Circularity

Measuring Circular Impact – Methodology and Guide for Practitioners

An Assessment of the Consumer Electronics Industry



April 2025

About

UNDRESS Circularity

UNDRESS Circularity is a collaborative industry project led by Circularity in collaboration with Fraunhofer IZM, Systemiq, and 12 industry partners (Assurant, circulee, Everphone, fixfirst, Foxway, Grover, Ingram Micro, rebuy, Recommerce Group, Reverse Logistics Group, Deutsche Telekom, Vodafone), further supported by Deutsche Bundesstiftung Umwelt and Deloitte. Furthermore, a group of associated stakeholders supported the project with expertise and feedback throughout the process, including WWF Germany, ETH Zürich, Circular Electronics Partnership, DIN, German Economic Institute – IW and Circularity Capital.

The project set out to advance the understanding of how to assess the impact of circular business models, taking into account real-world market conditions and user behavior. Accurately quantifying a business model's impact can support its optimization, enhance impact reporting, and strengthen communication with investors and customers.

Building on insights from the project's market report "From Consumer Insight to Circular Impact", numerous expert interviews and proprietary industry data, the consortium collaboratively developed a methodological framework and practical guide to assess the positive impact of circular business models.

The focus of this report is on the consumer electronics industry in Germany, for which we show a detailed case study assessment. However, the Circular Business Model Impact (CBMI) methodology is broadly transferable - offering a valuable tool to advance the development of resource-efficient practices across industries and geographies – supporting companies and other stakeholders in their transition to a measurable circular economy.

“

This project has been an incredible journey, made possible by the unique collaboration between a diverse group of dedicated partners and contributors. Their expertise, insights and the data they shared were essential for the success of this project. We are deeply grateful for the spirit of collaboration and openness that helped shape the Circular Business Model Impact methodology.



Dr. Marianne Kuhlmann & Dr. Paul Wöbkenberg,
Founders of Circularity

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Executive Summary

Measuring Circular Impact – Methodology and Guide for Practitioners and Assessment of the Consumer Electronics Industry

Motivation & Goal

The UNDRESS Circularity project tackles a critical blind spot in the impact assessment of circular economy business models (CBMs): the use phase of products. CBMs aim to create a positive impact primarily by prolonging and by intensifying the use of products. However, current assessments often rely on theoretical assumptions and the existing frameworks neglect how CBMs actually change use phases and influence user behavior that define the real environmental performance of circular offerings like rental or second-hand sales.

To fill this gap, a consortium—led by Circularity with Fraunhofer IZM, Systemiq, and 12 industry partners—developed the Circular Business Model Impact (CBMI) methodology. This novel framework puts changes in the use phase at the heart of the impact assessment and provides a robust, data-driven approach to quantify the environmental impact of CBMs. It is designed with and for practitioners, e.g. operators of rental and second-hand business models.

We apply the methodology to the consumer electronics industry, using proprietary data from 12 industry partners and representative market surveys with B2C and B2B users. We analyze the impact of rental and second-hand sales for different types of electronic devices, covering different use scenarios across B2C and B2B.

The novel CBMI methodology adds a missing puzzle piece to existing assessment frameworks

Our new method shifts the focus from product emissions to user behavior and usage time, introducing "active use time" as a core metric, in contrast to using standardized proxies for lifespan estimates. CBMI captures various mechanisms for increasing active use, such as improving the utilization of infrequently used devices or extending their active use period. It aggregates the negative environmental impacts (e.g., greenhouse gas emissions measured as global warming potential, or GWP) across all stages of a product's journey and distributes them over the active use time to assess the reduction of negative effects per unit of time (e.g., per year). The CBMI method enables the quantification of these avoided impacts (e.g., CO_2e emissions) at the product, business model, and market levels. In doing so, it provides a comprehensive framework for comparing linear and circular business models across a wide range of individual scenarios. The report also includes a detailed step-by-step guide for practitioners who want to apply the CBMI method to their own business context.

→ For details on the methodology in the context of other frameworks, jump to chapter 4.1 and 4.2.

Measuring Circular Impact – Methodology and Guide for Practitioners

The report provides a detailed step-by-step guide for practitioners to apply the CBMI method to their own business model, explaining each step and discussing our choices, assumptions and data of the case study for illustration.

The steps of the CBMI methodology are:

1. **Define the goal and scope** - focus on the right elements of the methodology
2. **Draw your system map** - represent product journeys for your business model
3. **Define your baseline** - chose a realistic and suitable benchmark for comparison
4. **Set-up the formulas** - assign parameters for calculating GWP and active use time
5. **Collect your data** - for GWP and active use time contributions, incl. rebound effects
6. **Calculate your results** - to obtain active use time and annualized environmental effects
7. **Derive specific actions** - interpret results to identify improvement areas

→ For the practical step-by-step guide, jump to chapter 5.

Application in practice: We provide a detailed case study on CBM impact assessing for consumer electronics

The case study provides an industry overview and tangible insights into key industry processes for the implementation of rental and second-hand offerings. Based on proprietary and market data, it showcases key results of the CBMI assessment conducted.

The analysis reveals: While circular offers for electronics are on the rise, electronic product lifecycles in Germany - such as those of the approximately 100 million smartphones currently in use - are still largely dominated by linear models: products are purchased new, used, and eventually discarded. According to Circularity's survey data, only 21% of users in Germany own at least one second-hand device, and just 1% have experience with renting devices. Among business users, adoption rates are higher, with 30% of companies having purchased second-hand equipment and around 10% accessing devices through rental models.

→ For more details on the B2C and B2B market for circular consumer electronics, please refer to our Market Report (Circularity 2024).

To holistically assess changes during the use phase of devices, it is important to account for all use phases up to the end-of-life. For example, more than 85% of rental devices are typically resold by rental companies for reuse elsewhere. Therefore, a CBMI assessment of a rental model should consider not only all rental cycles but also the subsequent usage enabled by the business model. Importantly, this includes use phases in other countries. To accurately assess circular product journeys, the international trade of used devices across borders must be considered. For instance, Europe imports over 10 million high-grade second-hand devices annually to meet domestic demand. Within Europe, devices are actively traded between countries to balance local supply and demand, while lower-grade devices with limited local demand are exported to international markets.

→ For more information in our deep-dive on international trade, please refer to chapter 2.2.

Our CBMI case study analysis underlines the enormous impact potential for rental and second-hand sales in the electronics sector.

Insights on rental:

In our case study, rental to private users of frequently used devices, such as smartphones, increased active use by 17%, leading to an 11% reduction in annual emissions. For less frequently used devices like gaming consoles, rental models significantly boost utilization, achieving 51% more active use and resulting in a 19% reduction in annual emissions.
Rental to business users typically involves a single rental cycle followed by resale, leading to a 26% increase in active use time and an overall 16% reduction in emissions compared to the baseline. The adoption of long term rental (>36 months) has increased over the last years, which confirms the appeal of rental and the associated services to businesses.

Insights on second-hand:

Second-hand sale of privately first used smartphones extends the active device use to ~5 years vs. 3.6 years in linear baseline, which leads to 17% lower emissions per year. Businesses on the other hand use their devices significantly longer. Second-hand resale of business held smartphones leads to an average of 33% longer active use, resulting in 20% annual emissions reduction compared to the baseline. In our case study, resale of business owned smartphones achieves the longest active use and strongest reduction of annual emissions, which indicates a significant potential for recirculation of business held devices. This especially holds true considering the high proportion of companies currently keeping or discarding their devices after use (70%) instead of bringing them into recirculation.

The results of our case study show that both rental and second-hand models can greatly extend how long and how intensively devices are used. The effectiveness of each model depends on the type of product (e.g. frequent vs infrequent use) and the user group. Because they strengthen different aspects of increasing active use, rental and second-hand models complement each other well, with each offering strong potential to create positive environmental impact.

Insights at market level:

In addition to the business model analysis, we also explored the effects of second-hand and rental offerings for a whole market, such as Germany. In a market like Germany, if 80% of the approximately 100 million smartphones in use were reused or rented, up to 200,000 tonnes of CO_2e could be avoided annually, and 2–3 million fewer new devices would be needed each year (~20 million new devices per year currently).

While these results show a massive untapped potential for CBMs to help reduce emissions from electronics use, it is important to acknowledge that no device lasts forever. Technical limits to device lifespans set a natural ceiling for the impact of CBMs. Using an 8-year technical lifespan for smartphones as a reference point, we estimate that current CBMs achieve around 20–50% of the possible emissions reductions from increased use. >50% of a smartphone's lifecycle emissions must be addressed through other strategies, such as improved product design, more sustainable production, and effective end-of-life material recovery.

→ For a detailed description of the impact mechanisms of rental and second-hand business models, please refer to chapter 3.

→ For detailed results and insights from the case studies, please refer to chapter 4.3.

The report concludes with actionable recommendations with regards to CBMI assessment

For companies: Use the CBMI methodology to enhance transparency for yourself and for others by publishing your results. Collect information on your incoming and outgoing product flows to enrich your modelling, especially on the use phases. Further improve your impact to close the gap to the theoretical limit as far as possible.

For investors: Use the CBMI methodology to enhance your due diligence impact assessment and support the most impactful businesses.

For regulators: Use insights from the CBMI method to inform policy making and shape a really impactful circular economy. Increase data availability for impact calculation, e.g. through better national or EU-wide data collection, improved device collection, harmonized EPR schemes, more transparency on exports.

For standard setters, framework developer, researcher: Evolve carbon accounting frameworks (e.g., GHG Protocol, ISO) and impact assessment methods to acknowledge and reward avoided emissions from use-phase interventions of circular business models.

This is a new methodological approach and must be seen as a starting point for discussion. We want to encourage a professional debate on this topic and would be grateful for collaboration to develop the CBMI method further, e.g. by refining the model and its assumptions, enriching the results with more data at market and company level, adapting and transferring the method to other geographies and industries.

The CBMI methodology is a tool for decision-makers to move from assumptions to evidence-based assessments of the impact of CBMs, in electronics and beyond. It is transferable to any product category and geography. Its insights help decision-makers identify actions that maximize the value extracted from each product and reduce the need for new products. In doing so, it empowers circular business models to fulfil their promise – limiting waste, reducing emissions, and conserving resources.

Circularity

Introduction

01

The State of the Industry

Industry, policymakers, and consumers continue to operate within a linear consumption model, where products are produced, sold, used, and eventually disposed of, with limited recirculation. This system relies on the continuous sale of new products, driven by frequent model updates and upgrades. It is highly unsustainable, contributing to growing resource scarcity and increasing volumes of waste (EEA, 2024a). Over the past 50 years, global resource consumption has more than tripled and is projected to grow by another 60% by 2060 (UN-IRP, 2024). Meanwhile, Germany's material reuse rate has only marginally increased in the past decade to about 13%, highlighting significant untapped potential for circular practices (EEA, 2024c).

Circular business models such as second-hand sales and rental offer promising alternatives to reduce the negative effects of today's consumption system. By translating circular economy principles - such as keeping products in use for as long as possible, eliminating waste, and circulating resources - into a customer value proposition, these models potentially reduce environmental effects, strengthen supply chain resilience, and offer financial benefits by lowering the need for material extraction and end-of-life disposal.

Consumer electronics represent a particularly relevant sector for circular business models. In Germany alone, more than 21 million new smartphones were sold in 2024 (Statista, 2025), and the total volume of electrical and electronic goods placed on the market doubled between 2012 and 2022 (Umweltbundesamt, 2024). This growth contributes to environmental challenges including harmful raw material extraction, high CO_2 emissions, and the generation of what is now the world's fastest growing waste stream (European Parliament, 2020; Baker, 2023). Electronic waste also bears significant health and safety hazards, especially in countries without modern recycling infrastructure.

Pioneering businesses have shaped the circular economy and are now receiving growing support from policymakers through measures such as the EU Right to Repair Directive (EP, 2022) and the Circular Economy Action Plan under the European Green Deal (EC, 2022).

A linear consumption model still dominates electronics, but circular business models promise to reduce emissions, waste and resource use.



> **Circular business models are the engines of the circular economy—they are how we put the principles of circularity into practice.**

Ellen MacArthur Foundation

The State of the Industry

UNDRESS Circularity
A Blueprint for Circular Impact Measurement

This report addresses a central gap in circular economy measurement: how to assess the positive environmental impact of rental and second-hand circular business models by focusing explicitly on changes in the use phase. It identifies key levers for impact optimization and offers a critical missing puzzle piece to existing impact assessment frameworks.

The Circular Business Model Impact (CBMI) methodology presented here is the result of the “UNDRESS Circularity” project - a 12-month industry collaboration led by Circularity in partnership with Fraunhofer IZM, Systemiq, and 12 industry partners (Assurant, circulee, Everphone, FixFirst, Foxway, Grover, Ingram Micro Lifecycle, rebuy, Recommerce Group, Reverse Logistics Group, Deutsche Telekom, and Vodafone). The project was supported by the Deutsche Bundesstiftung Umwelt and Deloitte.

The report introduces both a generalized methodology and deep dive illustration and case study of the consumer electronics industry - focusing on rental and second-hand business models. We examine these business offerings for the B2C and for the B2B sector. We selected four device categories within consumer electronics with different typical use patterns: frequently used devices (smartphones and laptops) and infrequently used devices (digital cameras and gaming consoles). This allows us for a differentiated analysis of the impact considerations for different use cases and product types.

The methodology and case analysis is developed based on different sources of input and data: proprietary industry data on rental and second-hand business activities shared confidentially by the project’s industry partners, market data from a representative B2C and B2B survey on the adoption and use of circular business models in Germany (published in the UNDRESS Circularity market report October 2024), and insights from numerous expert interviews.

This final report includes a system map to illustrate product flows in linear and circular business models in the consumer electronics sector, key processes and stakeholders. It introduces the CBM Impact methodology and offers a practitioner guide for impact assessment. And it presents key results from our case study, illustrating different scenarios based on the project’s proprietary data model.

While the current study focuses on electronic devices in Germany, the methodology is transferable to other products, industries as well as geographies. By providing a better understanding of the impact of circular business models, this report can help businesses, investors, users, and policymakers advance the shift toward a more resource-efficient circular economy.

A practical guide for measuring circular impact beyond existing frameworks and tools.

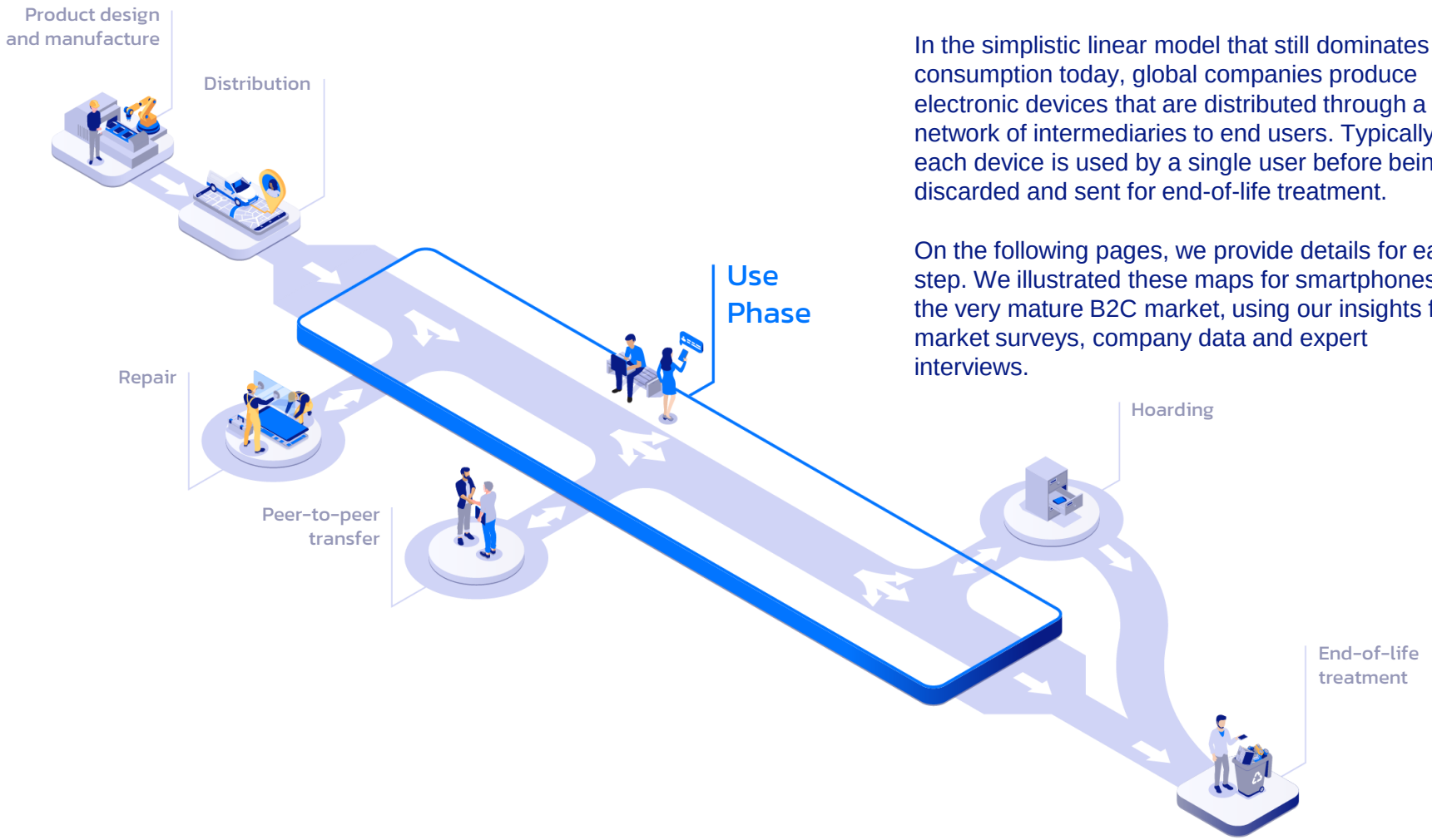
Circularity

A New Map for the Electronics Industry: From Linear to Circular Business Models

2.1 Today's Mostly Linear System
2.2 Circular Business Models: Second-hand Sales and Rental
2.3 Key Processes within the System

How products are used in practice plays a crucial role for the impact of a business model. In this chapter, we provide a system map for consumer electronics use in Germany. Chapter 2.1 shows a typical product lifecycle and relevant product flows in a linear model. 2.2 introduces rental and second-hand business models, explains key processes of both models and highlights key stakeholders.

2.1 Today's Mostly Linear System



In the simplistic linear model that still dominates consumption today, global companies produce electronic devices that are distributed through a network of intermediaries to end users. Typically, each device is used by a single user before being discarded and sent for end-of-life treatment.

On the following pages, we provide details for each step. We illustrated these maps for smartphones in the very mature B2C market, using our insights from market surveys, company data and expert interviews.

Steps in the Linear System: Production Design & Manufacture and Distribution

Product design and manufacture



Distribution



Product Design and Manufacture

Most electronics brands develop and design their products in their headquarter countries, while their manufacturing supply chains are globally distributed and highly complex.

Raw materials are extracted worldwide - from countries such as Chile, Peru, Australia, China, and the United States - and shipped for refinement, often to China. Mining these materials has considerable environmental effects through the depletion and contamination of groundwater, soil, and oceans, and consumes a lot of energy and thus contributes a relevant part to the products carbon footprint. (GSMA, 2025-2).

Specialized manufacturers and suppliers process these materials into electronic components. For instance, processors are designed by companies like Intel and AMD, while fabrication is often handled by foundries such as TSMC. Display units may come from suppliers like LG Display or BOE. Some brands, such as Apple, outsource assembly to contract manufacturers like Foxconn, while others, like Samsung, vertically integrate much of their component production and product assembly in-house.
These supply chains make electronics production a highly interdependent global industry, with key manufacturing and assembly hubs in East and Southeast Asia.

Distribution

Manufacturers (e.g., Apple, Lenovo, HP) distribute their products through large IT distributors (e.g., ALSO, Ingram Micro, Foxway), who in turn supply retailers (e.g., MediaMarktSaturn, Amazon), telecom operators (e.g., Deutsche Telekom, Vodafone, O2), and business IT service providers (e.g., Computacenter, Bechtle). Some OEMs, such as Apple, also operate their own direct-to-consumer retail channels.

The production of consumer electronics relies on a global network of suppliers, manufacturers, and assemblers. Distribution steps vary for B2C and B2B customers.

Steps in the Linear System: Use Phase

Use Phase

The way electronic products are used during the use phase varies depending on the device type and whether they are used privately or in a business context.

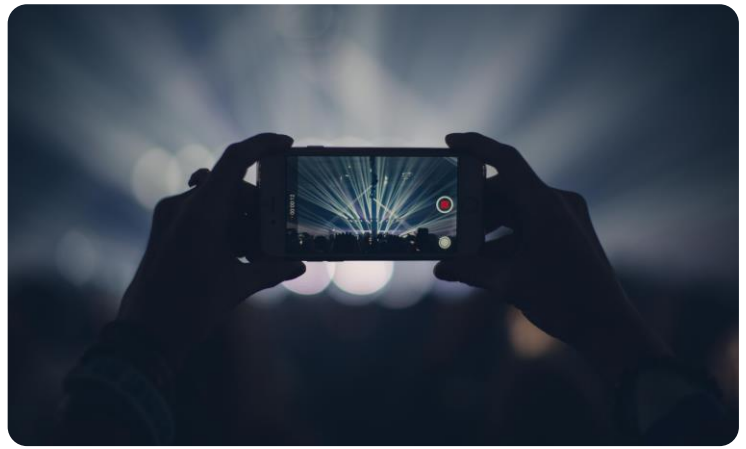
The UNDRESS Circularity market report provides a rich data set and a relevant analyses of consumer electronics use in Germany, based on a representative survey of ~1,000 private individuals and ~200 IT professionals from companies of various sizes. As this report, it focuses on smartphones, laptops, digital cameras and gaming consoles to cover different usage patterns and covers both B2C and B2B segments.

Private and business users of electronic devices differ in both usage duration and intensity. On average, private consumers use new devices for 3.9 years, with smartphones at 3.6 years, digital cameras at 3.3 years, and laptops at 4.4 years. Companies tend to keep devices longer: company smartphones are used for 4.5 years, laptops for 5.6 years, and digital cameras for 7.2 years before they reach the end of their use phase.

These findings align with previous studies, such as the European Environmental Bureau (EEB, 2019) and the European Commission (EC, 2023), which reported an average smartphone lifespan of around three years.
In addition, our market report captures variations by device type, user group, and business model, providing detailed data and nuanced understanding of use phase dynamics.

Device usage intensity also varies by category. Most private users (91%) use their smartphones daily. Laptops are used daily by 42% and at least weekly by another 31%.
In contrast, digital cameras and gaming consoles are used less frequently – weekly to monthly, or only occasionally - by around 80% of users.
Based on these patterns, we classify smartphones and laptops as frequently used devices, and digital cameras and gaming consoles as infrequently used devices.





The results of Circularity's B2C and B2B market survey, published in the UNDRESS Circularity Market Report, provide detailed insights into real-world consumer electronics usage.

Steps in the Linear System: User-initiated Repair, Peer-to-Peer Transfer and Hoarding

Once users stop using a device, two common outcomes follow:

User-initiated Repair

When a device breaks during the use phase, users may choose to repair it to restore functionality.
Defects remain the most common reason why products are no longer used. According to the UNDRESS Circularity market report, 60% of participants had stopped using their smartphones due to defects, and 40% had experienced a broken laptop. Looking ahead, 60% of users expect to replace their current device due to breakage.

User-initiated repair



01. Peer-to-Peer Transfer

Some users pass on devices to others directly, either through gifting (e.g., to family or friends) or private sales via platforms like eBay, Vinted, or Kleinanzeigen. These devices enter a second use phase without tests or refurbishment. Donation to charities is also common. Our UNDRESS Circularity market report for Germany showed: about 10% of previously used devices have been gifted non-commercially, 4% donated and around 19% were sold second-hand.

Peer-to-peer transfer



02. Hoarding

Hoarding refers to storing unused electronics with uncertain future reuse - typically in drawers or company storage. Hoarding is widespread in both private and business contexts: 28% of private users and 60% of companies reported keeping their last device as a backup after first use. bitkom reported about 210 million smartphones in Germany drawers in 2022. After a continuous increase over several years, the most recent data from 2025 shows a slight decrease for the first time.(bitkom, 2025) This also resonates with our market report from 2024, which shows a decrease in hoarding intention - from 28% for previously owned devices to 21% for currently owned ones. The final fate of hoarded devices is often unclear: they may be reused, sold, or passed on, but often lose resale value and are eventually discarded.

Hoarding



Steps in the Linear System: End-of-Life Treatment

End-of-life treatment



End-of-Life Treatment

In Germany, electronic devices must be disposed of as WEEE (Waste electrical and electronic equipment) and handled by certified recyclers. If not properly discarded (e.g., thrown into residual waste), they may end up in thermal treatment facilities. Consumers can bring devices to municipal recycling centres; electronic retailers and supermarkets are also legally required to accept small electronic devices for return. Companies and professional resellers typically task specialized recyclers with the collection of their discarded devices.

Despite these measures, Germany's WEEE collection rate was just 31% in 2021 (Umweltbundesamt, 2023), and the final destination of many devices remains unknown. Those devices collected are sent to certified recyclers (e.g., BRAL in Berlin or Electrocycling GmbH in Goslar) and then sorted, dismantled, and stripped of hazardous components. Next, companies like ALBA/Interzero or Remondis handle further processing, including shredding and material separation (e.g., PCBs, glass, aluminium, plastics). These materials are then sent to downstream processors for recovery. For instance, smelters like Aurubis recover precious metals, and plastics are either turned into recyclates by companies like Mocom or used for energy recovery, depending on purity.

Non-recoverable materials - or devices not disposed of properly - are incinerated. As of today, there is no large-scale closed-loop recycling of e-waste materials for reuse in electronics manufacturing.

Despite tremendous efforts, as of today, there is no closed loop recycling of e-waste materials.

Finally, a portion of e-waste is exported illegally, despite the Basel Convention prohibition (Basel, 2024). Gaps in regulation and misclassification - whether intentional or accidental - allow for such shipments, often to Africa or Asia (Unitar, 2022). In these regions, devices are frequently dismantled in large scrap yards under poor environmental and safety standards, polluting local environments with toxic substances like persistent organic pollutants and polychlorinated biphenyls. These chemicals can exceed safe intake levels by more than 100-fold (IPEN, 2019).

“

Many countries lack safe recycling systems. As a telco, we see it as our responsibility to help change that. Vodafone’s ‘One for One’ programme with Closing the Loop is a step toward reducing e-waste and building safer local infrastructure.



Andrea Scholz, Senior Sustainability and Circular Economy Manager
Vodafone GmbH

2.2 Circular Business Models:

Second-hand Sales and Rental

Circular business models turn circular economy principles - keeping products at their highest potential value, eliminating waste, and circulating resources - into a customer value proposition. Their goal is to extend or intensify the use of products and thus reducing resource consumption while generating value for users in a commercially viable manner.

This report focuses on two specific business models: second-hand sales and rental.

While other types of circular activities exist - such as stand-alone repair or recycling and resource recovery - second-hand and rental models were chosen for their increasing relevance and uptake as well as their focus on changing the use of products rather than materials. They influence the use phase most directly, allow redistribution across multiple users, and often include repair. Relevant insights can thus be drawn for repair businesses.

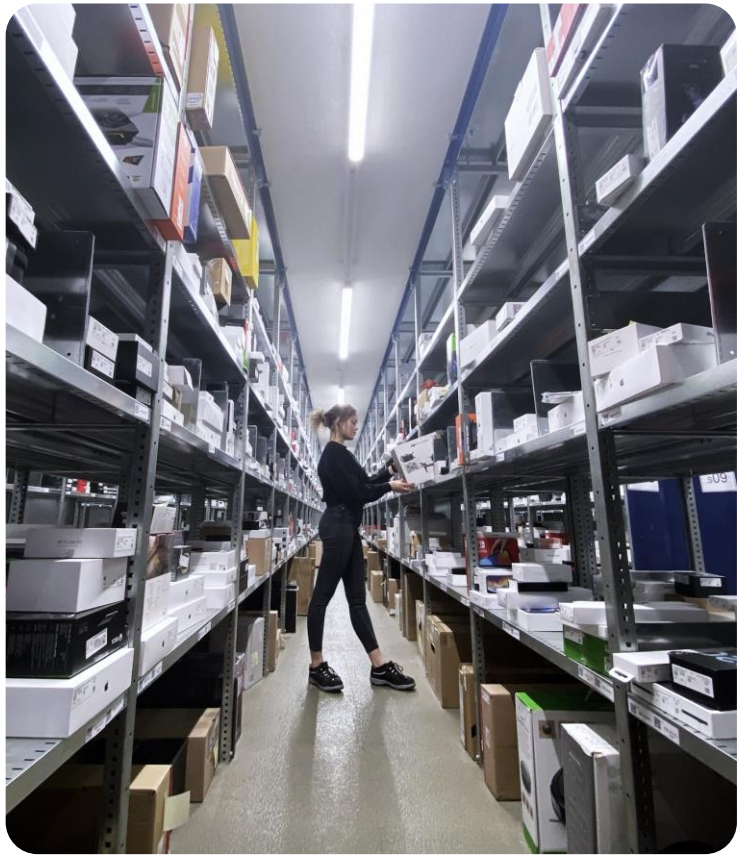


Image provided by Ingram Micro Lifecycle.

The System Map for Second-hand Sales

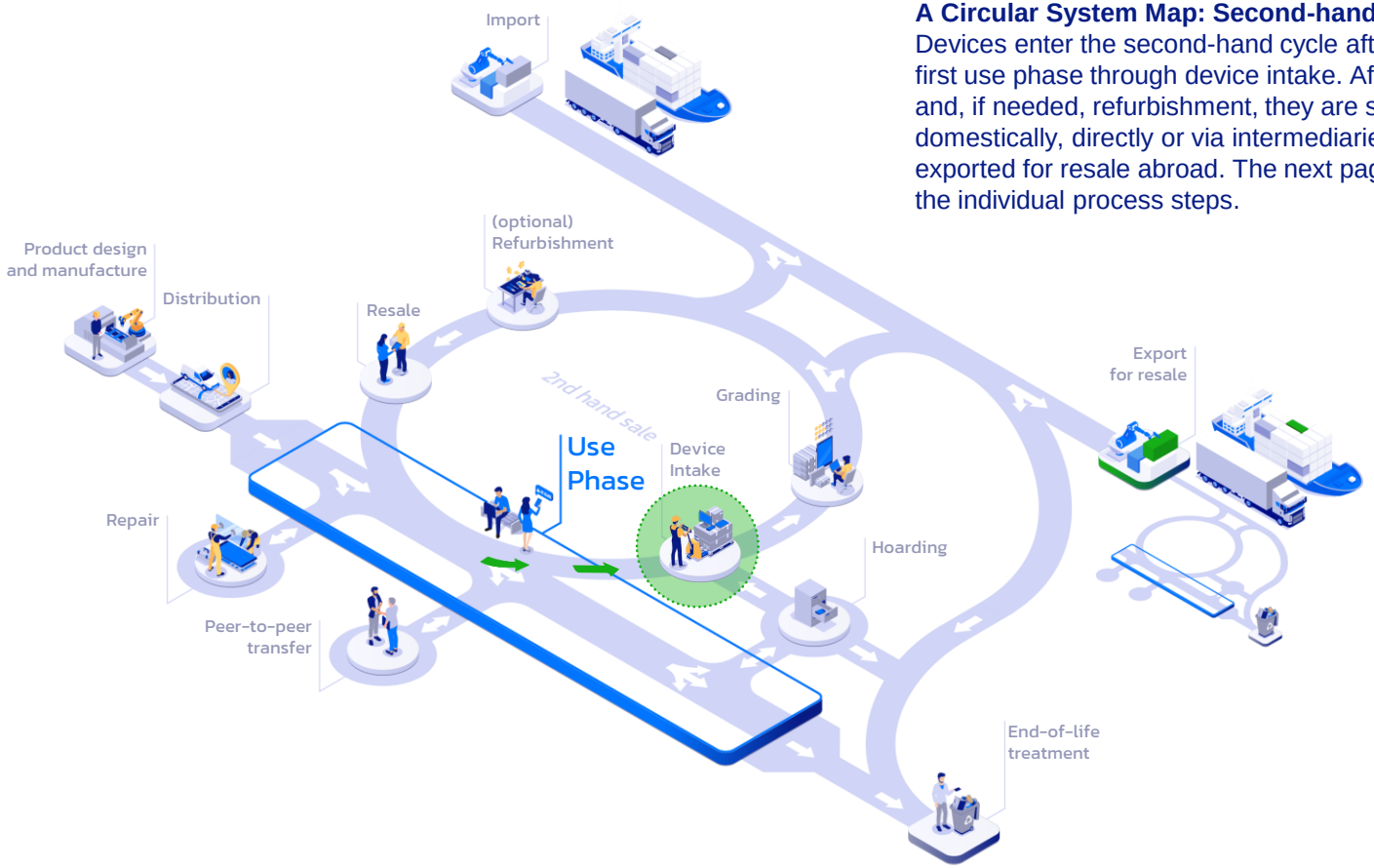
Circularity

Adoption of second-hand sale is rising slowly in Germany

Based on the UNDRESS Circularity market report, current adoption of second-hand devices among private consumers in Germany stands at 21%, up slightly from 19% the year before. Cost savings (62%) and sustainability (44%) are the top reasons cited for choosing second-hand products. Consumers report similar use expectations for refurbished and new products, indicating an intended use time of 3.6 years for pre-owned smartphones.

Adoption is higher among businesses: 30% of companies have already purchased second-hand laptops or smartphones for employees. However, second-hand products still only make up 7–8% of current business IT inventories. When asked why they chose second-hand, companies mention sustainability (56%), financial reasons (51%), and immediate device availability (49%).

Second-hand sales refer to the professional resale of electronic devices after their first use phase. Instead of being hoarded or discarded, still functional or repairable devices are collected from businesses and private individuals and redistributed into subsequent use phases.



A Circular System Map: Second-hand Sales
Devices enter the second-hand cycle after their first use phase through device intake. After grading and, if needed, refurbishment, they are sold either domestically, directly or via intermediaries, or exported for resale abroad. The next pages detail the individual process steps.

“

The cost and impact levers of buying second-hand for businesses are tremendous. We are convinced that once companies really understand that, the market will further accelerate.



Thomas Gros, Co-Founder and CEO
circulee

Steps in a Circular Second-hand Sales System: Device Intake and Import





Corporate devices make the biggest share of second-hand device intake. Germany imports large volumes of high-quality used devices, as demand exceeds local supply.

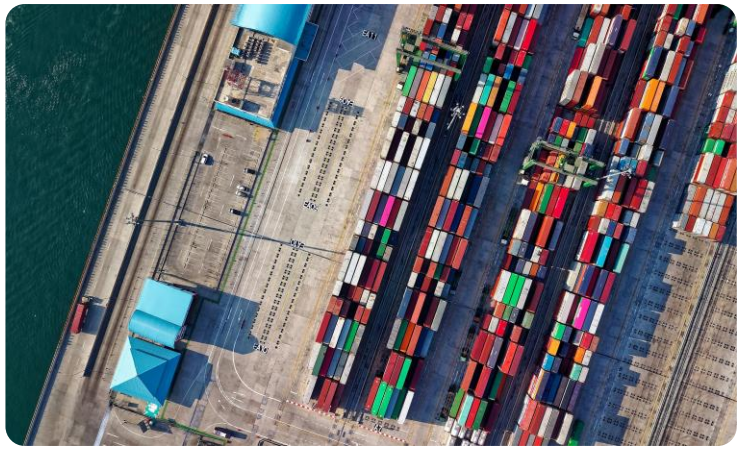
Device Intake

There are several pathways for a device to enter the second-hand loop. Most volume originates from corporate IT equipment that is sold to service providers like Ingram Micro Lifecycle or Foxway, transferred back to IT system integrators such as Bechtle or Computacenter, or returned to leasing or rental providers such as CHG-Meridian, Grover, or Everphone.

Private users also supply devices to the second-hand cycle by selling directly to professional resellers such as rebuy or Recommerce Group. Devices can also be traded in via platforms like Back Market or refurbed, or through trade-in programs offered by OEMs (e.g., Apple, Samsung), telecom providers (e.g., Telekom, Vodafone), or retailers like MediaMarktSaturn - often facilitated by third-party service providers such as Assurant or Foxway. In addition, resellers may trade with each other and with intermediaries to accommodate differences in supply and demand.

Import

Due to strong domestic demand for high-quality used smartphones, Germany also imports significant volumes of second-hand devices - primarily from the United States and neighboring EU countries.



Steps in a Circular Second-hand Sales System: Grading and Refurbishment

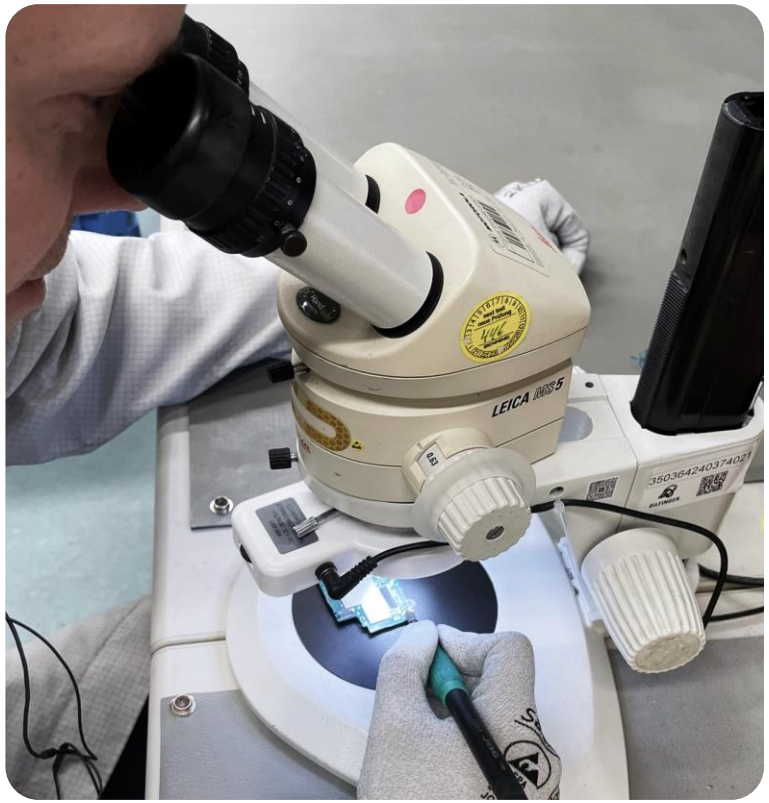


Image provided by Ingram Micro Lifecycle.

Grading

All devices undergo a similar process of cleaning, data deletion, and grading. While grading currently involves a combination of manual and automated/IT-assisted work, especially for smartphones the process is increasingly automated with the use of robotics. Grading assesses each device's functionality, cosmetic condition, and resale potential. It is carried out either by the professional reseller (e.g., rebuy, Recommerce Group, Computacenter) or by external service providers (e.g., Ingram Micro Lifecycle, Foxway, Cyculus). The outcome determines whether the device should be directly resold, refurbished, or sent for end-of-life treatment.

Refurbishment

Devices that justify a value-uplift before resale continue to refurbishment. This process can be handled by the reseller directly or outsourced to a service provider. Refurbishment includes repairs, if necessary, along with repackaging and preparation for resale.

Device grading determines the refurbishment needs and resale potential.

Grading



Refurbishment



Steps in a Circular Second-hand Sales System: Resale, Export and End-of-life Treatment

Resale

Devices selected for the German market are sold through the resellers' own online platforms (e.g., rebuy, Recommerce Group, circulee), through in-store second-hand offerings (e.g., Telekom, Vodafone) or via market places (e.g., Backmarket, idealo, MediaMarktSaturn). Devices that are not sold directly to the next user are resold to intermediaries.

Resale channels vary depending on device condition and market demand.

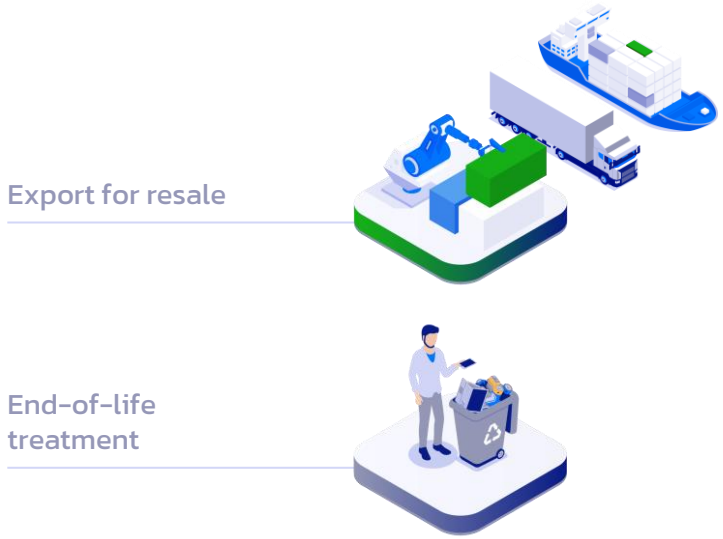


Export for Resale

Devices that are still functioning but lack domestic demand are often exported. Generally, high-quality second-hand devices can be resold in Germany or within the EU, while lower-grade devices are sent to markets outside the EU where demand is higher.

A global network of companies - including Foxway, Assurant, and PCS Wireless - manages this international distribution. They sell through own international channels or via brokers in major trading hubs such as Dubai or Hong Kong. Thereby devices are channelled to where current demand and resale price for a specific device type and grade category is highest, increasing the likelihood of a second life in another market.

However, reliable data on the international second-hand trade is limited, and there is little visibility into how these devices are used after export. Concerns also exist around improper recycling practices in some destination countries, where electronics are often dismantled in large scrapyards under unsafe environmental and health conditions.



End-of-Life Treatment

Typically, the large majority of devices entering a professional resale cycle are also resold. Our data shows that less than 5 % are routed to end-of-life treatment. This includes harvesting of spare parts or professional recycling, depending on device condition and material value.

**We need a single European market for used equipment to enable more trade of second-hand devices.
We always need a local entity registered with the national WEEE register in each country, this is a tremendous hassle and impedes device recirculation to the best suited markets.**



**Henning Never, Circularity Project Lead
Deutsche Telekom**

Circular Business Models: Rental

Rental business models enable temporary access to electronic devices. Devices remain the property of the rental provider, who manages their distribution, collection and redistribution to rental users. Rental agreements often include additional services such as insurance, maintenance, or device replacement, and are particularly common in the business-to-business (B2B) context, where they can include full IT and mobile device management.



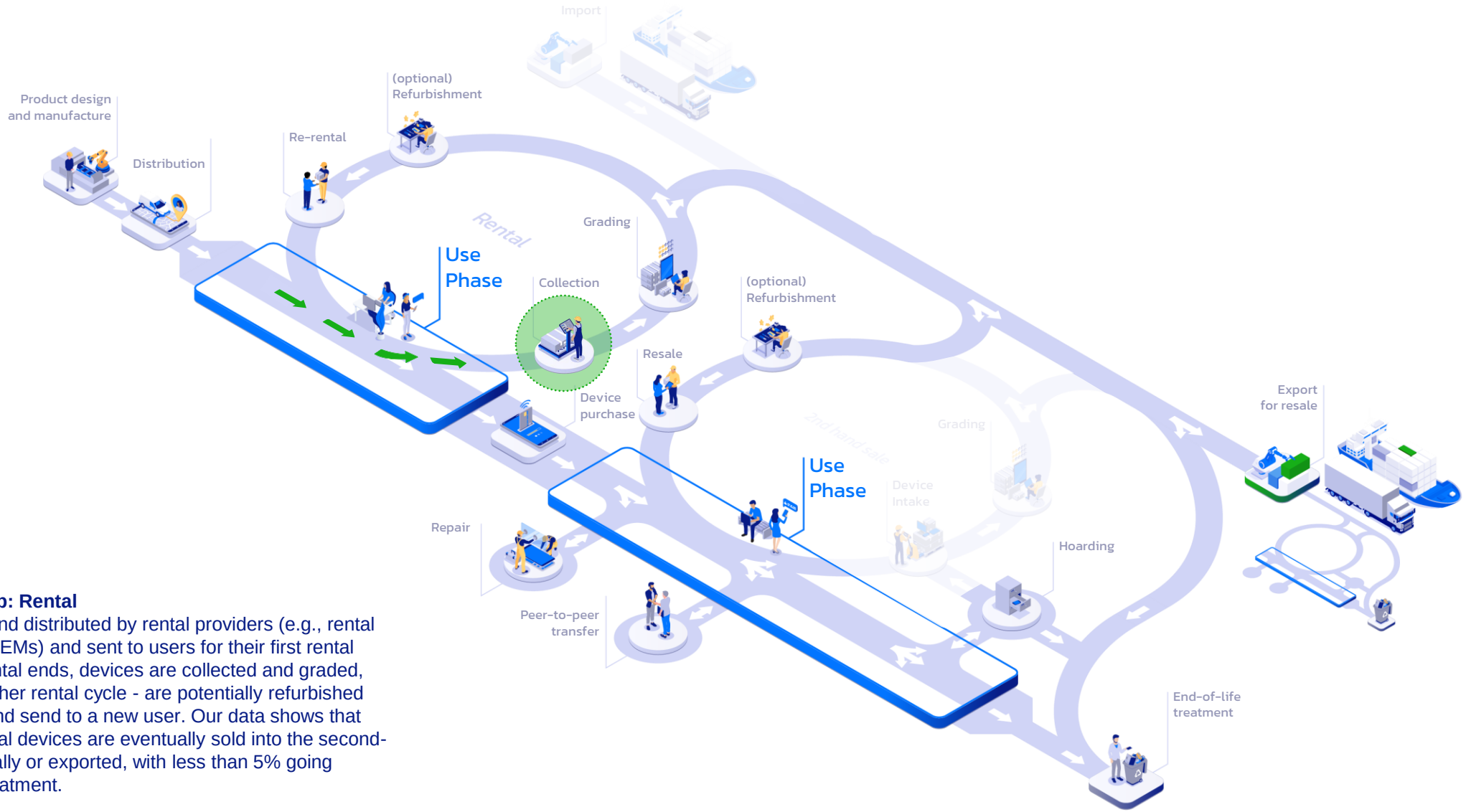
Image provided by Recommerce Solutions SA

Rental adoption in B2B much higher than in B2C markets, with room for growth in both

According to the UNDRESS Circularity market report, adoption of rental models among private consumers in Germany is still low. Only around 1% of survey respondents had experience renting electronic devices. A focused survey of current rental users (non-representative) showed that key reasons for renting include access to the latest technology (79%), flexibility (78%), and technical support (71%). However, many consumers still prefer long-term ownership, which currently limits wider adoption.

In contrast, rental models are more established in the business sector. About 11% of companies reported using rental services for their devices. The most important reasons cited were the availability of maintenance, service, and replacement options (86%). By renting, companies can outsource tasks such as device management, repairs and replacement. This increases flexibility, reduces internal effort, and shifts expenses from capital to operating costs.

The System Map for Rental



A Circular System Map: Rental
Devices are prepared and distributed by rental providers (e.g., rental service companies or OEMs) and sent to users for their first rental use phase. After the rental ends, devices are collected and graded, and - if suitable for another rental cycle - are potentially refurbished and then repackaged and send to a new user. Our data shows that the vast majority of rental devices are eventually sold into the second-hand market, domestically or exported, with less than 5% going directly to end-of-life treatment.

Steps in a Circular Rental System: Distribution, Rental Use and Collection

Circularity

Distribution

After production, manufacturers (e.g. Samsung) or large distributors (e.g., ALSO, Bechtle, MediaMarktSaturn) supply rental companies like Grover or Everphone with devices who assume ownership of the devices. Rental companies then offer the devices to private users or businesses under flexible contracts, often bundled with added services. Some OEMs, such as HP, or Lenovo, also offer rental options themselves, especially to B2B customers. Large IT service providers (e.g., CHG-Meridian), also operate rental or leasing models to companies.

Distribution



Rental Use

During the rental period, users access the device and use it without owning it. Contracts frequently include insurance or damage protection, as well as guaranteed fast replacement in case of malfunction or loss.

Rental use enables a large degree of flexibility and "piece-of-mind", especially to B2B users

Rental use



Collection



Collection

At the end of the rental period, devices are returned to the provider. While private users and smaller businesses typically send devices back by post, larger customers can receive pick-up services arranged by the provider or create return-labels for free shipping.

Businesses want simplicity and cost control. As-a-Service models deliver exactly that. Taking the management of device fleets off their shoulders and turning it into a flexible, scalable operational expense is a huge relief. And at the same time, it helps us extend device lifecycles and reduce environmental impact.



Falk Sonnenschmidt, Chief Revenue Officer
Everphone

Steps in a Circular Rental System: Grading and Re-rental

Circularity

Grading

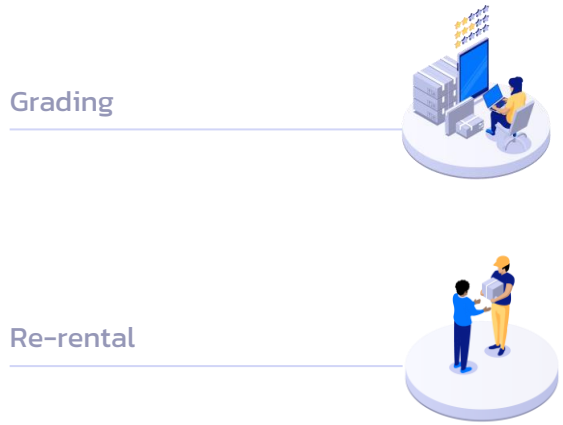
As during the intake of used device in second-hand models, returned devices go through mandatory data deletion and grading to assess their condition and reusability. Grading is handled either in-house or by third-party partners such as Ingram Micro Lifecycle or Assurant. Based on the grading result and current rental demand, devices may enter a new rental cycle, in some cases after refurbishment.

Re-rental

Devices that meet the required conditions for re-rental are temporally stored and then rented out again to new users. This process may repeat multiple times before it is sold to second-hand markets to - less often - sent to end-of-life treatment.



Image provided by Everphone.



Secure data deletion is the first step when devices are collected after rental cycles. Grading then determines their potential for re-rental or re-sale

Steps in a Circular Rental System: Three Exit Routes

Circularity

Exit routes – When devices are no longer suitable for rental - due to condition, age, or economic reasons - they can take one of several paths:

01. Resale via Second-hand Sales

Devices still in working condition may be sold through a variety of second-hand channels. The devices then enter the procedure described earlier for second-hand sales.

Resale via second-hand sales



02. Device Purchase by Users

Some rental contracts offer an option for users to buy the device at the end of the rental period by paying a small one-off fee.

Device purchase by users



03. End-of-Life Treatment

A small share of devices (typically under 1–5%) that are beyond repair possibilities are sent for professional recycling or parts harvesting.

End-of-life treatment



Most rental devices are sold for second-hand use. However, some devices are ultimately bought by the current rental user. A small fraction goes directly to end-of-life treatment.

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All devices returned – due to technical issues during a rental period or because the rental period ends – come back to us. This allows us to repair them or recover as much value as possible from their materials and components for continued circular use.



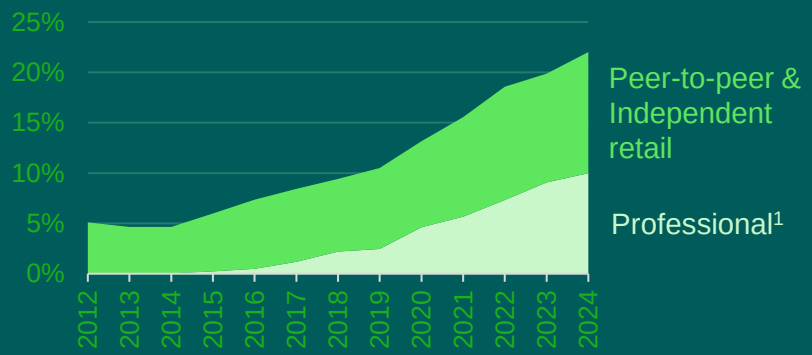
Lisa Steffenhagen, Senior Sustainability Manager Grover

Deep-Dive International Trade: Global Revenue of Second-hand Sales and Proportion of total Market

The international second-hand market is booming

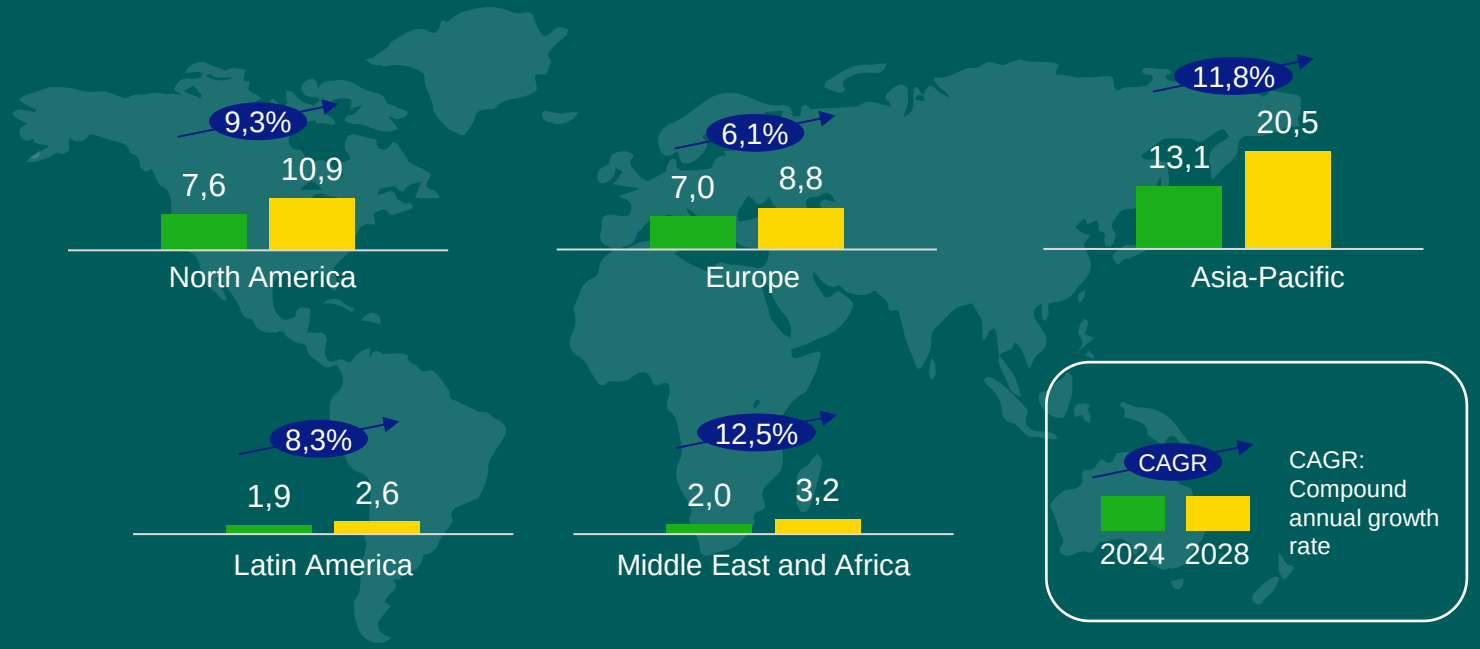
Second-hand is booming across the globe. Across regions, second-hand markets for smartphones, watches and tablets have doubled in share of the total market over the past five years. According to CCS Insight, the global market volume is expected to continue growing by 6% annually over the next years. At the same time, the primary smartphone market has been rather stagnating or declining in the last years.

Second-hand device sales as a proportion of the total market
(for smartphones, smartwatches, tablets)



The strongest growth in the second-hand market is expected in the Middle East, Africa, and Asia–Pacific, driven by increasingly professionalizing second-hand markets. Rising new device prices - often due to currency depreciation in regions such as Africa, Japan, and Australia - are pushing more consumers towards second-hand alternatives.

Revenue from professional[1] second-hand market ($B)



1) Professional resellers only, i.e. larger and chain retail stores, B2C marketplaces, OEMs, operators and insurance

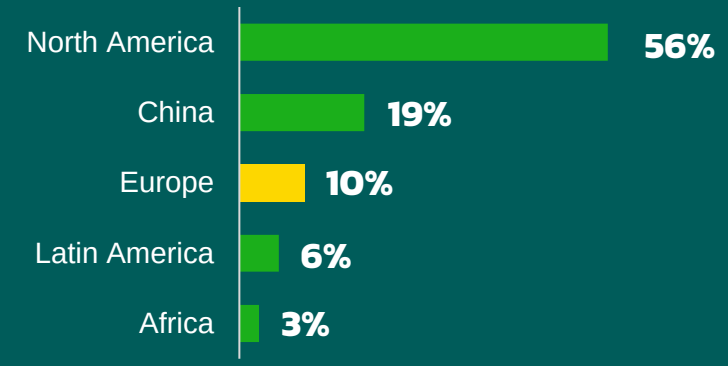
All data provided by CCS Insight

Deep-Dive International Trade: Regional Trade-in Rates and Supply-Demand Balance of Used Devices

International Trade-in and Import / Export

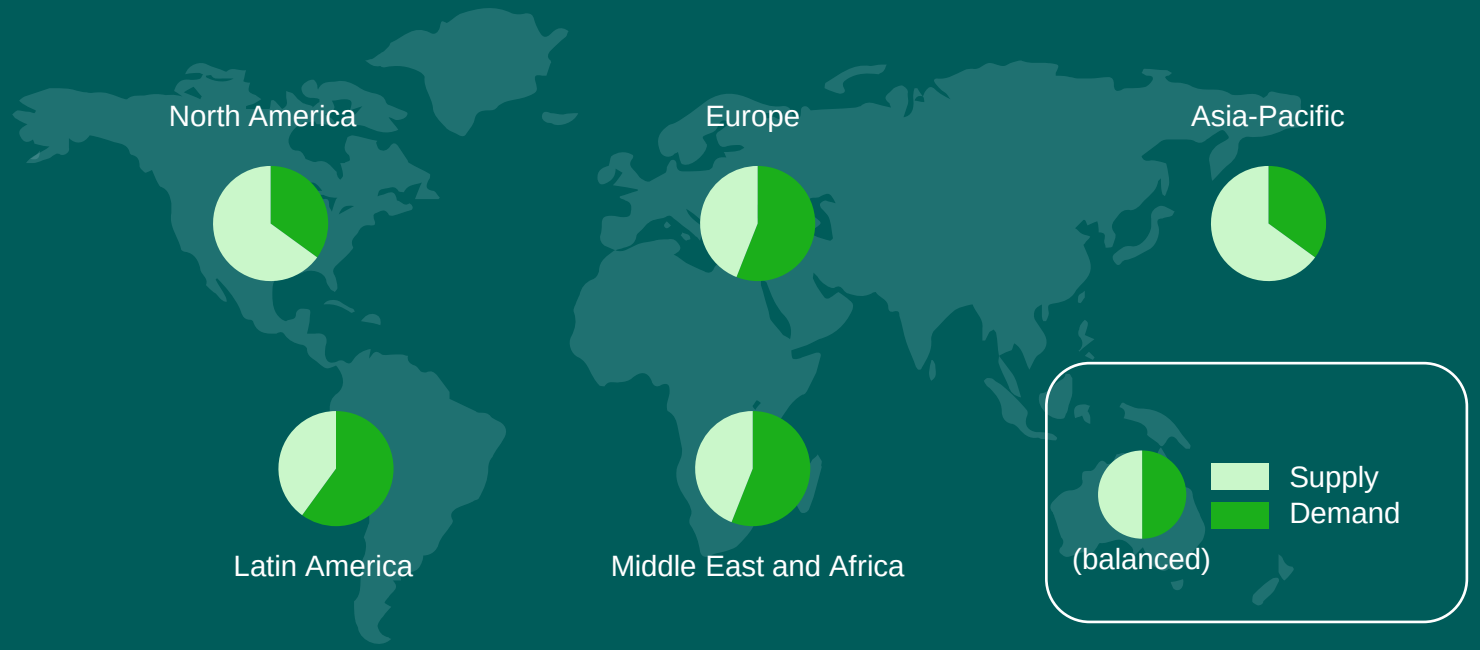
In Germany, devices are still more likely to be hoarded in drawers than traded in. The average trade-in rate across Europe stands at just 10%, significantly lower than in China (19%) and especially North America, where over half of all devices - 56% - are traded in, providing reliable supply to the second-hand and refurbishment market.

Regional Trade-in Rates



In line with low trade-in volumes, the EU needs to import 10–15 million smartphones annually to meet demand for mostly high-grade second-hand devices. These imports primarily come from North America, which exports around 30 million devices globally, and Asia-Pacific, with approximately 10 million global exports (data not shown). In regions such as Latin America and the Middle East & Africa, demand for second-hand devices also exceeds domestic supply. These markets show strong interest in more affordable, lower-grade second-hand devices, offering significant potential for lifetime extension of products that are no longer suitable for resale in other regions.

Second-hand smartphone supply and demand balance[1]



1) Visual representation of supply and demand of second-hand smartphones.
A larger demand (>50%) means regional supply (i.e. without imports) does not meet demand in that region

All data provided by CCS Insight

Deep-Dive International Trade: The Relevance of International Markets for Circular Impact – Interview with Stefan Nilsson from Foxway

Why is the international trade of used electronic devices crucial for the circular economy?
Stefan: To grasp the true impact of circular business models, we need to consider a device's entire lifecycle, not just its initial use. Many devices retain years of usability post-first use but may not find local demand. By exporting these devices to new markets, we facilitate additional use cycles, extending their overall lifespan and decreasing the need for resource-heavy production.

How many devices are traded – and where to?
Stefan: Foxway handles about 4 million devices each year –across industry, tens of million more change hands annually. A significant part of the trade happens between European countries – which is also our core market, but used devices are also sold internationally, reaching regions such as the Middle East, Africa, Latin America, and parts of Asia, where there is a rising demand for affordable, reliable tech. However, data on international trade is scare, challenging proper impact assessments.

Which devices have global appeal?
Stefan: Demand varies throughout Europe due to distinct preferences regarding device types and their aesthetic or functional requirements. In other regions, older models, such as the iPhone 8, X, or Samsung A-series, remain popular, especially in African markets and the global south. However, high handling costs still often lead to premature disposal of such lower-value devices in Europe, despite options for repurposing them.

What do global second-hand markets look like?
Stefan: Devices are usually traded in bulk, often through trading hubs like Dubai to regional distributors or retailers who handle local resale through increasingly organized second-hand channels**.** These markets are expanding swiftly worldwide and play a vital role in enhancing digital access, connectivity and extending device lifespans. There is a frequent misunderstanding believing the global flow of goods has a negative impact.
However, a key issue in some areas is the end-of-life treatment of devices. Without adequate collection and recycling systems, devices may enter informal waste streams, posing environmental and health risks. Thus, investing in local end-of-life infrastructure and partnering with organizations like Minimise or Closing the Loop is crucial to maintain the benefits of reuse.

How does international trade help lessen environmental impact?
Stefan: By exporting devices that have no local demand, we can prevent early recycling or disposal, extending product lifespan. In destination countries, this decreases the need for new, often low-quality devices that are difficult to repair and short-lived. This not only minimizes e-waste and the environmental footprint but, importantly, also addresses global digital inequality in consumption. The newly established KorpFoundation aims to further address this issue**.**



Stefan Nilsson,
Chief Impact Officer & Founder of Foxway. Stefan is also founder of the KorpFoundation for arts and science.

Measuring true circular impact means factoring in global reuse – international trade plays a key role in extending products lifetimes. More research and data is urgently needed in this area.

2.3 Key Processes within the System

Circular business models rely on a set of little-known core processes that are critical for the recirculation of electronic devices across multiple users and life cycles.

This section sheds light on these key processes involved in both second-hand sales and rental models, focusing on their role on device longevity, condition, and continued circulation in the system:



Device intake



Grading



Refurbishment, including potential repair



Re-sale



User-initiated repair

User initiated repair could be considered as self-standing business model

This report distinguishes between two types of repair. First, repairs initiated by users during a use phase - whether private individuals or businesses - referred to as user-initiated repair. Second, repairs carried out as part of professional refurbishment processes.

The focus of this report lies primarily on the latter: repairs performed by second-hand and rental providers as part of circular business models, with the goal of preparing devices for continued use across multiple life cycles.

Key Process: Device Intake



Image provided by Everphone

Device intake - also referred to as trade-in or buy-back - is the process by which professional resellers acquire used electronic devices for refurbishment and resale. Devices are collected from both business and private customers through various channels.

In the B2B segment, intake happens via returns from leasing agreements, direct purchases or returns from companies through IT service providers such as Bechtle or Computacenter, or acquisitions by lifecycle technology companies like Ingram Micro Lifecycle and Foxway.
In the B2C segment, devices are sourced through purchasing programs offered by dedicated platforms (e.g., rebuy, Recommerce Group) or through trade-in programs at retailers and telecom providers like MediaMarktSaturn, Vodafone, and Telekom.

Some service providers handle all operations after the trade-in for retailers or telecom providers. For example, a Foxway subsidiary handles grading, refurbishment, and resale for devices traded-in at MediaMarktSaturn stores, while Assurant manages Telekom's trade-in services, both in-store and online.

Step 1
Initial Evaluation:

In the beginning of the process users - private or business - enter details about the device on an online portal or in-store. They describe the device model and condition and receive a preliminary price estimate. For business clients returning larger quantities, the process is typically governed by framework agreements.

“

Smartphone trade-ins are standard practice in the US. Through our insurance, trade-in & upgrade programs, we often see the same device multiple times in its lifespan. This trend has not yet fully taken hold in the EU, but there is significant potential for insurance, trade-in & upgrade business models as well. As adoption increases, it will massively boost the second-hand market by making more devices available.



Alexander Heß, Country Manager Germany
Assurant

Key Process: Device Intake

Step 2
Device Submission

Once the preliminary offer is accepted, customers send in or drop off the device - either via postal services, physical drop-off points, or in-store handovers. For large clients, full-service reverse logistics solutions are offered. For example, Computacenter coordinates secure pick-up and transport, and DHL manages reverse logistics for CISCO Systems, including grading and recycling. (DHL, 2022). In addition to trade-in, leading reverse logistics providers deliver end-to-end services.

Step 3
Detailed Grading

Devices are shipped to processing facilities where they undergo technical inspection, data deletion, and further processing (see grading section for details).

Step 4
Final Valuation and Compensation

Based on the device's final grade, the customer receives compensation - either the originally quoted amount or an adjusted value - typically in the form of store credit, a discount on a new device, or a cash payment. If the final offer is declined, the device is either returned to the customer or sent to recycling.

Material Recirculation from Nonfunctional Devices

Depending on the device intake channel, not all devices are still functional. Specialized providers like Reverse Logistics Group (RLG), being part of Reconomy Group, ensures that materials remain in the resource cycle via take-back and producer responsibility schemes, material sorting facilities, plant and recycling equipment, reverse vending machines and tailored solutions across the whole value chain.

The moment where a device is handed in, the clock starts ticking to evaluate the device's potential for resale as quickly as possible.



Image provided by Ingram Micro Lifecycle.

Key Process: Grading

Based on condition and testing, submitted devices are assigned a grade that determines their next steps.

Grading takes place whenever a device changes ownership and evaluates its condition to determine resale or reuse potential. This process is typically conducted either by specialized service providers - such as Ingram Micro Lifecycle, Interzero, Dis-Connect, Cyculus, or reverse logistics companies like Reverse Logistics Group or DHL - or by the in-house teams of the respective rental providers and resellers themselves. Devices are checked for functionality, visual condition, battery performance, and possible defects according to a predefined grading system. The resulting grade guides the device's next steps in the value chain.

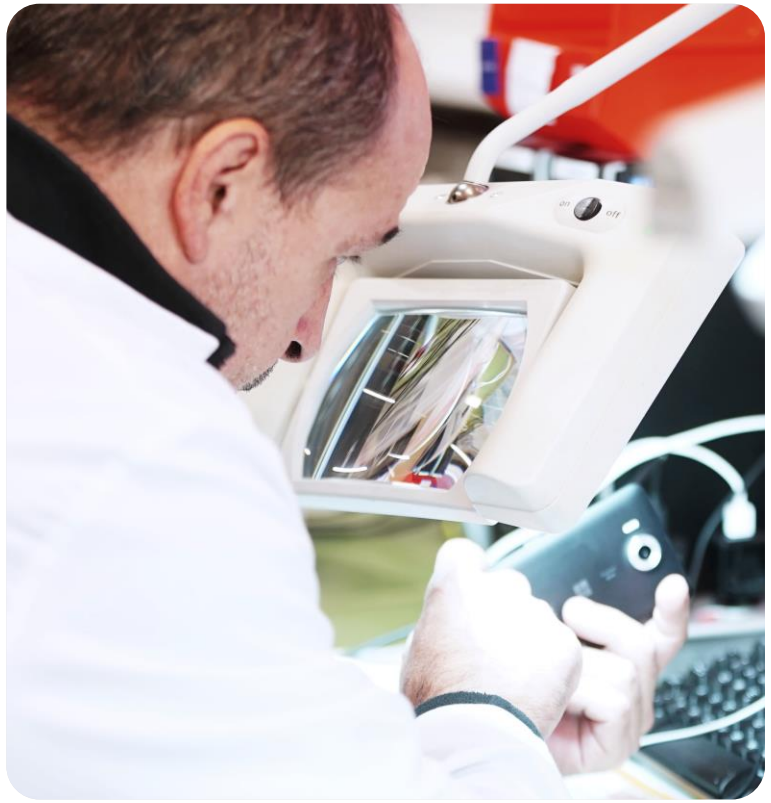


Image provided by Recommerce Solutions SA.

Step 1
Reception:

Incoming devices are first cleaned to enable proper inspection. A technician then manually checks each device, confirming the presence of required accessories, recording key information such as model and serial number, and identifying any visible damage. The unpacking process is often video recorded to have proof of the device's incoming condition and to combat customer fraud. Devices that are clearly non-functional are sorted out and sent back to the customer or for recycling. All others are prepared for the next step - (partially) automated testing.

Key Process: Grading

Step 2
Data Erasure

Devices must be reset to factory settings by the previous user before being sent in. If this has been completed, all data is then securely deleted again using certified data deletion software (e.g., Blancco). The process is fully documented. Devices that have not been factory-reset by the user often cannot be unlocked and are therefore excluded from further processing.

Step 3
Functional (often-automated) Tests

A series of functional tests is carried out to assess whether the device meets the technical requirements for refurbishment or resale. These tests cover key components such as battery performance, display, camera, audio, connectivity, sensors, and the charging port. While some tests are still performed manually, many providers now rely on semi- or fully automated systems. High-volume automated solutions - like those offered by Cyculus - can test over 100 smartphones per hour (Cyculus, 2025) and provide these grading services on behalf of other companies in the market.

Step 4
Grading Categorisation

Based on the results of both the visual inspection and functional testing, each device is assigned a final quality grade. While grading criteria can differ in the agreements between providers and companies, most follow multi-level scales - such as A to D or labels ranging from "like new" to "heavily used." The assigned grade determines the next step in the device journey, such as whether it can be resold directly, requires refurbishment, or should be sent for recycling.

Grading is key to re-circulation. Its speed, reliability, cost and customer trust are determining factors to how many devices can be re-used.

Key Process: Refurbishment

The refurbishment process aims to restore devices' technical functionality and visual condition in order to extend their usability. It includes cosmetic improvements such as cleaning and polishing, as well as functional repairs or component replacements. Once fully reconditioned, devices are repackaged, in some cases rekitted and prepared for redistribution.

Refurbishment is either handled in-house by resellers or outsourced to specialized service providers. Large international providers - such as Assurant, Reverse Logistics Group, Ingram Micro Lifecycle, and Foxway - operate dedicated refurbishment facilities across Europe, allowing for cost-effective and standardized reconditioning.

A device's market value (up-lift) drives the refurbishment decision.



Image provided by Recommerce Solutions SA

Step 1
Refurbishment Plan

A device's grade, current market demand, estimated resale price (current state vs. expected up-lift if refurbished), and refurbishment costs determine the decision to refurbish. Devices in good condition may be resold directly or receive only minor aesthetic treatment. Those requiring functional repairs or with potential for a higher resale value are more extensively refurbished before being put back on the market.

Key Process: Refurbishment

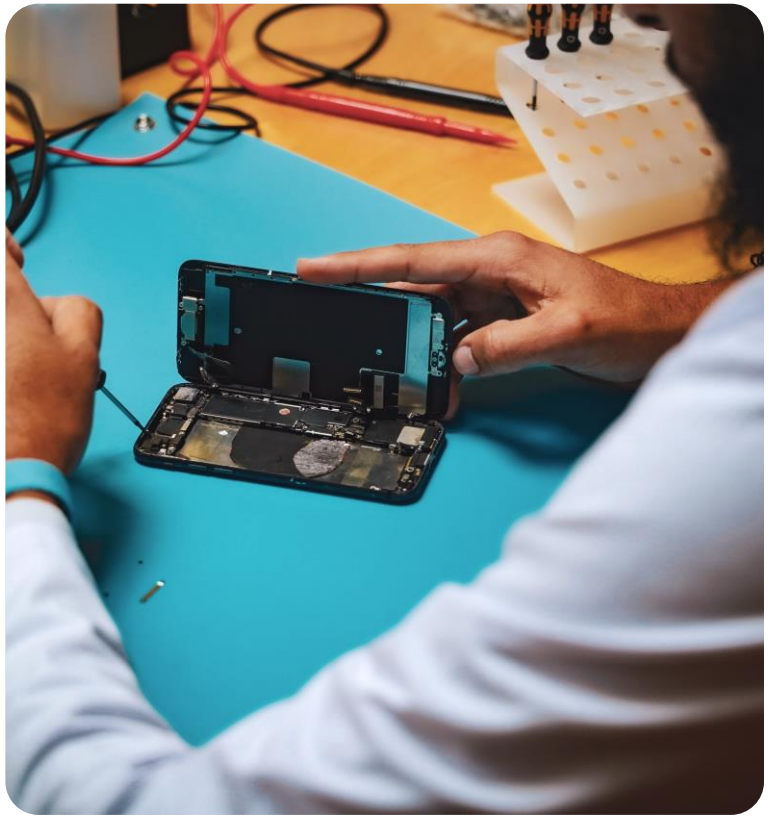


Image provided by Recommerce Solutions SA.

Step 2
Repair

If devices have technical defects - such as broken screens or depleted batteries - faulty components are repaired or replaced.
In Germany, many major service providers perform authorized repairs in line with OEM standards, using original components and following official guidelines. This may be required by OEMs or partners and helps maintain remaining warranty coverage. In some cases, defective parts are returned to OEMs for remanufacturing. OEM policies vary regarding the use of second-hand spare parts. Some permit them, while others do not.
In contrast, non-licensed repair providers can operate more flexibly - using refurbished or third-party parts, depending on customer agreement (see also user-initiated repair).

Step 3
Aesthetic Restoration

Cosmetic improvements are made to restore the visual condition of the device. This includes polishing screens, refinishing surfaces, or recoating where needed.

Step 4
Testing and Quality Assurance

After refurbishment, devices undergo final testing to ensure performance and safety requirements are met. The results are documented, and in some cases, the refurbishment process is certified.

Step 5
Packaging and Preparation

Refurbished devices are packaged for resale, ideally using the original packaging when available. To minimize waste, accessories like chargers or cables are offered optionally rather than included by default.

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To scale the circular economy, device recirculation must be seamless - through attractive trade-in programs, efficient refurbishment, and diverse resale channels. The biggest lever lies in matching each device with the right customer, which requires strong collaboration with resale partners across different markets.

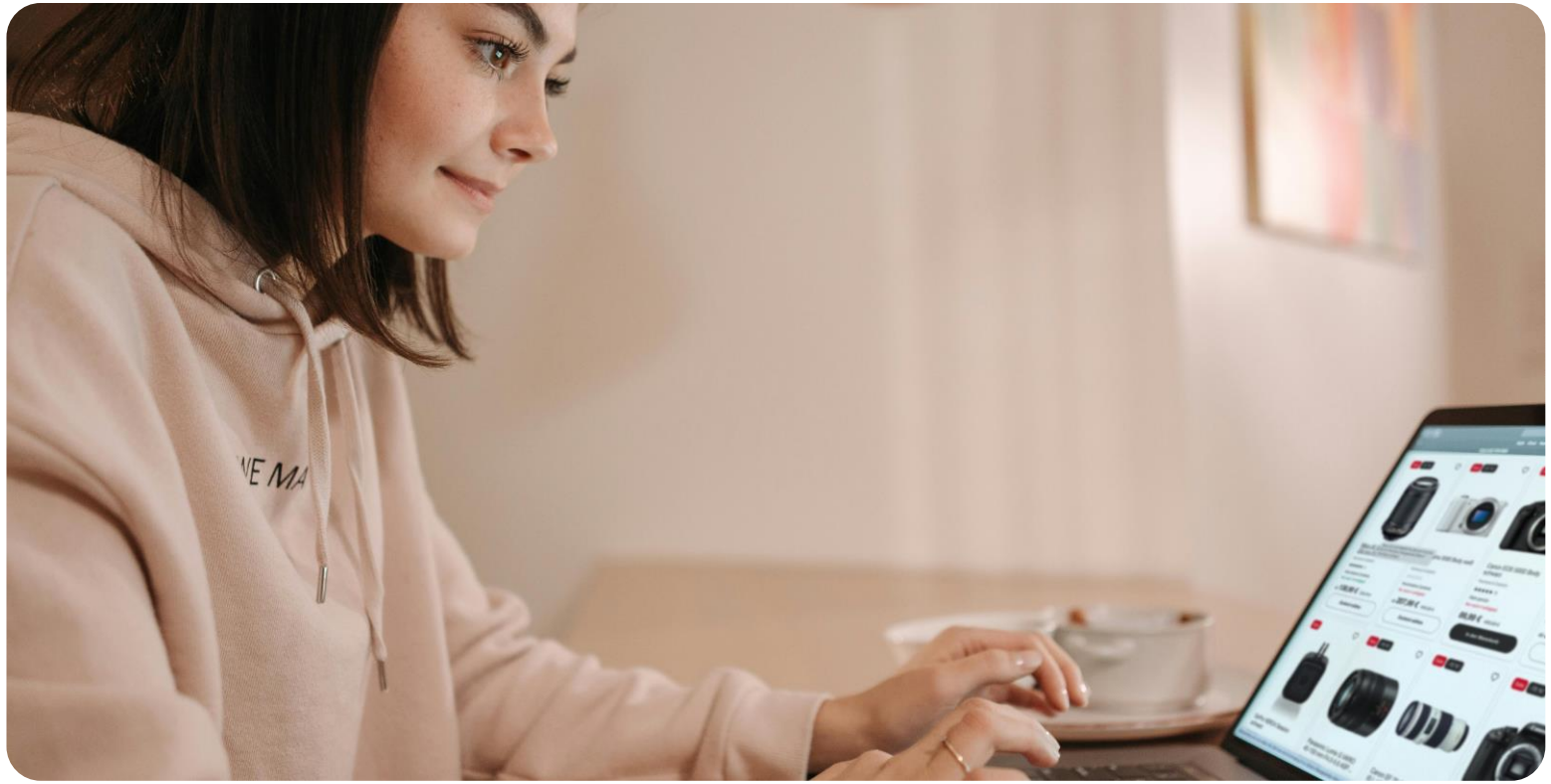


Adrien Serres, Country Manager Germany
Recommerce Group

Key Process: Resale

Once devices have passed data deletion, grading and, where applicable, refurbishment, they are redistributed through a variety of sales channels. The objective is to match each device to the most suitable customer while maximizing resale value. The chosen path depends on factors such as the device's condition, market demand, resale value, and customer type. Devices can either be prepared individually for sale, e.g. via own platforms or traders, or bundled for wholesale bulk distribution. In practice, most providers operate across multiple channels simultaneously - selling via their own platforms, third-party marketplaces, and global wholesale networks.

Finding the right customer for a particular device is key for maximizing its use. This requires a multi-channel re-sale strategy.



Key Process: Resale

Option 1
Resale via Proprietary Platforms and Channels

Many second-hand resellers operate their own dedicated online platforms to retain control over pricing, quality, and customer experience. Providers like rebuy and Recommerce Group sell refurbished devices directly to both private and business customers (B2C and B2B). In contrast, circulee focuses exclusively on B2B customers, offering professionally refurbished devices tailored to the needs of companies.
Technology providers such as Foxway and Ingram Micro Lifecycle also operate their own sales platforms. Foxway offers refurbished devices through its proprietary B2B and B2C platform, while Ingram Micro Lifecycle operates Renugo - a B2B auction platform where resellers and business buyers can bid on used devices. IT system integrators like Computacenter don't serve private customers directly but resell refurbished hardware to large corporations or institutions. Some OEMs, such as Apple, HP, and Lenovo, offer their own certified refurbished devices via their shops, websites or through authorized partners.

Option 2
Resale via Third-party Marketplaces

To extend their reach, many resellers also rely on third-party platforms. Device as a Service (DaaS) platforms, as well as IT system integrators like Computacenter, use external marketplaces such as Refurbed, Back Market, MediaMarkt Marketplace, Idealo, and notebooksbilliger to sell devices. These platforms provide infrastructure, visibility, and customer support - helping professional resellers connect with end customers more efficiently.

Option 3
Resale via Intermediaries and Global Networks

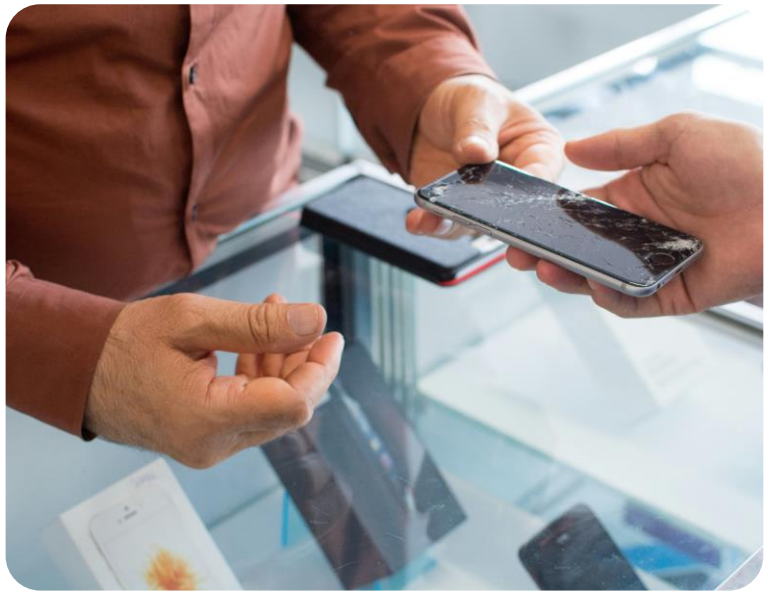
A vast international network of intermediaries, brokers, and exporters enables the global redistribution of used electronic devices. Devices are routed to the most suitable markets based on their condition and demand. Important players in this space include regional trade-in providers and platforms such as Northladder - active in over 10 EMEA countries (Northladder, 2025) - as well as lifecycle management companies like Assurant, Ingram Micro Lifecycle, and Foxway.

Global distributors such as Alchemy (operating in over 60 countries, trading 9 million devices annually) and PCS Wireless (active in over 80 countries, with around 10 million devices traded each year) play a key role in moving large volumes of devices internationally (Alchemy, 2025-1; PCS, 2021). Alchemy, for example, runs Callisto, a global B2B online platform connecting over 3,000 wholesale buyers and sellers (Alchemy, 2025-2).

Higher-grade devices can typically be resold within Germany or neighboring European markets where demand for A-grade devices is high. Lower-grade devices tend to move from developed markets such as Europe and the U.S. to emerging regions - including Eastern Europe, Asia-Pacific, South America, and Africa - where affordable technology is in high demand. In destination markets, local wholesale and retail distributors handle the final sale to end users.

Key Process: User-initiated Repair

User-initiated repair refers to any repair carried out by the device owner - whether an individual or a business - during the regular use phase of the device. It does not include repairs conducted as part of professional refurbishment within another circular business model.



When a device breaks, users may decide to repair it rather than replace it. The repair pathway depends on the warranty status and whether the device is insured:

- If the device is still under warranty, the manufacturer typically organizes and covers the repair.
- If the warranty has expired, users must pay for the repair themselves.
- If the device is insured, repair costs may be covered. Insurance can be arranged through the OEM (such as AppleCare), retail stores like MediaMarktSaturn (which works with insurers such as Zurich or Starr Europe), or through large insurance providers like Assurant.

For out-of-warranty repairs, users can choose among several options:

- Visiting a retail store
- Using an OEM-authorized repair center
- Going to an independent repair shop

The choice usually depends on the severity of the damage. Common issues - such as screen replacements - can often be resolved quickly at local repair shops, while more complex problems may require sending the device to a specialized service provider.
For example, MediaMarktSaturn handles minor repairs in-store, while more extensive repairs are performed by certified partners.

There is also a wide network of independent local shops offering fast repairs for common device types. Additionally, some users choose to repair their devices themselves, provided they have the required tools and skills. Repair platforms like IFIXIT support this by providing spare parts, tools, and step-by-step instructions.

Some companies focus specifically on supporting the repair ecosystem. FixFirst, for example, offers business-to-business services including AI-powered repair software, workflow management, integration with manufacturers and retailers, and tools to source spare parts more efficiently.

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To make repair more convenient and affordable for customers, we need to replace manual steps with automation, simplify decision-making through data, and empower repair providers with effective tools. There's huge potential - current processes could be up to 70% more time-efficient.



Sebastian Daus, Co-Founder & CEO
fixfirst.io

Circularity

Circular Impact Logic

3.1 Impact-logic of Circular Business Models
3.2 A Note on Impact Levers for CBMs

“

The core idea of circular business models is to keep products and extracted resources in circulation for as long as possible through reuse (therefore circulation), minimizing waste, emissions and other negative impacts on health or environment, and regenerate nature.

Adapted from Ellen MacArthur Foundation (EMF, 2024)

3.1 Impact Logic of Circular Business Models

According to the waste hierarchy, an effective way to reduce environmental effects of products is to prioritize reuse over recycling or disposal. Reusing products - rather than constantly producing new ones - means fewer products are needed to meet the same demand. This significantly lowers the environmental burden compared to the traditional linear consumption model, which serves as our baseline.

This report focuses specifically on the environmental effects during the use phase. That's why our analysis centers on the products themselves, not just the materials they contain. While material recovery through recycling remains an important strategy further down the waste hierarchy, reuse takes priority. It extends the lifespan of products and delays the need for new production entirely.

Active Use Time vs. Lifespan

We define active use time as the period in which a product is actually being used to fulfil its intended purpose. This is distinct from lifespan, which includes all time from production until end-of-life - including idle periods. For our analysis, we distinguish between frequently and infrequently used products.

For instance, a smartphone is typically used daily, so its active use time accumulates steadily. A digital camera, by contrast, may only be used during vacations or special occasions - meaning it spends much of its lifespan idle.

Re-use (prolonging and intensifying use) is the preferred lever for creating positive impact.

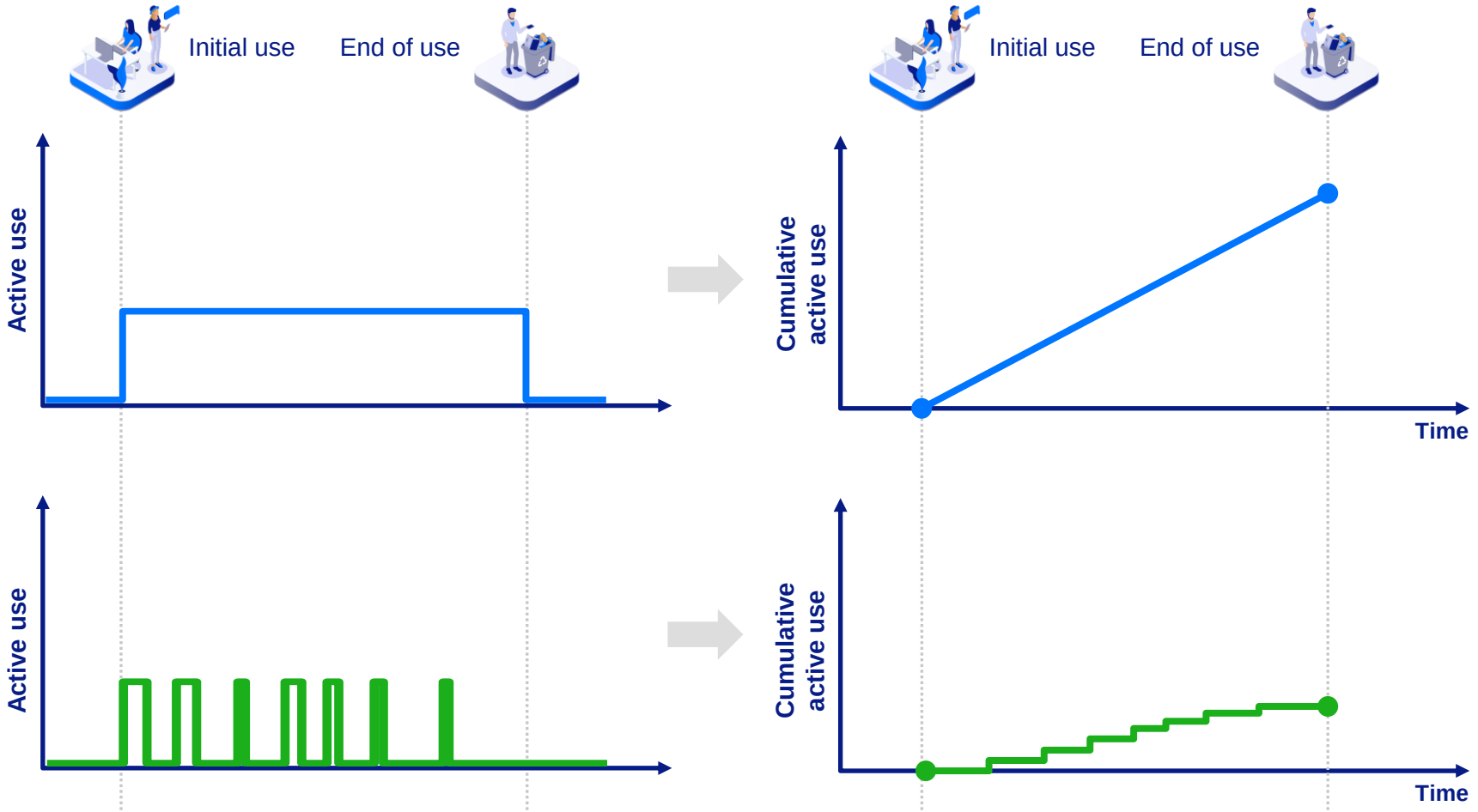
Illustration of Active Use Time of Devices for Frequently and Infrequently Used Devices

Frequently used devices are actively used continuously during their lifespan

Frequently used

Infrequently used devices are only occasionally in active use and remain idle for most of the use phase

In-frequently used



Frequently and Infrequently Used Devices

Less new devices are needed when lifetime can be extended or idle time reduced.



Frequently Used Devices

In a linear example, a user buys a smartphone, uses it daily for three years, and then discards it. In this case, three years of active use are generated. In a circular example, if the device is still in good condition after the first use phase, it is passed on to a second user - for example through second-hand resale - who uses it for another two years before it reaches end-of-life. The device then achieves five years of active use, instead of three.

As a result, in this case positive environmental impact is created by extending the total lifespan and thereby impeding the purchase of a new device by the second user.

Infrequently Used Devices

Infrequently used devices, such as digital cameras, accumulate very little active use time during their ownership. In a linear example, a digital camera might only be used for a period of four weeks per year - for example, during holidays - while sitting idle for the rest of the time.

In a circular example, a user only rents the camera when needed and returns it after each use. The same product can then be rented by multiple users within the same year, each for their individual high-use period. For example, the camera may be rented for five different vacation periods of four weeks each, accumulating 20 weeks of active use within one year instead of just four.

As a result, more active use time is generated from the same product over the same period. One device covers the needs of multiple users, reducing the need to produce additional products compared to a scenario where all users would buy and own their own camera.

Impact Logic of Second-Hand Sales

Impact logic of second-hand sales

Second-hand sale business models are based on acquiring idle products from users and bringing them back into circulation.

Although second-hand sales incur additional environmental effects (such as for logistics, grading, refurbishment, repair and redistribution) that would not exist in the linear consumption model, these activities are compensated, if the resale leads to sufficient additional active use. Resale models generate impact by prolonging the overall use time across multiple users. For infrequently used products, impact can in addition be generated if the product is used more intensively than before because the new user has a stronger need for the product, or if the product is resold frequently to only cover periods of intense use with each user (e.g. resale of a camera after the once-in-a-lifetime type holiday trip).

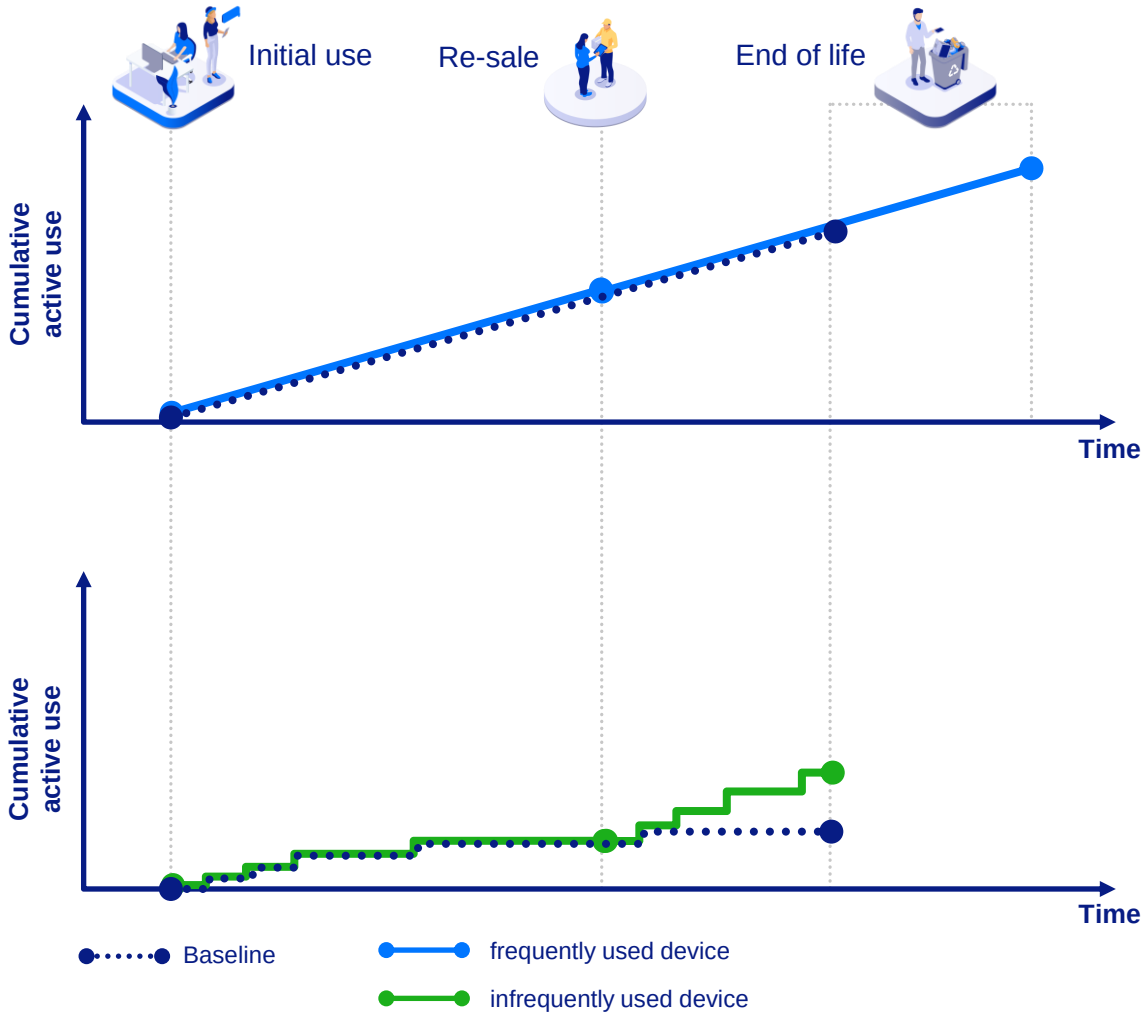
Ultimately, the second-hand model generates a positive impact when it leads to more actual active use time for a product compared to the linear alternative and compensates for additional environmental effects introduced by the circular model itself.

Active use time accumulates **every day** for as long as the smartphone is used. **Prolonging** the lifetime by resale to another user increases the total active use time.

Frequently used

Active use time accumulates **every time** the camera is used. **Intensifying** the use by resale to a user with more intense use increases the total active use time.

In-frequently used



Impact Logic of Rental

Impact logic of rental

Rental products typically enter the market as new or high-grade used products. Their distribution initially generates environmental effects similar to the linear model. Each rental cycle introduces additional environmental effects - for example, from shipping, packaging, cleaning, grading, and refurbishment. As with second-hand, these effects may be compensated by overall longer or more intensive product use.

For frequently used products, the rental model is environmentally beneficial if it leads to a longer overall lifespan across all users.
For infrequently used products, rental models are particularly impactful when they reduce idle time and enable higher utilization across several users.
In both cases purchases of new devices may be avoided.

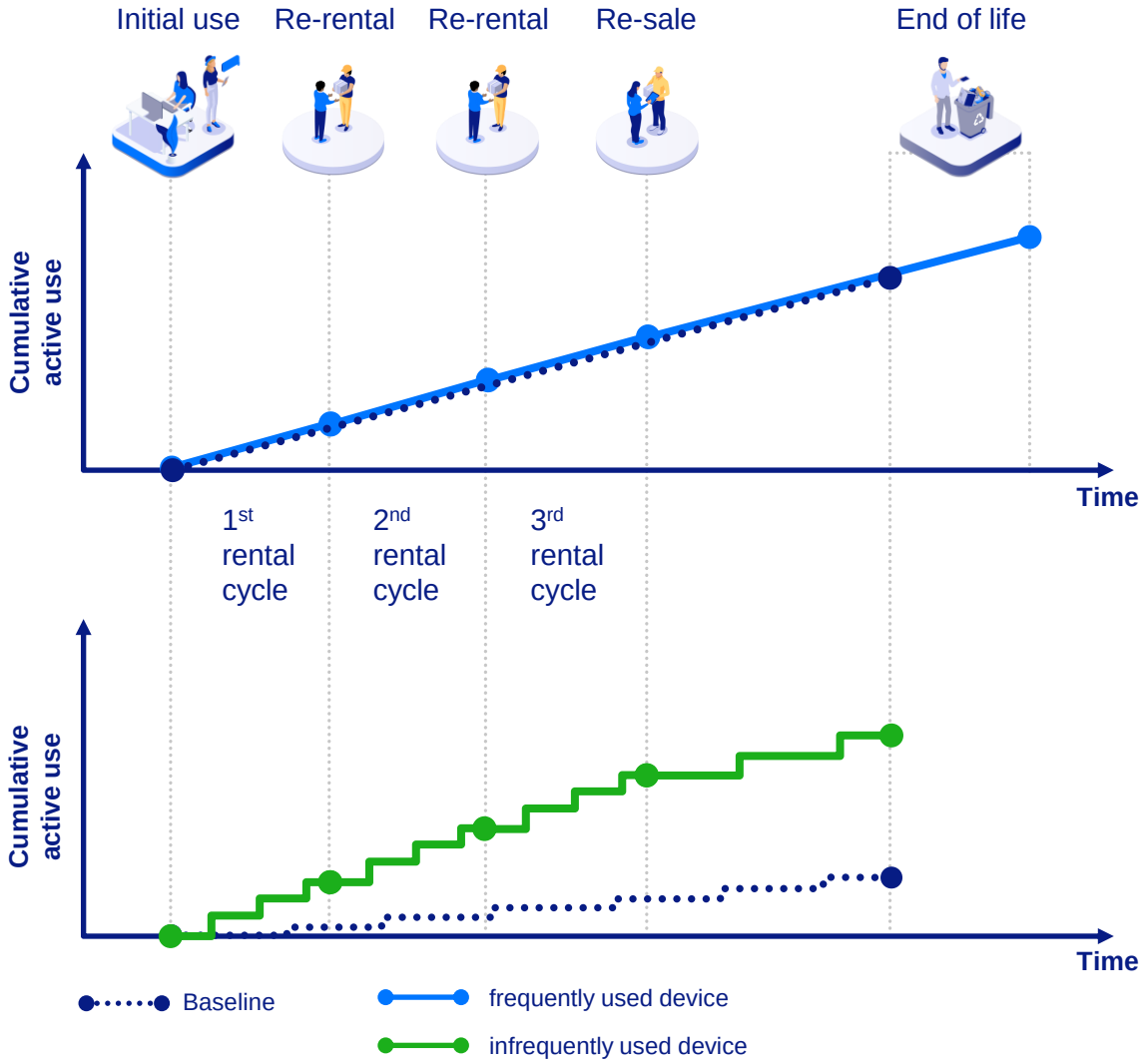
Additional emissions from circular processes - such as logistics, grading, refurbishment, and redistribution - make up just 2–3% of total lifecycle emissions and are quickly outweighed by the benefits of extended active use.

Active use time accumulates **every day** for as long as the smartphone is used. **Prolonging the lifetime** by rental and resale increases the total active use time.

Frequently used

Active use time accumulates every time the camera is used. **Intensifying the use** within a rental model increases the total active use time.

In-frequently used



Rebound Effects and Summary

Rebound effects may lower the positive impact

Rebound effects were explicitly investigated in the UNDRESS Circularity market report. The findings show signs of such rebound effects among private consumers in Germany:

- Users intending to resell their smartphones appeared to shorten the first use phase by 30–40%.
- 40% of respondents said they would upgrade devices more frequently through second-hand or B2C rental offerings.
- Around 20% indicated that second-hand availability could lead them to own more devices in total. This figure increased to 40% for rental offerings.

Rebound effects

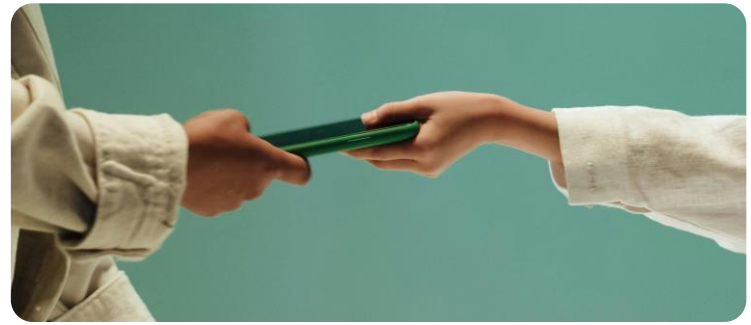
Rebound effects in circular business models refer to unintended increases in consumption that may offset the environmental benefits they are designed to generate. These effects can emerge when affordable second-hand or rental offerings change user behavior - by encouraging faster product replacement or access to additional products that would not have been purchased at full price in a linear model.

For example, attractive trade-in conditions can prompt users to sell functioning products earlier than they normally would, shortening the first use phase. Similarly, low-cost and flexible rental options may incentivize consumers to rent products they would not have bought otherwise, or to upgrade products more frequently.

These behavioral shifts can reduce the positive impact of circular business models and therefore must be accounted for in the assessment.

Summary

In summary, circular business models generate a positive environmental impact compared to linear consumption when they successfully increase the active use of products - either by extending their lifespan or by raising their utilization - and when these benefits outweigh the additional environmental effects associated with circular activities (such as refurbishment and redistribution), as well as any rebound effects triggered by the model itself.



3.2 A Note on Impact Levers for CBMs

As part of the project, we have started to collect the critical levers that can significantly influence the positive impact of CBMs:

Business Model Levers: Inherent design choices such as flexible rental durations, guaranteed device collection, integrated maintenance services, and trade-in incentives prevent idle time, ensure devices stay within circulation loops, and promote efficient redistribution.

Operational Levers: Measures such as preventive refurbishment, second-hand procurement, dual-use strategies, resale channel diversification, and proactive spare parts harvesting extend product use phases and improve the durability and availability of devices.

Customer Behavior Levers: Marketing the positive impact of circular models, offering warranties and repair insurance, educating users on product care, and ensuring professional service quality can influence user behavior toward more responsible product use.

Systemic and Policy Levers: Broader conditions—such as design for longevity, accessible and affordable repairs, availability of spare parts, fiscal incentives, harmonized EPR schemes, and improved export and trade transparency—play a critical role in shaping the success and scalability of CBMs.

While we do not discuss these levers in this report to limit the scope, they represent the basis for future work. Their effectiveness will depend heavily on operational execution, stakeholder collaboration, and supportive policy frameworks.
Further research, data collection, and sensitivity analysis will be crucial to better understand their relative contributions and optimize the design of circular business models for maximal environmental benefit.



How much impact does a circular business model create?

We have seen how circular business models operate and how they may create impact. Now we want to address the key question of this report: How much impact do they generate and how do we quantify it? To ultimately answer this question, we have developed the Circular Business Model Impact (CBMI) methodology, which we will introduce in the next chapter.

Circularity

Impact Measurement

4.1 Frameworks for Impact Assessment Status Quo – Overview and Motivation
4.2 CBM Impact Methodology
4.3 Case Study Results of the CBM Impact Methodology

Some well-established and rigorous impact assessment methods exist. However, evaluating the real-world usage patterns of circular business models remains a challenge. This report introduces a previously missing piece of the puzzle: a dedicated circular business model impact assessment methodology (CBM Impact methodology) that builds on and complements existing frameworks. The core focus lies on evaluating changes during the actual use phase, which is central to determining the environmental performance of circular business models.

4.1 Frameworks for Impact Assessment Status Quo - Overview and Motivation

At the company level, environmental reporting centers on overall sustainability performance, framed by Environmental, Social, and Governance (ESG) criteria. One key component is Greenhouse Gas (GHG) reporting, which categorizes emissions into Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), and Scope 3 (all other indirect emissions across the value chain, including product use). The GHG Protocol is the most widely used standard for measuring, managing and reporting GHG emissions across corporate operations, value chains and products. The scope 3 standard also includes emissions associated with the use phase of products, but does not account for variations through different usage patterns induced by circular business models, for example.

Another key issue is the lack of consensus on how to allocate emissions from production across multiple use cycles. Currently, the most widely used approach is the cut-off method, which allocates all production-related emissions to the product's first use phase, assigning zero environmental burden to subsequent uses (GSMA, 2025). Comparing emissions from refurbishment and resale activities with those associated with the production of a new device insinuate savings of up to 87% - however this does not represent a full-system view or incentivize the collection and longer use of devices from a first user perspective (Poppe et al., 2024).

Overview of existing Frameworks and Motivation

Under current standards, extending a product's use phase may even increase reported Scope 3 emissions due to the energy consumption of the device, without capturing the actual environmental benefit of avoided emissions by lowering demand for new production. Hence the question remains, how standards can account for the positive impact of changes in the use phase.
The Ellen MacArthur Foundation has called for updates to GHG reporting standards to fairly reflect circular practices - especially the allocation of upstream emissions over multiple users (EMF, 2025).

In the Circular Economy realm, the Circular Transition Indicators (CTI) are another widely applied company-level tool that seeks to assess the impact of circular business activites. Developed by the World Business Council for Sustainable Development (WBCSD), CTI enables businesses to measure circularity through the lens of material flows, helping to assess how effectively resources are being recirculated (WBCSD, 2024). While the optimization of product use phase through circular approaches is measured by an indicator, intended impact of changes in consumer behavior, unintended rebound effects, as well as effective use phase environmental impacts, are not quantified.

At the product level, Product Carbon Footprints (PCFs) and Life Cycle Assessments (LCAs) offer detailed analyses of environmental effects across a product's lifecycle - from raw material extraction to end-of-life. These approaches are recommended by organizations such as WBCSD and the World Resources Institute (WRI), and are guided by ISO standards 14040/44 (WBCSD, 2023; Russel, 2019; ISO, 2020). For instance, the total lifecycle emissions of an iPhone 16 are estimated at roughly 56 kg CO_2-equivalent (Apple, 2024).

In LCAs, the use phase plays a central role. However, many PCFs and LCAs use theoretical standardized values for the use phase in their calculations, which do not reflect how products are actually used - especially across multiple users and within circular business models (Bieser, 2023). This creates a gap in capturing the full impact of circular strategies.

Finally, simplified calculations are sometimes used to asses the positive impact of rental and second-hand offerings, in which a direct replacement of a new device is assumed (e.g. one rental cycle or one second-hand purchase replaces one purchase of a new device). However, while the use of devices may be extended, assuming a doubling of lifetime is too simplistic.

With UNDRESS Circularity, our goal is to bring transparency to the often-overlooked use phase impacts of CBMs and provide a method that actively accounts for changes in the use phase induced by circular offerings.

We developed a new data-driven methodology for assessing the impact of CBMs together with Fraunhofer IZM, Systemiq and 12 industry partners actively operating CBMs. In order to illustrate the workings and insights generated with this method, we present a detailed case study for the consumer electronics industry in this report.

The CBMI method enables a data-driven deep dive into the use phase, serving as a complement to established assessment frameworks such as the GHG Protocol, Circular Transition Indicators (CTI), and Life Cycle Assessment (LCA).

Our CBM Impact methodology focuses on the product use phase and adds a critical missing puzzle piece to existing impact assessment frameworks

CBMI Methodology: Focus on Avoided Emissions



Image provided by Everphone.

In the context of circular business models, we focus on accounting for avoided emissions - that is, the greenhouse gas emissions that are prevented by offering circular alternatives, compared to what would have occurred in a conventional, linear scenario.

The Avoided Emissions Framework developed by the WBCSD offers companies a structured approach to estimate and report emissions reductions that occur outside their direct operations, such as through more efficient or circular solutions. It provides comprehensive guidance on how to assess, calculate, and disclose these avoided emissions.

The CBM Impact methodology enables circular businesses to track and optimize avoided emissions

In the development of CBMI, we drew on key principles from this framework to develop a methodology specifically designed to evaluate the impact of rental and second-hand business models.

To go beyond the scope of the existing avoided emissions guidance, we also incorporated rebound effects and unintended additional emissions due to circular offerings into our assessment - addressing one of the framework's current limitations.

The CBMI methodology follows the logic of consequential impact assessment based on avoided emissions, without making any claims regarding the allocation of avoided emission credits.

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The CBMI Method’s focus on the use phase of electronics is critical in ensuring that the full lifecycle of a product is considered, and a perfect complement to existing frameworks like the WBCSD Circular Transition Indicators.

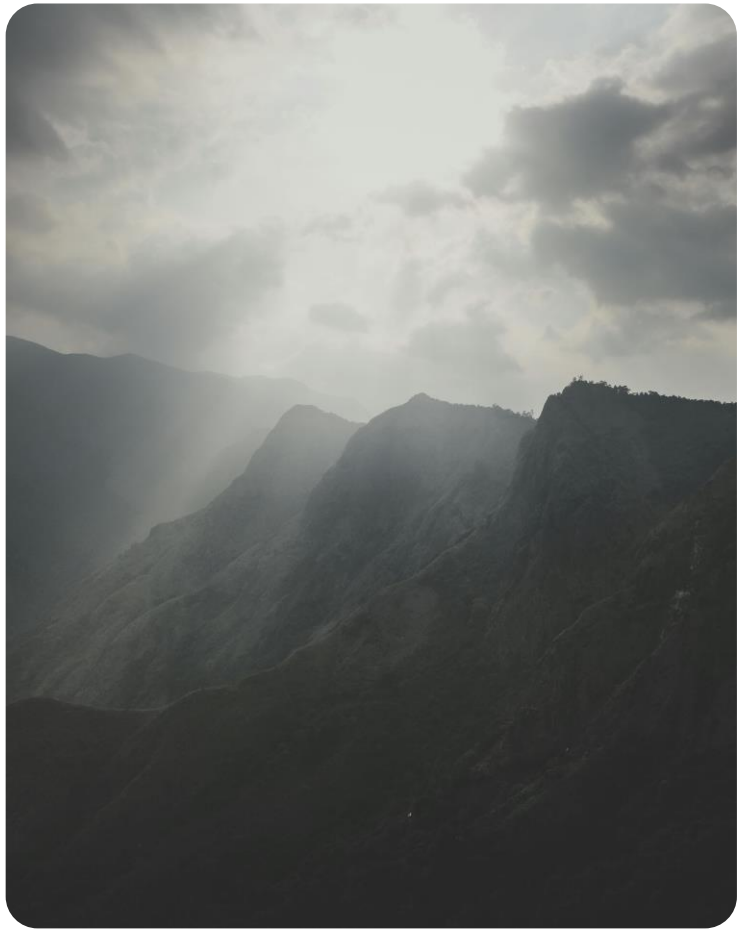


Daniel Reid,
Head of Circular Electronics Partnership

4.2 CBM Impact Methodology

Explained in simple terms

The CBM impact methodology assesses the environmental impact of circular business models such as resale and rental. It does so by defining scenarios - each representing a specific combination of business model, product type, and customer group - and analyzing how long and how often products are actively used within these scenarios. The method also adds up the environmental effects occurring along the product journeys within the scenario. By comparing the total environmental effects and the total active use time of these circular scenarios to a predefined baseline - typically a linear consumption model - we can assess the positive impact that a business model delivers, such as reducing emissions or conserving resources. The lower the sum of the environmental effects per year of use, the better the environmental performance. The methodology places particular emphasis on the use phase, as this is often the most decisive factor in determining a business model's overall impact.



Selection of Indicator for Environmental Effects

Preface on Environmental Measures – Global Warming Potential

A comprehensive assessment of the impact of circular business models involves comparing their total environmental effects to a linear baseline. The impact relevant categories include, among others, climate change, ozone depletion, various forms of human and ecotoxicity, air and water use and pollution, radiation, and the depletion of different resources. (EC, 2017)

In this report, we focus on Global Warming Potential (GWP) as the primary environmental indicator, expressed as tonnes of CO2 equivalents. The GHG Institute (2024) defines GWP as:

"Global Warming Potentials (GWPs) are a quantified measure of the globally averaged relative radiative forcing impacts of particular greenhouse gases in the atmosphere relative to Carbon Dioxide as the reference gas."

GWP is commonly used to assess value chain activities - such as production, logistics, and use phases - based on their contribution to climate change. This focus reflects established practice in both academic research and corporate sustainability reporting, for several key reasons:

- Standardization and comparability: GWP is one of the most commonly used and standardized indicators, making it a strong reference point for benchmarking and comparison.
- Alignment with climate goals: GWP directly relates to international climate targets and decarbonization strategies.
- Integration with LCA: GWP is fully embedded in Life Cycle Assessment (LCA) methodologies, ensuring compatibility with other environmental reporting frameworks.

However, the CBM Impact methodology presented in this report can be applied to measuring other environmental indicators with equal effectiveness. At every step of the assessment, environmental effects may also be measured in terms of generated waste, resource extraction, or other relevant metrics - depending on the chosen focus and available data.

In our report we use Global Warming Potential to assess the impact.
The method can equally be used for equivalents of resource savings, waste avoidance or other metrics.

CBMI Scenario Definition and Analytical Basis of Core Metric

CBMI Assessment with Focus on the Use Phase

The first step of the CBMI methodology is to model product journeys within the scope of the business model and draw a corresponding system map. The map needs to be tailored to the relevant user groups and product categories. Each unique combination of business model, product type, and customer group is referred to as a scenario. For example, a rental model for smartphones used by business customers would constitute one scenario.

We always define at least two scenarios:

- A baseline scenario, typically representing linear consumption
- A circular scenario, such as a smartphone rental model for B2B customers, for which the impact is to be assessed

Each scenario includes all steps of the product journey - from production through distribution, use, potential refurbishment or resale, to end-of-life treatment - ensuring a complete picture of the product's lifespan.

We assign a Global Warming Potential (GWP) value to each value chain step. For example, all emissions associated with manufacturing are allocated to the step "Production", while energy consumption is assigned to the corresponding use phases.

Where product pathways diverge (e.g., a device may be sold or discarded after use), we incorporate probabilities to reflect the likelihood of each outcome. For instance, we account for the share of devices that enter the second-hand market after a rental cycle.

During each use phase within the scenario, we track the active use time, defined as the period the device is actually in use (not idle). Multiple use phases - for example, two rental cycles followed by resale and ownership use - are added together to calculate the total active use time.

The result for each scenario is a pair of key indicators:

- Total active use time over the product lifespan
- Total GWP across all life cycle stages

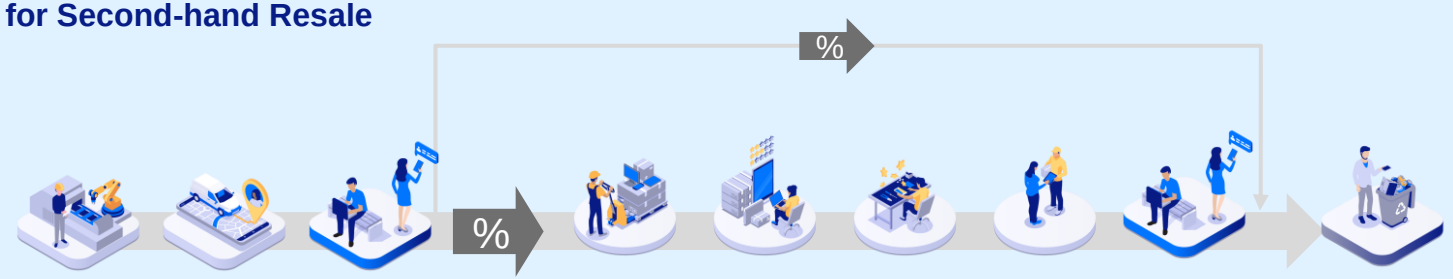
From these, we derive the **yearly GWP per active use**, which serves as the central metric for comparing scenarios and evaluating the environmental impact of circular business models.

CBMI captures active use time and GWP across the full product lifecycle for linear and circular product journeys. The central metric is GWP/active use.

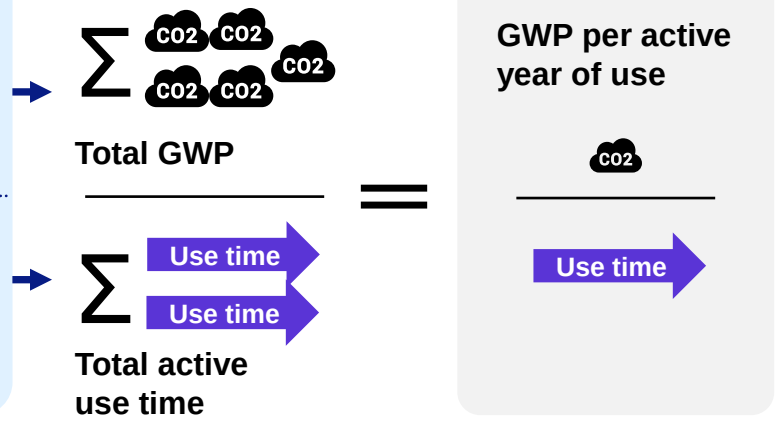
Development of Core Formula for Impact Calculation

Circularity

Example for Second-hand Resale



CBMI Assessment with Focus on the Use Phase



Assessment of the Calculation Results

Comparison of Circular Scenario with Baseline

In the second step, we compare the yearly GWP of the circular scenario - such as business rental for smartphones - with that of the baseline scenario, typically a linear product journey.

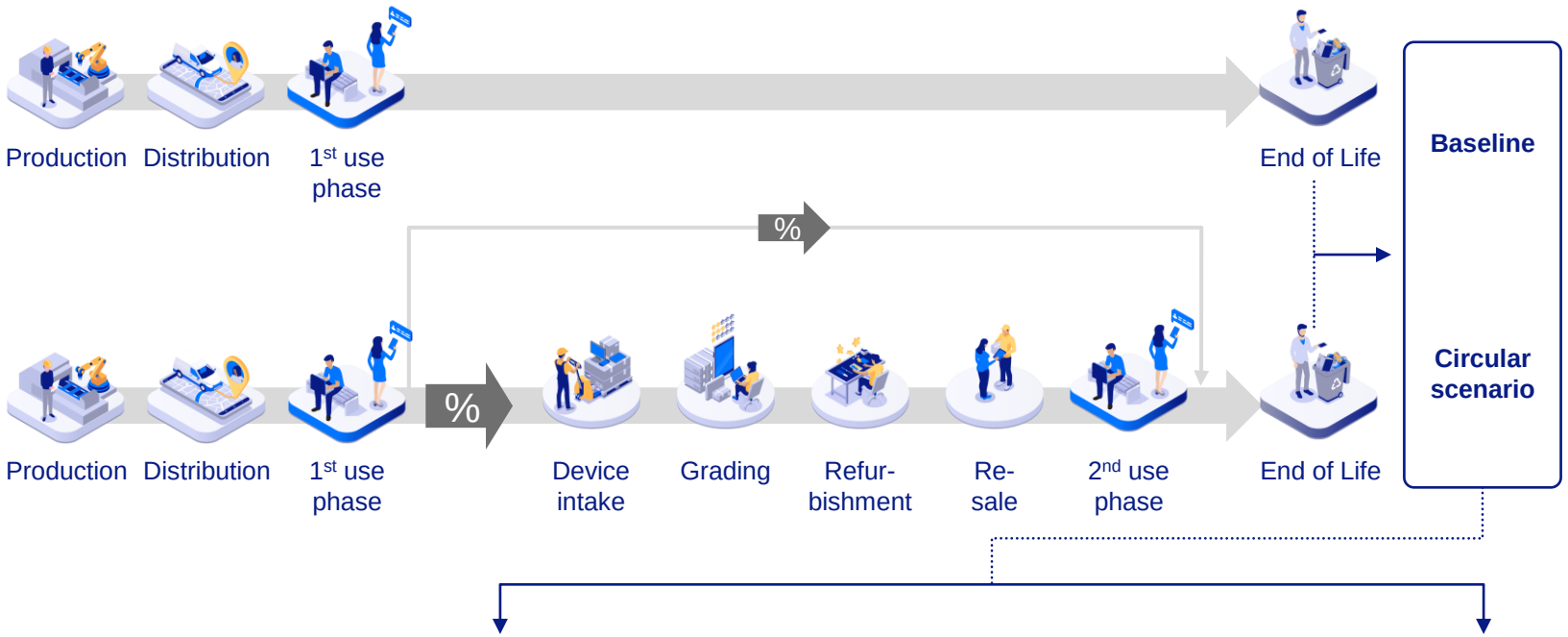
The difference between the two values reflects the environmental impact of the circular business model. The larger the annual savings in GWP generated by the circular scenario, the greater the positive environmental impact of the model. The annual emissions savings inherently account for the avoidance of new products compared to the linear model.

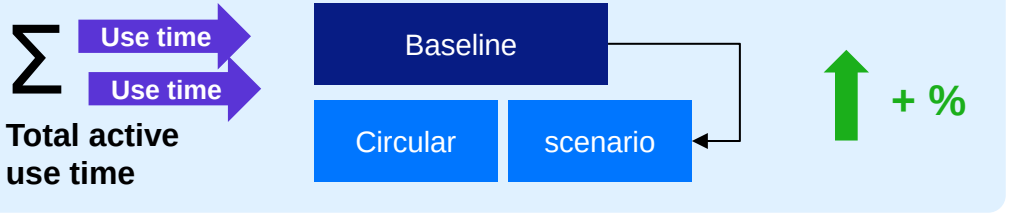
This measure allows us to quantify how effectively a circular business model reduces GWP over the entire product lifecycle compared to conventional consumption.

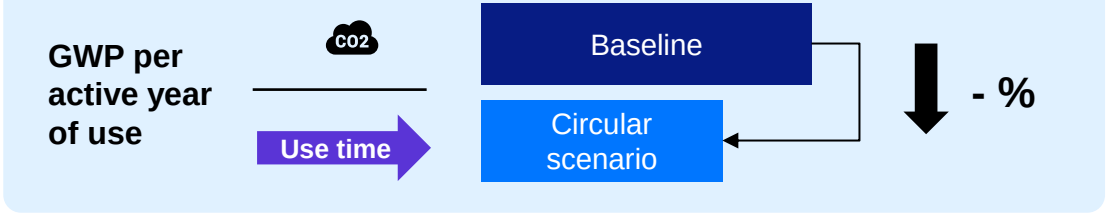
CBMI compares circular and linear scenarios to quantify annual avoided emissions.



Distilling the Calculation Results into the Core Metric for Impact Assessment







Comparison of Circular Scenario with Baseline

To better understand the environmental impact of circular business models, we apply the CBM Impact methodology across three analytical levels: the business model level, the product level, and the market level. Each level offers a different lens - ranging from individual product journeys to system-wide market dynamics - allowing for both detailed and aggregated insights into circular performance.

Three Distinct Levels for Analysis

Business model Level

The CBMI methodology is primarily applied at the business model level, where we assess the environmental impact of a complete circular business model scenario. This includes all relevant product journeys that take place within the model with a probability assigned to each product journey (corresponding to its likelihood based on company data). For example, in a second-hand scenario, first users may keep their devices for varying durations; some devices are refurbished and resold, others are not. Second users again use the devices for different periods before discarding them. These varying device journeys are modeled using data-driven parameters such as average first and second use durations and the actual share of devices entering second use - based on real company data and surveys. At this level, we compare the circular business model to a baseline (e.g., linear consumption) and calculate the resulting impact in terms of active use time or global warming potential (GWP).
Hence this perspective allows to compare specific business model strategies, do sensitivity analysis on individual parameters of the business model to identify levers for improvement, or simply assess the present business model practice.

Product Level

Beyond the business model analysis, the methodology also supports product-level impact assessments by isolating specific product journeys. This is done by setting the probability of one specific device journey to 100%, following one product through its full path - from production to end-of-life. For example, a smartphone might be purchased by one user, then resold as a refurbished device to a second user and eventually discarded.
This perspective may help generate simple insights for consumer facing marketing or to inform sensitivity analysis, by eliminating the majority of parameters.

Market Level

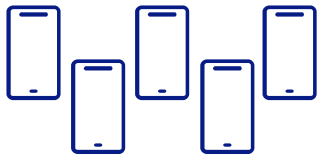
Finally, we can aggregate the business model results to the market level to estimate the overall impact of circular business model adoption for a defined market. This includes the distribution of products across different models - linear, rental, and second-hand - and their respective market shares. Based on assumptions about how these shares could evolve over time, we can calculate the total GWP of the market and assess the systemic contribution of circular business models to its reduction.
Analysis at market level permits companies to illustrate the motivation for operating a certain business model to their customers and investors by providing the „bigger picture“. It may also serve to inform policy making or other systemic measures or modeling initiatives.

Each CBMI level offers different granularity – from individual device journeys to system-wide shifts.

Three Distinct Levels for Analysis and a Note on Rebound Effects

Interpretation of Results

Business model level
Assess and benchmark your CBM or identify impact levers

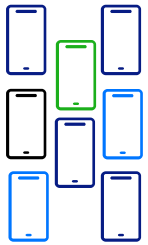


- Specific circular business model (e.g., rental or resale)
- Relevant product journeys within that model incl. probabilities, accounting for different user behaviors and outcomes



Product level
Generate simple messages and examples

- One specific product journey from production to end-of-life
- Illustrates direct active use time impact
- High accuracy due to limited assumptions



Market level
"Bigger picture" analysis for external stakeholders

- Market wide effects of circular business models
- Based on scenarios for market share distribution
- Limited accuracy due to multiple assumptions

Factoring in Rebound Effects

During the research for this study, we identified two main types of rebound effects in the context of B2C usage of electronics:

1. Shortened use durations triggered by circular offerings such as trade-in incentives or frequent rental upgrades. These effects are integrated into the assessment by using real-world usage durations as input parameters, derived from consumer surveys or company data.

2. Additional device access that would not have occurred without the circular offering. This is more challenging to incorporate. For instance, if rental models encourage users to access extra devices they would otherwise not have purchased, this added usage must be excluded from the calculation of total active use time, as it does not represent a substitution of new production but an increase in overall consumption.

A Disclaimer on Carbon Accounting & Allocation

A Note on Carbon Accounting and Allocation

There are various approaches to allocating a product's emissions across multiple use cycles, and perspectives differ widely. This holds particularly true for accounting of avoided emissions at the company level, which is not formally obligatory and less regulated.

A commonly applied method is the "cut-off" approach, where all production-related emissions are assigned to the first lifecycle only (GSMA, 2025). Under this logic, a reseller takes over a product with zero embedded emissions and accounts only for emissions arising from circular activities such as refurbishment and resale.

This report does not seek to resolve the question of how emissions should be distributed across companies or entities. However, it seeks to emphasize that different use phases within one product lifespan are interconnected - subsequent users and product journeys depend on the choices of earlier ones.

Importantly, the CBMI method does explicitly jointly consider the interrelated handprint and footprint of circular business models: the net avoided emissions that result from extending product use, compared to a linear alternative. When a circular business model replaces the need for additional new devices through more intensive or prolonged use of existing devices, these avoided emissions are captured across all use phases. The Global Warming Potential (GWP) is then distributed across the entire active use time of a product to reflect the full environmental performance of a particular business model, which is constituted of multiple use phases and interventions from several actors.

More Details in the Technical Report

An additional publication by the Fraunhofer IZM Institute provides a detailed technical reference for the CBMI methodology and data used in this project for calculating the case studies. It complements this report by offering in-depth explanations of the underlying assumptions, calculation methods, and data sources. (Proske, 2025)

To see practical examples for the application of the methodology and how it works, jump ahead into the step-by-step guide for practitioners (chapter 5)!

“

As investors committed to accelerating the transition towards the circular economy, we understand the value and importance of robust methodology for assessing the positive impact of circular business models. Having led the industry in impact assessment methodology since 2015, we are fully conscious of the complex nature of this assessment and appreciate the CBMI methodology from Circularity - it offers a practical, user-focused approach.



Nicola Keen, Operating Principal & Chief Impact Officer
Circularity Capital

4.3 Case Study Results of the CBMI Methodology

Having introduced the CBM Impact methodology, we now present selected case studies to illustrate insights that can be generated from it. Using blended data from twelve industry partners and the UNDRESS Circularity market report about the use phase of electronic devices, these case studies demonstrate how the methodology quantifies the environmental impact of circular business models such as second-hand sales and rental.

It allows us to answer the question *how much* positive impact circular business models generate for defined rental and second-hand scenarios. We present calculations for smartphones (frequently used) and gaming consoles (infrequently used) to assess the potential of the different impact levers: prolonging the use phase and increasing utilization. By analyzing both B2C and B2B customer groups for smartphones, we highlight potential differences in usage patterns between private and business users.



A Brief Disclaimer on the Cases

We do not represent a particular operator of a circular business model. We define our own scenarios and base them on realistic average data, assumptions derived from our surveys and expert input.
As practitioners, you can replace these inputs with your own company-specific parameters and assumptions in each case.

You'll find the step-by-step guide with detailed explanations of how to apply the CBM impact methodology - along with our specific assumptions for the case studies - in the following chapter 5.

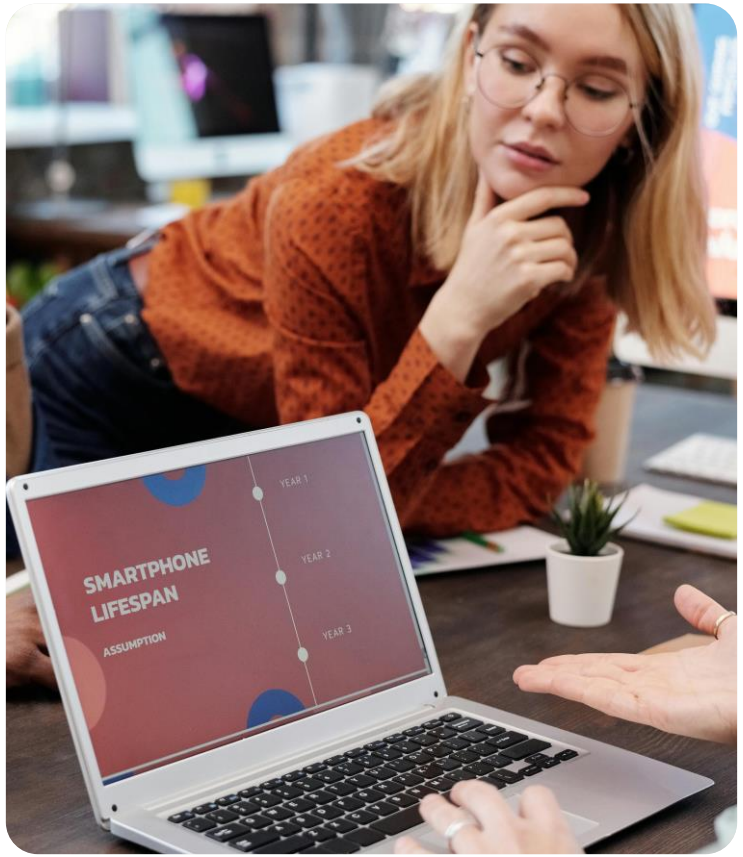
Case Study Definition and Scenario Selection

CBM Focus: Rental and Second-hand in B2C and B2B

At the business model level, we chose to assess the environmental impact of exemplary second-hand sales and rental models, based on averaged parameters from our industry data and market survey. We compare them to a defined baseline without the presence of these models in the market (to also include the effect of rebounds) and our theoretical limit scenario, which assumes the maximum technical lifespan.

Selected Level of Analysis

We start by looking at the business model level perspective to assess the different impact potentials between the two business models for frequently and infrequently used devices.
We then also illustrate case studies for product-level (B2B smartphones) and market level (optimistic CBM adoption scenario) analysis to demonstrate these capabilities of the CBMI methodology.



The Theoretical Limit

To give a fair assessment of the impact of circular business models, we have to consider the maximum extent to which they can actually prolong the use phase – i.e. the maximum technically feasible device lifespan. Here we assume a maximum smartphone lifespan of 8 years. Manufacturers typically indicate average lifespans between 2 and 8 years (Everphone, 2025) - but these figures reflect expected use rather than the absolute technical limit. We assume that 8 years is a technically feasible lifespan, also considering even longer reported use times in other geographies where devices are repaired more often. For gaming consoles, we assume a maximum lifespan of 10 years. These devices are typically designed to function for 5 to 10 years before factors like limited game availability or discontinued online support make them obsolete.

Definition of B2C Business Model Level Scenarios for Frequently Used Devices

B2C Rental and Second-hand for Smartphones

Baseline

The baseline reflects a linear consumption model. Our market research (report) showed that past and intended usage times of smartphones amongst private consumers averaged around 43 months. This usage is supplemented by a realistic 8% share of devices passed on through peer-to-peer transfers to a second life - without involvement from professional second-hand or rental providers. The baseline scenario therefore yields a total active use time of 46 months (43 months + 8% x 43 months) - resulting in annual emissions of roughly 17 kg CO_2e.

Rental

In the private rental scenario, 1-2 rental cycles generate about 18 months of active use time. After that 85% of the devices are thought to be reused. Second-hand users indicated in our market report that they used their second-hand devices for just as long as first-hand users, 43 months. Hence the total active use time for a typical rental scenario reaches 55 months (18 months + 85% x 43 months) - 17% higher than in the baseline scenario. The longer use time over two use phases increases the total active use and leads to annual emissions of 15 kg CO_2e, which is 11% lower than the baseline.

Second-hand Sale

Our market report indicated that first users kept their devices shorter (26 months vs 43 months), when they were able to resell them, e.g. through trade-in programs or professional platforms. In this scenario, we assume that 75% of devices are resold for a second use phase. The lower re-use factor reflects a more inhomogeneous quality of devices that are traded-in compared to those resold from rental programs. However, this factor can of course be much higher for individual companies who strongly select the devices they accept for resale. Based on our assumptions, the second-hand devices reach a total active use time of 58 months (26 months + 75% x 43 months). This leads to annual emissions of 14 kg CO_2e - 17% lower than the baseline.

Theoretical Limit

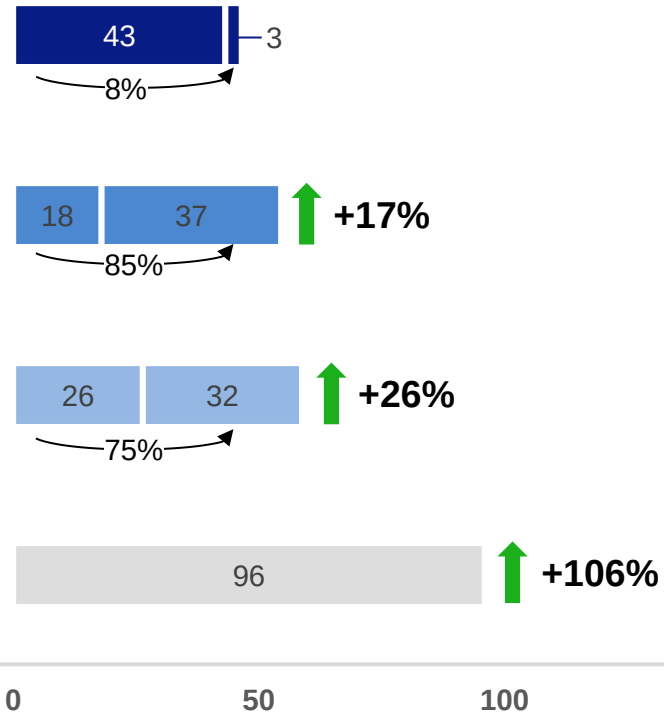
For comparison, we illustrated the theoretical limit at an active use time of 96 months, which would result in 9 kg CO_2e per year. The gap between 17 and 9 kg CO_2e per year is the possible range in which circular business models could reduce annualized emissions for smartphones with private users.

Results for B2C Business Model Level Analysis for Smartphones

For B2C smartphones, second-hand sales lead to the greatest increase in active use and the largest reduction in annual GWP. Extending the lifespan has the strongest impact, as utilization rates are already very high. The impact could grow even further if more devices were transferred to second use

B2C Rental and Second-hand for Smartphones

B2C



Scenario	Scenario Assumptions	GWP/year (kgCO2e) Based on active use time
Baseline	• First use phase of 43 months • Small fraction of devices repaired • 8% of devices privately given to 2nd user • 2nd use phase of 8% x 43 months (3 months) • **Σ 46 months total active use**	17 kgCO2e
Rental	• 1–2 rental cycles (18 months in total) • 85% of devices prof. re-sold • 2nd private use of 85% x 43 months (37 months) • **Σ 55 months total active use**	15 kgCO2e, -11%
Second-hand Sale	• First use phase of 26 months (rebound effect from trade-in) • 75% of devices prof. re-sold • 2nd private use of 75% x 43 months (32 months) • **Σ 58 months total active use**	14 kgCO2e, -17%
Theoretical Limit	• Full utilization for maximum technical product lifespan • **Σ 96 months total active use**	9 kgCO2e, -47%

Definition of B2B Business Model Level Scenarios for Frequently Used Devices

B2B Rental and Second-hand for Smartphones

Baseline

In the linear business scenario, devices reach a combined active use time of 55 months (see product level analysis below for details on use times), leading to annual emissions of approximately 14 kg CO_2e. This represents a 28% longer active use time compared to the private use baseline of 43 months, reflecting the tendency of business users to keep and utilize company-owned devices for longer periods than private consumers.

Rental

In the business rental model, devices are used for a total of 70 months - about 26% longer than in the baseline. This results in reduced annual emissions of 12 kg CO_2e, or 16% less than the baseline.
Recent data shows that companies' interest in long term (> 36 months) rental of smartphones is increasing. This demonstrates the strong appeal of rental models and their associated services to businesses.

Second-hand Sale

With a total active use time of 73 months, the second-hand scenario achieves the lowest annual GWP at 11 kg CO_2e - representing a 20% reduction compared to the baseline. This outcome reflects the combination of typically longer business use in the first phase with an added second use phase in the private segment, with the total benefit strongly depending on the share of devices that can be successfully resold.

Theoretical Limit

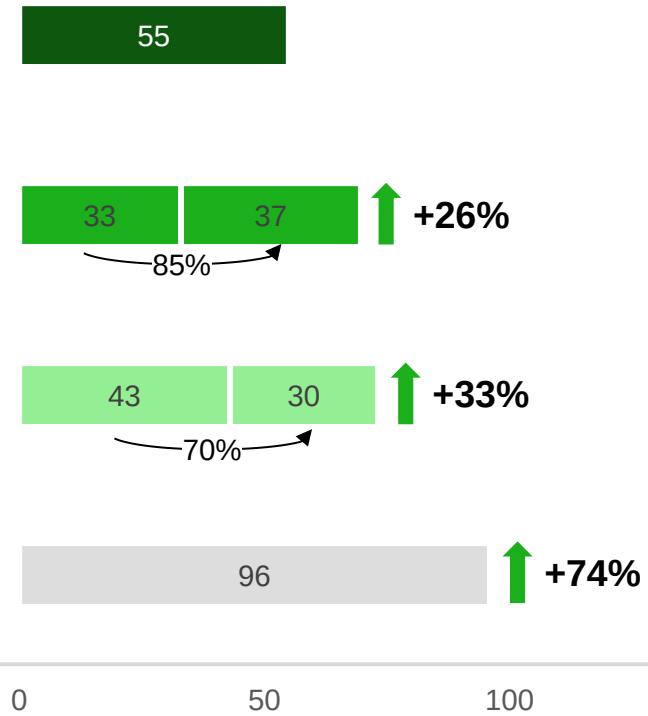
For comparison, we illustrated the theoretical limit with active use time of 96 months and 9 kg CO_2e per year. The gap between 14 and 9 kg CO_2e per year is the possible range in which circular B2B oriented business models can reduce emissions and generate impact.

Results for B2B Business Model Level Analysis for Smartphones

For B2B smartphones, second-hand sale also achieves the highest increase in active use and reduction in annual GWP, however closely followed by business rental. Both approaches could further increase their impact, for example, if more devices are transferred to second use and rental durations are extended.

B2B Rental and Second-hand for Smartphones

B2B



Scenario Assumptions

- Single business use phase
- Baseline, most common scenario for companies (~70%)
- **Σ 55 months total active use**

- 1 company rental cycle à 33 months
- 85% of devices prof. re-sold
- 2nd private use for 85% x 43 months (37 months)
- **Σ 70 months total active use**

- First use phase of 43 months (rebound effect of trade-in)
- 70% of devices prof. re-sold
- 2nd private use for 70% x 43 months (30 months)
- **Σ 73 months total active use**

- Full utilization for maximum technical product lifespan
- **Σ 96 months total active use**

GWP/year (kgCO2e)
Based on active use time

14 kgCO2e

12 kgCO2e -16%

11 kgCO2e -20%

9 kgCO2e -45%

Definition of B2C Business Model Level Scenarios for Infrequently Used Devices

B2C Rental and Second-hand for Gaming Consoles

Baseline

In the linear baseline scenario, the gaming console is owned for 46 months but only actively used about a third of the time - resulting in 15 months of total active use. If we consider that about 9% of devices are privately handed on for a second use phase, the baseline scenario yields a total active use time of 16 months, with annual emissions of around 151 kg CO_2e. This relatively low active use time - despite a longer ownership period - reflects the low utilization typical of infrequently used devices like gaming consoles, which are often kept for years but only used occasionally.

Second-hand Sale

Similar to smartphones, the rebound effect of having access to resale opportunities shortens the first use time of gaming consoles to about 9 months. Assuming 75% of devices are resold to a second user, the total active use time reaches 20 months (9 months + 75% x 15 months) - 20% more than the baseline - resulting in annual emissions of 138 kg CO_2e, a 9% reduction. While utilization remains comparable to private ownership, the second-hand model increases total usage by adding a second use phase.

Rental

In the private rental scenario, devices are rented two or three times and accumulate about 12 months of active use within a period of approximately 26 months. Thereafter, 85% of devices are sold for reuse adding another 15months of active use, resulting in a total active use time of 25 months (12 months + 85% x 15 months) - 51% more than in the baseline. This improvement stems not only from longer total use time across two to three rental cycles and following resale but also from higher utilization during rental periods, where the device is used more intensively than in private ownership. As a result, annual emissions are reduced to 123 kg CO_2e - a 19% decrease.

Theoretical Limit

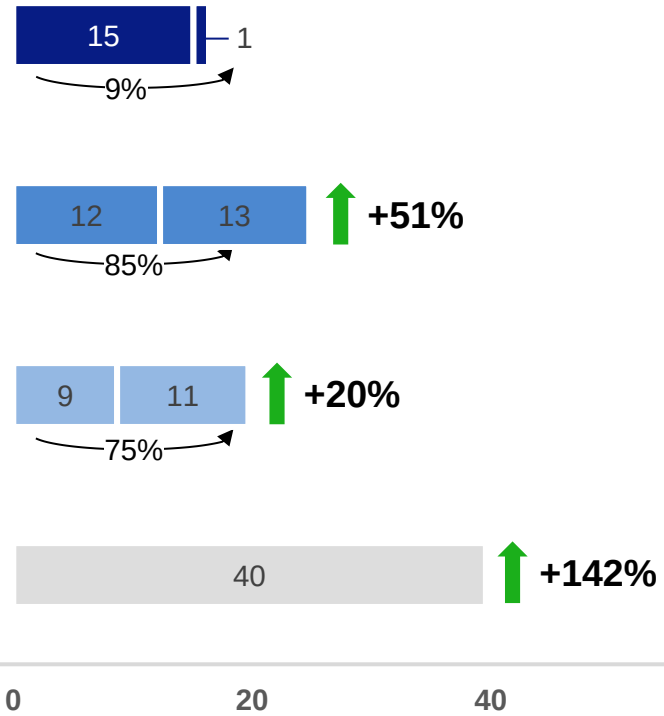
For comparison, we illustrate the theoretical limit with active use time of 40 months and 94 kg CO_2e per year. The gap between the baseline's 151 and the theoretical limit of 94 kg CO_2e per year is the range in which circular business models can reduce emissions and generate impact for gaming consoles.

Results for B2C Business Model Level Analysis for Gaming Consoles

For B2C gaming consoles, rental models clearly come out ahead. Increasing the utilization of infrequently used devices proves to be the most impactful lever here. The relative reduction in emissions is similar to that achieved for smartphones (around 20%), but the significantly higher footprint of gaming consoles results in greater absolute savings.

B2C Rental and Second-hand for Gaming Consoles

B2C



Scenario	Scenario Assumptions	GWP/year (kgCO2e) Based on active use time
Baseline	• First use of 46 months at 33% utilization = 15 months • Small fraction of devices repaired • 9% of devices privately given to 2nd user • 2nd use phase 44 months at 33% util.=15 months x 9% =1m • **Σ 16 months total active use**	151 kgCO2e
Rental	• 2-3 rental cycles (27 months in total at 46% util. =12 months) • 85% of devices prof. re-sold • 2nd use phase 15 months x 85% = 13 months • **Σ 25 months total active use**	123 kgCO2e, -19%
Second-hand Sale	• First use phase of 26 months (rebound effect of trade-in, 33% util. = 9 months) • 75% of devices prof. re-sold • 2nd private use 15 months x 75% = 11 months • **Σ 20 months total active use**	138 kgCO2e, -9%
Theoretical Limit	• Full utilization for maximum technical product lifespan • **Σ 40 months total active use**	94 kgCO2e, -38%

Benchmarking of CBM Performance against their Theoretical Limit

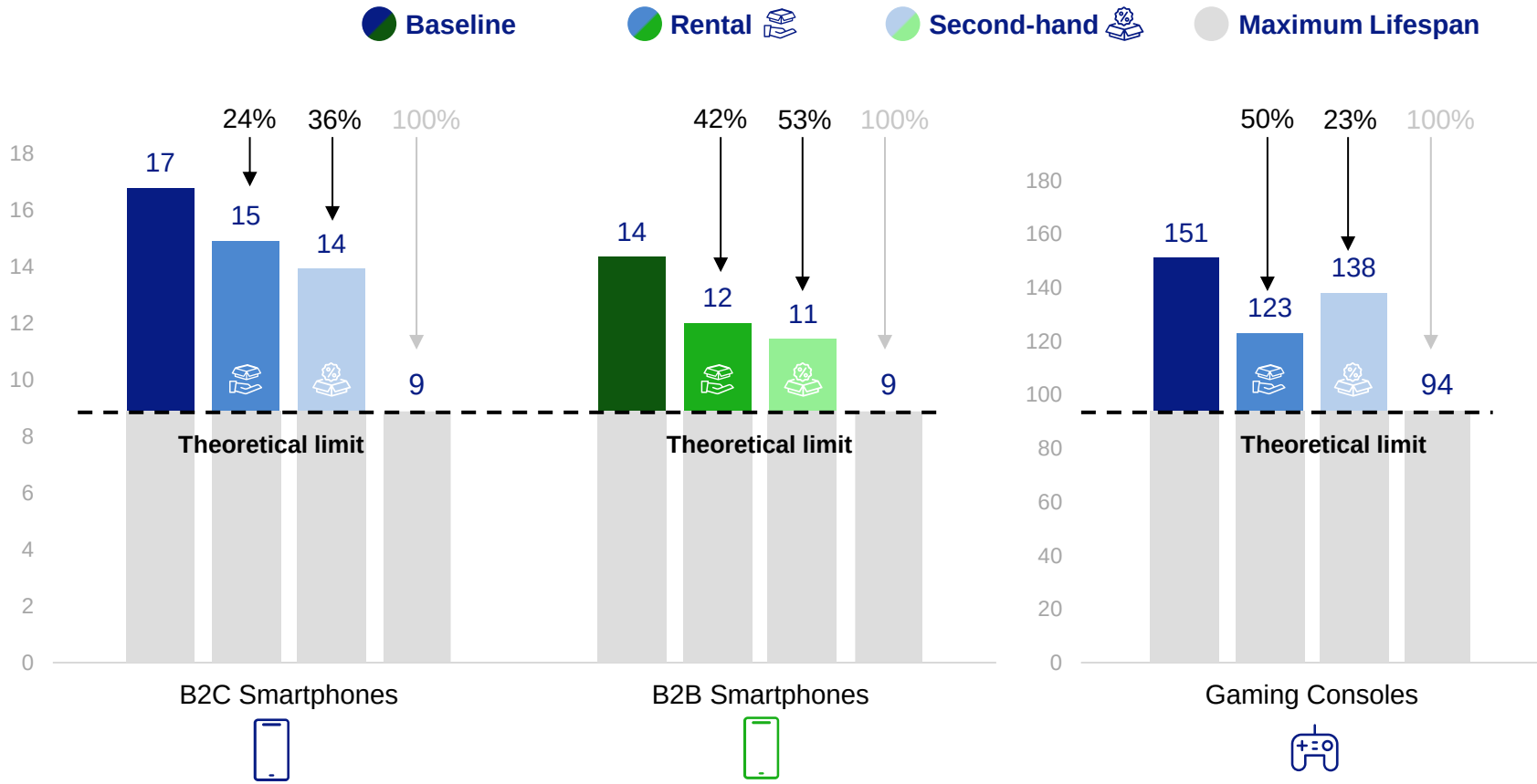
CBMs achieve 23-53% of their maximum potential impact

In this overview we look at the extend to which our rental and second-hand business model scenarios close the gap between the baseline and theoretical limit emissions. It illustrates how much room there is for optimization in the use phase, e.g. through circular business models (above the dotted line) and what part of the emissions have to be addressed by other levers (below the dotted line).

In our case studies, circular business models can already close the gap by 23% to 53%. This means there is still ample room for these business models, through longer use phases and more transfer of devices from one use phase to the next.

Emissions below the dotted line cannot be achieved by rental and second-hand business models. Further reductions will require changes in other parts of the product lifecycle, e.g. cutting production-related emissions, increasing product durability by design, as well as efficient end-of-life treatment strategies and closed loop material recovery.

GWP / year and Theoretical Limit for Circular Business Models



Summary Business Model Level Analysis & Intro Product Level Case Studies

Summary – Insights of analysis at business model level

Both second-hand and rental models demonstrate a measurable positive impact. Across all analyzed scenarios, annual emissions are lower than in the baseline - ranging from 9% to 20% per year, depending on device type, market segment and business model. The main driver for this impact is the prolongation of device use across multiple users, which both models enable. In addition, especially for infrequently used products like gaming consoles, the rental model also increases utilization by redistributing devices to users with higher demand.
Hence we conclude that rental and second-hand sales are highly complementary business models, each able to play out their impact potential differently, depending on product and user segment.

While the observed reductions are smaller than those in some other studies reporting 60–90% savings using the cut-off assumption (ADEME, 2020; Pamminger et al., 2021), this analysis takes a more equilibrated approach by allocating all emissions - including production - across the full product lifecycle.

To assess the effectiveness of CBMs in reducing total lifecycle emissions, we also compared them to a theoretical scenario in which all devices are used until they reach their full technical lifespan. This is the maximum active use time that could accumulate. Our circular scenarios close this emissions gap by up to 50%. Any further reduction beyond this theoretical minimum would require addressing product related emissions.

Second-hand and rental models show clear impact by increasing active use time and reducing emissions – they are highly complementary in reducing environmental effects for user segments and product types.

Product Level Case Studies

For illustrative purposes, we also show an example of analysis for the product level: B2B rental and second-hand sales of smartphones.



Definition of B2B Product Level Scenarios for Frequently Used Devices

B2B Rental and Second-hand for Smartphones on Product Level

B2B
Baseline

Our representative survey amongst business users in Germany yielded an average use time of 55 months for smartphones. In our baseline scenario we assume that the devices are discarded to end-of-life treatment afterwards, as this appeared to be the most common amongst companies (70% of respondents). The corresponding annual GWP is 14 kg CO_2e.

B2B
Rental

The business rental scenario includes an initial rental use phase of 33 months, followed by a second life through professional resale. This results in a 38% increase in active use time compared to the baseline and leads to a 22% reduction in annual GWP.

Product level analysis can help identify the product journeys that are creating the highest impact.

B2B
Second-hand Sale

In this scenario, the company use period of 55 months is followed by an average second-hand use of 43 months by a private user, which results in the longest total active use time of 86 months, 57% longer than the baseline, which results in a 30% lower annual GWP.

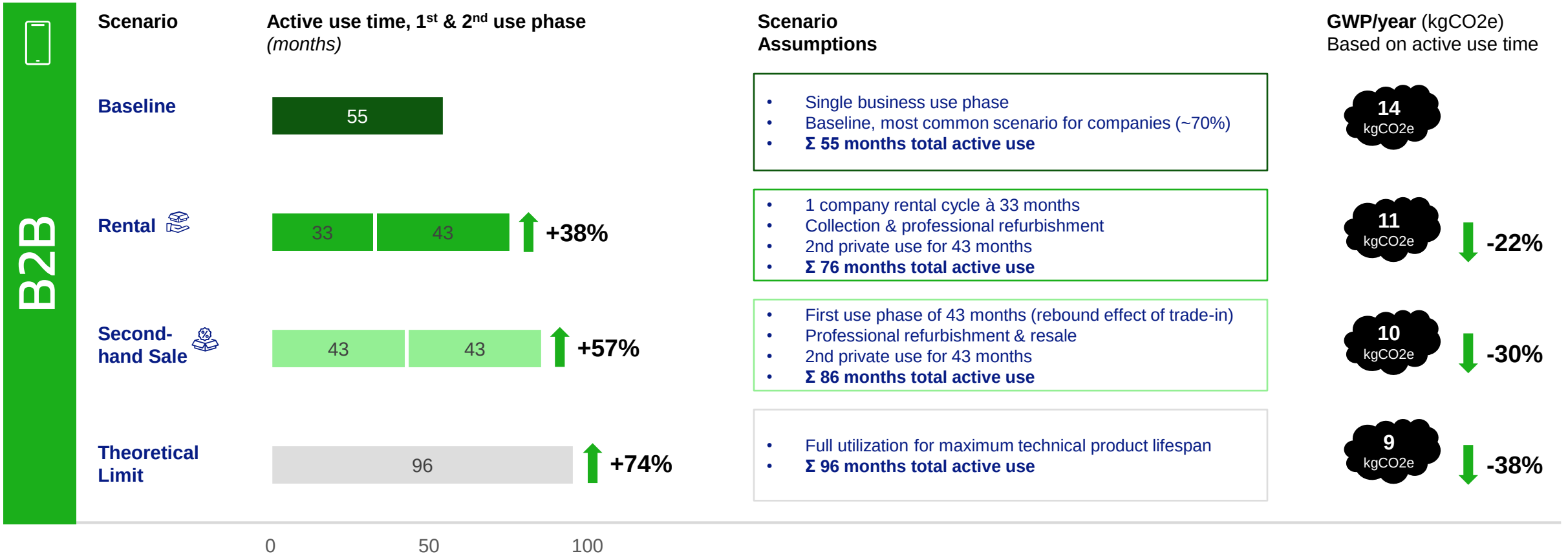
Summary - Insights at Product Level:

The positive impact across all device types (not all shown in the report) is greater than at the business model level, with increases in active use between 42% and 61% and annual emissions reduced by 24% to 32%. This is because we only examine devices that were actually recirculated and exclude those that followed a different path.
The device-level results permit to highlight individual device journeys and reveal in which journeys circular models deliver the strongest benefits (here B2B second-hand). This may help identifying the journeys one would like to support (as a business, investor or regulator) and what the levers could be to route more devices onto this particular product journey.

Results for B2B Product Level Analysis for Smartphones

The analysis of smartphone product journeys shows the important potential for second-hand sale of business devices. This product journey nearly closes the gap to the theoretical limit (80%).

B2B Rental and Second-hand for Smartphones on Product Level



Definition of Market Level Scenarios

We now extend the analysis to a market-wide perspective. The aim is to estimate the potential environmental savings and illustrate how circular offerings could influence a more sustainable future for smartphones at scale.

We apply the CBM impact methodology to a hypothetical market similar to Germany. Based on the number of active smartphone users (~70MM) and active mobile phone numbers (>100M), we estimate that approximately 100 million smartphones are in use across a mix of user segments and business models. (Wikipedia, 2025; Statista-2, 2025)

This example focuses specifically on private smartphone use to demonstrate how such an estimation can be conducted and what insights it can generate. For a detailed explanation of the assumptions and limitations behind this projection, please refer to the step-by-step guide in the following section. Detailed data used for the market level calculations is included in the appendix.

In a purely linear consumption scenario where all 100 million smartphones are used privately once and only 8% are handed on privately to a second use phase, the total annual GWP amounts to approximately 1,678 kilotons of CO_2e. This serves as the baseline for comparison. At the other end of the spectrum, an ideal best-case scenario in which all devices are used for their full technical lifespan of eight years serves as theoretical upper limit for positive impact, with total annual emissions reduced by 47% to approximately 889 kilotons of CO_2e.

Under current market conditions - with approximately 19% adoption of second-hand sales and 1% adoption of rental models amongst private users - total annual market emissions for smartphones in Germany are about 3% lower than in a purely linear scenario. For simplicity, this analysis ignores the currently higher adoption amongst B2B users and their slightly different usage characteristics explained earlier in the section. Nevertheless the results suggest that circular business models are already contributing to a measurable reduction in environmental impact.

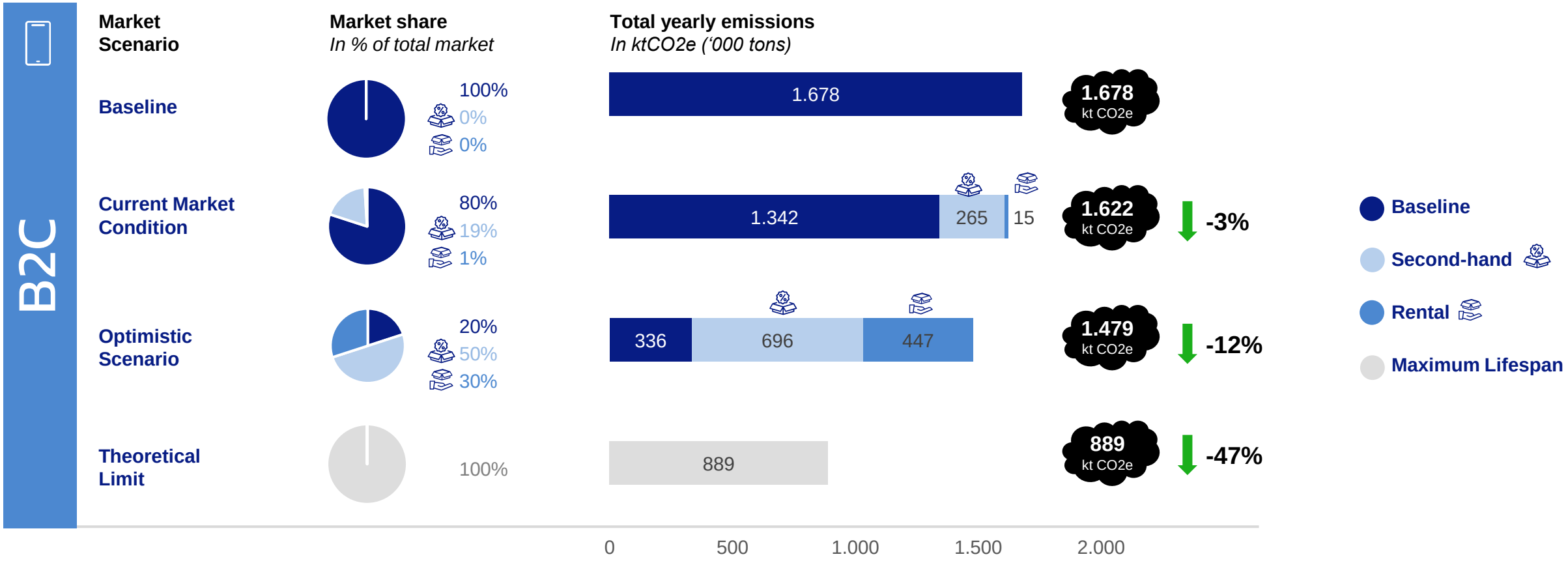
In an optimistic future scenario, where 50% of devices would be recirculated through the second-hand market, 30% of devices would be used in rental models (incl. resale) and only 20% following a purely linear pattern, the annual emissions could be reduced by up to 12% compared to the baseline. This corresponds to a total annual reduction of approximately 200 kilotons of CO_2e, equivalent to removing around 30,000 internal combustion engine cars from the roads (D-Carbonize, 2025).

The remaining gap to the theoretical limit illustrates that the cumulative effects of rental and second-hand business models still leave room for improvement and could yield a much more important contribution to reducing the emissions of electronics at market level. The levers to achieve this impact of course need to be assessed specifically for each business operation.

CBMs already lead to measurable savings of 56.000 t CO_2e in annual emissions for smartphone consumption – their widespread adoption could easily quadruple this impact.

Results for B2C Market Level Analysis for Smartphones

B2C: Market level – 100M Private Smartphones



Estimation of Avoided Devices and Limitations of the Case Studies

Avoided Devices

Longer use of products reduces their annual replacement rate on the market and hence less new devices are needed to cover demand. Based on the average total active use time from our market-level scenarios, we can approximate how many smartphones could be avoided through broader adoption of circular business models. For details on the calculation, please refer to section 5.6 in the step-by-step guide.

Total active use per smartphone (months)	*Baseline*	*Current market condition*	*Optimistic scenario*
	46,7	48,3	54,3

Detailed calculation is included in the appendix.

Compared to the baseline where no circular business models would exist, today's market adoption already increased the average active use time of devices by 4%. In the optimistic scenario, where 80% of the market adopts one of the two circular offerings, this increase reaches 16%. As a result, this would allow for an estimated 11% reduction in the total number of smartphones needed to meet the same market demand.

In a market of 100 million devices, that equates to up to 11 million fewer smartphones required to meet a constant market demand. Under current conditions, approximately 20-25 million (Statista, 2025) new smartphones have to be sold annually to keep the stock of devices constant and meet market demand. Under the optimistic adoption scenario, circular business models could reduce this number by 2-3 million devices every year.

Summary - Insights at Market Level

Using CBMI at market level, we can observe the accumulated effects of CBMs. The presence of second-hand and rental models for smartphones already contributes to a measurable reduction in annual emissions, even at today's relatively low adoption rates. Scaling up the use of these models in a market like Germany would further reduce both the emissions and the number of new devices needed to meet user demand. However, even in the most optimistic scenario, CBMs alone can of course not offset the environmental burden from device production.

Limitations of the Case Studies

The case study presented here shows the indicative results of a first analysis of the consumer electronics industry. It is based on blended market and industry data collected in this study, but also on informed rather conservative assumptions. Significant data gaps remain - especially regarding real usage behavior and further reuse domestically and even more so internationally, where data is particularly scarce. A dedicated module for international export for reuse has been developed but not yet been included here due to limited data availability.

Please also note that we do not represent any particular operator of a circular business model and we define our own scenarios and base them on realistic average data, using assumptions derived from our surveys and expert input. As practitioners, you can replace these inputs with your own company-specific parameters and assumptions in each case.

You'll find the step-by-step guide with detailed explanations of how to apply the CBM impact methodology - along with our specific assumptions for the case studies - in the following chapter.

Re-circulation of products and prolonging their use through new usage patterns is only one side of the story to reducing environmental burden. Design for longevity, upgradability, repairability and increased OEMs participation in these activities is key to increasing the lifespan of devices.



Clare Egan, Head of Sustainability
rebuy

Circularity

Step-by-Step Guide for Practitioners

05

In this chapter, we present a step-by-step guide that practitioners can use to apply the developed CBM Impact methodology for their own business model. The chapter walks you through each step - from defining a system map to deriving a formula for calculating GWP and active use time, gathering the necessary data, and using it to calculate the overall impact. At each step, we provide practical examples from our case study of the consumer electronics industry, based on market and industry data gathered in the UNDRESS Circularity project.

Checklist

Circularity

01

Define the Goal and Scope



02

Draw your System Map



03

Define your Baseline



04

Set-up the Formulas



05

Collect your Data



06

Calculate your Results



07

Derive specific Actions



The step-by-step guide provides a practical framework for assessing the impact of circular business models – including specific case study examples.



Step 1: Define the Goal and Scope

Goal: Clearly define the aim of the impact assessment

Clearly defining your goal and scope at the beginning helps tailor the model setup and data collection to your specific objectives. The structure of your system map, including product journeys and process steps, depends on your chosen scope. It matters whether you assess a single product or several categories, and which circular scenarios you select for the impact assessment. Depending on your objective, you can later focus on different parameters and examine them in more detail. For example, if you want to better understand individual impact levers or identify the product journeys with highest impact, conduct a product-level analysis. If you want to assess your business operations' impact perform analysis at the business model level. Or if you want to explore the scaling potential of circular business models carry out a market-level assessment. For more details about the three proposed levels of analysis of the CBMI methodology, please visit chapter 4.2.

Business model, Market, Customer and Product Selection

First, choose the circular business model you want to assess - for example, rental or second-hand resale. Then, select the product groups and customer segments relevant to your analysis. Decide whether to focus on individual products (e.g., specific smartphone models) or to evaluate broader product categories using representative averages. Define which customer segments to include, such as B2C, B2B, or more specific subgroups. Your selections will determine the structure of your system map and the process steps to model.

Define your Circular Scenarios

Define the specific product journey and the circular business model scenarios you want to assess. A scenario combines a product or product category, a customer group, and a specific business model - such as a rental of smartphones to private customers. The more precisely you define your circular scenarios, the more detail you can add in the following steps, for example individual steps in the typical product journey - and the higher the quality and accuracy of your impact assessment will be.

Consumer Electronics Case Study…

In our selected case study, the goal is to assess the positive environmental impact of two CBMs - second-hand sales and rental - for electronic devices in Germany. We analyze two representative product types - smartphones (frequently used) and gaming consoles (infrequently used) - to examine how the two key levers, prolongation and increased utilization, manifest in practice. We conduct the analysis for both B2C and B2B customers to highlight differences across the two user segments. We apply the assessment at three levels - business model, product- and market level - to demonstrate the specific insights each perspective provides.



Step 1: Define the Goal and Scope

…Consumer Electronics Case Study

Business Model and Product Level Scenarios

Rental

The rental provider purchases new devices and rents them out to private or business users for one or more rental cycles. After each return, the devices undergo refurbishment and can be re-rented to new users. Once the devices reach the end of their rental life, they are assessed for resale. Devices that are no longer suitable for resale - due to damage or wear - are routed directly to end-of-life (typically < 5-10%). All other devices are resold either to professional resellers in the domestic market or via traders and export channels to international markets. We then assume an additional private use phase. In this assessment, we evaluate rental scenarios for smartphones in both B2C and B2B contexts, and for gaming consoles in the B2C segment only.

Second-Hand

As a second-hand provider, you acquire used devices from private users or companies through trade-in programs, buy-back schemes, or other sourcing channels - typically receiving them in varying conditions. Devices that are no longer functional or unsuitable for resale, especially from low-quality sourcing channels (e.g. when users can just give back their old device when buying a new one), are directly routed to end-of-life. The remaining devices are refurbished and / or directly resold for a second use phase - either to private consumers in the domestic market or via export to international markets. We assume that all devices reach end of life after this second use phase. In this assessment, we evaluate professional second-hand resale for smartphones in both B2C and B2B contexts, and for gaming consoles in the B2C segment only.

Market Level Scenarios

We aim to understand the potential impact of circular business models on a market comparable to Germany, with about 100 million smartphones in use. We analyze two market scenarios for smartphones that differ in their adoption of linear consumption, professional second-hand sales, and rental models:

Current market: This scenario reflects today's conditions in Germany. Most users (80%) follow a linear consumption pattern, with a small share of 8% peer-to-peer transfers between private individuals. The actual adoption rates of professional second-hand models (around 20%) and rental offerings (around 1%) are based on findings from the UNDRESS Circularity market report.

Optimistic future market: This scenario models a highly optimistic outlook in which circular business models see broad adoption. It illustrates the potential of a future where approximately 80% of users shift away from linear consumption and adopt second-hand or rental solutions.

Step 2: Draw your System Map

Goal: Create a visual overview of the major product journeys for the selected products starting with production, covering all use phases.

To get started, map out all steps of the product journey that are relevant within the circular business model scenarios you defined. If the journeys vary significantly between product types or user groups, create separate system maps for each. For every journey, include all stages from production to end-of-life - with a strong focus on the use phase and potential for multiple use cycles by different users.

Illustrate how products enter the market, how they are used, collected, redistributed, and finally discarded. Include both internal processes carried out by your company and external steps handled by partners or service providers - such as OEMs, suppliers, second-hand traders, logistics providers, or recyclers. These process steps by service providers as well as product inflows into and outflows from your business (e.g., receiving new devices from manufacturers or acquiring used ones from trade-in programs) play an important role in the assessment. They should therefore be represented in your system map(s).

Rental - When mapping out your rental business model, keep the following questions in mind:

1. Where and how are your products initially manufactured, where do you source them from (e.g. from OEM, distributor, other sources) and how are they transported to your facility?
2. What happens between individual rental cycles? Include steps like collection, data deletion, cleaning, grading, and potential refurbishment.
3. Once a product exits your system - e.g. through resale or decommissioning - what is the likely next phase of its journey? Who handles it next, and what happens to it then (e.g., to what kind of user is it ultimately resold)?

Step 2: Draw your System Map

Second-hand sale product journey - keep the following questions in mind:

1. Where do you source your products from ? What does their previous lifecycle (most likely) look like - who owned them, how were they used, and which partners or channels were involved before they reached your business?
2. Which channels do you use for resale and what happens to the devices after resale per channel? Are they sold directly to end customers or via intermediaries?
3. What is the likely path they follow until they reach end-of-life? What happens to devices not suitable for resale?

Consumer Electronics Case Study

For our case study, we build on the system maps introduced in Chapter 2 to illustrate typical product journeys for the two selected business models - rental and second-hand resale - for our selected product categories smartphones and gaming consoles for both B2B and B2C user groups.





Step 3: Define your Baseline

Goal: Define the baseline scenario against which you want to compare your circular business model.

Define your baseline scenario, that is, the alternative scenario against which you compare your selected business model scenario to assess the generated impact. Many impact assessments compare a circular business model to a fully linear consumption scenario - meaning the product is used by one user and then discarded, without any form of reuse, resale, or rental. This simplified baseline is a good starting point, as it clearly shows the added value of circular models by emphasizing the benefits of extended use through recirculation. It's also the easiest baseline to model, since fewer data points are needed.
However, in practice, some private circular activities like user-initiated repair, peer-to-peer transfers, as well as some level of professional resale and rental services are typically already present. For a more realistic comparison against actual market conditions, it may therefore be more appropriate to define a baseline that includes existing circular practices. The way you define your baseline strongly affects the results of your analysis (Russel, 2019), and it shapes the conclusions you can draw from your assessment.

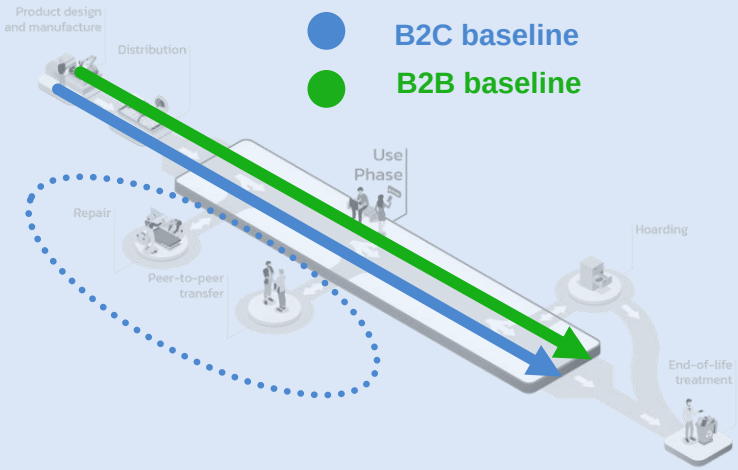
Consumer Electronics Case Study

For the case studies in this report, we establish the following baseline scenarios for comparison with our circular business models.

For our B2C case study scenarios, we select a baseline with a linear product journey, without any professional circular business model provider. That is, devices are bought through conventional retail channels and used for one ownership cycle, after which they go to end-of-life. On the business model level, we factor in 8% of private transfers (based on results from our market report). We exclude professional circular providers like second-hand platforms or rental services.

For our B2B case study scenarios, we also select a baseline with a linear product journey, without any professional circular business model provider. In the B2B scenario, no private transfers are realized, so the baseline is purely linear with one use phase, followed by end of life.

For our B2C market level estimation, we assume a market in which only the baseline of the business model level is present, that means devices are bought through conventional retail channels and used for one ownership cycle, after which they go to end-of-life. We again factor in 8% of private peer-to-peer transfer.





Step 4: Set up the Formulas

Goal: Adapt the formula for calculating the total GWP and active use time to your specific business model and selected scenarios.

Develop the calculation formula for your impact analysis, covering all steps of the selected product journey.
Note: Not all data necessary for the calculation may be available - we go into more detail about data collection in the following section.
For now, we focus on incorporating all relevant parameters to conduct the impact analysis: For the nominator of the formula, include all relevant factors to calculate total GWP, for the denominator, include all factors relevant to determine the total active use time over the product's lifespan.

To perform the calculation, you'll need to define the following components:

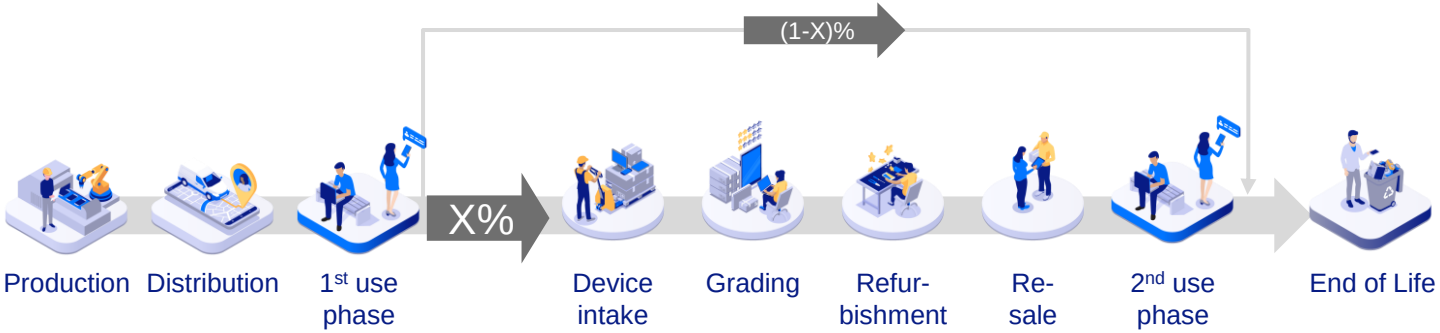
- **Parameters for GWP and Active Use Time:** For each step in your product journey, determine whether it contributes to Global Warming Potential (GWP), active use time, or both. For example, production and transport affect only GWP, while use phases contribute to both.
- **Recurring Process Steps:** For repeated activities such as rental cycles, structure the formula to reflect how often these steps occur. Include parameters directly connected to each rental cycle, like collection, grading, data deletion, refurbishment, and transport between users; and add a multiplier.
- **Use phase parameters:** For every use phase, add a variable parameter for its duration in years and a percentage for the utilization. This enables calculation of true actual active use time - e.g., a gaming console kept for 3 years but only used one-third of the time generates one year of active use.
- **Likelihoods:** Wherever the product journey could follow more than one route, introduce a parameter to reflect the likelihood of each outcome. For example, after collection, xx% of returned devices may be reusable, while yy% are discarded.
- **Final formula setup:** Sum the total GWP and total active use time for each scenario. From these two figures, derive the GWP per active year of use as your main result.



Step 4: Set up the Formulas

Circularity

Example: Simplified formula for total GWP and active use time in a second-hand sale scenario with only first and second use phase
(no subsequent use phases shown)



GWP Parameters:

Prod.:	Production
Distr.:	Distribution
Energy1st:	Energy consumption in first use phase
Dev.Intake.:	Device intake
Grad.:	Grading
Resale.:	Resale (incl. Transport)
Energy2nd:	Energy consumption in second use phase
EoL.:	End of life

Use time parameters:

T 1st use:	First use duration
U 1st use:	First use utilization
T 2nd use:	Second use duration
U 2nd use:	Second use utilization

Likelihood:

X%:	Share of devices transferred to second use phase

Total GWP (in $kgCO_2e$)

$$= GWP_{Prod.} + GWP_{Distr.} + GWP_{Energy\ 1st} + X\% * (GWP_{Dev.Intake.} + GWP_{Grad.} + GWP_{Refurb.} + GWP_{Resale} + GWP_{Energy\ 2nd}) + GWP_{EoL}$$

Total active use time (in years)

$$= T_{1st\ use} * U_{1st\ use} + X\% * T_{2nd\ use} * U_{2nd\ use}$$



Step 4: Set up the Formulas

Important Parameters for Rental:

- GWP parameters for production and distribution until they reach you / your first customer, in kgCO_2e for the selected product category
- A parameter for the average number of rental cycles of the selected product category
- A parameter for the duration of an average rental contract of the selected product category, in years
- A parameter for the utilization of the products during rental, e.g. how often cameras or gaming consoles are actually used, in percentage
- GWP parameters of all activities occurring in and between each rental cycle (i.e., collection, data deletion, grading, refurbishment, and re-rental), in kg CO_2e
- The share of products suitable and available for re-rental and the share of products sold to third parties, the share of products purchased by current users after their rental period, and the share of products transferred to end-of-life treatment, in percentages
- Parameters for the expected duration and utilisation for the second use phase of the product after it is resold to third parties, in years and percentages

A Special Note on Rebound Effect Parameters

The effect of shortened usage due to the availability of resale opportunities through circular business models can best be accounted for by using actual use time data as input for the model. In that case, no additional factors are needed.

In the case of additional consumption due to circular offerings, we recommend excluding this additional use from the calculation of total active use, e.g. by including a factor into the active use time calculation, such as (1-R) where R represents the share of devices that consumers say they would not have accessed, if it was not through the business model at hand. As a result, the negative effect of having put these devices onto the market is considered in the GWP calculation, but the positive effect of adding to the business model's total active use time is removed.



Step 4: Set up the Formulas

Circularity

Important Parameters for Second-hand Sale:

- GWP parameters for production and distribution to first user, for the selected product categories
- Parameters for the duration and utilization for the first use phase before you access the products and they flow into your resale cycle, in years and percentages
- GWP parameters of all internal activities preparing the resale (i.e., take-in, data deletion, grading, refurbishment, re-sale and transport), in $kgCO_2e$
- The share of all products suitable for resale by channel (e.g., direct sales to users, bulk sales to intermediaries etc.), and the share of products transferred to end-of-life treatment, in percentages
- The share of products that can be realistically re-used after bulk export via international traders, in percentages
- Parameters for the duration and utilization for the second use phases of the resold devices per sales channel

Consumer Electronics Case Study …

For our case study, we include a first and a second use phase only, without considering potential third or more use phases (see details in the section “We collect our data”). The first use phase can of course contain several rental cycles. In the circular scenarios selected for our analysis, the processes between use phases - such as collection, data deletion, grading, and refurbishment - are combined under a single generalized parameter labelled “Refurbishment”.

We defined the following parameters for the formulas used in our baseline and the two circular scenarios. For more detailed information on each parameter and how to populate them, please refer to the following chapter on data collection.



Step 4: Set up the Formulas

Circularity

…Consumer Electronics Case Study

Parameters that contribute to GWP

- Manufacturing
- Initial transport for distribution to seller and end user
- Transport to second use
- Repair
- End of life treatment
- Energy consumption within the use phase

Additional for circular scenarios:

- Transport within rental (between rental cycles)
- Refurbishment between rental cycles (in rental model) or between first use and second use phase (in second-hand model)

Parameters that contribute active use time

- Duration of first and second use phase in ownership
- Utilization in first and second use phase in ownership

Additional for rental:

- Number of rental cycles
- Duration of rental cycles
- Utilization during rental cycles

Likelihoods

- Peer-to-Peer transfer from the first into the second use phase
- Devices suitable for resale after the final rental cycle
- Devices suitable for resale after second-hand device take-in

When setting up the formula, aim to be as comprehensive as possible – even if not all data points are available yet.



Step 5: Collect your Data

Circularity

Goal: Collect all data needed to populate the formula you have set up.

To populate the formula, you need to collect two major types of data for the baseline and the reference scenarios:

- GWP data to quantify the environmental effects across the product lifecycle
- Use phase data to better understand how your products are actually used and to calculate active use time

If you have a large product portfolio or if you work with many customer groups, it can be helpful for the first analysis to cluster products and users into similar categories to simplify data collection, e.g. grouping different kinds of headphones into one category or using average use cycle durations. Likewise, user data can be aggregated based on user groups with similar behavior patterns, such as segmenting B2B customers by company size.

The Importance of Data Collection

High quality data to assess both negative and positive environmental impacts are often hard to get. Actual data on the carbon footprint of business activities needed for the GWP parameters is often scarce and incomplete, especially for individual process steps within a product's lifecycle. Even more challenging is the collection of real-world data on how products are actually used - such as their usage duration, intensity, or fate after first use - as this information is rarely tracked systematically and spread across many actors, markets and often even geographies. Companies with large product portfolios may also struggle with the complexity of data gathering.

Nevertheless, it is a very valuable exercise to set up the impact analysis as proposed, as it provides guidance to understand the relevant levers influencing the magnitude of the potential impact, and to have a structured outline as to which data is needed, and which is available and which isn't. In the first step, you can work with proxies from research or reports, and develop plausible estimates you can refine and replace over time. At the same time, you can engage in obtaining real-world data - potentially by working with your BI or operations teams, by starting to systematically collect data yourself where possible, collaborate with partners along the value chain, as well as research institutes or consultancies to get access to further data or engage in joint data collection (e.g., joint market surveys).



Step 5: Collect your Data

Circularity

GWP Data

Some of the data on the GWP of individual steps along the product journey may already exist within your company's ESG and sustainability reporting (e.g., scope 1-3 emissions) or can be obtained from partner companies. Any remaining data gaps will need to be filled through individual data collection or by identifying suitable proxies.

Production

Product-specific GWP values can often be obtained from OEM-published Product Carbon Footprint (PCF) or Life Cycle Assessment (LCA) data, usually found in their sustainability reports or online product information (e.g., Apple, Samsung, HP). If LCA data is used, be sure to exclude all contributions from the use phase or recycling and keep only production emissions. If this information is not available, proxies can be taken from LCA databases such as Ecoinvent, Sphera, or reports from research institutes like Fraunhofer or the Öko-Institut.

Transportation

If managed by your company in-house, internal ERP and logistics systems (e.g., SAP) can provide transport-related data such as shipping distances, mode of transport and packaging. For outsourced logistics, service and logistics providers may be able to supply emissions data related to packaging, storage, and freight. As a first simplifying step, standard emissions factors can be used to estimate the GWP. Such emission factors may be researched, for example from the list of recommended LCA databases by the GHG protocol on their website.

Circular Process Steps (e.g., Refurbishment)

If performed in-house, data for specific processes can be collected from internal records such as technician logs (e.g., average time spent on repairs), and materials used. These values can also be available from suppliers or component manufacturers. If grading or refurbishment activities are outsourced, request emissions data or estimates directly from service providers.

End-of-Life Treatment

GWP values for recycling or disposal can be obtained from environmental reports of recycling partners or publicly available sources. This includes average emissions per disposed device or data for specific end-of-life pathways (e.g., WEEE processing in Europe). Reliable emissions data for e-waste handling is also published by institutions like Unitar (E-Waste Monitor) or can be found in databases such as Ecoinvent and Statista.

Overhead Activities (Scope 1–2 Emissions)

To further complement the assessment, you can also integrate overhead-related GWP into the specific steps that your company performs inhouse. As these overhead emissions
are typically unrelated to the number of products processed, they can be treated as fixed values, collected once, and can then be allocated proportionally across business activities, such as the total number of second-hand products sold, similar to financial cost allocation. Company sustainability reporting typically includes Scope 1–2 emissions covering direct and indirect emissions from general operations. These include emissions from company-owned vehicles, buildings, purchased electricity, heating, and employee commuting, as well as warehousing.



Step 5: Collect your Data

Use Phase Data

Use Phase Duration

Information about the use phase can be gathered to some extent for individually sold devices - for example, through customer surveys or partner information. However, for devices resold in bulk, it is much more difficult to track their final destination and actual usage, since there is typically no visibility into where each device ends up or how it is used.

Rental providers can draw on reliable internal data such as the duration and number of rental contracts for each device for the first use phase. Obtaining data on the duration of the second use phase after the device is resold is more difficult as there is often no data available. Here, estimates can be used as first proxy, e.g. based on market surveys. In addition, professional buyers can be asked to provide information as to where and to whom the devices are sold to start building a data base to understand different potential secondary use cases.

Second-hand providers can collect data on the first use phase during the trade-in process - for example, by asking customers how long the device has been used or by estimating the duration based on the device's age or time of market release of the device type. For the duration of the second use phase, customer surveys can help estimate how long users typically (intend to) use their second-hand devices. If sold to professional buyers, engaging with buyers can be a first valuable step, as described above.

Lastly, for devices sold in bulk to resellers or traders, it is particularly challenging to obtain reliable data on their subsequent product journeys or actual usage. In some cases, you may have information about the destination markets, or the resale channels based on device type or grade. This can serve as a starting point for making informed assumptions and developing proxy values - which can be refined and expanded over time as more insights become available. In the worst case, uniform assumptions across product groups and resale channels may have to be made.





Step 5: Collect your Data

Use Phase Data

Utilization

To understand how intensively devices are used, surveys among private and business customers can provide valuable insights into daily usage patterns and frequency. These can be tailored to specific device categories (e.g., smartphones vs. gaming consoles) and customer groups (e.g., private vs. business users). While useful for estimating real-world behavior, survey results are generally less robust than data from the devices or an installed software, as responses often reflect perceived behavior rather than verified use. Such device-specific usage data - such as screen time or active usage periods - can sometimes be obtained directly from connected devices via OEM or software telemetry (e.g., Apple or Android systems). However, this data is often only existent for few devices and often proprietary and seldom shared. In a first step, it can therefore be useful to work with estimates. For frequently used devices, a 100% utilization can be assumed, while for infrequently used devices the percentage should be smaller.

Likelihood Parameters (e.g., Reuse Share)

Operational records or internal systems can reveal the proportion of products that are successfully processed and resold/transferred to subsequent use phases or those that are sorted out and sent to end-of-life. The information can also be requested from partners. Data on user decisions - such as the likelihood that a device is traded in after first use instead of being hoarded in the drawer - can be gathered through customer surveys.

Rebound Effects

There are several ways to obtain data on rebound effects. The most reliable data comes from actual usage information during the first use phase - such as device age at the time of trade-in, rental duration, or frequency of upgrades. Alternatively, rebound effects can be assessed through customer surveys, though these often reflect subjective perceptions and are more difficult to model - for example, when customers say they would rent a device due to the available offer, but wouldn't have bought it otherwise. In such cases, it is advisable to work with conservative assumptions.

International Trade: Data on the international trade of used devices can support several key parameters in your model. For example, by analyzing device flows, you can gain information that helps you refine your assumptions for subsequent use phases - such as adjusting the expected use phase duration depending on the country of final sale, or modifying the emissions parameters based on the local energy mix in that region. Some international organizations have already published studies on this topic. You can also get data on export routes for used devices from these studies or from providers like CCS Insight, who track and publish second-hand market data.

Use phase data often requires significant effort to gather – but it is highly valuable and essential for a reliable impact assessment.



Step 5: Collect your Data

Consumer Electronics Case Study

To assign values to each step in the calculation model, we drew from a variety of data sources, as summarized below. The most important data points - those related to the use phase, such as duration, utilization, and likelihoods of device journeys - are listed in detail in the appendix for transparency and reference. A more detailed overview of the assessment and the parameters used in the calculations can be found in the second report of the UNDRESS Circularity project by Fraunhofer IZM (Proske, 2025).

GWP Data

For the case studies in this report, Fraunhofer IZM provided GWP parameters per device type based on their own LCA database, combining information from multiple established sources. We used the following list of parameters in our calculations.

Parameter in all scenarios	Description of GWP producing activity
Manufacturing	Manufacture of the product (including accessories like chargers) depending on product specifics like weight or included accessories.
Transport for distribution	Transport emissions from manufacture to seller and end user, depending on the mode of transport (e.g., by air, sea, or road) and distance between production and use phase locations. We used average values for transport from Asia to Germany.
Transport to second use	Transport emissions for logistics between the first and second use phase for average distances (in our case for road logistics within Germany).
Repair	Repair activities in the baseline scenario, where devices are repaired once within the lifetime.
End of life treatment	Recycling of the device once it reaches end of life treatment. In the case study we used data for recycling in Germany.
Energy consumption for each use phase	Emissions from energy consumption in the use phase depend on the local energy mix in the respective country. We used the German energy mix in all our scenarios, given the limited data on international trade and final destinations of the devices.
Rental	
Activities between rental cycles	Selection of activities for devices between rental cycles,, e.g. collection, data-deletion and grading - and refurbishment when needed. We included a collective parameter for the average activities including refurbishment happening between rental cycles and before resale.
Transport within rental	Transport including the device collection from the rental user, and transport to the next rental user, potentially additional transports to third party service providers in-between.
Second-hand	
Activities between ownership use phases	Selection of activities after trade-in, for example data-deletion and grading - and refurbishment when needed. We included a collective parameter for average activities after the first use phase, including for refurbishment.



Step 5: Collect your Data

Consumer Electronics Case Study

Use Phase Data

We used data on the user behavior for rental and second hand in B2B and B2C markets from the UNDRESS Circularity market report, conducted in Germany in 2024. In addition, we used blended proprietary business data from the industry partners of this project (in NDA-protected and anonymized form). Lastly, we used insights from public reports and relied on expert knowledge from the Core- & Associated Partners of this project, as well as numerous additional interviews with national and international experts conducted throughout the project. From this data, we derive the following use phase parameters.

Rental	Description of active use parameter
Number of rental cycles	The average number of times the product was rented out to a rental use, per product or product category and customer group (B2B or B2C)
Duration of rental cycles	The contract duration of the rental cycle depending on the product and customer group
Utilization during rental cycles	The share of time the product was actively used during the rental phase, in percentage of total duration of the contract, by product and customer group.
Duration of second use phase	Duration of the second use phase for devices after they are sold for reuse, by product and customer group.
Utilization in second use phase	The share of time the product was actively used during the second use phase by product and customer group, in percentage of total duration of the use phase.
Second-hand	
Duration of first and second use phase	Duration of the second use phase for devices after they are sold for reuse, by product and customer group.
Utilization in first and second use phase	The share of time the product was actively used during the second use phase by product and customer group, in percentage of total duration of the use phase.



Step 6: Calculate and Interpret your Results

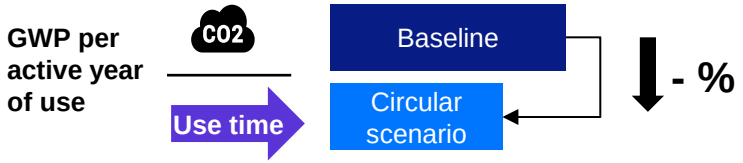
Circularity

Goal: Use the populated formula to calculate the results of your scenarios and compare them to the selected baseline.

Once all parameters in the formula have been defined and populated with data for both the baseline and circular scenarios, you can calculate the final model outputs. Dividing the total GWP by the total active use time provides you with yearly GWP per active use - your key indicator for environmental impact. You can now compare circular scenarios to the baseline. As a practitioner, you can now draw specific insights from the analysis:

- how much additional active use is enabled by the circular business model
- how many emissions are avoided through extended or intensified product use
- how many new devices could be avoided thanks to the longer use duration (see info box)

Calculation of Avoided Emissions



Consumer Electronics Case Study
You can find the results of our calculations for the case study in chapter 4.3: Case Study Results of the CBM Impact methodology.

Calculating Avoided Devices

When products remain in active use for a longer period, they can replace the need to manufacture new ones. The longer the total active use time, the fewer new devices are needed to meet the same level of demand. The number of avoided new products per year can be estimated using the following formula.

$$\text{Avoided devices per year} \approx \left(1 - \frac{\text{Baseline active use time}}{\text{Extended active use time}}\right) \times \text{Annual new devices entering the market currently}$$

However, please keep in mind that this simplified calculation does not consider the additional environmental effects caused by circular business models - though these typically account for less than 5% of total lifecycle emissions.



Step 7: Derive specific Actions

Goal: Revisit your initial goal and scope and derive specific actions based on the results.

Congratulations! Once you've completed the assessment, you can now measure and quantify the real-world impact of your circular business model - grounded in actual usage data and product journeys. Building on these insights about the current state, you can derive actions to track and further optimize the impact in the future.



Internal Strategy & Operations

- *Manage for impact:* Incorporate metrics like active use time or reuse rates into regular business tracking and share findings with management to guide company performance.
- *Optimize processes:* Identify concrete changes to logistics, refurbishment, or product management based on impact levers and align with operational teams on the implementation. Set-up KPIs based on CBMI analysis to track the success of your initiatives.
- *Optimize offering:* Use the insights to refine rental or resale offerings to further improve the positive impact and reduce rebound effects. Communicate about these improvements to your customers and investors, using data obtained from the CBMI analysis.

External Communication

- *Engage customers and markets:* Use the insights to better inform users about sustainability benefits
- *Collaborate with industry partners:* Share impact data and impact levers obtained from CBMI analysis with industry partners and service providers to help improve overall data collection and contribute to increased comparability and transparency, all while inciting your partners to join you in doing more for impact.
- *Inform investors:* Communicate your circular impact and optimizations as part of your sustainability narrative to investors and funding partners.
- *Engage policymakers:* Contribute your knowledge from the CBMI analysis about system-wide levers and the effects of your circular business model to the public debate - for example, by raising important issues like data transparency in the second-hand market with policymakers.

Processing our customer's preloved electronics, turning them into refurbished products, we see first-hand how the circular economy reduces waste, introduces new revenue streams, and supports sustainability goals. UNDRESS Circularity brings much-needed transparency and awareness to these benefits, uniting us all under one shared goal: to reshape a linear economy into a circular one.



Anja Krabbe,
Manager Customer Care & Business Development
Ingram Micro

Circularity

Conclusion & Outlook

06

Highlighting the key take-aways from our study….

The **UNDRESS Circularity** project has brought together leading industry practitioners and experienced stakeholders to address a critical blind spot in the impact assessment of circular economy business models: the product use phase.

The **Circular Business Model Impact (CBMI) methodology** and practitioner guide introduced in this report place changes during the use phase at the core of impact assessment. They offer a robust, data-driven framework to quantify the environmental impact of circular business models, explicitly factoring in how these models influence actual product use. It enables practitioners to identify key parameters for maximum active use of products and thereby mitigate their negative environmental effects.

In a **cross-company case study** on consumer electronics in Germany, this report demonstrated how the CBMI methodology can be applied in practice. The results underline the clear potential of circular business models by highlighting **actual environmental impacts already achieved today**, as well as the potential improvements that could be realized in the future.

Rental and second-hand models significantly prolong active use times and lower annual emissions per device – by up to 20% for smartphones and by 19% for gaming consoles. At a market level, widespread adoption of CBMs in Germany could reduce the need for new smartphones by 2–3 million units and thereby avoid approximately 200,000 tons of CO_2e annually.
The results show that **current CBMs achieve around 20–50% of the maximum emissions reductions possible** through extended use, considering the technical limits of product lifespans. This demonstrates their already significant impact, while highlighting room for further improvement. However, **additional strategies are essential** to tackle the emissions beyond the limit of CBMs. These include further advancing material use and product design for durability and repairability, improving the sustainability of production and service processes, enhancing end-of-life treatment and material recovery, and critically reassessing how many devices are truly needed overall.

The analysis shows significant potential to further increase the positive impact of circular business models. In addition, solutions beyond CBMs — including improved product design, end-of-life strategies, and conscious consumption — are required to fully address the environmental footprint of consumer electronics.

… and pointing toward future action: addressing improvement levers and data collection…

While this report primarily focused on assessing the current environmental impact of existing circular business models, it also highlights the significant potential for further **boosting the impact of CBMs:**

Companies can actively **enhance the positive impact of their CBMs** by leveraging a variety of **operational levers**, such as integrating second-hand products into rental offers, enabling dual use (private / professional) of devices, further optimizing resale channels and proactively refurbishing high-wear components. An important lever also lies in directly **addressing users'** insecurities and concerns regarding CBMs for example by increasing awareness and transparency, offering **additional service** such as extended warranties for refurbished goods and delivering **excellent user experiences** at relevant touch points such as trade-in, service handling and collection.
Although some of these levers have been identified in this report, we did not discuss the individual levers and their respective influence on the overall impact in detail. F**uture work** could focus on systematically analyzing such levers, capturing data on the various improvement strategies and **conducting sensitivity analyses** to better understand which measures most effectively increase positive impact. By doing so, companies and stakeholders can move beyond measuring impact toward actively maximizing it.

A significant limitation of the methodology is the **availability of reliable data** – especially for the **use phase.** For our case study, we conducted extensive market surveys, collected proprietary data from industry partners, and carried out numerous expert interviews. Despite these efforts, significant data gaps remain, and we also had to use informed assumptions for our analysis (see technical report for details).

To accurately assess and optimize circular product flows, we urgently need greater **transparency and data availability** – within companies, at national levels, and across global trade systems.

To improve impact assessments and the management of circular product flows, companies need to more systematically **collect data on the devices handled**, including capturing data on the origins of sourced devices, monitoring their usage patterns during service provision, and importantly, **inquiring about resale destinations and intended subsequent usage**.

At the same time, broader **systemic gaps** persist, particularly concerning the **tracking of electronic devices** within Germany's extended producer responsibility (EPR) system and **across international borders.** There is currently very limited reliable information on the whereabouts, usage, and end-of-life fate of devices once they leave national markets. Addressing these gaps will require **coordinated efforts** by companies, policymakers, and regulators to improve transparency and **establish consistent data collection mechanisms** at both the national and international levels.

Accurate assessments of circular business models urgently requires more data collection and transparency on product use and flows across the globe.

… and further advancing the rigor in methodical impact assessment.

In the **UNDRESS Circularity** project, we set out to design a practical, data-driven approach that captures the real-world dynamics of extended product use and avoided emissions through **use-phase improvements across multiple life cycles** and ownership stages. If carbon accounting and target-setting are to be effective tools for reducing emissions across all phases of a product's life, including the use phase, then the **avoided emissions** must be **allocated fairly** among all contributing stakeholders.

While we believe the methodology provides a strong and valuable foundation, we fully acknowledge that **further refinement and extension** are both possible and necessary. We therefore actively encourage researchers, practitioners, and standard setters to continue building on and extending the **Circular Business Model Impact (CBMI)** framework.

We also emphasize the importance of **continued alignment** and mutual reinforcement between this methodology and broader environmental accounting frameworks – such as the GHG Protocol, the Circular Transition Indicators, the Product Environmental Footprint, and ISO standards.

As discussed in this report, the **CBMI methodology is designed to complement existing standards**, not replace them, and we hope that this work can contribute to the ongoing evolution of impact assessment and carbon accounting tools in a way that fully accounts for the role of **circular strategies** in **driving environmental benefits**.

Ultimately, realizing the full potential of circular business models requires not only measuring their impact more accurately, but also **continuously improving** the strategies that drive positive change. We hope that this report provides both a solid foundation and an invitation for further collaboration across industry, research, and policy to advance circularity as a key lever for environmental sustainability.

From Measurement to Action: Unlocking the Full Potential of Circular Business Models

Our report is intended to support key stakeholders in quantifying and **advancing the positive environmental impact of circular business model**s. Specifically, the CBMI methodology seeks to enable:

Company decision-makers to assess and optimize the environmental impact of their circular business models.

Investors to strategically allocate capital toward circular business models that deliver measurable outcomes.

Users to make informed choices about how to access and use technology in more sustainable ways.

Policymakers to create enabling conditions – through policy, legal frameworks, and incentives – that foster measurable resource efficiency and circular innovation.

Think tanks and researchers to complement and further advance current assessment frameworks.

By applying a standardized approach, results will become more comparable across business models, industries, and geographies, enabling better decision-making and more targeted interventions to accelerate a resource-efficient circular economy.

The CBMI methodology equips stakeholders to move from assumptions to evidence, make impact transparent and comparable, and identify key levers for maximizing positive outcomes. We look forward to collaborating to further advance this data-driven approach and turn ambition into measurable action, in electronics and beyond.



Dr. Marianne Kuhlmann & Dr. Paul Wöbkenberg,
Founders of Circularity

About the Authors

Key contacts & contributors

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Circularity

Circularity is the professional Do-Tank and Consultancy for the Circular Economy. We support companies in their circular transformation and facilitate cooperations along and across value-chains to develop circular solutions. Visit our website and sign up to our newsletter to receive the latest news.

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Systemiq accelerates the transition to a sustainable economy by redesigning systems in energy, materials, food, cities, and finance - developing scalable solutions through partnerships, advisory work, and targeted investments.

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Deloitte supports businesses in building a long-term future by combining strategic foresight thinking with technology, innovation and tailored solutions that drive sustainable long-term value and positive transformation.

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Circularity

Additional information

07

Acronyms

Acronym	Meaning
B2B	Business-to-Business
B2C	Business-to-Consumer
CBM	Circular Business Model
CBMI	Circular Business Model Impact
E-waste	Electronic waste, WEEE
EU	European Union
GWP	Global Warming Potential (in kgCO2 equivalent)
IT	Information Technology
LCA	Life cycle assessment (in carbon accounting)
MDM	Mobile Device Management
NDA	Non-Disclosure Agreement
OEM	Original Equipment Manufacturer
PCF	Product Carbon Footprint
WEEE	Waste Electrical and Electronic Equipment



Glossary

Term	Definition
Active use	The time a product is actually being used (rather than sitting idle)
Baseline	The reference scenario, usually the linear consumption model, used to compare the impact of circular business models
CBM / Circular business model	A business model designed to translate circular economy principles (such as keeping products at their highest potential value, eliminating waste, circulating resources) into a customer value proposition.
CO2e	CO_2 Equivalent (CO_2e) – A standardized unit used to measure the global warming potential of different greenhouse gases, expressed in terms of the amount of CO_2 that would have the same impact over a given timeframe.
Data-deletion	The process of securely erasing all data from a device to prevent unauthorized access, using certified methods and software
Environmental effect	All negative environmental consequences associated with a product or a specific step in the value chain, including the consumption of natural resources, the release of greenhouse gas emissions, and the generation of waste. This term describes the absolute environmental burden without reference to a baseline scenario (see impact)
Global warming potential (GWP)	A metric that expresses the climate effect of a product or process by converting all greenhouse gas emissions into their equivalent amount of CO_2. It provides a standardized way to assess and compare contributions to global warming across different materials and activities.
Grading	The process of assessing the cosmetic condition and technical functionality of a used device to determine its resale potential, including data deletion and cleaning

Glossary

Impact	The difference in environmental effects between an analyzed scenario and its baseline, based on criteria such as resource use, greenhouse gas emissions (e.g., global warming potential), and waste generation.
Lifespan	The total duration a product remains in use - from its first use until it is hoarded or reaches end-of-life - regardless of whether it is actively used or idle during that time.
Rebound effect	An unintentionally triggered increase in consumption that occurs as a result of the availability or use of circular business models. This effect can partially offset the environmental benefits of circularity - for example, when lower prices for second-hand or rental products lead consumers to purchase or use more devices than they would under a linear model.
Refurbishment	The process of professionally restoring used devices to an improved cosmetic/functional condition to improve the reuse/resale potential
Reverse logistics	The system of collecting and transporting used products to enable reuse
Scenario	A specific selection of business model, product and customer group for which the assessment is performed (e.g., a rental business model for smartphones to private end customers)
Use phase	The period during which a device is in the possession of a user and available for use, regardless of whether the user owns or rents the device.
User-initiated repair	All repair activities performed or arranged by the device user, including authorized, third-party, or self-repair
Utilization (also intensity of use)	The actual rate of use of a device compared to its total lifespan, accounting for periods of idle time (in days per year or % of the time)

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Utilization and active use time per device and use phase type

Device	Use phase type	Use time duration (months)	Active use time (months)	Utilization	Source / Assumptions
Smartphone	B2C first use	43,2	43,2	100%	Market report
	B2C second use	43,2	43,2	100%	Market report
	B2C first use before trade-in	26,4	26,4	100%	Market report survey, sub analysis on rebound effect (not published)
	B2C rental phase	18,0	18,0	100%	Conservative assumption
	B2B first use	55,2	55,2	100%	Market report
	B2B first use before trade-in	43,2	43,2	100%	Market report survey, sub analysis on rebound effect (not published)
	B2B rental phase	33,0	33,0	100%	Assumption based on current typical contract duration
Gaming console	B2C first use	45,6	15,1	33%	Market report
	B2C first use before trade-in	26,4	8,7	33%	Market report
	B2C second use	44,4	14,7	33%	Market report
	B2C rental phase	27	8,2	46%	Conservative assumption for typical contract duration

Market report: UNDRESS Circularity market report

Likelihood parameters for business model scenario

Device type	User group	Scenario	Likelihood	Source / Assumption
Smartphone	B2C	Peer-to-Peer transfer	8%	Analysis from market report: % of respondents to transfer their smartphone privately (non-commercial)
		Rental Re-sale after rental phase	85%	Conservative assumption based on blended partner information, expert input and interviews
		Second-hand sale Re-use of traded-in devices	75%	Blended probability of partner data for different business models and expert discussions, reflecting various conditions of devices traded in. The spread between regular trade-in and targeted device purchasing for resale models was significant.
	B2B	Rental Re-sale after rental phase	85%	Conservative assumption based on blended partner information, expert input and interviews
		Second-hand sale Re-use of traded-in devices	70%	Blended probability of partner data and expert discussions, e.g. reflecting lower condition of devices after longer business use
Gaming console	B2B	Peer-to-Peer Transfer	9%	Analysis from market report: % of respondents to transfer their smartphone privately (non-commercial)
		Rental Re-sale after rental phase	85%	Conservative assumption based on blended partner information, expert input and interviews
		Second-hand sale Re-use of traded-in devices	75%	Blended probability of partner data for different business models and expert discussions, reflecting various conditions of devices traded in

Market level information – Market share and resulting active use time

Market level scenario:	Business model level scenario	Market share	Active use time (months)	Weighted active use time (months)	Resulting scenario active use (months)
Pure linear consumption	Baseline	100%	47	46,7	46,7
	Rental	0%	55	0,0	
	Second-hand	0%	59	0,0	
Current market conditions	Baseline	80%	47	37,3	48,3
	Rental	19%	55	10,4	
	Second-hand	1%	59	0,6	
Optimistic scenario	Baseline	20%	47	9,3	54,3
	Rental	50%	55	27,4	
	Second-hand	30%	59	17,6	

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UNDRESS Partners

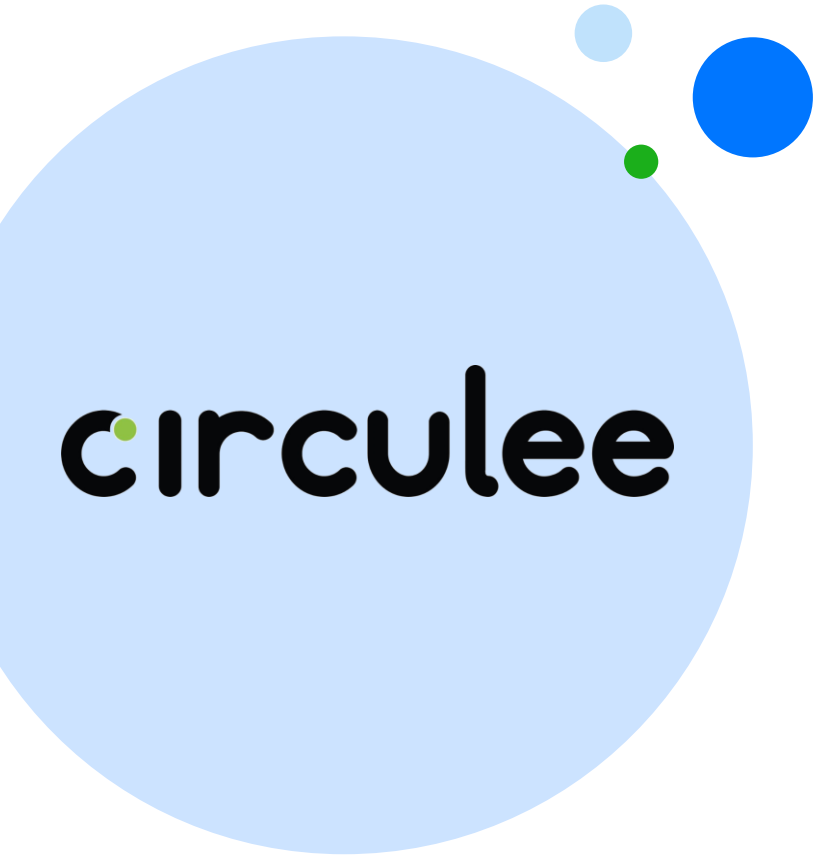


Who we are and what we do

Assurant is a premier global protection company that partners with the world's leading brands to safeguard and service-connected devices, homes, and automobiles. As a Fortune 500 company operating in 21 countries, Assurant leverages data-driven technology solutions to provide exceptional customer experiences.

The company offers a wide of solutions which are designed to support a circular economy by extending the life of mobile devices and minimising electronic waste. In the last 15 years, Assurant's initiatives have managed to repurpose and recycle more than 180 million devices worldwide, which has diverted over 36,000 metric tons of e-waste away from landfills. This has also helped to avoid 9.4 million metric tons of CO2 emissions through device reuse.

Assurant's Device Care Centres utilise advanced robotics, AI, and automation to process, inspect, and grade devices efficiently, ensuring high throughput and quality for the secondary market. The company's sustainability initiatives are further supported by solutions like CarbonIQ, which tracks the carbon footprint of devices throughout their lifecycle, helping clients achieve circularity and net-zero goals. Through these efforts, Assurant not only reduces environmental impact but also supports digital equity by making certified pre-owned devices accessible to a wider audience.



Who we are and what we do

circulee is a Berlin-based company advancing the circular economy in the electronics industry by providing certified refurbished IT hardware to small and medium-sized enterprises. Co-founded and supported by CHG-MERIDIAN, a leading international technology manager and financing expert, circulee leverages over 40 years of lifecycle management expertise to deliver high-quality, sustainable solutions. Devices - including laptops, smartphones, and monitors from top brands like Apple, Samsung, Lenovo, Dell and HP - are professionally refurbished using certified processes in CHG-MERIDIAN's technology centers, ensuring reliability and data security.

circulee's offering includes a digital device management platform, rapid delivery, a twelve-month warranty, and automated CO_2 and e-waste impact reporting, making sustainability both accessible and measurable for clients. By extending device lifecycles, circulee enables companies to reduce IT procurement costs by up to 50% and cut their carbon footprint by 70–80% compared to buying new equipment.

Who we are and what we do

Deutsche Telekom is one of the world's leading integrated telecommunications companies, serving approximately 261 million mobile customers, 25 million fixed-network lines, and 22 million broadband lines. Active in more than 50 countries, the company provides fixed-network, mobile communications, internet, and IPTV products and services to consumers and businesses across Europe and the United States.

We place particular emphasis on sustainable features when designing our products. This includes our telecommunications services, the related devices, including plastic-free packaging, and low-carbon shipping to customers.

Together with our partners for buy-back, refurbishment or collection services, we create conditions so that our customers can use the devices for longer, and for ensuring that the hardware can be reused or professionally recycled at the end of its service life. We use low-threshold return mechanisms for this, such as collection boxes in all stores.



In addition, we engage in specific customer outreach or offer buy-back options to purchase used but still high-quality customer devices.

In 2024 we have globally

- taken back more than 11 million mobile devices
- taken back more than 4.5 million fixed line devices (CPEs), >40% of which have been refurbished. Our aim is to ensure that all returned CPEs are either refurbished, stored for future processing, or recycled.

Who we are and what we do

Everphone is the one-stop solution for over 400k company smartphones, tablets and workplace solutions. The EU & US-based company leads the DaaS market with more half a million devices under management - as non-leasing alternative. Their platform manages procurement, system integration & refurbishment for devices such as smartphones, tablets and laptops for international enterprise customers.

The “DaaS” (Device as a Service) provider offers corporate customers GDPR-compliant mobile device management (MDM), a suitable telephone plan, quick replacement service in the event of defects as well as refurbishment & reintegration of used devices.
With Everphone’s service, companies no longer have to worry about anything concerning their mobile devices. If a device is broken, replacement devices are included in our service. Unusable smartphones are no longer sitting in the drawers of companies. As a result, critical earth resources are saved and less is produced overall. The devices are kept in the value chain for as long as possible.



Who we are and what we do

FixFirst is a GreenTech startup that aims to end the throw-away world by making circular services such as repair easy, accessible, and attractive - for everyone.

Their workflow and ai-tools for repairers increase service efficiency by up to 70% and the booking platform fix1.today enables brands and cities to offer and scale circular services while ensuring compliance with new regulations for EcoDesign and the Right-to-Repair. Customers include service providers (for maintenance, repair, refurbishment or recycling) and service operators (like manufacturers, retailers, insurances or cities).

Their vision is a world where fixing products comes first.
More here: https://linktr.ee/fixfirst



Who we are and what we do

Foxway is a leading European provider of circular technology services, specializing in sustainable lifecycle management for IT and consumer electronics. With over 1,200 employees, Foxway operates across more than 130 countries, serving large organizations, the public sector, and resellers through a network of nearly 6,500 sales points. The company's comprehensive portfolio includes Device as a Service, IT asset disposition, recovery, refurbishment, remarketing, and secure data management for devices such as smartphones, laptops, and other IT equipment.

Foxway's core contribution to the circular economy lies in maximizing the lifespan of electronic devices. By refurbishing and redeploying used equipment, Foxway enables devices to have second, third, or even fourth lifecycles, significantly reducing e-waste and conserving resources. When devices reach end-of-life, Foxway ensures responsible recycling and material recovery, supporting both profitability and sustainability for its customers and partners. Their mission is to enable sustainable tech for as many as possible, with the ambition making digital access less damaging to our planet.



Who we are and what we do

Grover enables people and empowers businesses to subscribe to tech products flexibly instead of buying them. Founded in 2015, Grover's mission is to make exceptional technology more accessible. With Grover and Grover Business, currently over 300k active subscribers and companies get access to a wide range of over 1,000 tech products, including smartphones, laptops, virtual reality (VR) gear, and wearables on a flexible, monthly rental basis.

Rentals are available in Germany, Austria, the Netherlands, and Spain at GROVER.COM, as well as in Germany through Grover's online and offline partner network, including Europe's leading electronics retail group, MediaMarktSaturn. Grover's business model of renting out and refurbishing tech products contributes to devices being used more frequently and for a longer period. This increases the potential to avoid e-waste. To date, Grover has circulated over 1.9 million devices, and employs around 300 people across ten countries.



Who we are and what we do

Ingram Micro Lifecycle is a global leader in lifecycle extension services, dedicated to **enabling a circular economy** for technology products. We offer tailored state-of-the-art solutions that address the return, refurbishment, repair, and recommerce of technology products. These solutions help our customers maximize the value and lifespan of their electronic devices, maintaining a transparent chain of custody and compliant data handling.

With a presence in over 57 countries and 134 logistics and services centers, we support a wide range mobility and IT OEMs, providing services for a wide range of devices, including smartphones, laptops, servers, and enterprise IT equipment. Our comprehensive suite of environmentally responsible services is designed to meet the unique needs of operators, retailers, insurers, enterprises, and OEMs.

Our centers are audited to industry standards, varying site to site, including ISO 14001, 45001, 22301, 27001, 9001, 21964, R2 v3, and e-Stewards. We have a track record of boosting customer NPS, enabling lower e-waste, and scaling refurbished electronics fulfilment.



Who we are and what we do

rebuy is a leading European second-hand sales company headquartered in Berlin, employing over 600 people from 28 countries. With operations in seven active markets - Germany, Austria, France, the Netherlands, Spain, and Italy - rebuy trades approximately 9 million items per year. The company specializes in buying and selling pre-owned electronics and media, including smartphones, laptops, tablets, games, books, and more.

rebuy's business model centers on the circular economy: they purchase used devices from consumers, rigorously test, refurbish, and resell them with a warranty, thus extending product lifecycles and reducing electronic waste. Their advanced grading and refurbishment centers, including automated smartphone grading, ensure quality and efficiency. By enabling the reuse of millions of devices, rebuy is preventing over 200t of electronics waste per annum and saves 35.000 trees, making a significant contribution to sustainability and resource conservation in the electronics sector.

Who we are and what we do

Recommerce Group is the European leader in the trade-in, refurbishment and resale of hightech products. In 2024, Recommerce has crossed over 180M€ in turnover and processed 800,000 devices.

Operating in over 25 countries, we enable all players to enter Circular economy through comprehensive and innovative trade-in and resale solutions– across all product categories, from consumer electronics to gardening products. Since 2009, we've collected and refurbished over 6 millions devices and returned €370M to consumers and therefore boosting European purchasing power through trade-in programs.

We stand out through our commitment to quality and transparency attested with the Label RecQ, Quality refurbishment by DEKRA and our various ISO Certifications (9001, 14001 and 27001).

Our purpose is to extend the lifespan of consumers products and accelerate the circular economy at scale - combining economic, environmental, and social value for our partners. We are selling 28 000 Carbon Credits to industrials who want to reduce their environmental footprint.



Who we are and what we do

RLG, part of Reconomy Group, combines advanced technology, deep expertise, and passionate people to support the circular economy, reducing waste and conserving resources. Our vision is a waste-free world powered by circular growth.

We deliver data-driven solutions for returns, reuse, recycling, and disposal - ensuring consistency across global operations. Our services include:

- Environmental Compliance, giving support and tools in operating Producer Responsibility Organisations (PROs) to comply with environmental legislation;
- Data Management, fulfilling data requirements of Extended Producer Responsibility (EPR), and providing valuable insights and reporting;
- Deposit Return Systems design and implementation;
- Development of Circular Take back Solutions;
- and Consultancy and Advice.

With operations in over 80 countries and 26 local hubs, RLG provides scalable, sustainable solutions worldwide. Our extensive product and packaging database enhances environmental performance and compliance, and with more than 600 employees dedicated to environmental progress, we are actively fostering innovation and commitment to sustainability.



Who we are and what we do

As one of the leading telecom providers in the country, we bring people, businesses, and machines together across Germany. Whether it's browsing, calling, or streaming – millions of customers rely on our network every day.

But staying connected also means taking responsibility.
With our Climate Transition Plan, we're working towards science-based targets to become net zero* by 2040 – across our entire value chain. Because we believe in driving change, not just connection.

And that goes beyond connectivity:
We're a large provider of mobile and fixed devices in both the consumer and business space. That comes with responsibility – and we're committed to building a circular economy for devices. Our goal: extend the life of products and help customers make lower-carbon choices.

And we're already seeing real results:

- Fixed devices like routers and TV boxes are rented to our customers. More than half of the returned devices are refurbished and reused – this has enabled us to give several million devices a second life.
- The life of smartphones can be prolonged with a 36-month financing option. Used smartphones can be returned via our Re-trade or Recycling Service. And with our One for One programme, we take it a step further: for every new phone sold to a private customer, we collect a used device for recycling – in countries without proper recycling infrastructure. So far, we've collected over 2.7 million phones.

More circularity, less CO_2 – and a clear step towards a more sustainable future.

**Net zero means that we reduce our CO2e-emissions by at least 90% and offset unavoidable residual emissions with certified climate projects*