa, Cameroon, Côte D'Ivoire). However, enforcing the legislation is very challenging. Some countries, such as Rwanda, have recently passed regulations governing e-waste management. Uganda implemented an Electronic Waste Management Policy in 2012. In the East Africa community, Tanzania, Rwanda, Uganda, Burundi, Kenya, and South Sudan have adopted a regional e-waste strategy to achieve a sustainable e-waste management system (EACO 2017). The strategy prioritizes a) strengthening the policy, legal, and regulatory framework for sustainable resourcing of e-waste management, b) putting in place the requisite e-waste management infrastructure, c) establishing mechanisms for comprehensive and sustainable mobilization for e-waste management resources, d) strengthening e-waste coordination structures at regional and national levels, and e) promoting research and innovation in e-waste management.

E-waste management system

E-waste management in Africa is dominated by thriving informal sector collectors and recyclers in most countries; neither organized take-back systems nor license provisions for sorting and dismantling e-waste exist. Government control of this sector is currently very minimal and inefficient. The handling of e-waste is often processed in backyards by manual stripping to remove electronic boards for resale, open burning of wires to recover few major components (e.g. copper, aluminum, and iron), and the deposition of other bulk components, including CRTs, in open dumpsites. An example that has attracted international attention is the Agbogbloshie site in Ghana – always referred to as Africa's largest electronic waste dump. However, Agbogbloshie's reality is complex and can be described as a well-organized scrapyard as opposed to an e-waste dumpsite. At Agbogbloshie, roughly 5,000 scrap workers turn up at the dump every day to search for valuable metals contained in the waste, such as aluminium and copper.

In such cities or countries where the e-waste is a source of revenue for many, the "informal" e-waste collection rate is extremely high, most of the valuable materials are recovered, and many components are reused or resold. The downside of such intense informal activities is not of interest economically or that don't end up having a second application are disposed of in a hazardous way.

Few countries, such as South Africa, Morocco, Egypt, Namibia, and Rwanda, have some facilities in place for e-waste recycling, but those co-exist with the existence of a large informal sector. Therefore, some of those recycling companies have struggled to progress and increase the volumes processed, but interesting pilots and energies are also mobilized through new initiatives. On the other hand, sizeable countries such as Nigeria, Kenya, and Ghana are still very reliant on informal recycling. A study conducted in Nigeria shows that approximately 60,000-71,000 t of used EEE were imported annually into Nigeria through the two main ports in Lagos in 2015 and 2016. It was found that most of the imported used e-waste was shipped from developed countries such as Germany, UK, Belgium, USA, etc. Additionally, a basic functionality test showed that, on average, at least 19% of devices were non-functional (Odeyingbo, Nnorom, and Deubzer 2017).

E-waste management problems and attendant remedies are somewhat similar in the various sub-regions of Africa. In summary, the major problems include the lack of adequate public awareness, lack of government policy and legislation, lack of an effective collection system and EPR system, the dominance of the recycling sector by an uncontrolled, ill-equipped informal sector that pollutes the environment, lack of adequate recycling facilities, and poor financing of hazardous waste management activities.

E-waste status in the Americas in 2019

13.1 Mt | 13.3 kg per capita
e-waste generated

9.4% | 1.2 Mt
e-waste documented to be collected and properly recycled

10 countries
have a national e-waste legislation/policy or regulation in place

984 population (millions) **34** countries analysed

$14.2 billion USD
value of raw materials in e-waste

26.3 Mt CO_2 equivalents
potential release of GHG emissions from undocumented wasted fridges and air conditioners

0.01 kt
amount of mercury from undocumented flows of e-waste

18 kt
amount of BFR from undocumented flows of e-waste

Countries with the highest e-waste generation per sub-region

Caribbean

0.1 Mt | 7.8 kg per capita 1% | 0.001 Mt 16

Jamaica	18 kt

Northern America

7.7 Mt | 20.9 kg per capita 15% | 1.2 Mt 367

USA	6.918 kt
Canada	757 kt

Central America

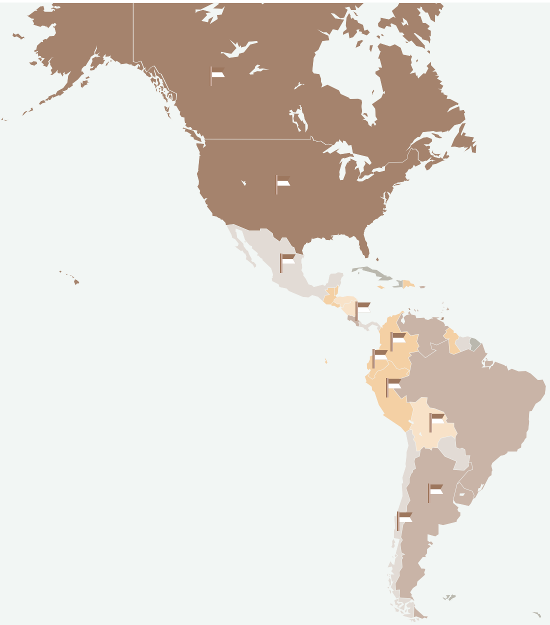
1.5 Mt | 8.3 kg per capita 3% | 0.04 Mt 176

Mexico	1.220 kt
Guatemala	75 kt
Costa Rica	51 kt

South America

3.9 Mt | 9.1 kg per capita 0.7% | 0.03 Mt 425

Brazil	2.143 kt
Argentina	465 kt
Colombia	318 kt



Legend
E-waste generated (in Mt and kg per capita)
E-waste documented to be collected and properly recycled
Population (in millions)

E-waste generated
0 to 4 kg per capita
4 to 7 kg per capita
7 to 10 kg per capita
10 to 15 kg per capita
15+ kg per capita

Legislation

The United States of America does not have national legislation on the management of e-waste, but 25 states and the District of Columbia have enacted some form of legislation. The state laws vary in their scope and impact and in whether or not they prohibit consumers from disposing electronics in landfills. In all, the laws cover 75-80% of the USA population. However, due to the differences in scope, many areas of the country, including states covered by laws, do not have convenient collection opportunities. Apart from California and Utah, all states that have implemented laws use an EPR approach. Canada does not have a national legislation in effect on the management of e-waste, as the federal agency would not have this authority. However, 12 provinces and territories have regulations in place with industry-managed programmes – all but Nunavut, the least populated territory in Canada. On average, the product scope is much wider than USA; in many Canadian provinces, the EPR requirements can be met by joining an approved e-waste compliance scheme.

Regulatory advances in Latin America take time, and only a few countries have managed to establish e-waste laws. Although there has been considerable progress regarding the implementation of specific e-waste regulations in Latin America in the past 5-10 years, this progress is limited to a few countries, and for the rest, the road ahead is still very long. Apart from Mexico, Costa Rica, Colombia, and Peru – likely the leading forces in the region for environmentally sound e-waste management and which, in 2020, are working on improving the already established systems, only Brazil and Chile are establishing the bases from which to start with the implementation of a formal regulatory framework for e-waste.

Brazil recently published the "Sectoral Agreement for the Implementation of the Reverse Logistics System for WEEE from households" for public consultation, and its formal signature is expected in 2020.

After enacting the "Framework Law on Waste Management, Extended Producer Responsibility, and Promotion of Recycling" in 2016, Chile is now working on the specific e-waste regulation, which will include collection and recycling targets and set the guidelines for the implementation of formal collection systems.

Seven years after implementing Decree 1512 for waste from computers, printers, and peripherals, Colombia is working on a new regulation to extend EPR to all e-waste categories and make adjustments to the integrated management system for e-waste, taking into account the lessons learned and the guidelines established by WEEE Law 1672 and the National Policy for WEEE Management.

Looking back already on five years since the implementation of its first e-waste management systems, Peru has been evaluating the experience very closely so that it can close loopholes and make alignments with the country's general waste management strategy. The revised regulation is expected to be published soon and will also extend the scope of e-waste categories with a mandatory collection target of small and large household appliances and, in particular, cooling appliances.

As of 2020, Mexico is planning on reviewing the current regulation after its first five-year term and has been expanding several studies in order to redefine the responsibilities of involved stakeholders, establish clearly defined categories, and set mandatory collection targets, thereby increasing collected and formally recycled volumes.
Costa Rica has finally overcome its initial challenges created by contradictory regulations and is now focusing on improving the implementation of the current regulation. Following numerous unsuccessful initiatives and law projects with a specific focus on e-waste at both the federal and provincial level, Argentina has now changed its approach by drafting an EPR law for multiple waste categories. The law is still being discussed in the Congress.
Through its Ministerial Agreement 191, Ecuador has been enforcing the take-back of mobile phones from all mobile phone operators and importers, which led to the collection and recycling of nearly 50,000 units in 2017.
Bolivia introduced the principle of EPR in its general waste management law in 2015, which applies to several waste fractions, especially batteries. Nevertheless, the law has never been regulated and therefore doesn't establish any applicable collection targets.

The short summary of abovementioned countries highlights a general problem observable throughout the region: the lack of harmonisation of these regulations and the general principles they are based upon. Most of them present differences in the general approach (EPR vs. shared responsibility vs. public sector programmes), in jurisdictions level (federal vs. state vs. city), the definitions of the fundamental principles, the involved stakeholders, the allocation of roles and responsibilities, and the applicable e-waste categories, just to name a few.

E-waste management system

The USA undertook general measures to prevent e-waste at the federal level and, so, does have a set of regulatory measures for limiting the adverse effects posed by unappropriated disposal and treatment of electronics. Certain electronics, if meeting certain criteria, must be managed under the requirements of the Resource Conservation and Recovery Act (RCRA). Federal agencies are directed to use electronics recyclers that are certified according to either the Responsible Recycling (R2) or e-Stewards standards. Hundreds of electronics recycling facilities have been independently certified to one or both of the certification programmes, whose standard have been updated and enhanced since their inception in 2010.
Latin America still offers a very wide range of companies involved in today's e-waste management and disposal activities, especially when it comes to the development of the local recyclers. On one hand, while there were only three R2-certified companies south of Mexico just a few years ago, there are now more than 15. On the other hand, the number of e-waste recyclers in nearly all countries has grown considerably, but most of the newer companies are still at the very bottom of the learning curve. Although there have been some interesting initiatives, it has not been possible yet to establish technical standards that respond to the local conditions of the region.

Without a doubt, the growing number of recyclers in the region is also a consequence of the growing volumes of formally collected end-of-life electronics. In countries with a specific legal framework for e-waste and mandatory collection targets, such as Colombia and Peru, the growth of the collected volumes has been steady and remarkable. In parallel, the range of appliances collected has also widened. The focus is no longer only on information and communication technologies only. Goods – especially cooling appliances – have been included in the scope, and there are several projects focusing primarily on energy efficiency programmes and the development of local infrastructure in order to ensure proper handling and treatment of discarded appliances and, thus, the reduction of greenhouse gas emissions.

Driven by regulation, the importance of formal collection systems is also increasing, as is the number of individual or collective compliance schemes. Very large quantities are still handled by the informal sector or, in the best cases, stored away in basements. The informal sector is part of the labor structure of Latin America, but only very few countries, such as Brazil and Chile, are actively addressing their role in relation to e-waste management. Recognition, regulation, and integration of their work in this area is clearly one of the region's great challenges.

Another challenge is the lack of contributions from the research field. There are hardly any e-waste statistics, and the few available have been overused and are worn out. There is a need for up-to-date information and proven methodologies that support the definition of policies and regulations. Only by getting a grip on such updating of information will it be possible to tackle the far more complex topic of raising the awareness level and educating consumers of all sorts to help bring e-waste management in Latin America to the next level.

E-waste status in Asia in 2019

24.9 Mt | 5.6 kg per capita
e-waste generated

11.7% | 2.9 Mt
e-waste documented to be collected and properly recycled

17 countries
have a national e-waste legislation/policy or regulation in place

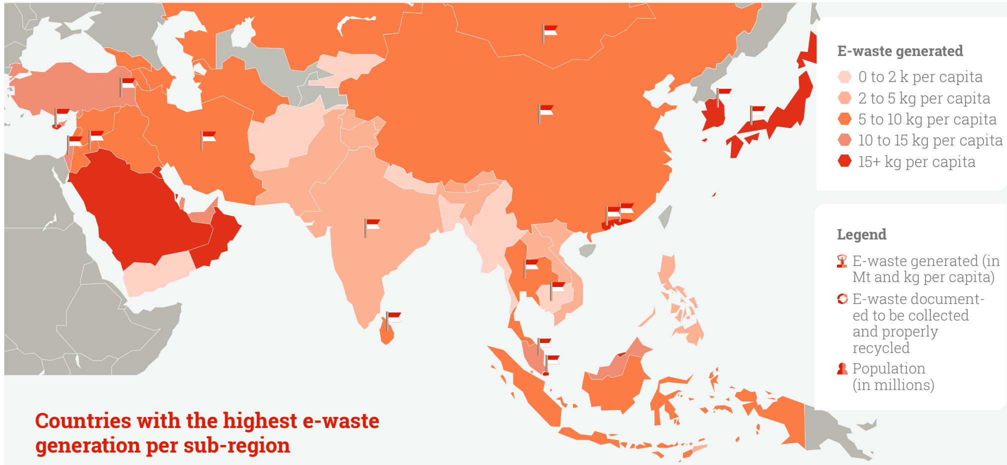
4445 population (millions) **46** countries analysed

$26.4 billion USD
value of raw materials in e-waste

60.8 Mt CO_2 equivalents
potential release of GHG emissions from undocumented wasted fridges and air conditioners

0.04 kt
amount of mercury from undocumented flows of e-waste

35.3 kt
amount of BFR from undocumented flows of e-waste



Countries with the highest e-waste generation per sub-region

Western Asia

2.6 Mt | 9.6 kg per capita 6% | 0.2 Mt 272

Turkey	847 kt
Saudi Arabia	595 kt
Iraq	278 kt

Central Asia

0.2 Mt | 7.1 kg per capita 5% | 0.01 Mt 31

Kazakhstan	172 kt
Turkmenistan	39 kt
Kyrgyzstan	10 kt

South-Eastern Asia

3.5 Mt | 5.4 kg per capita 0% | 0 Mt 656

Indonesia	1.618 kt
Thailand	621 kt
Philippines	425 kt

Eastern Asia

13.7 Mt | 8.6 kg per capita 20% | 2.7 Mt 1590

China	10.129 kt
Japan	2.569 kt
Republic of Korea	818 kt

Southern Asia

4.8 Mt | 2.6 kg per capita 0.9% | 0.04 Mt 1896

India	3.230 kt
Iran (Isl. Rep.)	790 kt
Pakistan	433 kt

Legislation

The South Asian region has begun to recognise the importance of proper e-waste management. India is the only country in Southern Asia with e-waste legislation, although several other countries are considering such legislation. In India, laws to manage e-waste have been in place since 2011, mandating that only authorised dismantlers and recyclers collect e-waste. A manufacturer, dealer, refurbisher, and Producer Responsibility Organization (PRO) were brought under the ambit of the E-Waste (Management) Rules 2016. The National Resources Policy (still in draft at time of publishing) also envisages a strong role for producers in the context of recovering secondary resources from e-waste.

In Southeast Asia, some countries are more advanced. The Philippines does not have a regulation specifically for e-waste management, but it does have a range of 'hazardous waste' regulations that cover e-waste as it is considered "hazardous" waste. The Philippines has formulated the "Final Draft Guidelines on the Environmentally Sound Management (ESM) of Waste Electrical and Electronic Equipment (WEEE)", which will hopefully be passed soon. Cambodia now has a specific law relating to e-waste management with the 2016 Sub-decree on Electrical and Electronic Equipment Waste Management (E-waste Management). This Sub-decree covers all activities regarding disposal, storage, collection, transport, recycling and dumping of EEE waste. Myanmar does not have regulation for e-waste, and e-waste has not specifically been categorized as hazardous waste. However, Myanmar has recognised the importance of hazardous waste management and is currently working towards a Master Plan and guidelines for it.

China has national legislation in force that regulates the collection and treatment of fourteen types of e-waste (i.e. five types, initially, and nine more were later added). The regulated fourteen types of e-waste are: televisions, refrigerators, washing machines, air conditioners, personal computers, range hoods, electric water-heaters, gas water-heaters, fax machines, mobile phones, single-machine telephones, printers, copiers, and monitors. Other countries in East Asia, such as Japan and South Korea, have advanced e-waste regulation.
In Japan, most EEE products are collected and recycled under the Act on Recycling of Specified Kinds of Home Appliances and the Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment. Japan was one of the first countries globally to implement an EPR-based system for e-waste.

In Western and Central Asia, e-waste legislation advances are still very poor. There are some formalized legislation of mercury-containing lamps. However, for types of e-waste, collection, legislation, and e-waste management infrastructure is mostly absent. Some highlights are that the Kyrgyz government is developing new legislation introducing the EPR concept, which will also apply to e-waste. The government is currently developing a resolution aimed at addressing the management of e-waste. It contains a definition of this category of waste and provides directives for its collection, storage, disposal, transport, and recycling. In Kazakhstan, the EPR for e-waste has been reflected in the concept for transition of the Republic of Kazakhstan to a Green Economy, adopted in 2013, which provides a basis for the implementation of "the principles of a manufacturer's extended liability to cover part of the costs for collection and disposal of packaging, electronic and electric equipment, transport vehicles, batteries, furniture, and other used goods". This is close to the EPR concept, but does not have any licensing or financing mechanism to cover the transportation and depollution in the legislation. The inclusion of such licensing and financial mechanisms are currently under discussion.

E-waste management system

The e-waste management systems found in Asia are rather broad. They range from very advanced e-waste management systems, such as in South Korea, Japan, China, and the province of Taiwan, to informal activities that coexist alongside the advanced recycling system in China, but which dominate the e-waste management in the other parts of Asia. E-waste management in South Asia is largely based on informal sector activities for collection, dismantling, and recycling. Legislation in India has been a driver for the setting up of formal recycling facilities, and there are 312 authorised recyclers in India, with the capacity for treating approximately 800 kt annually. However, formal recycling capacity remains underutilised, as the large majority of the waste is still handled by the informal sector. There are 31 authorised PROs providing compliance services, including the collection and channelization of e-waste to formal recycling facilities, as well as the administration of awareness campaigns. Enforcing rules remains a challenge, as do other aspects, such as the lack of proper collection and logistics infrastructure, limited awareness of consumers on the hazards of improper disposal of e-waste, the lack of standards for collection, dismantling of e-waste and treatment of it, and an inefficient and tedious reporting process.

Current statistics show that China is the world's top e-waste producer, having generated 10.1 Mt of e-waste in 2019. China plays a key role in the global EEE industry for two primary reasons: it is the world's most populous country, so the domestic demand of EEE is very high, and it has a strong EEE manufacturing industry. Additionally, China plays a significant role in the refurbishment, reuse, and recycling of e-waste. Driven by e-waste regulation and the facilities expansion, the formal e-waste recycling industry has shown considerable growth in treatment capacity and quality; more than 70 million e-waste units are dismantled annually (China Ministry of Ecology and Environment 2019). According to the Chinese government, the actual collection and recycling rate is 40%, but it is important to note that this number only refers to 5 EEE products, as opposed to the 54 EEE products (UNU-Keys) listed in the international e-waste classification (Annex 1). The collection and recycling rate drops to 15% if all 54 products are considered. The informal sector has been dramatically declining, due to stricter controls from China's new environmental law. The illegal importation of e-waste disappears more expeditiously because of the solid waste ban import policy. However, the increasing gap between fund levies and subsidies is imposing the distinct challenges for e-waste funding policy (Zeng et al. 2017). The Chinese Government has set targets of sourcing 20% of raw materials for new electronics products from recycled content and recycling 50% of electronic waste by 2025 (World Economic Forum 2018). Taiwan's (Province of China) e-waste collection and recycling rate had reached 64% of the products covered by the legislation in 2018[(37)]; this significant achievement is based on the 4-in-1 recycling system that focuses on applying the EPR concept to the recycling system. The mechanism has substantially improved under the supervision of the Recycling Fund Management Board (RFMB), which is under Taiwan Environmental Protection Administration's jurisdiction. Taiwan has about 20 e-waste recycling facilities whose capacity is higher than the current domestic e-waste generation, so the e-waste recycling business in Taiwan is experiencing challenges. Japan relies on a strong legal framework, an advanced collection system, and developed processing infrastructure. In 2016, under the Act on Recycling of Specified Kinds of Home Appliances, Japan collected 570.3 kt through official channels.

In Central Asia, most of e-waste generated ends up in landfills or illegal dumping sites. In the Kazakhstan EPR system, some collection and recycling sites have been set up, but the capacity is not sufficient to manage the country's entire e-waste or to finance the transportation of e-waste to it. In the entire region, it is common that consumers send their discarded electric/electronic devices to small companies, which then dismantle them and reuse certain components. So, several governments took measures in order to address the issue. For instance, in Uzbekistan, progress was achieved from 2014-2016 by upgrading municipal waste infrastructure, and in 2017, the president launched a major five-year programme to improve waste collection, disposal, and recycling nationwide. However, no regulatory measures have been introduced specifically in relation to e-waste.

In Western Asia, the countries range from very rich to very poor. Despite that, the e-waste management system is mostly informal. In the rich countries, there are large migrant workers that reuse or repair donated used-EEE from the richer households, but this is unique within the region. The United Arab Emirates have invested in a specialized facility located at the Dubai Industrial Park that has a capacity of 100 kt of e-waste per year. However, as aforementioned, most e-waste is largely uncontrolled and managed by the informal sector. In the middle and south of Palestine, there are three main landfills where e-waste is dumped, and the region is experiencing illegal imports of e-waste without having the adequate environmentally sound recycling infrastructure in place. According to an e-waste study conducted in 2019 by UNIDO in coordination with the Lebanese Ministry of Industry, a certain quantity of e-waste in Lebanon is also landfilled, and more still is exported as scrap, mainly by the informal sector, while a small percentage is dismantled and sent to abroad to recycling facilities through the formal sector. The study also revealed that e-waste recycling in Lebanon is currently limited because of high operational costs, particularly energy, and the complexity and potential hazards of e-wastes (UNIDO 2019).

E-waste status in Europe in 2019

12.0 Mt | 16.2 kg per capita
e-waste generated

42.5% | 5.1 Mt
e-waste documented to be collected and properly recycled

37 countries
have a national e-waste legislation/policy or regulation in place

740 population (millions) **39** countries analysed

$12.9 billion USD
value of raw materials in e-waste

12.7 Mt CO_2 equivalents
potential release of GHG emissions from undocumented wasted fridges and air conditioners

0.01 kt
amount of mercury from undocumented flows of e-waste

11.4 kt
amount of BFR from undocumented flows of e-waste

Countries with the highest e-waste generation per sub-region

Eastern Europe

3.2 Mt | 11 kg per capita 23% | 0.7 Mt 289

Russian Federation	1.631 kt
Poland	443 kt
Ukraine	324 kt

Northern Europe

2.4 Mt | 22.4 kg per capita 59% | 1.4 Mt 105

United Kingdom	1.598 kt
Sweden	208 kt
Norway	139 kt

Southern Europe

2.5 Mt | 16.7 kg per capita 34% | 0.9 Mt 151

Italy	1.063 kt
Spain	888 kt
Greece	181 kt

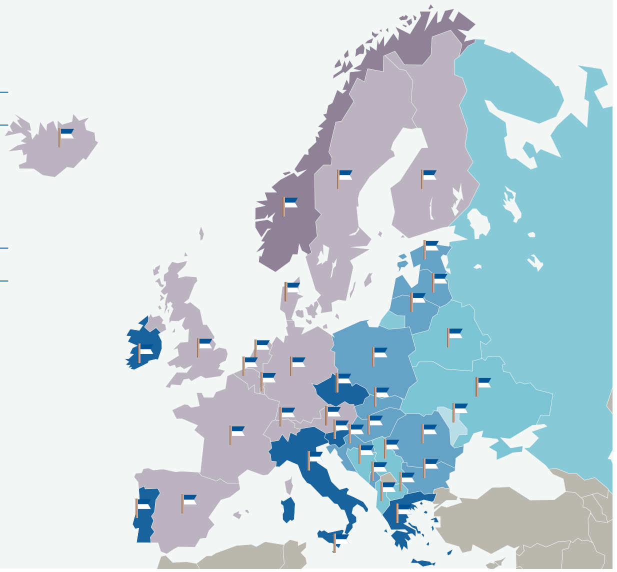
Western Europe

4 Mt | 20.3 kg per capita 54% | 2.1 Mt 195

Germany	1.607 kt
France	1.362 kt
Netherlands	373 kt

Legend
E-waste generated (in Mt and kg per capita)
E-waste documented to be collected and properly recycled
Population (in millions)

E-waste generated
0 to 5 kg per capita
5 to 10 kg per capita
10 to 15 kg per capita
15 to 20 kg per capita
20 to 25 kg per capita
25+ kg per capita



Legislation

In Europe, the majority of e-waste is regulated by the WEEE Directive (2012/19/EU). This regulation is in force in the European Union and in Norway. Other countries – including Iceland, Switzerland, and several Balkan countries, such as Serbia and Bosnia and Herzegovina – have similar laws. The WEEE Directive set collection, recycling, reuse, and recovery targets for all six categories of e-waste. From 2018 onwards, article 7 of the WEEE Directive states that the minimum collection rate to be achieved annually by a member state shall be either 65% of the average weight of EEE POM in the three preceding years or 85% of e-waste generated on the territory of a member state in 2018. Bulgaria, the Czech Republic, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia, and Slovakia may have the option to remove themselves from this regulation by 2021 because of their relatively low level of EEE consumption. The latest developments in the implementation of the WEEE Directive are the introduction of the open scope and newly specified reporting guidelines.

Since August 15, 2018, the so-called open scope has been in place. The open scope means that EEE products are a priori considered to be in scope in the European Union, unless specific exclusions apply. This means, in practice, that new products, such as clothes and furniture with electric functionality, can fall under the directive. With regard to e-waste statistics, the most important decisions are calculation methods for preparation of reuse, exports of e-waste, the e-waste generated methodology, and the reporting categories. Preparation for reuse is defined as the weight of whole appliances that have become waste and of components of e-waste that, following checking, cleaning, or repairing operations, can be reused without any further sorting or preprocessing. It also contains a decision on the registration of e-waste exports. Where e-waste is sent for treatment in another member state or exported for treatment in a third country in accordance with Article 10 of Directive 2012/19/EU, only the member state that has collected and sent or exported the e-waste for treatment may count it towards the minimum recovery targets referred. Note that the directive does not yet cover any decision on exports of reused products, as they are not yet waste. Also, member states have to report the data on the weight of e-waste generated. Another decision is that data shall be reported in the six categories, but that Category 4, Large equipment, is split into Category 4a (Large equipment excluding photovoltaic panels) and Category 4b (Large equipment including photovoltaic panels).

In Ukraine, an EPR system based on the EU WEEE Directive is in development, by the association agreement from the EU and Ukraine. Thanks to the collaborative project supported by the EU, the Ministry of Ukraine Regional Development received support to establish a legal basis on the disposal of electronic waste and batteries. Recently, the two-year project "Implementation of Management System for Waste of Electric and Electronic Equipment and Batteries in Ukraine" has been completed. This project helped develop two laws: The Bill on Batteries and Accumulators and the Bill on Waste of Electric and Electronic Equipment, which is expected to pass parliament in 2020.

In Belarus, there is a general law, Law No. 271-Z on waste management, dated July 20, 2007. E-waste is managed within a framework of EPR of manufacturers and suppliers. The e-waste categories featured are large equipment, whose lengths are over 160 cm; medium-sized items, sized 80-160 cm; and small items, under 80 cm in length. Within the "Municipal Waste Management and Use of Recycled Resources" component of the national programme "Comfortable Accommodation and Favourable Environment" for 2016-2020 (Order of the Council of Ministers of Belarus, dated April 21, 2016, No. 326), an objective was set to reach the intermediate target of 20% by 2019. Ferrous metal law bans the collection of e-waste by metal scrap recyclers. Despite that, such collection probably still happens. Valuable components are taken out, and hazardous substances are dumped. In Moldova, a national strategy on waste has been in effect since 2013. There is an EU-Republic Moldovan association agreement, under which several association agreements on environmental legislation exist. Within that context, the EPR on e-waste was approved in 2018. In Moldova, e-waste is classified into the 10 categories of the old EU WEEE Directive, as opposed to the current 6 categories enforced in the EU. The EPR law specifies that there are also collection and recycling targets based on EEE POM of the three preceding years. In 2020, there is a 5% collection target. This will gradually increase by 5% each year until 30% in 2025. In 2017, Russia has started an EPR programme for electrical and electronic scrap. Manufacturers and importers must help collect and process obsolete electronics in accordance with Russian circular economy legislation.

E-waste management systems

In the European Union, there is a very well-developed compliant e-waste management infrastructure to collect e-waste in shops and municipalities by private operators, as well as to further recover the recyclable components of the collected e-waste and dispose residuals in a compliant and environmentally sound manner. This has been established by the relatively long-running history of EU e-waste legislation since early in 2003. Consequently, statistics show that 59% of the e-waste generated in Northern Europe and 54% of e-waste generated in Western Europe is documented as being formally recycled; the e-waste collection data was reported for 2017. Those are the highest percentages in the world. For the reference year 2019, 85% of e-waste generated, or 65% EEE POM of the three preceding years, has to be collected by a member state of the EU, which indicates that collection and recycling must increase even further to meet the collection targets.

The feasibility of achieving the target and the location of other e-waste have therefore been subject to several country studies in recent years. During the writing of this study, the most recent studies have been performed in the Netherlands (Baldé et al. 2020) and Romania (Magalini et al. 2019). These studies indicate that an increasing share of e-waste, compared to the e-waste generated, has been compliantly recycled in the past. However, significant parts are still managed outside the compliant recycling sectors in the EU. E-waste management takes place by exporting for reuse, e-waste that is disposed of in mixed residual waste as well as e-waste that is non-compliantly recycled with metal scrap. In the Netherlands, the exports for reuse have been quantified as being roughly 8% of the total e-waste generated (Baldé et al. 2020). These exports are mostly comprised of EEE from IT servers and laptops from dedicated refurbishing companies, as well as used fridges, used microwaves, and other durable goods that are stuffed in second-hand vehicles or containers and shipped to Africa. Exports for reuse are considered as lifetime extensions and are a part of the circular economy. But many other EU countries do not have such data, and without it, reaching the collection targets in those exporting countries will be more difficult, if not impossible. The lower-income EU countries that have a lower consumption of EEE than higher-income countries can also be recipient countries of those exports for reuse. The recent studies also indicate that despite the relatively high environmental awareness in the EU, e-waste is still disposed of in residual waste, and the small e-waste ends up in residual waste bins. This comprises approximately 0.6 Mt of the EU's e-waste (Rotter et al. 2016). A positive note is that the share of e-waste in the residual waste declined in the Netherlands from 11% to 9% of e-waste generated in the past decade (Baldé et al. 2020). The largest uncompliant flow of e-waste is managed together with metal scrap, but without proper depollution steps in place.

Compared to other European countries in its region, Belarus has a relatively advanced e-waste collection and recycling sector. There are municipal drop-off and collection points and private pick-up and collection points, and e-waste is also collected from repair and service centers. Belarus collected 23 kt of e-waste in 2019. The collection from households is incentivized by a small financial transaction that the compliant waste collector (or recycler) receives from the government. However, private companies and governmental agencies have to pay for the e-waste collection. The e-waste collection from public agencies might be hampered because they have to pay a small fee, and the agencies are typically underfunded. So, public agencies typically store the equipment.

In other Eastern European countries, such as the Balkans, e-waste collection is beginning and an e-waste management infrastructure is currently in development, but not yet achieving same rates of e-waste as in Northern and Western Europe. In Moldova, there are collection points from municipalities. Some private companies get equipment from schools, universities, and other public authorities. In Russia and Ukraine, there are enterprises that collect e-waste and manage it in an environmentally sound manner. However, there are too few e-waste collection points, and the e-waste management capacity is not enough to recycle all domestic e-waste in an environmentally sound manner. Thus, e-waste is likely to be recycled together with metal scrap or dumped in landfills.

E-waste status in Oceania in 2019

0.7 Mt | 16.1 kg per capita
e-waste generated

8.8% | 0.06 Mt
e-waste documented to be collected and properly recycled

1 country
has a national e-waste legislation/policy or regulation in place

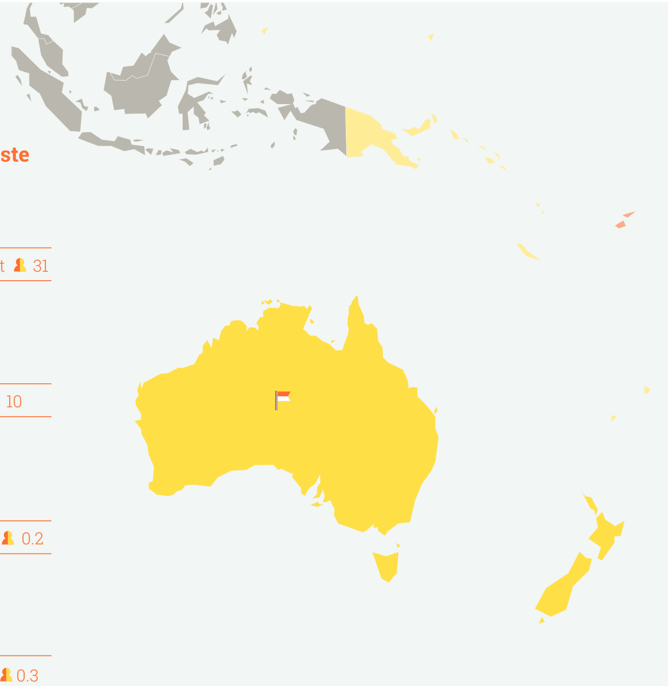
42 population (millions) **12** countries analysed

$0.7 billion USD
value of raw materials in e-waste

1.0 Mt CO_2 equivalents
potential release of GHG emissions from undocumented wasted fridges and air conditioners

0.001 kt
amount of mercury from undocumented flows of e-waste

1.1 kt
amount of BFR from undocumented flows of e-waste



Countries with the highest e-waste generation per sub-region

Australia and New Zealand

0.7 Mt | 21.3 kg per capita 9% | 0.06 Mt 31

Australia	554 kt
New Zealand	96 kt

Melanesia

0.02 Mt | 1.5 kg per capita 0% | 0 Mt 10

Papua New Guinea	9 kt
Fiji	5 kt

Micronesia

0.0005 Mt | 2 kg per capita 0% | 0 Mt 0.2

Micronesia (Fed. St.)	0.20 kt
Palau	0.17 kt

Polynesia

0.001 Mt | 3.1 kg per capita 0% | 0 Mt 0.3

Samoa	0.6 kt
Tonga	0.3 kt

Legend
E-waste generated (in Mt and kg per capita)
E-waste documented to be collected and properly recycled
Population (in millions)

E-waste generated
0 to 5 kg per capita
5 to 15 kg per capita
15+ kg per capita

Legislation

The National Television and Computer Recycling Scheme (NTCRS) was implemented in Australia under the Australian Government's Product Stewardship Act 2011. The Act went into effect on August 8, 2011. Under the Act, the Product Stewardship (Televisions and Computers) Regulations 2011 also went into effect on November 8, 2011. This regulation provides Australian householders and small business with access to industry-funded collection and recycling services for televisions and computers. The co-regulatory aspect is a key feature of the above regulation, whereby the Australian Government, through the regulations, has set the outcomes to be achieved by industry and how the plan to be implemented. The television and computer industries, operating through the approved co-regulatory arrangements (Producer Responsibility Organisation) will determine how to deliver these outcomes efficiently. The plan provides approximately 98% of the Australian population with reasonable access to collection services. These services may include a permanent collection site at a local waste transfer station or retail outlet, or at one-off events. The television and computer industries are required to fund collection and recycling of a proportion of the televisions and computers disposed of in Australia each year and to increase the rate of recycling of televisions and computers in Australia to 80% by 2026-2027.

E-waste management system

Under the Product Stewardship (Televisions and Computers) Regulations 2011, approved co-regulatory arrangements are required to provide independently audited annual reports for the Department to publish. These co-regulatory arrangements report on a range of matters related to their role as administrators of the plan. Currently, four co-regulatory arrangements manage the day-to-day operation of NTCRS. Since the plan's inception, more than 291 kt of TV and computer e-waste has been collected and recycled. During the 2017-2018 financial year, the plan recycled approximately 58 kt of e-waste, equating to a recovery rate greater than 93%. The plan also ensured that all recyclers were certified to AS/NZS 5377:2013 standards with regard to recycling e-waste safely (Australian Government 2019).

With a ban starting in July 2019, the Government of Victoria is the latest Australian state government to ban e-waste in landfills and has announced an A$16.5 million package both to encourage safe management of hazardous materials found in e-waste and to enable greater recovery of the valuable materials, ultimately leading to a more stable industry and more jobs for Victoria. Sustainability Victoria launched a new campaign, implementing a A$1.5 million community education programme on July 4, 2018 to educate Victorians about the value of e-waste and how it can be recycled. The campaign features a new website, ewaste.vic.gov.au, which includes an animated video showcasing the valuable materials inside our electronics and social media and digital advertising (Sustainability Victoria 2019).

Compared to Australia, the Government of New Zealand is still considering developing a mandatory national plan for dealing with the e-waste issue. Estimations are that more than 97 kt of e-waste are being disposed of as landfill each year with more than 98.2% of generated household e-waste ending up in landfills. Such an outcome is largely due to limited diversion of e-waste into more appropriate recycling and treatment and the lack of a mandatory product stewardship-based approach to managing e-waste in New Zealand. E-waste product stewardship plans by individual producers are few and relatively minor. As well, there is no formalized system overall for e-waste management (Blake, Farrelly, and Hannon 2019).

The Pacific Islands region (PICTs), consisting of 22 countries and territories, face unique challenges due to their spread-out geography. The limited availability of suitable land on small islands and atolls for constructing landfills, the islands' remoteness, and the islands' relatively small populations cause issues for large economies, as waste management technologies, rapid urbanisation, limited institutional, and human resource capacities are among the key challenges faced by PICTs. The Secretariat of the Pacific Regional Environment Programme (SPREP) has the lead responsibility for regional coordination and delivery of waste management and pollution control action and uses the strategic management framework, Cleaner Pacific 2025, in guiding regional cooperation and collaboration. SPREP also works with key international and regional partners to achieve greater integration of sustainable funding and to support mechanisms for waste, chemicals, and pollution management programmes.

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