AMBIENTA

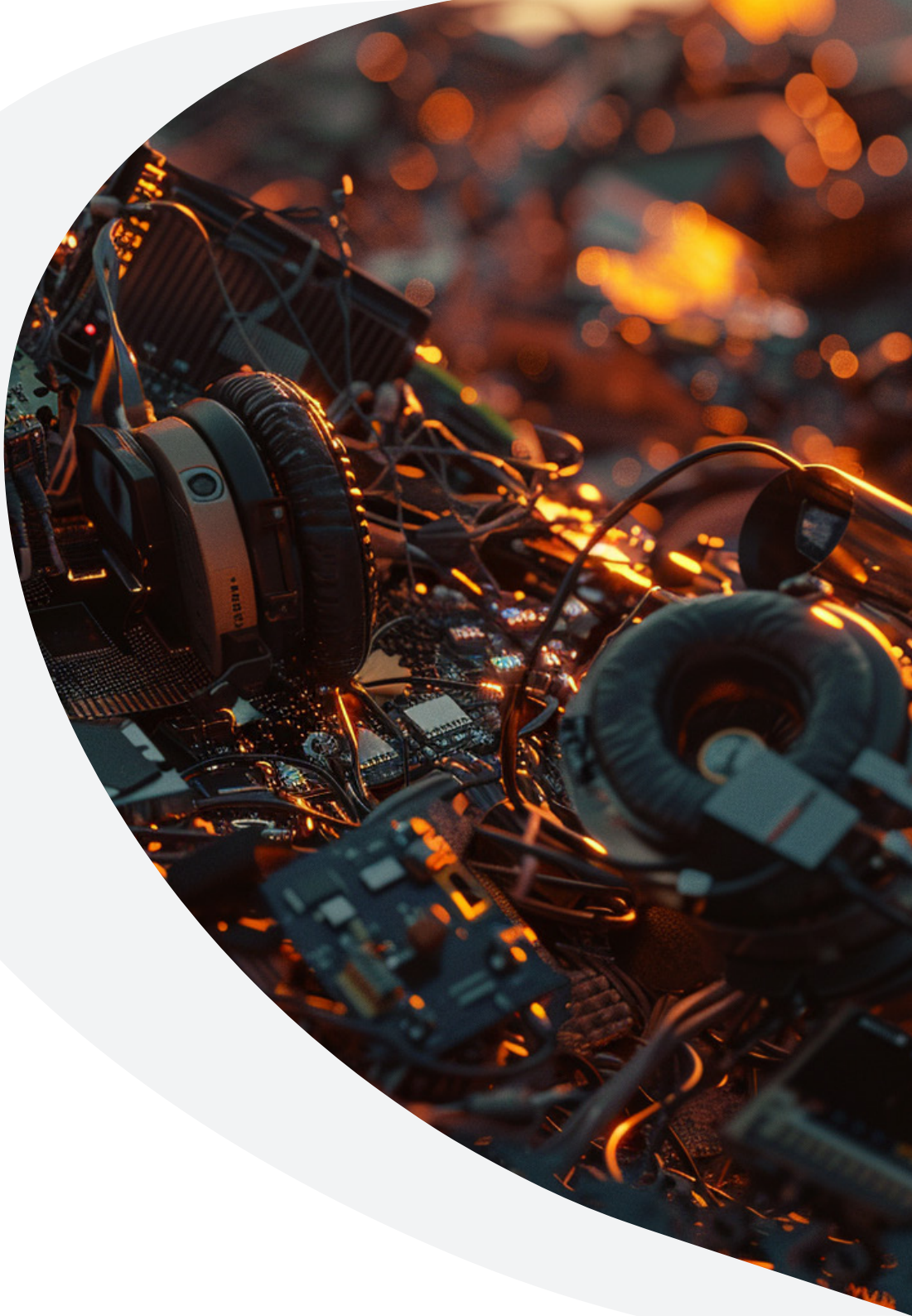
E-waste

January 2025

MAIN CONTRIBUTORS

Luca Zerba Pagella
Associate, Sustainability & Strategy

Fabio Ranghino
Partner, Head of Sustainability & Strategy



Theme of the Month

Europe generates 17.6 kg of e-waste per capita annually, the highest globally, yet less than half (42.8%) is formally collected.

Environmental problem

Electronic waste (e-waste) refers to discarded electrical and electronic devices, including household appliances, consumer electronics, and IT equipment – from large items like refrigerators and washing machines to smaller devices such as smartphones and laptops.

- Temperature exchange equipment
- Screens and monitors
- Lamps
- Large equipment
- Small equipment
- IT and telecom equipment (small)

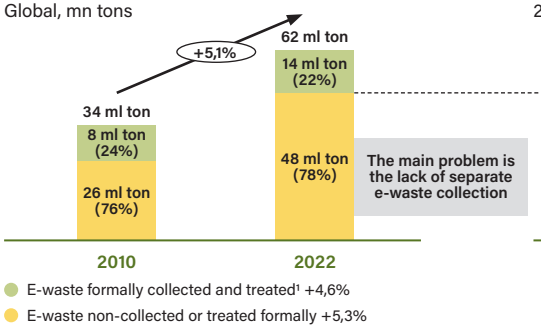
Source: Ambienta analysis on United Nations and Eurostat. Categorization change depending by jurisdiction/players

E-waste is one of the fastest-growing waste streams globally, with volumes projected to exceed 90 million metric tonnes (Mt) by 2030, tripling the growth rate of municipal solid waste. This acceleration is driven by rapid technological advancements, shorter product life cycles, and limited repairability. In 2022 alone, e-waste generation reached 62 million Mt, yet only 22% was formally collected and recycled.

Despite containing high-value materials such as gold, silver, copper, and rare earths, much of the waste ends up in landfills, incinerators, or is processed informally, leading to severe environmental hazards. Informal recycling often relies on open burning and acid leaching, which release toxic substances such as lead, mercury, and brominated flame retardants into the environment. These pollutants contaminate air, soil, and water, creating long-term health risks in regions where unregulated dismantling occurs.

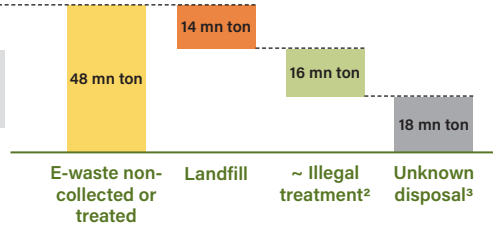
Figure 1: Global e-waste generation and treatment

Global, mn tons



Non-treated e-waste

2022, Global, mn tons



Source: Global e-waste monitor 2024

1. It is the input for the recycling process, not as output.
2. Improper processing or export of e-waste, often involving informal dismantling in low-income countries without safety measures.
3. Untracked or unreported due to the extensive networks of informal buyers, especially in low-income countries.

Even in Europe, where regulatory frameworks and economic cases are more developed, e-waste management remains a significant challenge. The region generates 17.6 kg of e-waste per capita annually, the highest globally, yet less than half (42.8%) is formally collected. The remainder is either improperly discarded, exported through illegal channels, or processed informally, leading to substantial material losses and environmental harm. Despite the EU WEEE Directive, which mandates collection targets and treatment standards, enforcement remains inconsistent across member states, with varying levels of compliance.

Illegal exports of e-waste to countries with weak environmental regulations persist, undermining formal recycling efforts and shifting the environmental burden elsewhere. Initiatives such as the Right to Repair movement and modular product design regulations aim to extend product lifespans and reduce waste generation. However, implementation remains slow, hindered by opposition from manufacturers, high repair costs, and a lack of consumer awareness. Without stricter enforcement, financial incentives for refurbishment, and more accessible repair solutions, e-waste volumes in Europe will continue to rise, outpacing improvements in collection and recycling capacity.

Environmental Solutions

Improving e-waste management requires action on multiple levels, from extending product lifespan to enhancing collection and recycling efficiency. Current recycling rates remain low due to limited consumer participation, inefficient waste streams, and high processing costs. Addressing these barriers is essential to reducing the environmental impact of e-waste and to increasing material recovery.

There are three key areas of intervention:

1. **Improving the efficiency and economic viability of material recovery**

   Recycling e-waste is often costly and inefficient due to its complex material composition and low-value components. Enhancing recovery processes can improve profitability and sustainability. Key improvements include:

- Developing advanced sorting and separation technologies, including shredding, optical sorting, density separation, and magnetic separation, to maximise material purity.
- Investing in more efficient smelting and metal refining systems to enhance metal extraction and recovery from scrap and electronic waste.
- Reducing processing costs through automation and improved logistics in recycling facilities.

2. **Extending product lifespan through maintenance, repair, and reuse**

   Increasing the lifespan of electronic devices delays waste generation and reduces raw material extraction. Key strategies include:

- Encouraging preventive maintenance and modular designs to make repairs easier.
- Expanding repair and refurbishment services to extend the usability of products.
- Supporting reuse markets and IT asset disposition (ITAD) to enable second-life applications for electronic devices.

3. **Increasing e-waste collection and formal recycling participation**

   Many electronic products never reach formal recycling streams, leading to material losses. Solutions include:

- Expanding collection networks and take-back schemes to improve consumer participation.
- Implementing financial incentives or deposit-refund systems to encourage adequate disposal.
- Strengthening enforcement against illegal exports and informal processing, which contribute to environmental harm.

Integrating these approaches is essential to transitioning towards a more circular and resource-efficient electronics industry.

Theme of the Month

Investment opportunities

The economic impact of e-waste mismanagement is substantial. In 2022, the total material value of global e-waste was estimated at $117bn, primarily composed of metals ($91bn, 78% of the total), plastics ($21bn), and other components ($5bn). However, only $36bn worth of materials were recovered, resulting in the loss of over $81bn in valuable resources due to inefficient collection and processing.

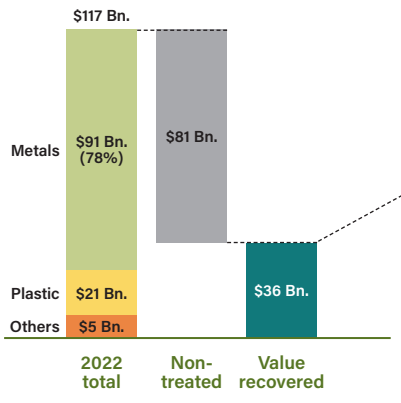
By 2030, material recovery from e-waste is projected to reach $50bn, driven by:

- A higher volume of electronic products entering the waste stream (+$12bn).
- Improved collection rates (+$5bn).
- Higher market prices for recovered materials (+$6bn).
- However, declining content value in some e-waste categories could reduce gains by $9bn.

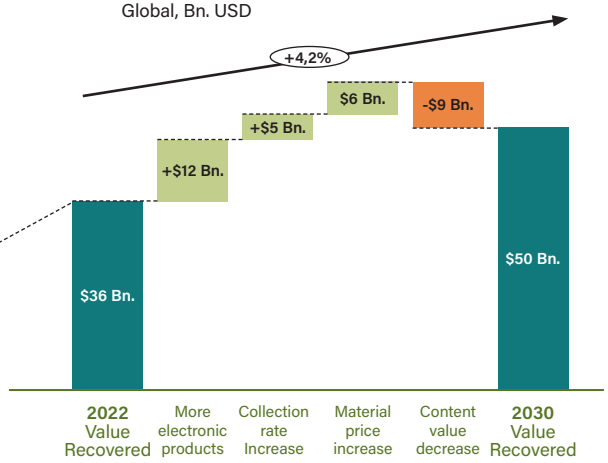
A notable trend in e-waste is the declining material value per unit in some e-waste categories due to design changes and material substitutions aimed at reducing production costs. Devices are becoming lighter, using fewer valuable metals, and incorporating more complex materials, making recycling less profitable and more labour-intensive. For example, printed circuit boards now contain less gold, palladium and large appliances use cheaper alloys instead of high-value metals and the longer-lasting LED lighting reduces waste volume but increases recycling complexity. However, this decline in value per unit is outpaced by the general rising e-waste volumes, improved collection rates and metal prices, sustaining overall market growth.

In 2022 over $81bn in valuable resources was lost due to inefficient collection and processing.

Figure 2: E-waste value by material 2022
Global, Bn. USD



E-waste value recovered by material in 2030
Global, Bn. USD



Source: Ambienta analysis on different sources

The e-waste recycling and circular electronics sector offers strong growth potential, driven by rising waste volumes, improving collection rates, and increasing material demand. Key investment areas include:

- **Sorting, Pre-Processing and Material recovery machinery:** This is a well-established segment, but automation and advanced separation technologies are driving efficiency gains, improving material recovery and recycling economics. While commodity price volatility remains a risk, increasing regulatory pressure on recycling rates, and rising material demand are expected to sustain growth. Additionally, smelting and chemical refining technologies are becoming more critical to making material recovery more cost-effective and resource-efficient, reinforcing the sector's investment appeal.

- **IT Asset Management (ITAM) & IT Asset Disposition (ITAD):** ITAM and ITAD are driven by the shift toward circular IT models, data security concerns, and regulatory compliance requirements. These business models extend hardware lifespan through tracking, repairs, and secure data erasure, reducing e-waste while providing recurring revenue streams. Software-driven ITAD models in particular offer scalability and differentiation.

- **Reuse and Refurbishment Market:** The reuse and refurbishment market is expanding rapidly, driven by Right to Repair regulations and increasing demand for second-life electronics, yet it remains fragmented and less mature, with scalability challenges and varying consumer adoption levels across regions. Companies providing refurbished product marketplaces, spare parts, and professional repair services are gaining traction, but widespread adoption depends on regulatory enforcement, cost competitiveness, and consumer awareness.

In conclusion, e-waste is growing faster than collection and recycling rates. While lower material value per unit makes recycling more challenging, rising waste volumes, improving collection rates targets, and higher metal prices will sustain market growth. The key to improving e-waste recycling lies in improving material recovery, extending product lifespan, and expanding collection networks. Investment opportunities are strongest in automation for sorting and refining, IT asset management, and refurbishment, all aligned with regulatory shifts toward a circular economy. Long-term success will ultimately depend on scalability, regulation enforcement, and economic viability.

The e-waste recycling and circular electronics sector offers strong growth potential, driven by rising waste volumes, improving collection rates, and increasing material demand.

Important information