

# Unlocking the financial potential of e-waste management

# Research objectives

Develop an overview of electronic waste management that facilitates the identification of business opportunities, highlighting its potential for financial return and its positive impact on the environment and society. The analysis aims to provide key information, emerging trends, and relevant cases that spark the interest of investors, positioning this area as an attractive option aligned with the principles of sustainability and social responsibility.

# Introduction

The rapid pace of technological innovation and the growing obsolescence of electronic devices have created a global challenge: the management of electronic waste.

Proper treatment of this waste is not only an urgent need to mitigate negative environmental and social impacts but also represents a significant economic opportunity for investors.

Electronic waste recycling offers vast potential for recovering valuable resources, such as precious metals, rare earth elements, and reusable components, which can be reintegrated into the production chain. Furthermore, innovative opportunities arise in the remanufacturing of electronic equipment, allowing for the revitalization of discarded devices, creating value and generating new income sources.

This report outlines some of the opportunities that exist in electronic waste management. The goal is to stimulate and guide financial community actors to explore an emerging sector where profitability is combined with a positive impact.

# 01

## Global statistics of E-waste

The latest available data (GESP, 2024) shows that in 2022, a record 62 million metric tons of electronic waste were generated, which equals an average of 7.8 kg per capita per year. This global waste volume is 82% higher than the one recorded in 2010, and it is expected to reach 82 million tons by 2030, representing a global annual increase of 2.6 million tons.

This type of waste is the fastest-growing waste stream worldwide, with projections of accelerated increases in the coming years due to the rapid obsolescence of technological devices and low recycling rates.

Currently, only 22.3% of this waste is documented as being formally collected and recycled in an environmentally sound manner.

This small fraction of waste that is properly recycled represents a huge loss of valuable materials like gold, copper, silver, iron, and other precious metals. It is estimated that each year, materials worth tens of millions of dollars are lost, which could be recovered through more efficient recycling processes.



Total Global E-waste:

**62 Mt**

Projected E-waste  
Generation by 2030

**82 Mt**

Global recycling rate

**22.3%**

Potential value of recoverable materials:

**\$91 billion**

annually, mainly copper, gold, silver, and iron.

Average per capita generation

**7.8 kg**

# Potential opportunities from E-Waste recycling

The global challenge associated with the increasing generation of electronic waste has presented a range of attractive business opportunities for investment. Various factors converge to make e-waste recycling a sector with both present and future potential:

## Economic value of materials

E-waste recycling emerges as a secondary source of valuable materials that can be recovered and sold. According to data from the Sustainable Cycles (SCYCLE) program of the United Nations Institute for Training and Research (UNITAR, UN), for example, one million mobile phones can yield 24 kilograms of gold, 16,000 kilograms of copper, 350 kilograms of silver, and 14 kilograms of palladium. These materials, which could otherwise be lost in landfills, are strategic resources that can be reused for new devices.

## Scarcity of natural resources

The growing demand for elements such as rare earths, cobalt, and lithium has led to a shortage of these resources. With the reduction in the availability of metals in mines and quarries, secondary production through 'urban mining' is emerging as a strategic solution. According to the International Energy Agency (IEA, 2022) report, the demand for metals for clean technologies, such as lithium and cobalt, is expected to grow



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**In the face of uncertainty and growing global trade tensions, e-waste remanufacturing enables the securing of critical resource supply, representing a long-term competitive advantage for technology companies."**

John Holm, Senior Vice President Pyxera Global.

by more than 400% in the next two decades, making the need for an effective recycling system even more urgent.

## **Competitive advantages derived from a sustainable supply**

The recovery of critical minerals will represent a competitive advantage for companies that manage to secure a stable and sustainable supply chain. In addition to the economic benefits of reduced dependence on mining extraction, tech companies may benefit from a regulatory environment that increasingly threatens to restrict the production and international trade of natural resources.

## **Advances in regulatory frameworks**

An increasing number of countries are implementing stricter regulations on waste management, creating a favorable legal environment for the development of new businesses. In the European Union, for example, the Waste Electrical and Electronic Equipment (WEEE) Directive requires a significant percentage of electronic waste to be recycled, which has driven the development of infrastructure for its proper treatment. Globally, the rise of similar regulations is gradually leading to the creation of incentives for companies operating in the recycling sector recovery.



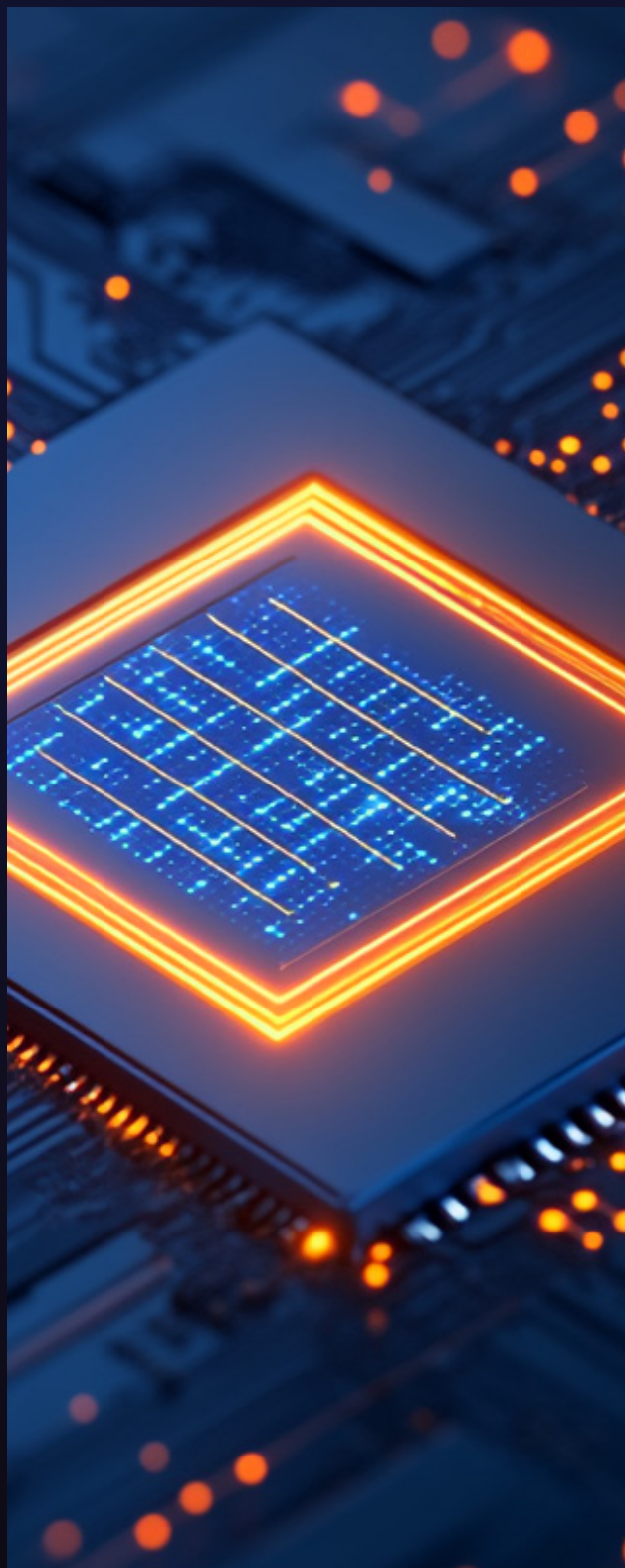
**Globally, the rise of similar regulations is gradually leading to the creation of incentives for companies operating in the recycling sector.**

## Technological innovation

Technological advances have enabled the development of more efficient and cost-effective recycling processes, capable of reducing costs and increasing the economic feasibility of projects. Studies from ECLAC and the Environmental Science & Technology journal of the American Chemical Society confirm that the benefits of recycling small IT and telecommunications equipment outweigh the costs associated with their processing. Moreover, it is estimated that the recycling costs of minerals such as gold and copper in this category of waste are up to 13 times cheaper than conventional extraction from mines, creating an opportunity for investment in recovery.

## Increase in demand for electronic devices

The digitalization of society, along with the obsolescence (both planned and perceived) of devices, generates large amounts of e-waste. This trend represents a constant source of demand, both for new materials for the manufacturing of electronic devices and for discarded materials that can be recovered.



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Why the "electronic waste"  
market is not working at  
its full potential today

The economic viability of electronic waste recycling initiatives is tied to several factors. While the sector has the potential to generate significant environmental and economic value, it faces structural and operational limitations that hinder its efficiency and profitability.

One of the main challenges, as will be discussed further, is logistics. The fragmentation of waste generation, lack of adequate infrastructure, and the diversity of devices to be recycled complicate the collection, transportation, and efficient processing of electronic waste. This leads to higher operational costs and makes resource optimization difficult.

In many regions, the volume of collected electronic waste is insufficient to achieve economies of scale and ensure the profitability of operations.

Despite efforts to implement Extended Producer Responsibility (EPR) mechanisms, there is a significant gap between the amount of electronic products discarded and the processing and management capacity available. This is reflected in low recovery rates and the persistence of improper disposal practices, such as dumping and incineration, which generate severe environmental and health impacts.



The high initial investment costs in recycling equipment, material separation technologies, and hazardous substance treatment also represent a major barrier to the entry of new players into the market.

The volatility of recovered material prices adds another layer of complexity. Precious metals and rare earths, which have high demand, frequently experience fluctuations in their prices, generating uncertainty for recycling companies and complicating long-term planning. Additionally, some

recovered materials do not have a well-defined market, which limits their commercial value and complicates the recycling process.

The lack of economic and regulatory incentives also hinders the sector's development. The absence of clear policies and government support makes it difficult to create a favorable environment for investment and entrepreneurship. In many countries, regulations on electronic waste management are weak or not effectively enforced, allowing the proliferation of informal and unsustainable practices.

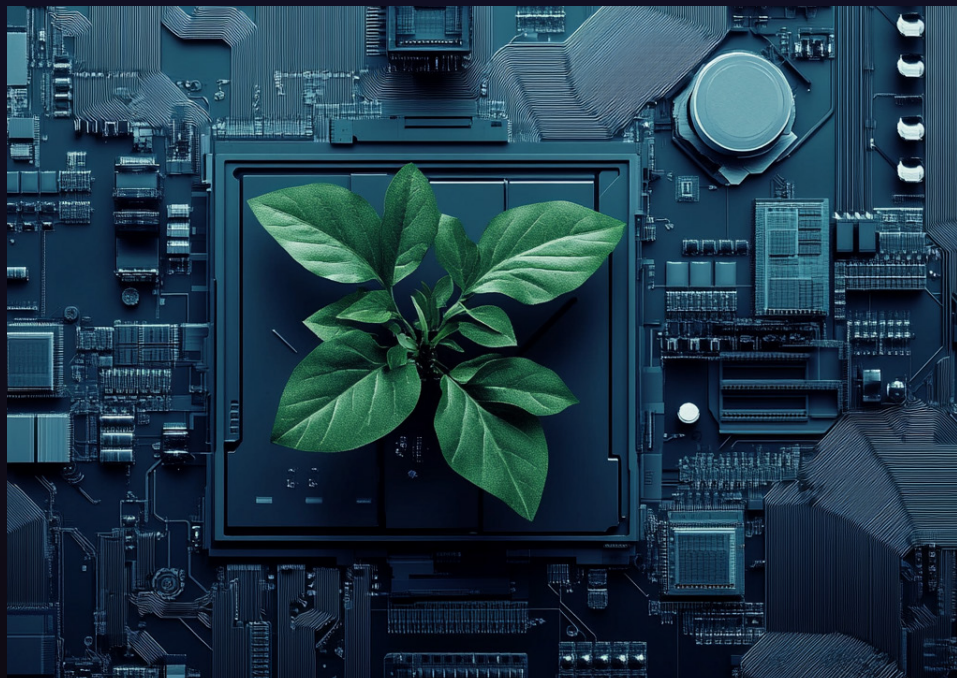
Finally, consumption habits and limited public awareness of the importance of recycling electronic waste and the consequences of improper management also contribute to the

issue. In a world where disposal prevails over repair and recycling, and where information on the risks associated with electronic waste is scarce, adopting responsible consumption practices and citizen participation in recycling programs becomes difficult.

In sum, the "electronic waste" market faces a confluence of interconnected challenges that prevent the sector from reaching its full potential. Overcoming these barriers will require a comprehensive approach involving all relevant stakeholders, from producers and consumers to governments and recycling companies. It will also require the financial community, which plays a crucial role in driving investment in infrastructure, logistics, and technologies—critical pillars for the development of a robust and sustainable market.

**“Sustainability is not just a moral imperative, but an economic opportunity. Companies that embed ESG (Environmental, Social, Governance) into their DNA not only mitigate risks, but also unlock new sources of value.”**

Chrisso Pogitsas



Where are the opportunities to  
capture value? A call to action  
for the financial community

The sector offers a variety of economic opportunities capable of attracting a wide range of financial players, from investment funds to banking institutions and venture capital firms.

These opportunities primarily arise from the accelerated transition towards a circular economy, which focuses on environmental sustainability as a driver of new economic possibilities.

Below are some of the most promising investment areas, which stand out for their high potential profitability.



"The real challenge isn't just measuring social impact, but integrating it into the core business strategy. When you do that, ROI becomes more than just financial—it turns into a competitive advantage."

Steve Rochlin, Impact ROI.

## 4.1

### Recovery of value from electronic waste.

One of the most relevant opportunities in electronic waste management is value recovery through the refurbishment and repair of used electronic equipment. Instead of discarding them, devices can be restored and resold, extending their lifespan and reducing the demand for new products.

There are various successful business models, with examples that can serve as inspiration for other companies. Financial institutions have an opportunity here to support the development of these or other innovative business models, fostering the growth of economically promising initiatives aligned with sustainability demands.

## Refurbishment and Trade-in Schemes

In these schemes, consumers exchange used products for credits to purchase new or refurbished items. Companies such as Staples and Dell, among others, use these schemes. In the case of Dell, more than 2 million units of electronic equipment have been refurbished and sold since 2008, generating over USD 120 million in revenue and preventing more than 200,000 tons of e-waste from ending up in landfills (Dell, 2022). Fairphone, for its part, has stated that it has sold over 500,000 units of its refurbished smartphones in the last decade, with a high recovery rate of the materials used and an estimated 30% revenue growth (Fairphone, 2023).



### Dell

2 million units of electronic equipment have been refurbished and sold since 2008

### Fairphone

sold over 500,000 units of its refurbished smartphones in the last decade

## Voluntary return programs

In these programs, implemented by companies like Apple and Best Buy, manufacturers or retailers voluntarily accept used electronic products for recycling or proper disposal. In its 2023 environmental report (Apple, 2023), as well as in various press releases and related news, Apple

reported having recovered more than 40,000 tons of materials that were reused in new products, with an estimated value exceeding USD 60 million, reducing production costs and dependence on virgin raw materials.



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## Product as a Service (PaaS) and financial leasing models

This is a business model where companies offer products as services, charging for their use rather than ownership. The provider is responsible for the maintenance, repair and recycling of the product. The Xerox company, as an example, has managed to reduce energy consumption and

the use of virgin materials by approximately 80% in its printing equipment under the “managed service” model, which contributed to reporting significant benefits reflected in its financial statements (Xerox, 2024).

## Future buyback guarantee programs

This involves operations where companies offer a buyback guarantee for their used products, incentivizing consumers to return them for refurbishment or recycling. For example, HP has recovered over 800,000 tons of hardware (particularly large-format printers) since 2000, thanks to the implementation of such programs, which reported estimated savings of over USD 1 billion in material costs due to the reuse of recovered plastics and metals (HP, 2023).



## 4.2 Investment opportunities in high-tech recycling infrastructure

When devices can no longer be reused, extracting valuable materials from electronic waste becomes an economically viable option. Through proper recycling, it is possible to recover high-value materials, making this investment a strategic opportunity to replace primary material extraction with recycled resources.

Studies from entities such as the Environmental Protection Agency (EPA) and reports from

consulting firms like McKinsey & Company and MarketsandMarkets indicate that well-planned investments in recycling infrastructure can generate financial returns exceeding 15%.

This data is supported by success stories from pioneering companies in the sector, which have demonstrated the profitability of their investments. For example, Tomra Systems (Norway), a leader in recycling technology, has achieved a significant increase in revenue

by expanding its recycling plants in Europe, reaching a return on equity (ROE) of over 18% (Tomra Systems, 2023). Similarly, Sims Municipal Recycling (U.S.), a subsidiary of Sims Limited, has notably improved its material recovery capacity through investments in recovery plants, resulting in positive financial metrics, as reflected in its annual report (Sims Limited, 2024) and other consulted press sources .

Associated with increased recovery capacity, an expanding phenomenon is the development of secondary markets for recovered materials. This involves the creation of platforms to buy and sell products at the end of their life cycle or their components, allowing access to their acquisition with cost savings of up to 30%. Various cases can be cited in this regard, such as Recyclable Materials Exchange (RME), RecyclingMarkets.net, and Planet Ark Recycling Near You (Australia).

## Investments in the development and validation of innovative technologies for material separation, classification, and recovery.

# 4.3

Technological innovation plays a key role in improving recycling efficiency. New technologies, such as artificial intelligence and robotics, can accelerate separation processes and enhance the quality of recovered materials, thereby boosting the profitability of the entire circuit.

Academic articles published in journals like “Waste Management” and “Resources, Conservation and Recycling” project significant growth in the market for technologies aimed at improving recycling processes in the coming years.

Specialized consulting and research firms such as Grand View Research and Frost & Sullivan demonstrate that investing in companies and entrepreneurs dedicated to developing recycling technologies can yield gross profit margins of up to 60% on the investment.

According to information published on business data platforms Crunchbase and Pitchbook, over USD 500 million was reported invested in “Tech Waste” companies during 2020 and 2021.

Tech startups addressing waste recycling through the use of artificial intelligence, robotics, and machine learning have attracted significant interest from venture investors, according to these platforms.

For example, the British company Recycleye secured a new Series A funding round in 2023 for USD 17 million to advance the development of computer vision and machine learning

technologies that enable robots to identify and classify different types of waste with high levels of accuracy. Similar cases have been recorded in companies like ZenRobotics (currently owned by Terex, U.S.), CloudBlue, and Recycling Technologies, indicating notable investor interest in this business vertical.

According to information from the Pitchbook portal on the “Waste Management and Recycling” sector, there is a growing trend in investment in green technologies and smart recycling. Capital invested in this sector, which was around USD 300 million in 2016, surpassed USD 1 billion within just five years, with an upward trend.

Technological innovation is driving significant advances in recycling efficiency and profitability, attracting substantial investment in AI- and robotics-powered solutions that are transforming the waste management sector into a fast-growing and lucrative market.



# 4.4

## Investment alternatives to optimize supply chain logistics

The core of the business lies in optimizing existing infrastructures to maximize the flow of recoverable materials. By connecting various facilities and creating large-scale logistics networks, economies of scale can be leveraged, operational costs reduced, and profitability of operations significantly increased.

Reports prepared by Deloitte and articles published in the “Journal of Cleaner Production” and by the Institute of Scrap Recycling Industries (ISRI) analyze strategies for optimizing the supply chain in waste management and present recommendations based on best practices in logistics.

It is estimated that collection capacity can be increased by at least 30% simply through improvements in logistics processes, maximizing the amount of e-waste that can be processed. This increase in collection is key to achieving the



necessary scale to make recycling businesses viable, as they directly depend on massive processing capacity to be profitable.

The main opportunities to advance in this area are primarily based on the development of digital platforms that connect waste generators with recyclers, facilitating the scheduling of pickups and tracking of waste.

The use of advanced software and algorithms allows for determining the best possible routes for distance traveled, time, and fuel consumption, while maximizing the number of pickups per trip. This could result in a direct reduction in operational costs associated with transportation of up to 25%, which is highly attractive to investors, as it means greater profit margins for operators.



## 4.5 Creation of specialized financial vehicles for recycling and the circular economy of electronic waste

There are a range of opportunities for the financial community, ranging from the creation of investment funds to support for innovative financing models. These models not only

promote recycling and sustainability but also generate attractive financial returns. Some of the ways that financial actors can engage with this growing sector include the following:

## Creation and capitalization of specialized investment funds for the circular economy

Market consulting reports from firms like Bain & Company and Allied Market Research highlight the growing interest of investors in diversifying their investment portfolios through the financing of projects dedicated to reducing and processing electronic waste.

ESG (Environmental, Social, and Governance) funds are experiencing notable growth. According to Bloomberg, ESG assets are expected to reach USD 50 trillion by 2025, representing over a third of the projected USD 140.5 trillion in global assets. The expected return rates for these funds range from 12% to 18%, exceeding market averages, according to estimates from financial service institutions such as Sustainalytics, Morningstar, and the Morgan Stanley Institute for Sustainable Investing, among others.

While renewable and clean energy continues to be the main focus of many sustainable investments, there is a growing interest in financing projects related to waste management. Funds like Circularity Capital, Closed Loop Partners, and The Eco Enterprise Fund are already financing projects related to the circular economy, including electronic waste recycling.



ESG assets are expected to reach  
**USD 50 trillion**  
by 2025

## Promotion of the green bond market

Green bonds finance projects related to waste management, recycling, and the circular economy. These instruments allow investors to support projects with specific environmental and social objectives.

According to a report from the Climate Bonds Initiative (CBI), the global green bond market reached a record volume of \$522.7 billion in 2021 (Climate Bonds Initiative, 2021). It is estimated that the current traded volume has doubled that amount.

According to information from the International Capital Market Association (ICMA), green bonds offer returns similar to or slightly higher than conventional bonds, with an average ROI of 3% to 5% per year, depending on the issuer and the term. This does not account for the additional advantages they provide to issuers, such as improvements in corporate reputation and access to new institutional investors.

Background on this can be found at the European Investment Bank (EIB), which has issued green bonds to finance electronic waste recycling initiatives in Europe, such as recycling plants in France and Romania.

Another example is Natura Cosméticos S.A., a Brazilian multinational dedicated to hygiene and cosmetics, which received an investment of approximately USD 36 million from BID Invest. This operation allowed the company to access funds through the issuance of sustainability-linked bonds to finance the development of bioingredients sourced from the Amazon. Although this latter case belongs to a different sector, it illustrates how the international financial community can support private initiatives focused on the sustainable redesign of products, which could serve as a model for the electronics industry.



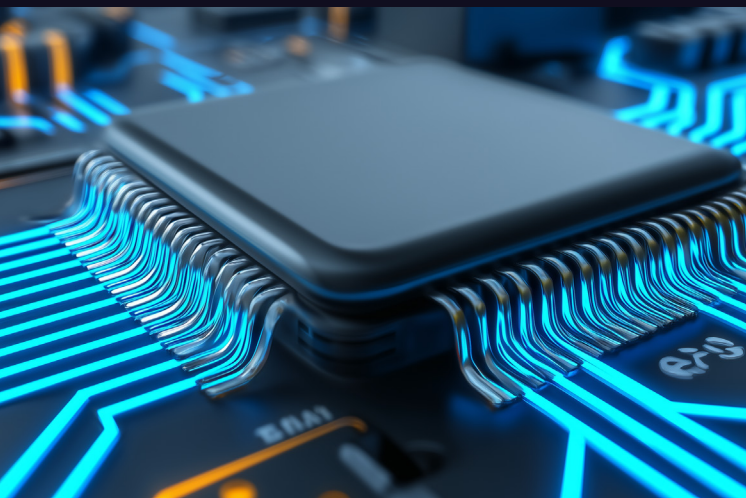
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## Crowdfunding

Crowdfunding is an emerging option for financing e-waste recycling projects, particularly appealing for small and medium-scale initiatives.

The global crowdfunding market surpassed USD 15 billion in 2021, with an annual growth rate of 12%. It is estimated that between 5% and 10% of crowdfunding campaigns are related to sustainability and circular projects, which would represent an average annual volume of approximately USD 1 billion.

Platforms like Material Focus, RePack, Kickstarter, Indiegogo, and EcoGrow have mobilized resources from various sources to support the recycling and reuse of electronic devices. According to data from the Ellen MacArthur Foundation, the average returns on investment (ROI) for circular projects exceed 20%.



## Blended finance

Blended finance combines public, private, and development resources to fund projects that present high risks or uncertainties but also have high social, economic, and environmental potential.

A relevant example is the Clean Energy Fund, which supports e-waste recycling and renewable energy projects in emerging economies in Asia and Africa with resources from the World Bank (WB), the Green Climate Fund (GCF), and the private sector.

In general, multiple experiences of financing e-waste recycling projects can be observed, linking public sources such as funds from the United States Agency for International Development (USAID), European funds (Horizon 2020 program), and other national governments, combined with private capital from companies or institutions such as Hinckley Group, Dell Foundation, HP, and others. These investments are aimed at developing systems to improve waste collection and recycling. According to reports from the promoting entities, these investments range between USD 10 and 20 million, with average positive returns exceeding 5%.



# 05

## Key findings and conclusions



Although awareness of the environmental and social impacts of electronic waste is steadily increasing, the financial sector still plays a limited role in driving scalable circular solutions. Regulatory fragmentation, lack of clear incentives, and the absence of reliable data on environmental and social performance hinder informed investment decisions in this field.

Nevertheless, the e-waste sector holds significant untapped value. Innovative business models are emerging—such as refurbishment and trade-in programs, Product-as-a-Service (PaaS) strategies, and future buyback schemes—that have proven both environmentally beneficial and economically viable. These models help extend product lifecycles, generate recurring revenue streams, and open new opportunities for financial institutions to support high-potential sustainable initiatives.

At the same time, strategic investment opportunities are emerging in advanced recycling infrastructure and cutting-edge technologies for material separation and recovery. This is

particularly relevant in an increasingly tense geopolitical context, where competition among major powers such as the United States, China, and the European Union has intensified the global trade war. As trade policies become more protectionist—featuring export restrictions, tariffs, and the reshoring of strategic value chains—securing access to critical raw materials, such as rare earths, lithium, cobalt, and other valuable metals found in electronic waste, has become vital for maintaining industrial and technological competitiveness. Recovering these materials from e-waste offers a tangible way to strengthen resource sovereignty, reduce dependency on external suppliers, and build more resilient supply chains.

Improving logistics efficiency—through digital platforms, reverse logistics systems, or regional processing hubs—can also reduce operational costs and enhance the profitability of recycling, contributing to the economic viability of the sector.

To effectively mobilize capital at scale, it is essential to design specialized financial instruments. Thematic circular economy investment funds, green bonds, crowdfunding platforms, and blended finance schemes can help mitigate perceived risks and attract a broader range of investors. These tools are especially important in contexts where traditional financial mechanisms fall short of the needs of emerging green sectors.

Despite existing challenges, there is clear evidence of scalable, financially sound solutions within the e-waste ecosystem. These models are ready to be replicated and scaled, provided there is coherent alignment between regulatory frameworks, technological innovation, and financing strategies.

Unlocking the financial potential of e-waste management requires a shift in mindset: from seeing it as a regulatory burden to recognizing it as a strategic investment opportunity. With the right policy frameworks, innovative financial tools, and strong collaboration across key system actors, e-waste management can become a central pillar of a more profitable, resilient, and sustainable circular economy.



# 06

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