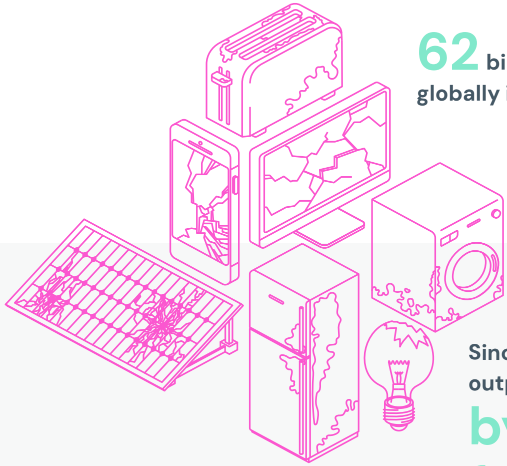
Executive Summary

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

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

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

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



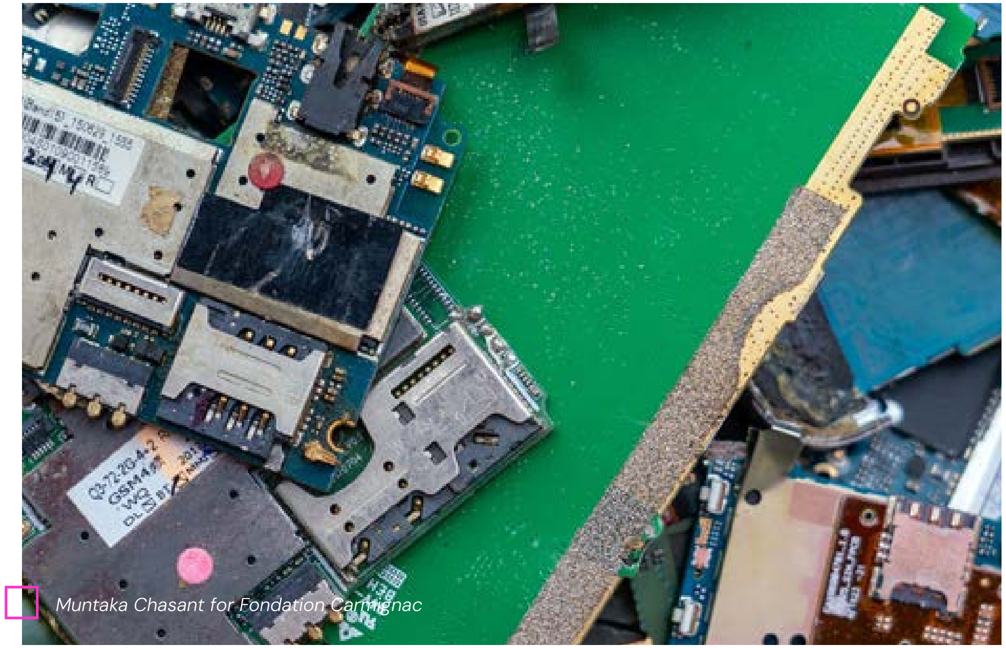
62 billion kg of e-waste generated globally in 2022.

7.8 kg per capita.

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

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

Source: The Global E-waste Monitor 2024



Muntaka Chasant for Fondation Carmignac

62 billion kg

of e-waste in 2022 have the following characteristics:

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

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

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

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

Source: The Global E-waste Monitor 2024

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

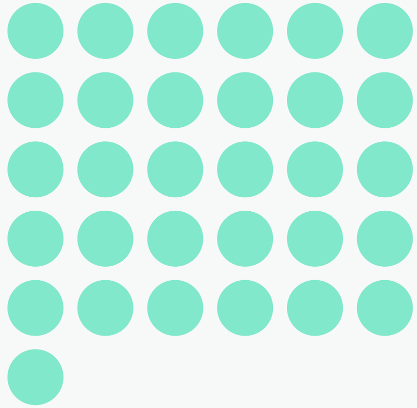
An estimated 19 billion kg of e-waste, mainly from metals like iron which is present in high quantities and has high recycling rates in almost all e-waste management routes, were turned into secondary resources. Platinum-group metals and precious metals were among the most valuable metals but present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

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

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

Composition of Global E-waste in 2022

31 billion kg of metals

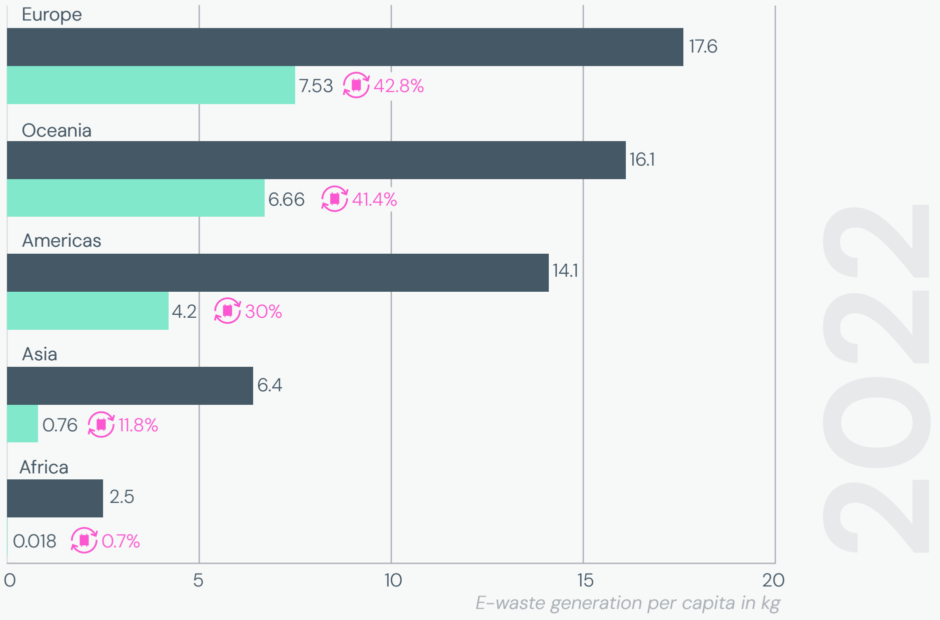


17 billion kg of plastics

14 billion kg of other materials

Source: The Global E-waste Monitor 2024

Amount of E-waste Generated and Collected



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

Source: The Global E-waste Monitor 2024

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

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

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

Bénédicte Kurzen / NOOR for Fondation Carmignac

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

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

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

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

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

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

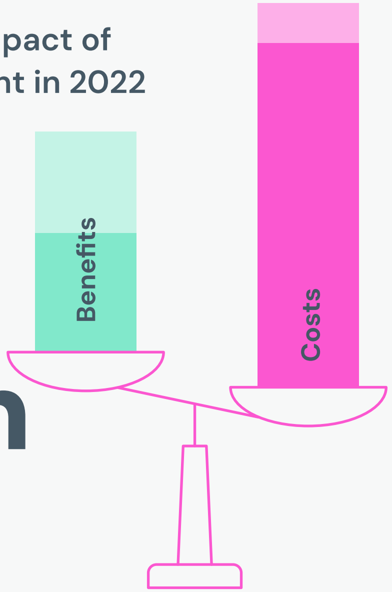
46 countries
have provisions on e-waste collection rate targets.

Source: The Global E-waste Monitor 2024

Bénédicte Kurzen / NOOR for Fondation Carmignac

Overall Economic Impact of E-waste Management in 2022

–37 billion USD



Annual economic monetary impact of e-waste management globally.

Benefits

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

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

Costs

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

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

Source: The Global E-waste Monitor 2024

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

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

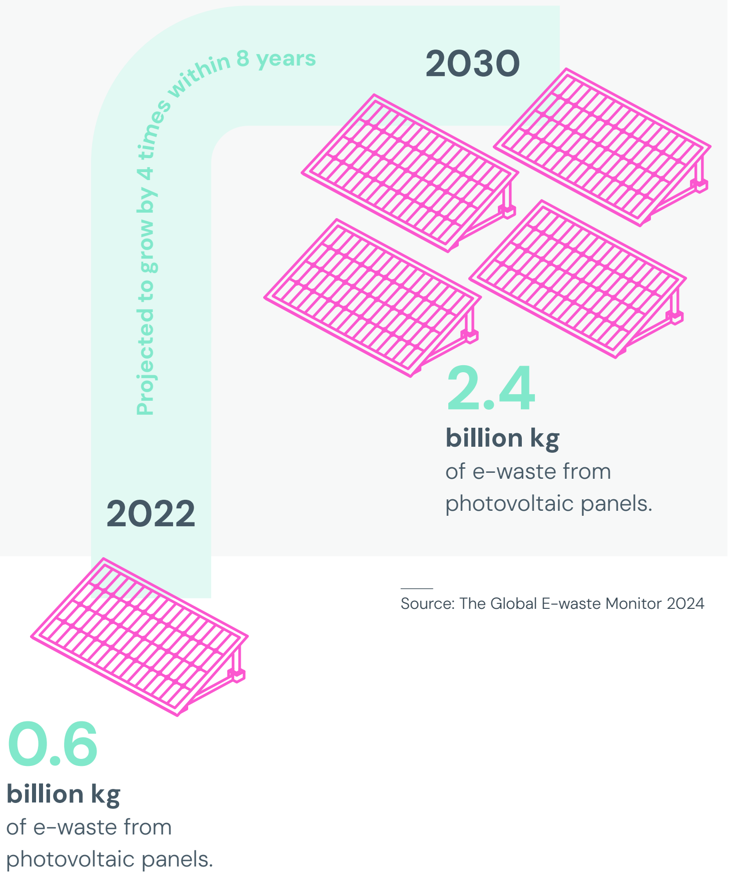
Currently, e-waste management generates USD 28 billion worth of secondary raw materials out of the maximum of USD 91 billion. Most losses occur due to incineration, landfilling or substandard treatment. The current secondary raw material production avoids extraction of 900 billion kg of ore.

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

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

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

Global E-waste Generated from Photovoltaic Panels



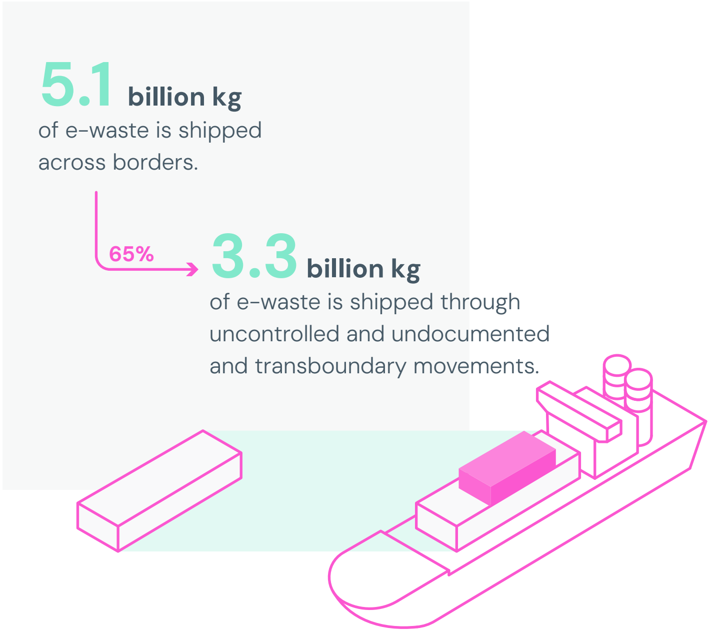
Source: The Global E-waste Monitor 2024

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

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

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

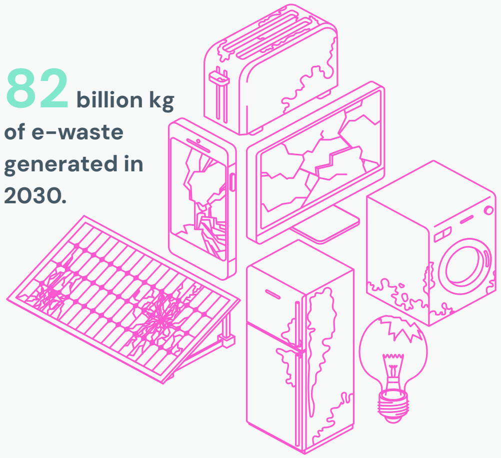
Most controlled transboundary flows take place within and into Europe and East Asia. However, many subregions face specific hurdles; for example, countries in Africa, Latin America and the Caribbean have concerns about transboundary movements and illegal shipments. One of the primary challenges in controlling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



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

2030 Projections and Future Scenarios

82 billion kg of e-waste generated in 2030.



Source: The Global E-waste Monitor 2024

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

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

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

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

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

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

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

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

20%
2030 Business as Usual

38%
2030 Progressive

60%
2030 Aspirational

Source: The Global E-waste Monitor 2024

Bénédicte Kurzen / NOOR for Fondation Carmignac

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