GUIDE ON CIRCULAR TRANSFORMATION OF ELECTRICAL AND ELECTRONIC EQUIPMENT

EDITORS

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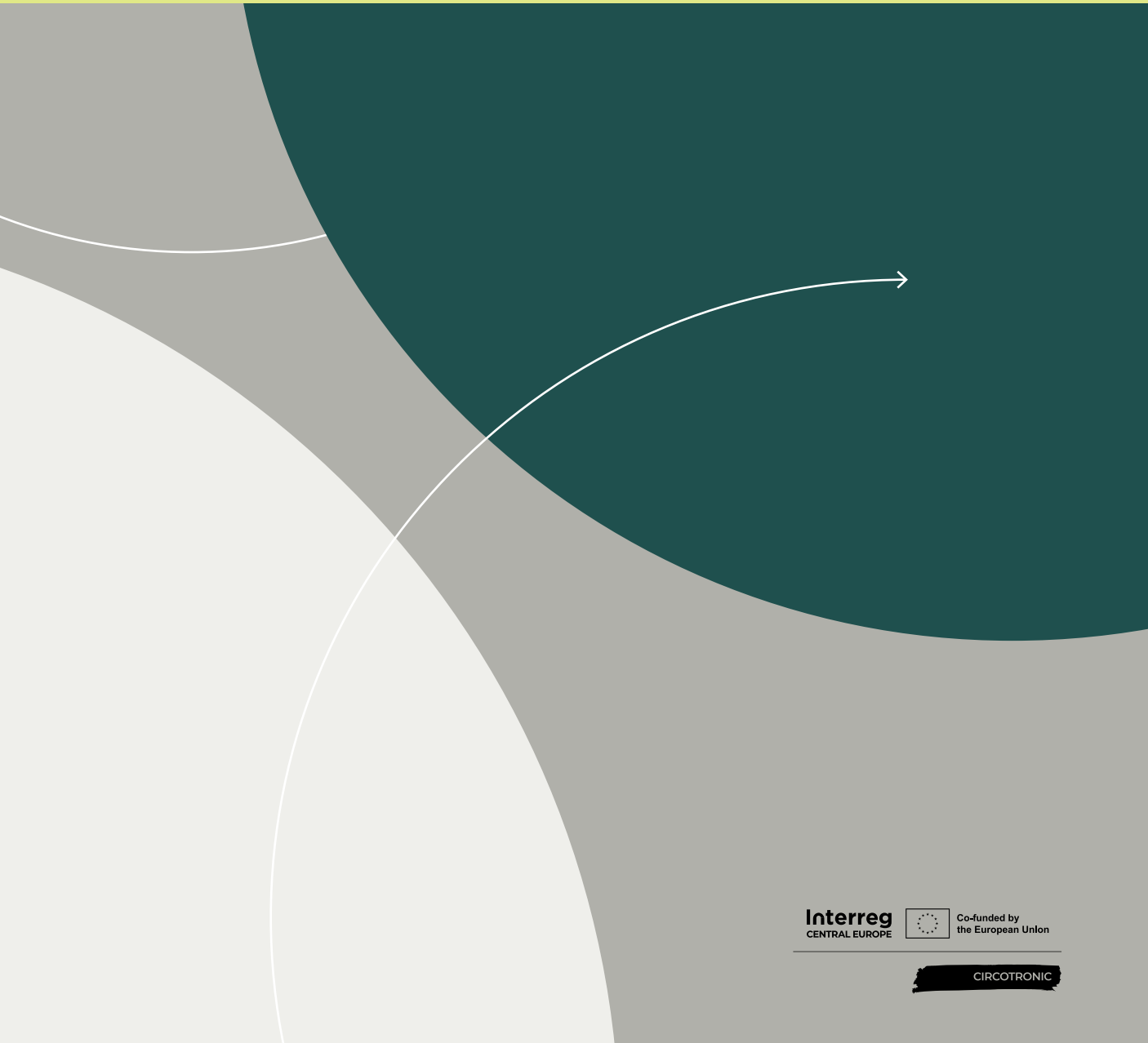

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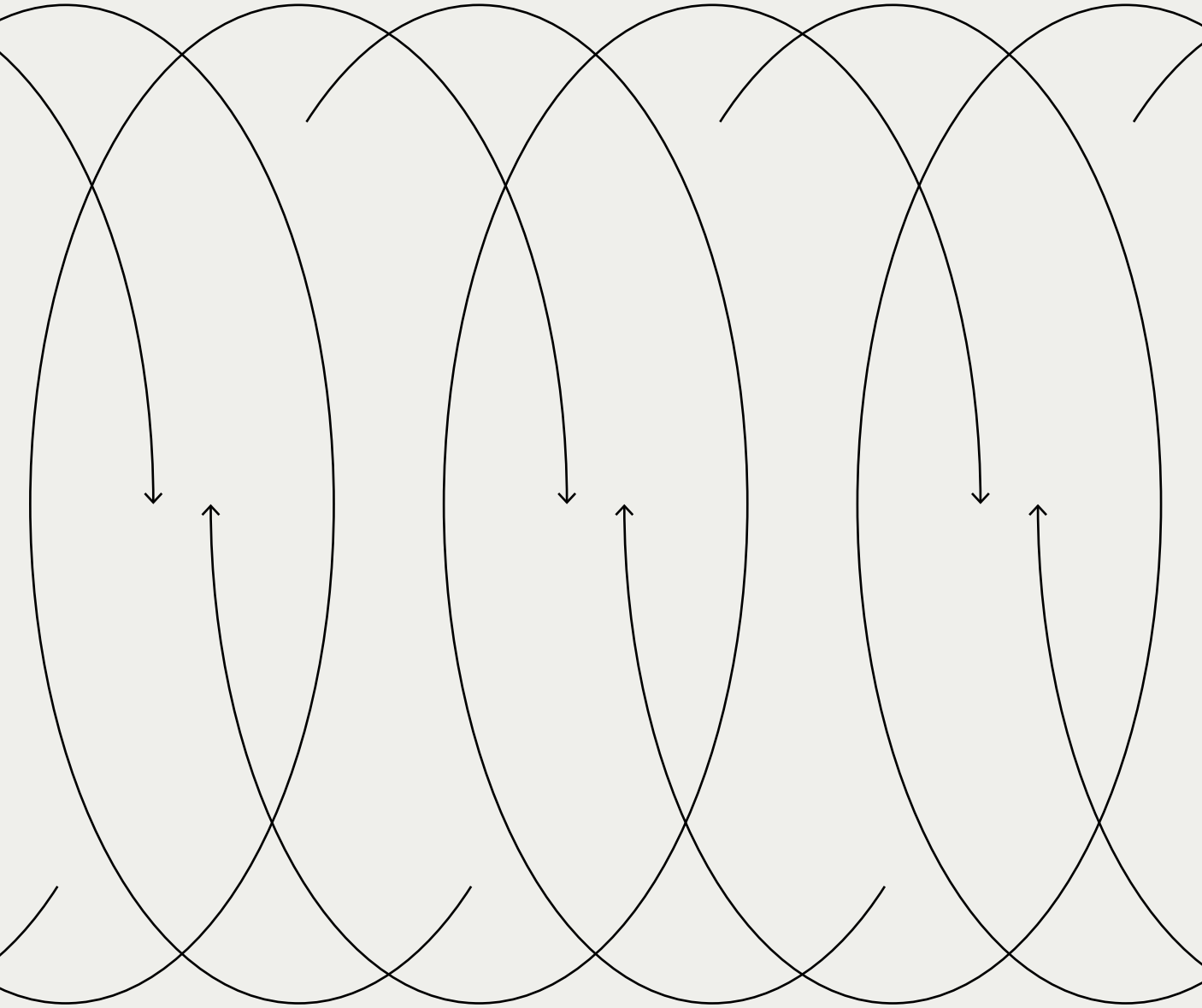

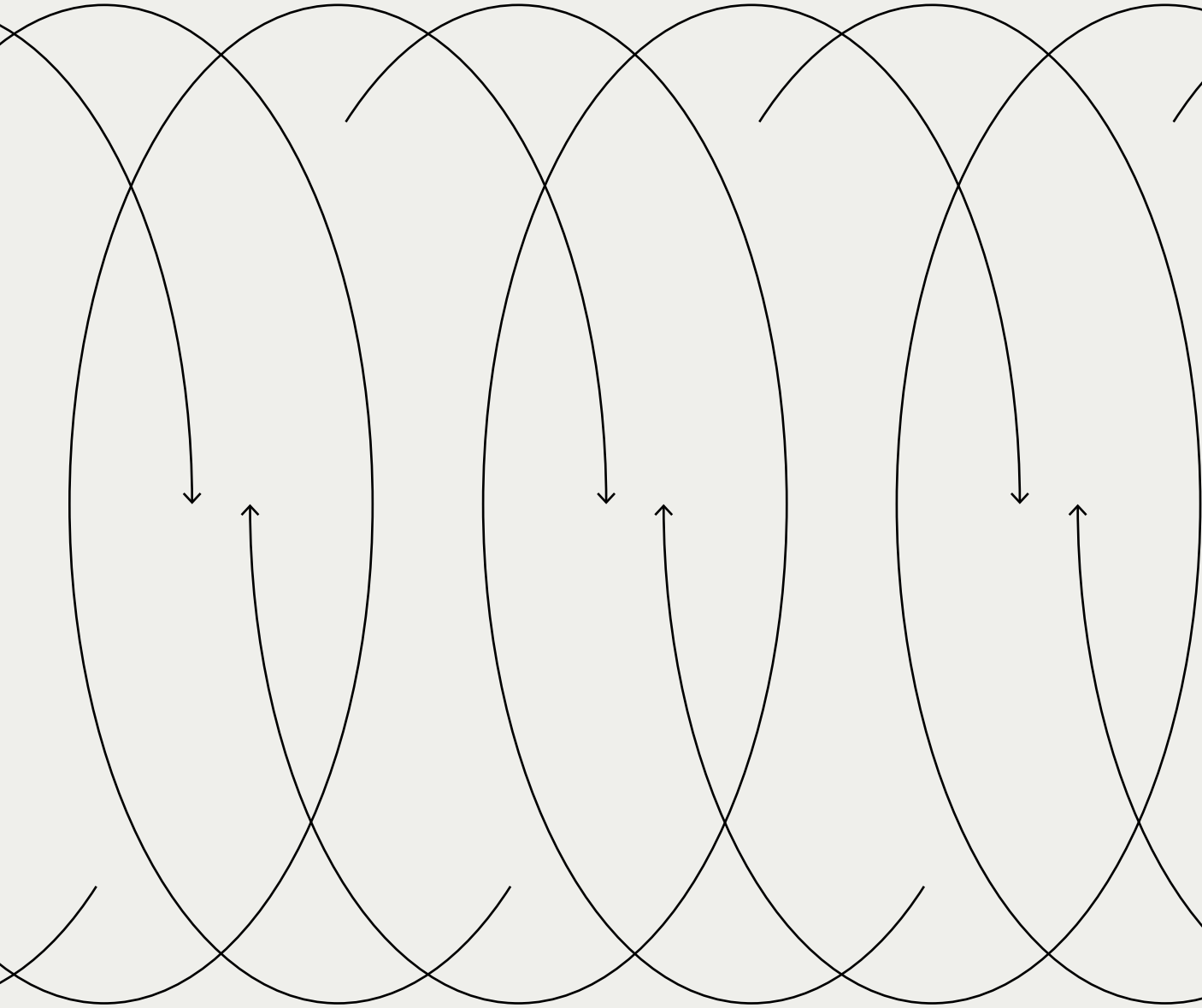

Acknowledgement

This guide is one result of the Interreg CENTRAL EUROPE project: CIRCOTRONIC - Transnational Network of Circular Labs for EEE.

CIRCOTRONIC is a three-year Interreg project (2023-2026), where the overall aim is to improve the circular economy of electronic products (EEEs). Together with Small and Medium-sized Enterprises (SMEs), circular products and business models are developed, circular hubs for information exchange created and a catalogue of measures for political implementation is developed.

In the first work package various tools were developed or selected on the topics of design, materials & recovery, and business models and value chains. The tools have been tested with SMEs of the EEE sector and circular solutions have been developed. As outcome of the learnings of this practical application the guideline for transformation has been developed.

Additionally, “circular” labs have been created, where experiences will be exchanged in an international network to support the development of circular solutions. In the last part of the project political framework conditions and necessary measures have been defined in order to further realize the circular economy for EEEs.

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ABBREVIATIONS

ABS	Acrylnitril-Butadien-Styrol
B2B	Business to Business
BOM	Bill of Materials
CBM	Circular Business Model
CE	Circular Economy
CEAP	Circular Economy Action Plan
CSRD	Corporate Sustainability Reportung Directive
DMC	Domestic Material Consumption
DPP	Digital Product Passport
EEE	Electric and Electronic Equipment
EPD	Environmental Product Declaration
ESG	Environmental, Social, Governance
ESPR	Ecodesign for Sustainable Products Regulation
ESRS	European Sustainabilty Reporting Standard
GDP	Gross Domestic Product
GRI	Global Reporting Initative
ICT	Information and Communication Technology
IoT	Internet of Things
LCA	Life Cycle Assessment

PaaS	Product-as-a-Service
PC	Polycarbonate
PCB	Printed Circuit Board
PCDS	Product Circularity Data Sheet
PET	Polyethylene terephthalate
PP	Polypropylene
PV	Photovoltaic
Q&A	Questions & Answers
SME	Small and Medium-sized Enterprises
SPI	Sustainable Products Initiative
VSME	Voluntary Standard for Sustainability Reporting

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Guide overview

This guide is a result of the Interreg CIRCOTRONIC project.

The aim of this guide is to give SMEs hands on information on topics and steps to be addressed on their way on the transformation from a linear to a circular company. This guide is structured in three parts. In Part I the knowhow (theoretical content, tools, etc.) that can be helpful for such a transformation is described. Part II presents three examples of SMEs from the Electric and Electronic Equipment (EEE) sector, that have applied the tools and know-how during the testing phase in the CIRCOTRONIC project to improve their products and services. Part III includes Questions & Answers (Q&A) on the general transformation process and tool specific questions which have been asked by several SMEs during the testing phase.

The aim of Part I is to provide SMEs with the needed information on resource issues and the regulatory requirements in order to motivate companies to start the transformation process. The main focus in this part lies on the theoretical content and frameworks needed for such a transformation. In each chapter supportive tools are mentioned, their application is displayed in the case studies, which are presented in Part II. General and tool specific FAQs for the circular transformation are listed in Part III. The key take aways for SME are summarised in a practical way at the end of each chapter. Part I is structured like a roadmap, as depictured in Figure 1 along the main topics Motivation, Implementation and Communication, which breaks down into the following chapters:

- Circular Economy (CE) basics
- Regulatory framework for Circular Economy in the EU
- Life cycle thinking
- Circular products
- Circular materials
- Circular Business Models (CBMs)
- Environmental communication

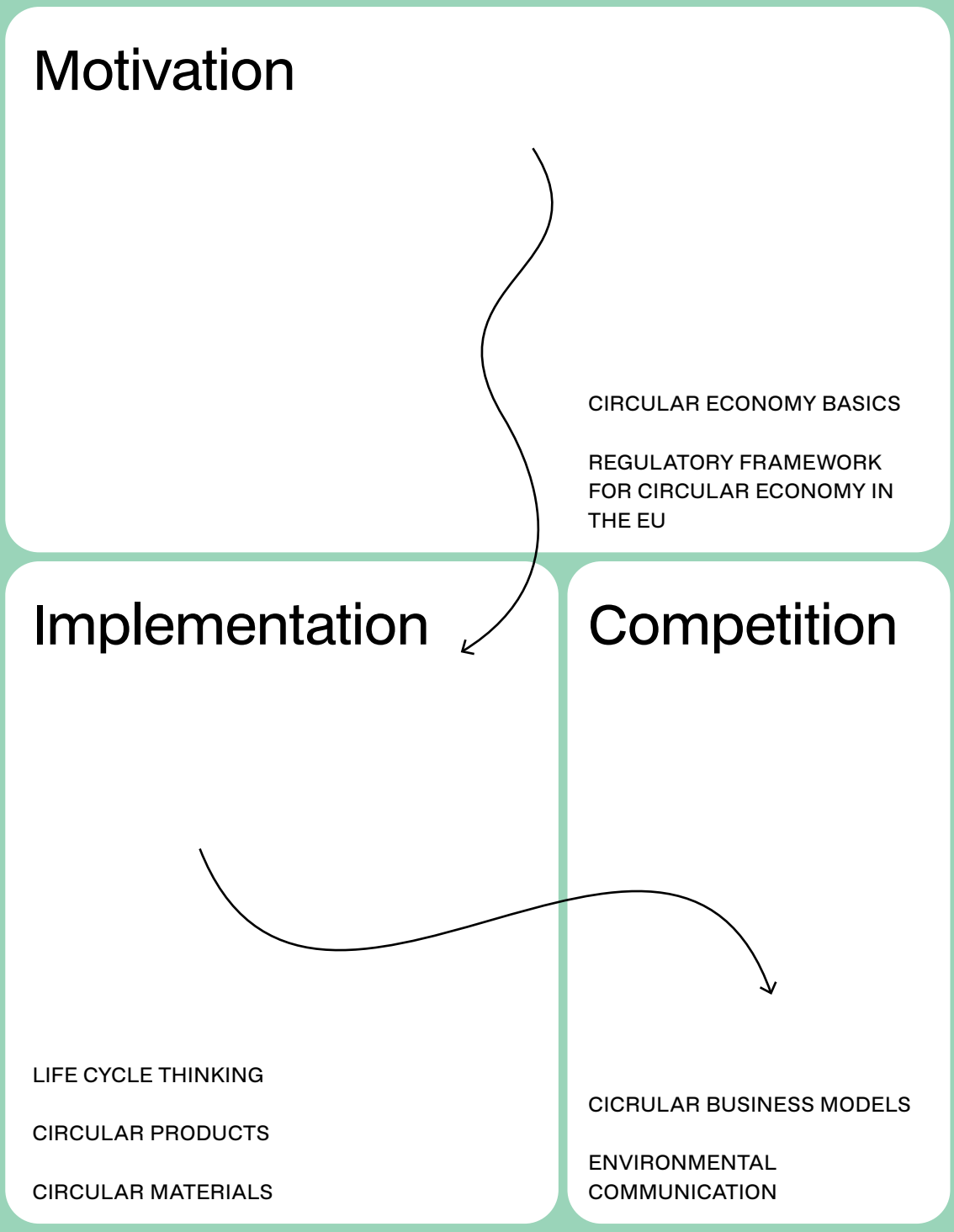


FIGURE 1: ROADMAP OF CIRCULAR TRANSFORMATION & STRUCTURE OF PART I

Part I

Knowhow on the transformation process

MOTIVATION

Circular Economy basics

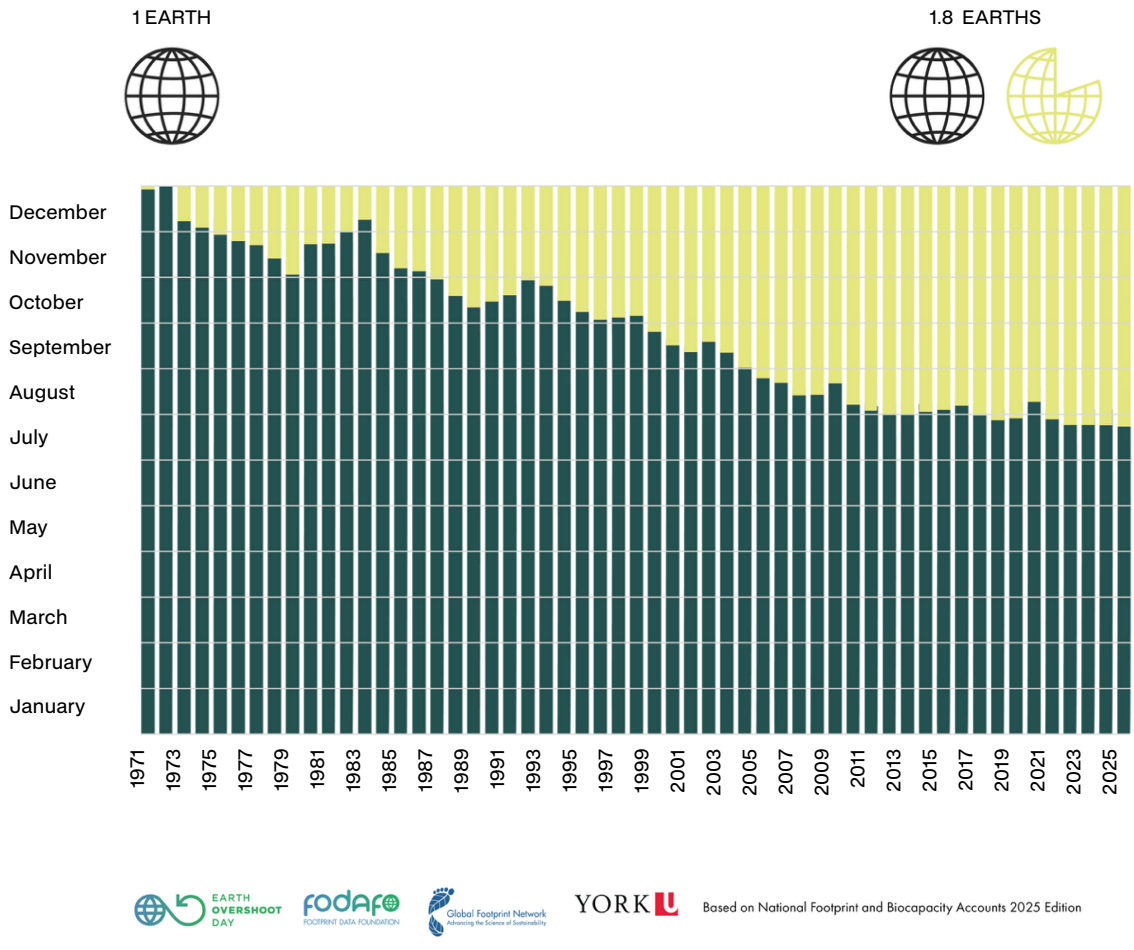
WHAT IS THE RESULT?	Understand the importance and potential of CE
WHAT DO I HAVE TO DO?	Get familiar with main CE strategies
WHICH INSTRUMENTS ARE RELEVANT?	Waste Hierarchy R-Strategies CE-Strategies ISO 59000 series
WHAT DO I HAVE TO WATCH OUT FOR?	Business opportunities when incorporating circularity

The problem of resource overuse

Humanity today faces one of the greatest challenges of modern times: the overexploitation of natural resources. Our current economic model is largely based on a linear “take–make–dispose” system, in which raw materials are extracted, processed, consumed, and then discarded. This practice is neither sustainable in the long term nor compatible with planetary boundaries.

One key indicator highlighting this problem is Earth Overshoot Day (see Figure 12). It symbolizes the day of the year on which humanity has used up all the natural resources that the earth can regenerate within a year. In 2025, this day already fell on July 24, earlier than ever before. This means that we would currently need around 1.75 Earths to continue our lifestyle sustainably - a drastic overuse of planetary resources. Unfortunately, the global demand for resources continues to grow - primarily due to emerging economies such as the BRICS countries and increasing consumption in industrialized nations.

FIGURE 2: EARTH OVERSHOOT DAY 1971 – 2025 [1].



Overexploitation leads to serious ecological consequences, such as deforestation, soil sealing, water scarcity, acidification and overfertilization, climate change, etc. In addition to changing ecosystems and reaching planetary boundaries, overexploitation also increases the risk of geopolitical tensions over critical materials such as rare earths, gallium, palladium and cobalt - which are economically very relevant but carry an increased supply risk. Also many future technologies to limit ecological consequences, such as electric cars, photovoltaic (PV) modules are dependent on critical materials and are therefore at risk.

Electronic waste as an example

The electronics industry is a particularly resource-intensive sector. Smartphones, computers, household appliances - all of these products require rare earths, plastics, metals and other raw materials. The lifespan of electronic devices is also continuously decreasing. Planned obsolescence and products that are almost impossible to repair mean that devices are often replaced after just a few years. As a result, enormous amounts of electronic waste are generated worldwide every year.

According to the Global E-Waste Monitor 2024 [2], around 62 million tons of e-waste were produced worldwide in 2022 - an increase of 82% since 2010. This corresponds to a global amount of 7.8 kg per person per year. Only around 22% of this was collected properly and recycled at best. Only a small proportion of this was reused.

The e-waste that was not officially collected was either collected informally or, in the worst case, ended up in illegal landfills. This often happens in countries with weak environmental legislation, where unprofessional attempts to recover valuable metals such as gold, silver and copper result in toxic substances and heavy metals such as chromium, mercury, lead or brominated flame retardants escaping unfiltered into the environment and polluting people and nature. For example, children and young people burn polyvinylchloride (PVC)-coated cables to get at the copper they contain. The uncontrolled release of refrigerants from the treatment of cooling units also contributes to climate change and the destruction of the ozone layer.

With around 16 kg of e-waste per person per year, Europe is one of the leaders in e-waste generation. In addition to the environmental impact, a large proportion of valuable and critical materials are also lost due to inadequate recycling management. Even through common industrial recycling routes, critical raw materials are hardly ever recycled, as they only occur in very low concentrations in the products and the recycling routes are designed for the extraction of valuable metals such as copper, steel and aluminium.

Decoupling economic growth and resource consumption

The debate on sustainable management increasingly revolves around the question: is it possible to decouple economic growth from resource consumption?

In theory, yes - through increased efficiency, innovation and new economic models such as the CE. In practice, however, this decoupling has so far only been successful to a limited extent. While some industrialized countries are seeing a decline in material consumption per unit of Gross Domestic Product (GDP), absolute resource consumption continues to rise globally.

A look at Europe shows: Domestic Material Consumption (DMC) - is around 14 tons per capita per year in the EU [3], well above the global average (around 9 tons per capita per year). Although countries such as Germany, Sweden and France have made relative progress thanks to recycling quotas and energy-efficient technologies, absolute consumption remains high. Unfortunately, the so-called “rebound effect” often implies that while more efficient technologies can reduce material and energy use, the resulting cost savings tend to increase overall consumption - leading to a higher resource use. The outsourcing of production to other countries also leads to a distorted picture and an apparent decoupling, as GDP increases in Germany, but resource consumption is recorded in another country. Real absolute decoupling would only be possible if overall consumption fell globally despite economic growth.

Overall, global material consumption has tripled since 1970 to over 100 billion tons per year. According to the Circularity Gap Report 2024 [4], only 7.2% of this will be recycled - and the trend is still downwards.

Advantages of the Circular Economy

One key solution towards decoupling is the CE. In contrast to the linear economy, it is based on the principle of keeping materials in circulation for as long as possible - through reuse, repair, recycling and sharing models.

The advantages of a consistently implemented CE are manifold:

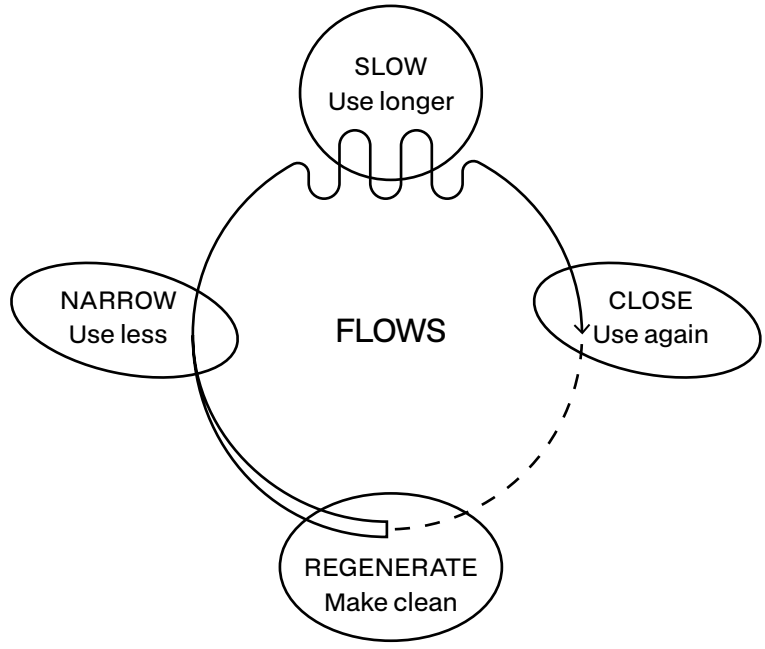
- REDUCTION OF SUPPLY RISKS & RESOURCE CONSUMPTION: Reuse and recycling reduce dependence on imported raw materials - particularly important for critical materials such as rare earths or lithium for batteries. It also reduces the overall consumption of resources.
- GREATER CUSTOMER LOYALTY: Companies that offer durable, repairable products and service models can build stronger customer relationships and stand out from the competition.
- CREATION OF NEW JOBS: The EU Commission estimates that over 700,000 new jobs could be created in Europe by 2030 [5] - particularly in repair, recycling and new business models.
- CLIMATE PROTECTION: A study by the Ellen MacArthur Foundation shows that a CE could reduce global CO_2 emissions by up to 45% [6] - primarily through lower energy requirements, material consumption and avoided emissions in production.
- COST SAVINGS: The reuse of components and materials can reduce production costs.
- NEW BUSINESS MODELS: The innovative strength of companies is strengthened by promoting new business models such as “product-as-a-service”, sharing platforms or take-back systems. Circular companies create a competitive advantage over their competitors through innovative ideas and early adaptation to strict environmental regulations.

The EU supports companies in the transformation towards a CE through funded projects such as CIRCOTRONIC. The framework for this is created by the European Green Deal [7] and the Circular Economy Action Plan (CEAP) [8], among others, presented in more detail in chapter ”Regulatory framework for Circular Economy in the EU”.

Main strategies of Circular Economy

Circular design strategies aim to either **close the loop** (recover resources), **slow the loop** (extend product use), **narrow the loop** (increase efficiency), or **regenerate** (support natural systems and resource renewal). The four strategies are shown in Figure 3 and serve as common thread within this guideline - all discussed in this report are a part of one of those four. **Closing** means that resources are recovered (not incinerated!) from products when they are disposed, which increases economic resilience and reduces virgin material consumption. **Slowing** means that products are designed to last, not to break, which enables new business models as "Product as a Service" and creates trust to customers. **Narrowing** stands for using only as much as needed – we should have in mind how much material is actually necessary for our products, which also leads to increased economic efficiency. **Regenerate** addresses our environment and social structures. Eliminate critical raw materials that cause human suffering and environmental pollution wherever you can – to enable our ecosystem for regeneration.

FIGURE 3: MAIN CE STRATEGIES [9].



A widely applied strategy-package which leads to slowing, closing, regenerating and narrowing are the **R-strategies**: Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle and Recover. Note the order of those strategies, as they correlate with the value of a product, starting by waste prevention where value is captured, ending with incineration or disposal (landfill) where value is lost entirely. In the following depiction you will find an overview summarizing the bespoken strategies, which are widely accepted across CE publications and will accompany you through this guideline.

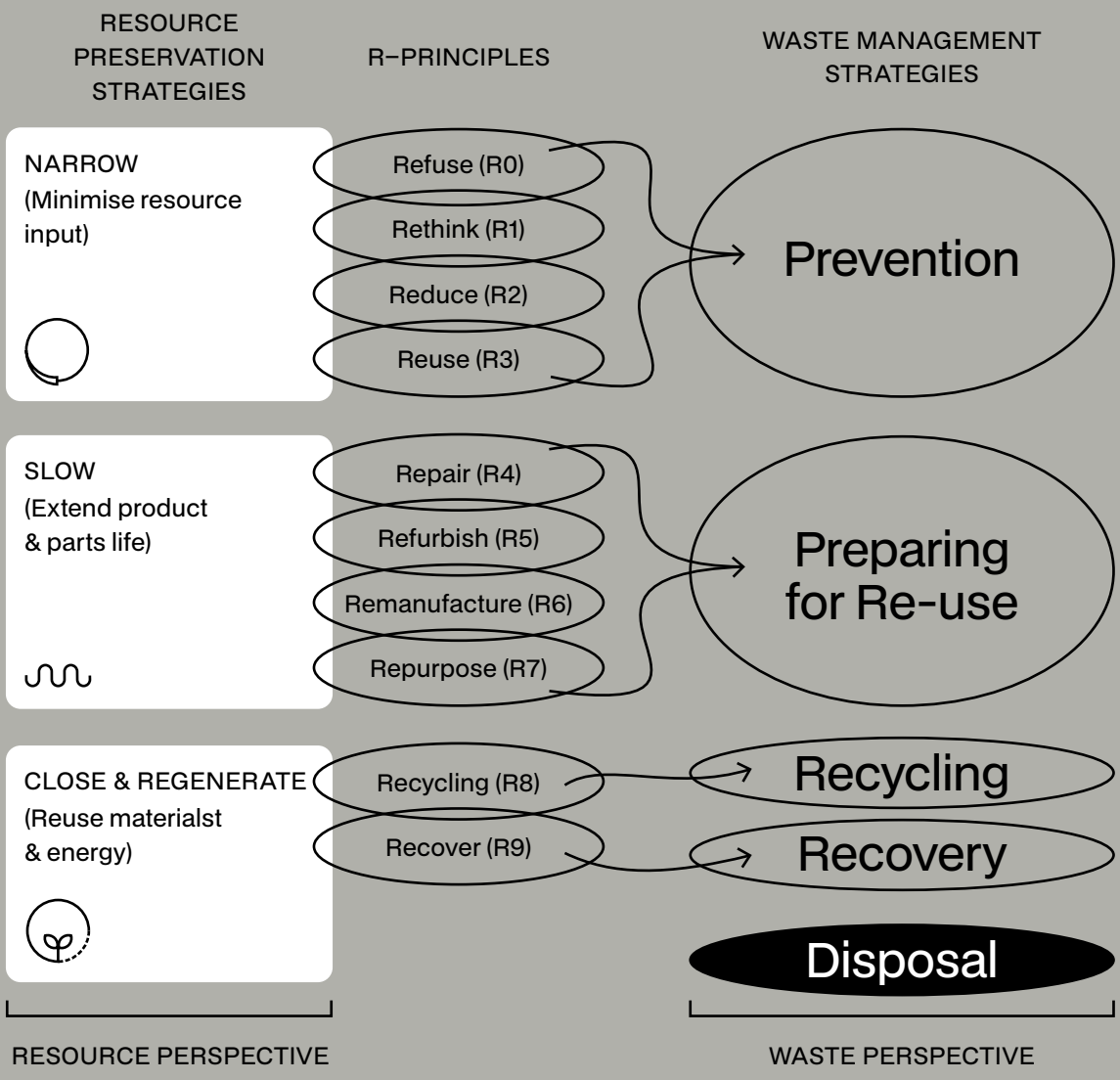


FIGURE 4: WASTE HIERARCHY, R-STRATEGIES AND CE STRATEGIES CONNECTION [10].

FIGURE 5: FAIRPHONE 6 [11].

Practical example: Fairphone

The Dutch company Fairphone tries to incorporate the principles of the CE in their products. It produces modular smartphones, as presented in Figure 5, that focus on repairability, fair working conditions, and transparent supply chains.

The most important circularity features of the “Fairphone” are:

- Modular design: users can replace components such as the camera, battery or display themselves – without the need for special tools. For example, the battery can be replaced in just a few seconds by opening a quick-release fastener. Spare parts are also readily available. So, components are used longer as only broken or outdated ones are exchanged (**slowing**).
- Sustainable materials: Use of recycled plastic (**closing**), conflict-free minerals and fairly traded gold (**regenerate**).
- Longevity and updates: Fairphones receive software updates for many years, which keeps them longer in use than usual (**slowing**).

Fairphone shows that technological innovation, economic success and social and ecological responsibility are compatible. Even though the company only has a small market share so far, it serves as a role model for a radically different approach in the electronics industry.

ISO 59000 series: standards for Circular Economy

The ISO 59000 series is a set of international standards that help companies and organizations move from a linear “take, make, use, throw away” economy to a circular economy. ISO 59004 [12] explains the main ideas, important rules, and practical tips for using these standards. ISO 59010 [13] gives advice on changing business models and networks to work in a circular way. ISO 59020 [14] provides ways to measure and check how circular a system is. ISO 59040 [15], which focuses on product data sheets, and ISO 59014 [16] which looks more closely on how to recycle materials safely. There are also two technical reports, ISO/TR 59031 [17] and ISO/TR 59032 [18], which give examples and advice on how businesses can use these standards. Together, all these documents help organizations plan, measure, and improve their circular economy efforts. Figure 6 presents an overview of the ISO 59000 family of standards on CE.

Figure 1 - ISO 59000 family of standards

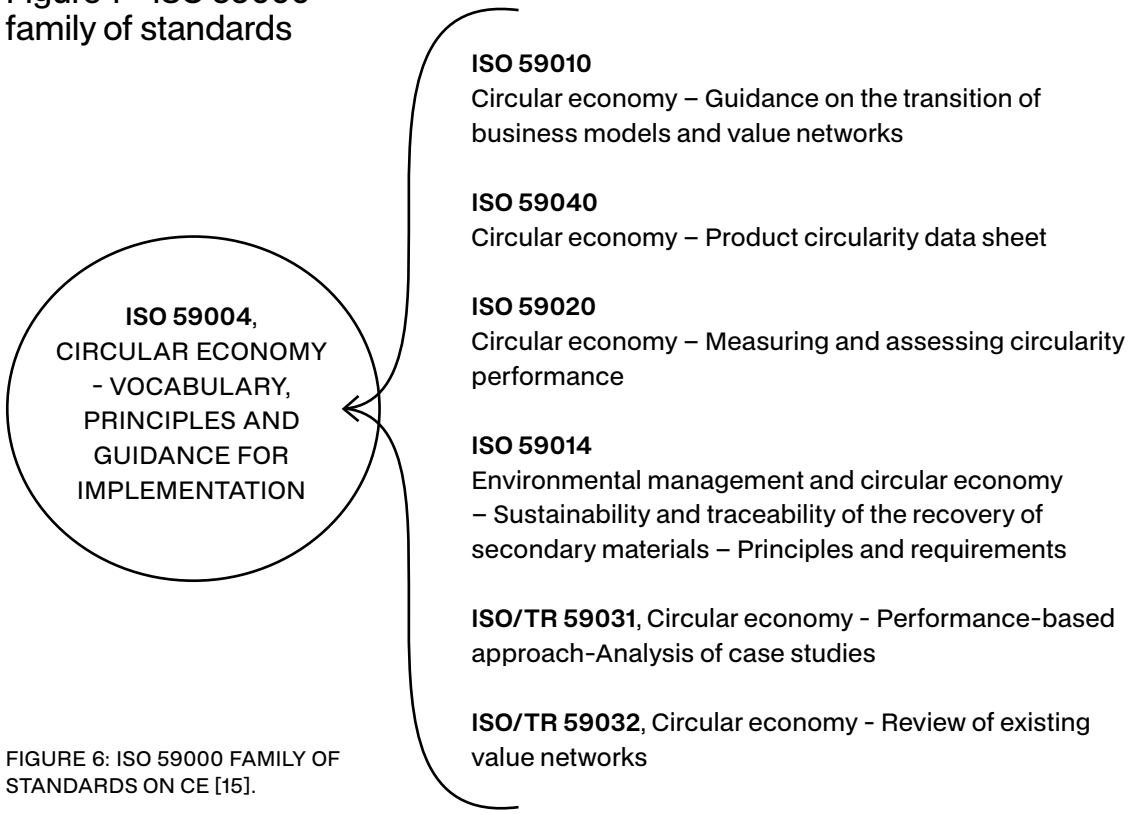


FIGURE 6: ISO 59000 FAMILY OF STANDARDS ON CE [15].

Supportive tools

To understand the importance and possibilities of circularity and sustainability two tools are available that helps companies to get into this topic. Q&As of these tools are presented in Part III.

Strategy for Circularity and Sustainability

This tool guides SMEs in developing a comprehensive strategy for circularity and sustainability. Using a modular approach, it helps businesses understand their current state, set a vision, involve stakeholders, and integrate circular goals into operations and long-term planning. It connects to other tools in the toolbox to support informed decision-making and implementation.

Future Scenarios

This tool helps companies explore potential future developments through structured scenario planning. By examining key drivers of change and building multiple scenarios, it enables businesses to anticipate risks, identify opportunities, foster innovation, and improve strategic resilience in a rapidly evolving environment.

Take-away for SMEs: A transformation is possible

Current trends in resource consumption and waste generation clearly show that “business as usual” is not an option. The Earth Overshoot Day is being reached earlier every year, e-waste volumes are rising and global demand for raw materials is constantly increasing.

Decoupling economic growth and resource consumption is technically possible, but requires a rethink in politics, business and society. The transition to a CE offers a key opportunity here - ecologically, economically and socially.

Examples such as Fairphone prove that sustainable innovations are feasible and can result to a competitive product on the market. A determined political/regulatory framework, international cooperation and a change in awareness among consumers and companies will foster the transition towards circularity.

Regulatory framework for Circular Economy in the EU

WHAT IS THE RESULT?	Know the most relevant CE regulations and their requirements on product and component level
WHAT DO I HAVE TO DO?	Screen relevant CE regulations and their updates
WHICH INSTRUMENTS ARE RELEVANT?	EU Green Deal Circular Economy Act Circular Economy Action Plan Ecodesign for Sustainable Products Regulation Digital Product Passport EU Taxonomy
WHAT DO I HAVE TO WATCH OUT FOR?	Prepare for the upcoming EU regulations on Ecodesign and Circularity

The European Union has established a comprehensive **CE legislative framework** that fundamentally transforms how products are designed, produced, and managed throughout their lifecycle according to circular principles. At the core of this framework lies the recently enacted **Ecodesign for Sustainable Products Regulation** (ESPR) [19], which represents a significant shift from the traditional linear economy model toward a circular approach that prioritizes resource efficiency, product durability, and waste prevention. The new framework establishes mandatory requirements that extend beyond energy-related products of the previous Ecodesign directive to encompass virtually all physical goods placed on the EU market.

Complementing this initiative, the upcoming **Circular Economy Act** [20], proposed for 2026, will further strengthen legal frameworks, establishing binding targets and measures to ensure the effective implementation of circular principles across member states. These legislative efforts are pivotal in driving the EU towards a more sustainable and competitive future, aligning with broader environmental and economic goals. For companies operating in Central Europe, particularly those embedded in manufacturing and supply chain-intensive sectors, adapting to the EU's expanding legislative landscape on circularity is no longer optional. It is essential for legal compliance, operational efficiency, and future market access.

In this context, several other cornerstone regulations have been introduced and reinforced in recent years, forming a coherent policy framework for sustainable economic transformation. Below is an in-depth examination of the most impactful regulations within the EU's CE agenda, specifically: **the Green Deal** [7] which contains the **CEAP** [8], **Sustainable Product Initiative** (SPI) [21] with the **ESPR** [19], the new **Battery Regulation** [22] and the **EU Taxonomy Regulation** [23]. Each of these legislative instruments presents distinct obligations, opportunities, and implementation challenges that companies must understand and address systematically. In the following a short overview of this non exhaustive list of legislative instruments is presented.

EU Green Deal

The European Green Deal [7] is a concept developed by the European Commission in 2019, which contains a set of policy initiatives regarding clean energy supply, a sustainable industry, mobility, finance and much more for reaching the goal of a climate neutral Europe in 2050. Moreover, the greenhouse gas emissions should be lowered by 55% in 2030, compared to 1990. In this section an overview about selected provisions that address CE are presented: CEAP, SPI and the ESPR. Find their connexion depicted in the following Figure 7.

Circular Economy Action Plan

The CEAP [8] is one of the main building blocks of the green deal, which aims to shift our European economy from a linear towards a circular one; waste should be prevented and resources kept in the EU economy for as long as possible.

ECODESIGN FOR SUSTAINABLE PRODUCTS REGULATION (ESPR) and its integration in the EU Green Deal

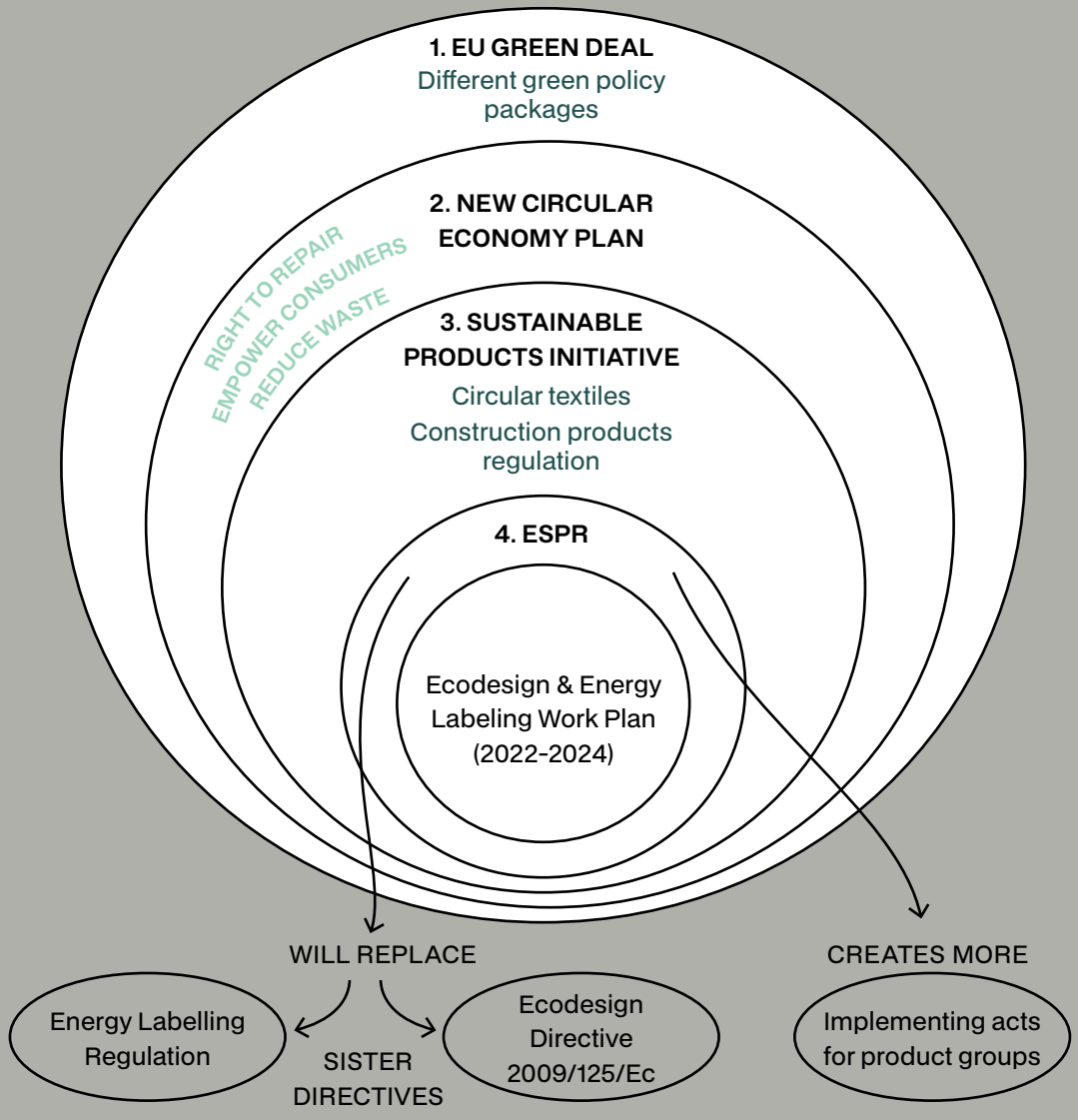


FIGURE 7: EUROPEAN GREEN DEAL POLICY FRAMEWORK [24].

POLICY (-PLAN)

All measures and provisions that are introduced under the action plan object, e.g., that sustainable products become the EU norm, there is a focus on resource intense sectors (including electronics and information and Communication Technology (ICT)), ensure less waste and lead global efforts on CE. The CEAP contains three main actions:

- A **Sustainable Product Initiative**, which include i.e. the “right to repair” and the **ESPR**.
- **Key Product Value Chains**, which include i.e. provisions for packaging waste and also the new **Battery Regulation**.
- **Less Waste More Value**, including i.e. restrictions for waste exports and microplastic pollution.

Sustainable Products Initiative

The central element of the SPI [21] is the ESPR which is about to replace the current Ecodesign Directive [25], extending its scope nearly to all products that are placed on the EU market. The main goal of the SPI is to make those products more sustainable, which could have vast consequences for EU imports as well as for products that are locally produced in Europe. According to the SPI products are more sustainable if they are more **durable, reusable, repairable, recyclable and energy efficient** – so we find circular strategies within Europe’s central ambitions for becoming climate neutral. The SPI explicitly considers **electronics and ICT equipment**, textiles, furniture, steel, cement and chemicals [21].

Ecodesign for Sustainable Products Regulation

The **ESPR** [19] entered into force on **18 July 2024**. It replaces the older Ecodesign Directive and creates a much broader framework for sustainable products. While the Ecodesign Directive only applied to certain energy-related products such as refrigerators, heaters, and computers, the ESPR now covers almost all physical goods sold in the EU, with only a few exceptions such as food, medicines, vehicles, and national security products. The key aspects of the legislation are presented in Figure 8.

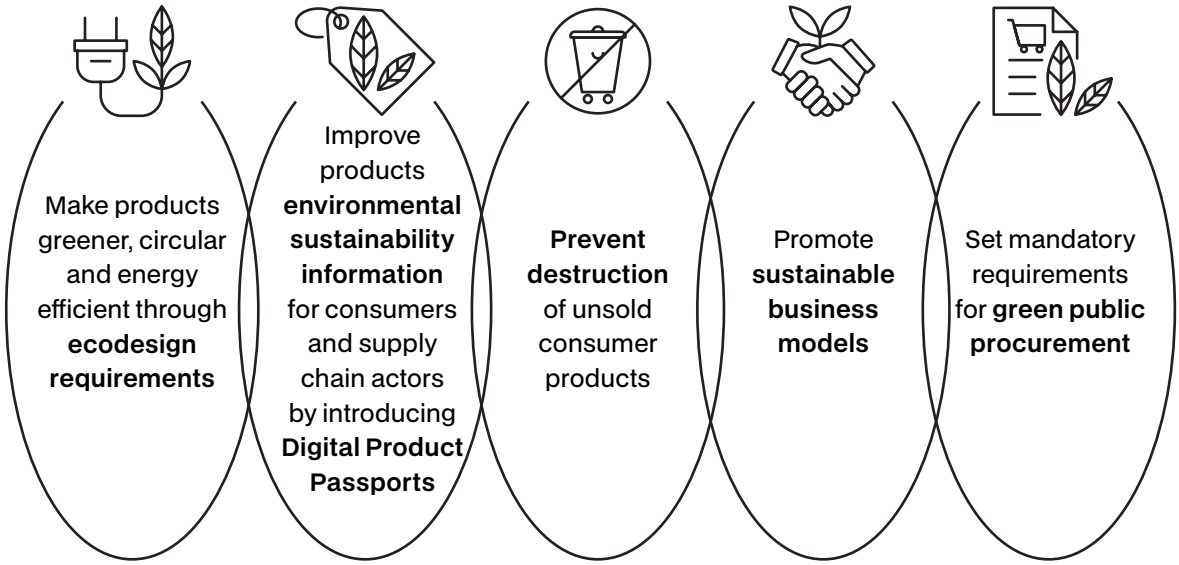


FIGURE 8: KEY ASPECTS OF THE ESPR [26].

The ESPR sets out how products must be developed in the future and lists specific ecodesign requirements. They should last longer, stay reliable throughout their use, and are being built to be repaired or upgraded instead of being thrown away. At the same time, they should use less energy and fewer resources, and they should be designed so that materials can be recovered and recycled at the end of life. The regulation also requires companies to reduce the overall environmental impact of their products. It will help companies to move from traditional linear to Circular Business Models (CBMs). Overall, the ESPR will support EU's transition to a CE.

The ESPR rules for specific product categories are introduced gradually. Washing machines and dishwashers, for example, are planned for 2026, while electric motors will follow in 2028. After each new measure is adopted, companies generally have at least eighteen months to adapt their processes before the rules apply.

One of the most important innovations of the ESPR is the **Digital Product Passport (DPP).** This is a digital record that will address many products and provide key information about, e.g., what they are made of, how durable, reliable, reusable and repairable they are, how much energy and resources they use, and what their environmental footprint is, etc. The DPP will make supply chains more transparent, help companies recover valuable materials, and allow regulators to check compliance more easily. For consumers, it will make it much clearer which products are sustainable, and which are not.

To make this possible, companies will need to collect accurate data and share it across their value chains.

Beyond design and information requirements, the ESPR also introduces new rules on how products are managed on the market. One important measure is the **prevention of the destruction of unsold goods**. Companies will no longer be able to routinely dispose of unsold textiles, electronics, or other products. Instead, they must look for ways to reuse, donate, or recycle them and if not possible they have to communicate how much they dispose.

Another measure is the promotion of **green public procurement**. Public authorities, like some of the largest buyers in the EU, will be required to include sustainability criteria in their purchasing decisions. This creates stronger demand for greener products and encourages businesses to improve their product designs.

Battery Regulation

As described above the new Battery Regulation [22] is not part of the SPI, but of the CEAP action “Key Product value chains”. It entered into force in July 2023, ensuring that batteries that are placed on the EU market are sustainable and circular throughout their whole life cycle – from the sourcing of materials to their collection, recycling and repurposing. This regulation has significant importance as batteries are one key technology for reducing carbon emissions and becoming climate neutral, therefore their demand increases rapidly (by a factor of 14 till 2030), but on the other hand are indispensable, causing environmental pollution. Next to batteries also textile and construction products do have a specific regulation next to ESPR.

EU Taxonomy Regulation

The EU Taxonomy Regulation [23] is a new system for defining which business activities can be called environmentally sustainable and therefore, which one gets a financing. It is based on science and focuses on six main goals: tackling climate change, adapting to its effects, protecting water and seas, promoting a CE, reducing pollution, and safeguarding biodiversity.

The regulation sets criteria and minimum performance thresholds that activities must meet to qualify as sustainable. Companies are also required to disclose how their activities align with these rules, showing both their environmental contribution and whether they meet the “do no significant harm” principle. In addition, businesses must respect minimum social and labour standards.

For firms covered by the Corporate Sustainability Reporting Directive (CSRD) [27], reporting taxonomy alignment is mandatory and includes turnover, capital spending, and operating costs.

Beyond compliance, the taxonomy is reshaping financial markets. Investors increasingly use it to identify credible green investments, while companies must review and report on their operations in detail. This makes sustainability a central part of business planning and signals a shift towards more ambitious environmental practices across the economy.

Supportive tools

To help understanding the complex field of CE regulations, one tool developed within the Circotronic project is available that will make it easier. Q&As of this tool are presented in Part III.

ECODESIGN – THE LEGISLATIVE FRAMEWORK

This tool simplifies access to complex EU legislation on product design and environmental requirements. It provides an online overview of current and upcoming regulations, helping companies—particularly SMEs—understand and integrate legal requirements, such as the Ecodesign for Sustainable Products Regulation and Digital Product Passport, into their product development and strategy.

Take-away for SMEs: Circular Economy – New rules, new opportunities

The shift to a CE is changing business across the EU. New rules, such as the ESPR and the EU Taxonomy, are not standalone measures. They are part of a wider plan to make companies more sustainable, innovative, and resilient. For businesses, the change is significant. Following the law is no longer enough.

Better design practices, such as reducing harmful substances, simplifying disassembly, and lowering production waste, are central for compliance. Furthermore, businesses must develop systems to facilitate the recovery of valuable materials from end-of-life products through design, supplier partnerships, and targeted recycling programs. Companies need to rethink how they operate, get different teams working closely together, and create a culture where sustainability is part of everyday decisions. Those that embrace circular practices will not only meet the rules but also become leaders in Europe's move toward a greener economy.

By focusing on better product design, responsible waste management, clear reporting, and honest communication about the environment, companies can create long-term value, earn trust, and actively support Europe's green goals. See the next chapters how to implement that.

IMPLEMENTATION

Life Cycle Thinking

WHAT IS THE RESULT?	Know how to assess the environmental and circular hotspots of the product and how to select relevant CE-strategies
WHAT DO I HAVE TO DO?	Finding CE-Strategies relevant for the product and aiming for a low environmental impact
WHICH INSTRUMENTS ARE RELEVANT?	Life Cycle Assessment
WHAT DO I HAVE TO WATCH OUT FOR?	The environmental performance of the own products

In order to find improvement hotspots for a circular transformation, the concept of life cycle thinking can be used. **Life Cycle Thinking** [28] involves a holistic approach to product development by considering all phases of a product's life cycle—from raw material extraction to end-of-life. These phases are interconnected: changes in product design, usage patterns, or business models can shift not only the total environmental impact but also the relative importance of each life cycle phase.

By adopting life cycle thinking, designers and decision-makers move beyond focusing solely on production or cost and instead gain a more complete understanding of the product's environmental performance. This approach supports more effective and sustainable design choices by highlighting where the greatest impacts and opportunities for improvement lie.

The **Product Life Cycle** refers to all stages a product undergoes from its creation to disposal. The life cycle phases are presented in Figure 9 and include:

- **Raw Materials**
  Involves the extraction of raw materials and the production of semi-finished goods or components along the upstream supply chain.

- **Production**
  Refers to the actual manufacturing or assembly process. Depending on the product, this can range from resource-intensive fabrication to the simple assembly of pre-made components. Like in the Raw Materials phase, production often results in waste or by-products.
- **Distribution**
  Covers the transport of the finished product and its packaging to the end user. This may include multiple transport stages, such as shipping by container, trucking to logistics hubs, and consumer pickup.
- **Use**
  Represents the operational life of the product. This phase involves ongoing resource and energy consumption — e.g., electricity for a refrigerator or batteries for a remote control.
- **End of Life/Use**
  Encompasses disposal, recycling, or energy recovery (e.g., incineration). While incineration can recover energy, it usually results in material loss and environmental emissions.

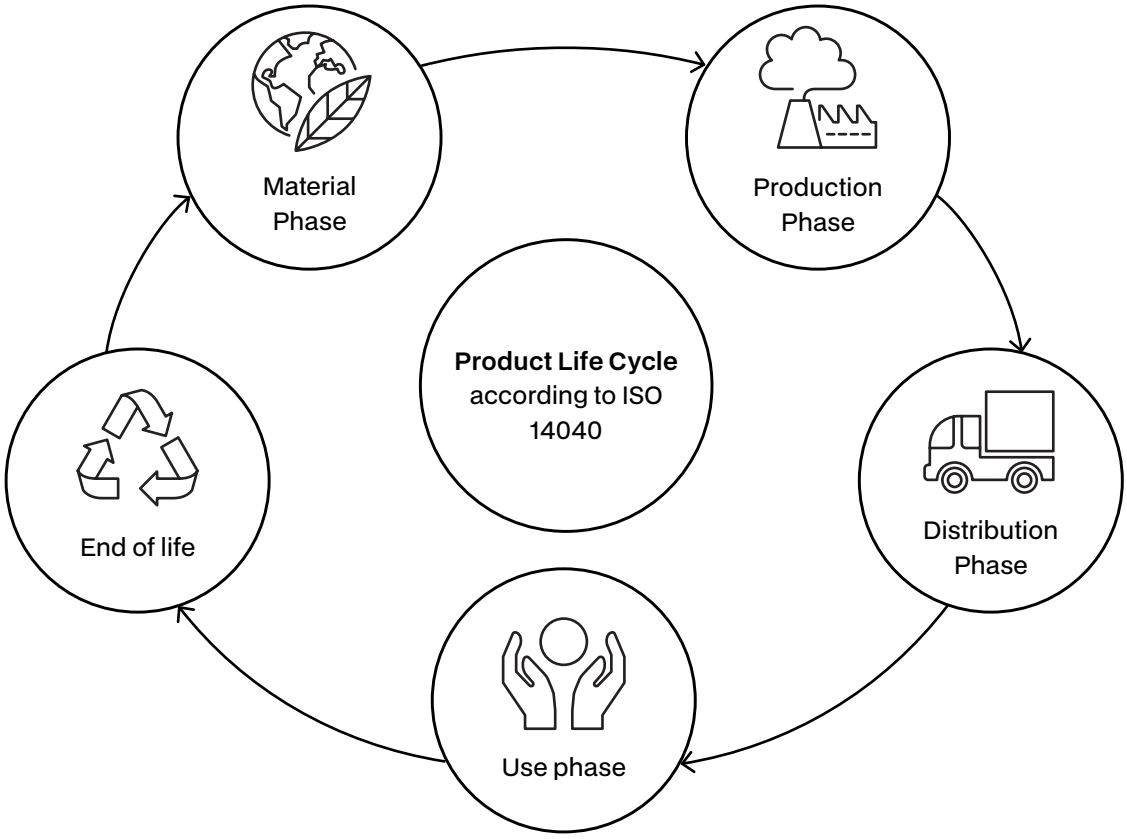


FIGURE 9: LIFE CYCLE STAGES ACCORDING TO ISO 14040 [29].

To assess the environmental impacts of each life cycle phase, an environmental assessment is performed.

Environmental assessment

A wide variety of environmental impacts occur throughout the product life cycle. Products consume resources and generate emissions, which place a burden on the environment. These impacts — on both the environment and human health — can be mitigated through thoughtful product design, particularly by applying the principles of **Ecodesign**. These impacts can be assessed using various tools, such as a full **Life Cycle Assessment (LCA)** according to **ISO 14040** [30], a simplified **LCA Screening**, or qualitative methods like the **MET Matrix** (a methodical analysis of Materials, Energy, and Toxicity across the life cycle). With the help of environmental databases and software tools, detailed digital twins of the product and its life cycle can be modelled and the environmental impacts calculated.

Once the environmental assessment is done, an environmental profile of the product can be created, which highlights the most important life cycle phase.

Types of environmental profiles

Because each phase of the life cycle can dominate the environmental footprint of a product, five types of **environmental profiles can be distinguished**. The most common types are:

- **Raw material-intensive products**
  High environmental impact during material extraction or manufacturing. Examples: Aluminium cans, complex electronics.
- **Production-intensive products**
  Similar to type 1, but the production process itself dominates due to complexity or energy use needed for production processes.
- **Distribution-intensive products** (rare)
  Dominated by transportation impacts, often due to long distances and heavy weights.
- **Use-intensive products**
  The **use phase** has the highest environmental impact due to long-term energy consumption.
  Examples: Refrigerators, washing machines, televisions.

- **End-of-life-intensive products**
  Disposal or recycling phases contribute significantly, particularly for hazardous or long-living waste.

For a better understanding of the concept, a case study of an electric hair clipper is presented.

LCA example: electric hair clipper

The hair clipper* in question has an environmental profile of **Type 1: Raw material intensive**, with minimal contributions from other phases (see Figure 10).

* IN THE FOLLOWING THE LCA OF AN ELECTRIC HAIR CLIPPER IN PERSONAL AND PROFESSIONAL USAGE ARE ANALYSED AND DOCUMENTED. THE ENVIRONMENTAL PROFILE IS DEFINED AND POSSIBLE IMPROVEMENT OPTIONS SUGGESTED

In typical **personal use**, the device is used briefly and infrequently, and its environmental impact is dominated by materials, especially the **charger unit**. Key design improvements focus on reducing the impact of the charger by using a **universal or smaller design** and **minimizing material use** and complexity to **enhance recyclability**. Additional strategies include designing for disassembly, using fewer or lower-impact materials, and extending the product's lifespan through replaceable parts.

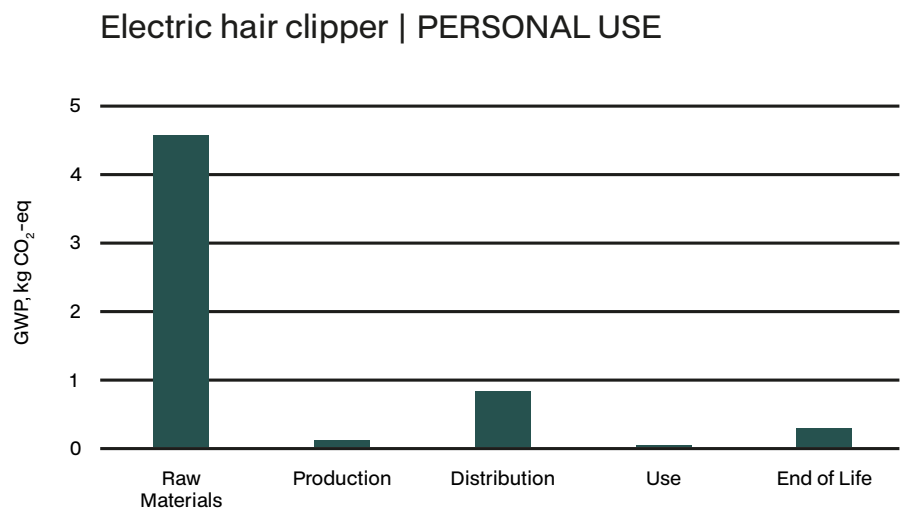


FIGURE 10: ENVIRONMENTAL PROFILE ELECTRIC HAIR CLIPPER, PERSONAL USE (OWN SOURCE).

However, in a **professional context**, such as a hair salon, the same product may be used **daily for extended periods** over multiple years. This shift raises several questions:

- Does the usage pattern alter the environmental profile?
- Does the charger remain the optimal improvement point?
- Does the **use phase** become more dominant due to increased energy consumption?

In this case, the hair clipper—previously identified as raw material-intensive — now appears as a **use-intensive product with a notable raw material impact** (see Figure 11). This highlights how different patterns of use can lead to entirely different environmental profiles for the same product.

As the **use phase** becomes dominant, the strategies for improvement must shift accordingly. Potential measures include implementing a **more energy-efficient heating unit** or exploring **alternative operating principles** that reduce power consumption. Lower energy demand could also enable the use of a **smaller charger**, which would simultaneously reduce environmental impacts in the **raw materials** phase.

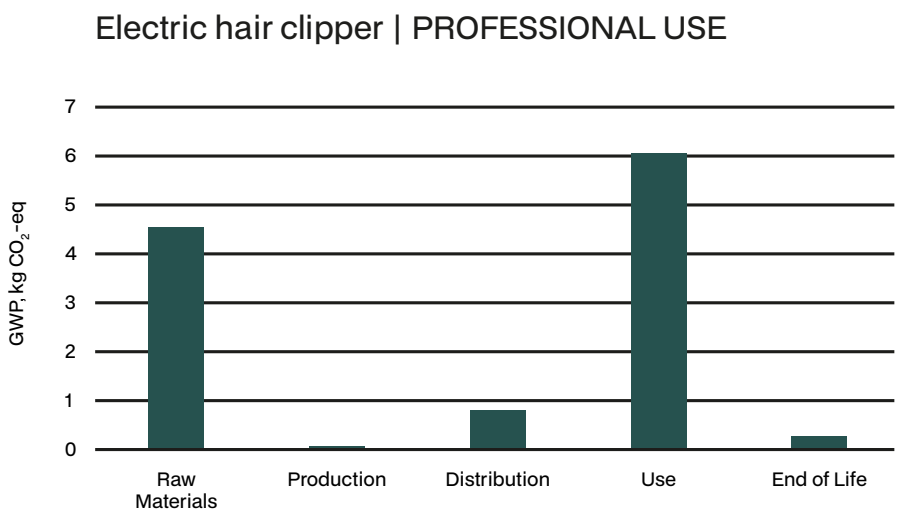


FIGURE 11: ENVIRONMENTAL PROFILE ELECTRIC HAIR CLIPPER, PROFESSIONAL USE (OWN ILLUSTRATION).Once the environmental profile of a product is clear a circularity assessment can be carried out to find out how well the product is currently performing in terms of circularity, and which strategies makes sense to improve the environmental performance and the circularity of the product.

Especially for products with a raw material intensive profile, circular solutions can be very beneficial, as the need for virgin materials is reduced or avoided and in case of reuse or remanufacturing, most of the production and distribution steps can be skipped. Also, for products with a high value (e.g., smartphone), meaning lots of energy and material is put into its production, it is more important to keep the circle as small as possible (e.g. reuse) (see Figure 12) as for products with a lower value (e.g. plastic bottle). For products with a use-intensive profile, the environmental impact, extending the lifetime of the product or its components could lead to higher environmental impacts than replacing the product with a more efficient one. As there is no general answer which strategy should be chosen if a product is use-intensive, material intensive, etc. this process should always be carried out iteratively.

Supportive tools

To apply Life Cycle Thinking on your product, there is a variety of tools that can be used. In this section, a brief overview of such tools is provided. Q&As of these tools are presented in Part III.

CYRKL WASTE SCAN

The CYRKL Waste Scan tool helps company's analyse waste streams to identify potential for CO_2 and cost savings. Additionally, it aims to enhance material flow transparency, bring innovation, technology, and data to waste management, and help companies achieve their sustainability targets by finding cheap and environmentally friendly solutions. It's designed to help companies across Europe to manage their waste more effectively, turning waste into resources and thus into revenue.

CIRCITNORDEN CIRCULARITY ASSESSMENT TOOL

The CircitNorden Circular Assessment Tool is expected to lead to more sustainable product designs that are aligned with CE guidelines; Identification and implementation of design changes that significantly reduce environmental impacts and enhance product sustainability; and Improved decision-making in product development, resulting in products with higher circularity potential and lower ecological footprints.

ECODESIGN+

Allows you to create a product model considering all life cycle stages (raw materials, manufacturing processes, distribution, EoL). The tool immediately shows you the results in a one-page document which can be used for internal communication/discussions. The results include the total PCF of the whole life cycle of the product, where the life cycle stage with the most impact can be identified. For each life cycle stage, the details of the PCF are shown in order to identify the materials or processes impacting most to the PCF. Once the most relevant components/processes/materials are identified, the improvement can start. To do so the product models can be duplicated in order to change some parameters like different kind of materials to see the impact on the total PCF. Then the tool allows to compare the different modelled product scenarios and to select the best performing one.

CIRCULARITY ASSESSMENT TOOL

With the Circularity Assessment Tool, you can select relevant CE strategy based on a simple questionnaire with six questions, identify optimization potentials of the product by targeted assessments as well as improvement ideas focusing on the most promising optimization potentials.

ECOCHAIN – LCA TOOL

Ecochain (Mobius/Helix) provides quantitative life cycle assessment (LCA) to model products, identify environmental hotspots, compare scenarios, and export results in PDF, CSV, or XLS formats. It supports ecodesign decisions and sustainability claims.

Take-away for SMEs: The environmental profile defines the relevant strategies

Analysing the environmental impacts of the own products throughout their life cycle is essential for identifying the most effective opportunities for improvement. By using methods such as LCA, designers and engineers can figure out which life cycle phase impacts most significantly the environment, whether it be raw material extraction, production, distribution, use, or disposal. For this purpose, easy and intuitive software is available.

Ecodesign focuses on strategies that are specific to the product's environmental profile. For raw material-intensive products, reducing material complexity or improving recyclability may be key; for use-intensive products, optimizing energy efficiency and influencing user behaviour becomes more critical.

Moreover, the environmental profile of a product is not static, it can shift based on context, usage intensity, or logistical factors. One and the same device may require different design priorities depending on how and where it is used. Environmental assessments should be incorporated as early as possible in the design process to get the greatest results.

Circular products

WHAT IS THE RESULT?	• A circular product which fulfills the selected strategy • A product with reduced environmental impacts
WHAT DO I HAVE TO DO?	Adapt the design acc. to the design measures fitting to the CE-strategy
WHICH INSTRUMENTS ARE RELEVANT?	• CE design strategies & guidelines • Life Cycle Assessment Methods • ISO 59020 – Measuring and assessing circularity performance
WHAT DO I HAVE TO WATCH OUT FOR?	Circular solutions like modular designs could end up with a higher environmental impact - monitor environmental impacts!

The core goal of the CE is to **preserve a product's value at the highest possible level** for as long as possible. A circularity assessment evaluates how effectively a product retains its value throughout its life cycle within a CE framework. This involves considering different **levels** at which value can be retained: the **product level** (e.g., through reuse or repair), the **part level** (e.g., through remanufacturing or refurbishment), and the **material level** (e.g., through recycling) (see Figure 12). Each level represents a different degree of value preservation, with the product level maintaining the most value and the material level the least. Beside several available tools and other methods to assess a product's circularity, the new standard **ISO 59020** [14] defines indicators for assessing the circularity performance. It provides a structured approach to evaluate how well a product supports and already fulfils the strategies "reuse", "recycle" and "remanufacturing". The indicators assess in which percentage a product already is built **from** reused, recycled or remanufactured parts or materials and how much **of this product** is already reused, recycled and remanufactured.

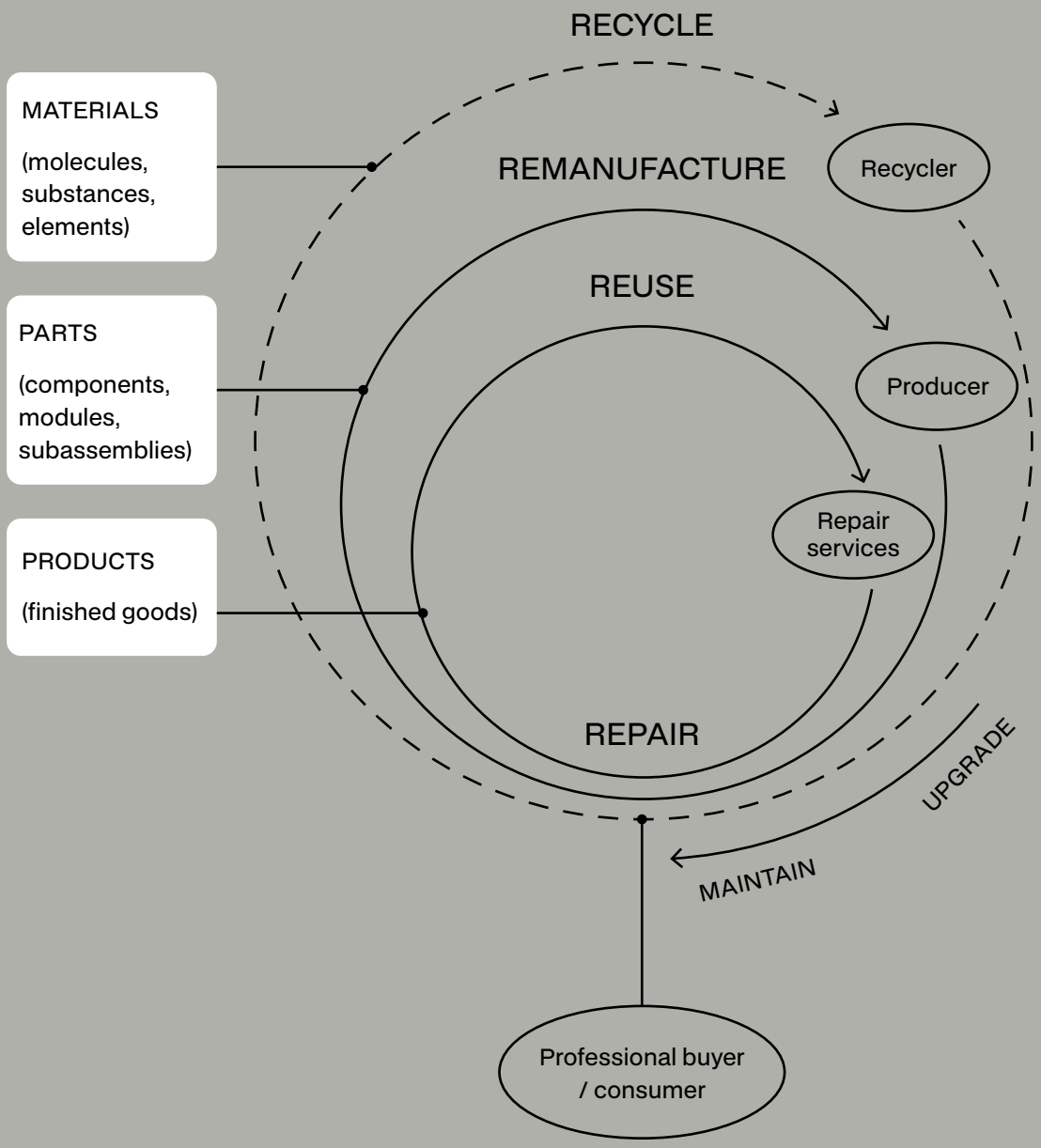


FIGURE 12: OVERVIEW ON CIRCULAR STRATEGIES [31].

In Table 1 a non-exhaustive list of possible design strategies for closing, slowing, narrowing, and regenerate the loop is given, which is explained in more detail in this chapter with specific design measures. These measures can vary depending on the guideline/tool/method that is used, so this should just be taken as an inspiration of possibilities.

A circular product design might require either even more resources initially. Especially if the business model changes the product design might need to be adapted, or even new products are required. Modularity enables easy repair and the possibility to upgrade the hardware of the product, increasing its lifetime, but this modularity also leads to additional connectors, housings or fasteners, thus more material. Without an appropriately adapted business model, the newly gained advantages of a circular product can rarely be profitable in terms of environmental benefits nor economically for the company. To learn more about defining an appropriate business model, see chapter “Circular Business Models”.

CLOSING THE LOOP	• Design for recycling
SLOWING THE LOOP	• Design of long-life products • Design for remanufacturing/refurbishment
NARROWING THE LOOP	• Design for materials sufficiency • Design for energy sufficiency
REGENERATING THE LOOP	• Design for renewable materials • Design for renewable energy

TABLE 1: DESIGN STRATEGIES FOR CLOSING, SLOWING, NARROWING AND REGENERATING LOOPS [32, 33].

Closing the loop

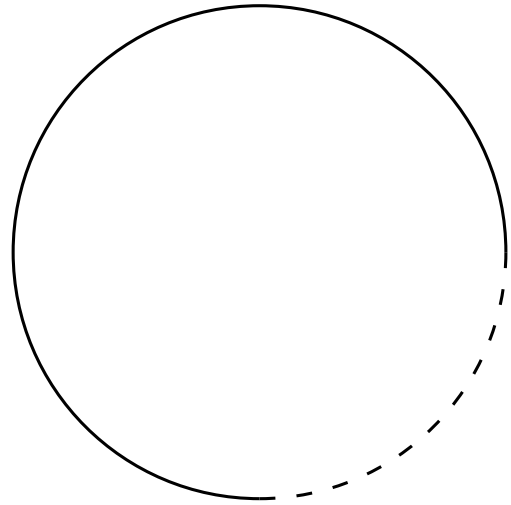


FIGURE 13: CLOSE THE LOOP [32].

Closing the loop focuses on recovering and reintegrating materials at the end of a product's life. A key strategy is ***Design for recycling***, which enables efficient separation and processing of materials —especially in complex, multi-material products. This involves using recyclable materials, reducing material variety, avoiding hazardous substances, and ensuring disassemblability. However, **recycling should be a last resort**, as it only preserves material value and not the energy or labour invested for the product itself. Whenever possible, strategies like reuse, repair, or remanufacturing should be prioritized.

Effective **reverse logistics** is also essential to enable collection, return, and sorting of used products. This includes clear labelling, digital tracking, and coordination with recycling and recovery partners.

By closing the loop, valuable resources are kept in use and waste is minimized — but it requires smart design and system-level planning.

Design for recycling

Facilitates material recovery by ensuring materials can be easily separated, identified, and processed.

DESIGN GUIDELINES

- **Use recyclable materials**: Select materials with high recyclability and available recycling streams.
- **Reduce material diversity**: Limit the number of different materials used.
- **Ensure easy separation of materials**: Avoid composite materials or inseparable multi-material components.
- **Mark materials clearly**: Use standardized labels or identifiers (e.g., plastic resin codes).
- **Avoid hazardous substances**: Ensure compliance with regulations (e.g., RoHS) and safety for recycling processes.

Closing loops for electronic articles

A core principle of circular production is to keep materials in use and prevent them from becoming waste. During electronics manufacturing, waste arises from off-cuts, sprues, flash, defective parts, and surplus raw materials. Rather than discarding these materials, closed-loop systems can be implemented within the production plant.

- Regrind plastics can be reused if material quality stays consistent.
- Metal off-cuts can be remelted or returned through supplier buy-back.
- Internal loops reduce virgin material use and retain value.
- Fewer colours and additives in plastics improve recyclability.
- Simplified materials make sorting and reuse easier.

While internal reuse is ideal, not all waste can be fed back into the same process. In such cases, secondary use through external channels offers a valuable alternative. There are now specialized (often online) industrial marketplaces that connect manufacturers with recyclers, material processors, or other companies seeking production offcuts and surplus materials. These platforms make it possible to sell or donate waste streams—such as plastic regrind, sheet metal remnants, or unused packaging—to be used in other industries or applications [32].

The success of both internal and external recycling strategies depends on good documentation and material traceability. Knowing the exact composition, colour, and processing history of waste materials enables better matching with reuse opportunities and ensures compliance with safety and quality standards in their next application.

Beyond direct material loops, smarter process control helps reduce the generation of waste in the first place. This includes precise tooling, digital simulation before tooling or prototyping, and real-time quality monitoring to reduce the volume of defective parts. When waste is unavoidable, documenting and quantifying its sources enables systematic reduction strategies.

Slowing the loop

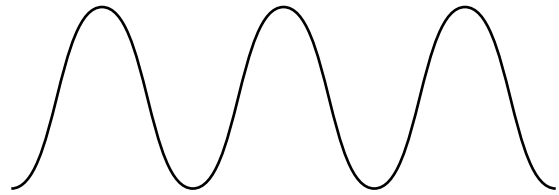


FIGURE 14: SLOW THE LOOP [32].

Strategies for slowing the loop focus on increasing product longevity and extending use. This begins with ***Design for long life products***, which emphasizes durability, high-quality materials, and timeless design to reduce the need for frequent replacement. Additionally, ***Design for repair, refurbishment, and remanufacturing*** helps extend the product's life by enabling restoration and reuse. When long-term ownership is less feasible — due to fast-changing trends or technology — **service-based models** such as leasing, rental services can keep products in use longer or products are used more intensively. In such models, providers retain ownership, creating strong incentives for durable, repairable designs. This requires the right CBM, explained in chapter "Circular Business Models".

Together, these strategies reduce resource use and environmental impact by slowing down the rate at which new products are produced and discarded.

Design for long life

Extends the product's useful life, reducing the need for replacement and conserving resources.

DESIGN GUIDELINES

- **Use high-durability materials**: Select materials with proven longevity and performance.
- **Design for robustness**: Ensure tolerance to rough handling or environmental stress. Try to design the lifetime of components equally.
- **Future-proof aesthetics and features**: Avoid short-lived trends and allow updates.
- **Test for reliability**: Conduct accelerated aging and stress tests.

Design for repair, refurbishment, and remanufacturing

Enables the product or its components to be restored, upgraded, or reused in a later life cycle.

DESIGN GUIDELINES

- **Consider a modular architecture**: Use modules that can be individually replaced or upgraded.
- **Easy access to wear-prone parts**: Position commonly replaced parts in accessible locations.
- **Use standard components**: Prefer off-the-shelf, widely available parts.
- **Provide repair instructions**: Include manuals, videos, or QR codes linking to documentation.
- **Ensure availability of spare parts**: Offer easy access to replacement parts for a longer period.
- **Design for reprocess-ability**: Allow rework of parts (e.g., regrinding, refinishing).
- **Upgradeability**: Enable hardware or software updates that extend or update functionality.
- **Durable interfaces**: Use robust and futureproof electrical and mechanical connections to support multiple life cycles.
- **Design for multifunctionality:** Consider a modular design that can be used for different purposes to intensify the use phase of the product.

Slowing the loop for electronic articles

Slowing the loop for electronic articles can be approached on two levels – the entire product and the part level. Can the entire product be repaired or retrofitted (remanufactured in a way, that it satisfies modern applications)? If not, which components can be extracted and used in other electronic articles? The goal is always to maintain the highest value level possible, or in other words, to keep existing products as complete as possible and use them as long as possible. When we think about that, it becomes apparent that we

proactively can support and give the opportunity for slowing loops within product development. Designing electronic articles in a way, that they can be repaired more easily, or that components can be extracted or exchanged in simple fashion (see fairphone example in chapter “Circular Economy basics”). The royal discipline would be to design components in a way that they can be used in as much devices as possible, for as long as possible.

Narrowing the loop

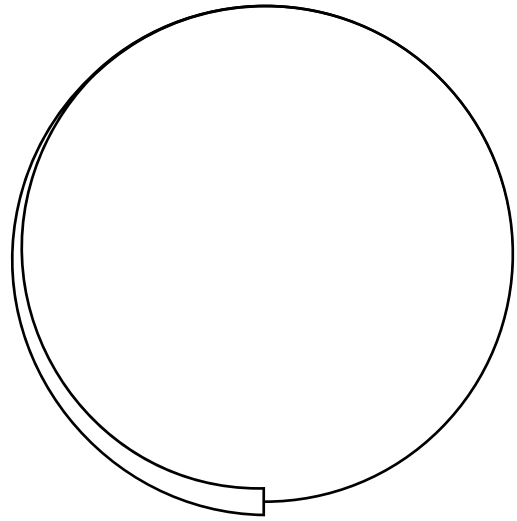


FIGURE 15: NARROW THE LOOP [32].

Strategies for narrowing the loop focus on reducing the input of materials and energy throughout the product lifecycle. This approach emphasizes using fewer resources from the start and making more efficient use of them during production, use, and disposal. A central strategy here is ***Design for material sufficiency***, which involves selecting materials that are renewable, recyclable, non-toxic, and have low environmental footprints. For instance, using recycled aluminium or bio-based plastics instead of virgin materials can significantly cut down the embodied energy and raw material demand in the manufacturing process.

Another key aspect is ***Design for material sufficiency***, which aims to reduce energy consumption across all life-cycle stages. This might involve designing

products that are energy-efficient in use—such as low-power appliances or electronics—or optimizing manufacturing processes to consume less energy. For example, a household appliance like a refrigerator can be designed to use high-efficiency compressors and insulation, significantly lowering its operational energy needs over time.

Design for material sufficiency

Focuses on reducing the quantity and impact of materials used in products.

DESIGN GUIDELINES

- **Minimize material use:** Reduce overall material volume without compromising functionality or durability.
- **Select durable materials:** Prioritize materials that extend product lifespan and resist wear.
- **Enable reuse of materials:** Favor materials that retain quality over multiple life cycles.

Design for energy sufficiency

Focuses on reducing energy consumption during production, use, and end-of-life stages.

DESIGN GUIDELINES

- **Optimize for energy-efficient use:** Design products that consume less energy during operation.
- **Reduce energy in production:** Choose processes and materials that require less energy to manufacture.
- **Support low-energy maintenance:** Ensure ease of repair and maintenance with minimal energy demand.
- **Enable energy-efficient logistics:** Design products for compact, lightweight transport and storage.

Narrowing the loop for electronic articles

Circularity in production starts with minimizing the use of energy and keeping production materials in use as long as possible. The production of printed circuit boards (PCBs) or active and passive components needs a lot of energy and water also electronics contain a lot of rare earth elements where the mining needs a lot of energy. Even when powered by renewables, reducing consumption is essential to minimize the embodied energy in products.

An electronics company commented that improving energy efficiency in production can be achieved by optimizing cycle times, adjusting temperature profiles, and ensuring machines run only when needed. Regular energy audits help identify inefficient equipment or processes and upgrading older machinery with energy-efficient alternatives and adjustments can lead to lasting reductions und long term usage. Real-time monitoring systems offer visibility into consumption patterns and synchronize energy use with actual demand.

Regenerating the loop

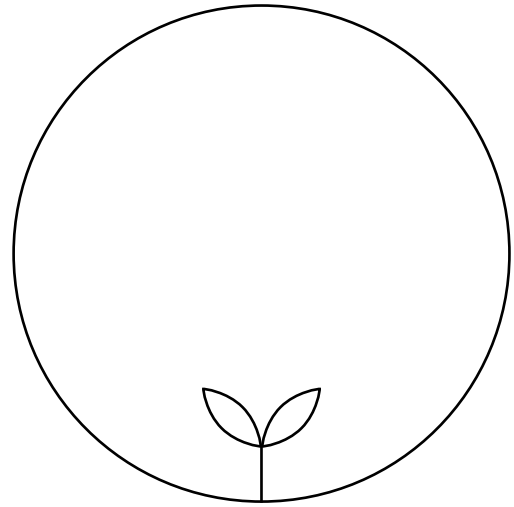


FIGURE 16: REGENERATE THE LOOP [32].

Strategies for regenerating the loop go beyond reducing harm — they aim to restore and support natural systems. This includes using **renewable materials** that can safely return to the environment, such as biodegradable packaging made from plants or fungi (***Design for renewable material***). These materials reduce dependency on finite resources and can help regenerate soil or ecosystems after disposal. Another approach is to power products and production with **renewable energy**, like solar-powered devices or factories run on wind or hydro energy (***Design for renewable energy***). This reduces emissions and supports a clean energy transition.

Design for renewable materials

Focuses on reducing dependency on scarce or critical raw materials by integrating renewable or abundant alternatives where possible.

DESIGN GUIDELINES

- **Substitute critical raw materials:** Explore alternatives to rare or conflict-prone materials (e.g., using carbon-based materials instead of rare earths where feasible).
- **Integrate renewable or bio-based materials in non-critical parts:** Use biodegradable plastics, recycled biopolymers, or natural fibres in casings and packaging.
- **Minimize material toxicity:** Avoid coatings, glues, or additives that hinder recyclability or biodegradability.
- **Source responsibly:** Ensure that essential critical materials (e.g., lithium, cobalt) are ethically sourced and certified (e.g., RMI, Fair Cobalt Alliance).

Design for renewable energy

Focuses on reducing fossil fuel dependence by improving energy efficiency and enabling renewable energy use throughout the product lifecycle.

DESIGN GUIDELINES

- **Use renewable energy in manufacturing:** Prioritize suppliers and facilities powered by clean energy (e.g., solar-powered chip fabrication).
- **Design for energy autonomy:** Enable operation with renewable sources—e.g., solar charging for portable devices or compatibility with green energy grids.
- **Support clean energy infrastructure:** Ensure product compatibility with smart grids, off-grid solar systems, or energy-harvesting technologies.

Regenerate the Loop for Electronic Articles

Circularity also extends to the often-overlooked materials that support production—lubricants, coolants, adhesives, and cleaning agents. These are a big lever for regeneration as environmentally friendly, biobased or nontoxic materials which can replace the current materials. These substances are rarely part of the final product, but they have environmental impacts and can present barriers to material recovery or recycling if not carefully managed.

To support circularity, processing auxiliary materials should be selected based on both performance and end-of-life considerations. Water-based and biodegradable flux materials, for instance, can replace mineral oil-based or alcohol-based variants, reduce contamination risks and simplify wastewater treatment. Filtration and recovery systems allow coolants and solvents to be reused multiple times before disposal, extending their useful life and reducing total consumption.

Standardizing auxiliary materials across production lines improves handling efficiency and reduces waste from expired or excess stock.

Supportive tools

To develop circular products, there is a variety of tools that can be used. In this section, a brief overview of such tools is provided. Q&As of these tools are presented in Part III.

CIRCITNORDEN CIRCULARITY ASSESSMENT TOOL

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Take-away for SMEs: Stay circular and keep the value as high as possible

By applying CE design guidelines, you can bring circular strategies directly into product development. This means creating products that last longer, can be repaired, and stay valuable even after use. Every step in this direction reduces waste, saves resources, and moves your business closer to a truly sustainable circular economy.

Circular materials

WHAT IS THE RESULT?	Circular materials are selected in order to minimize resource consumption, use renewable and close material loops
WHAT DO I HAVE TO DO?	Identify options to use circular materials in the own products.
WHICH INSTRUMENTS ARE RELEVANT?	• Bill of Materials • EU Critical raw material list • Recycling rates
WHAT DO I HAVE TO WATCH OUT FOR?	Watch out for (new) offers of circular materials and evaluate if they can be used in your product.

In the last chapter we learned about circular strategies, or how we can realize closing, slowing, narrowing and regenerating within a product level, and especially within the domain of electronic articles. However, it becomes apparent that materiality is crucial for implementing such strategies. The choice of material often determines the duration of products (slowing), if they can be recycled (closing), how much of it is needed (narrowing) and under which environmental as well as social conditions they are sourced (regenerating). Material selection in a circular context must balance environmental goals with functional and commercial realities. The choice of recycled or alternative materials is strongly influenced by the functional requirements of the end product, such as strength, thermal stability, or electrical insulation. In many cases, these requirements are further shaped by client expectations or industry standards, which may specify the use of particular materials or limit alternatives due to safety, branding, or regulatory reasons. So, in this chapter we dedicate ourselves for obtaining an overview about what CE means for our products on a material level. The chapter is structured as described in the picture below.

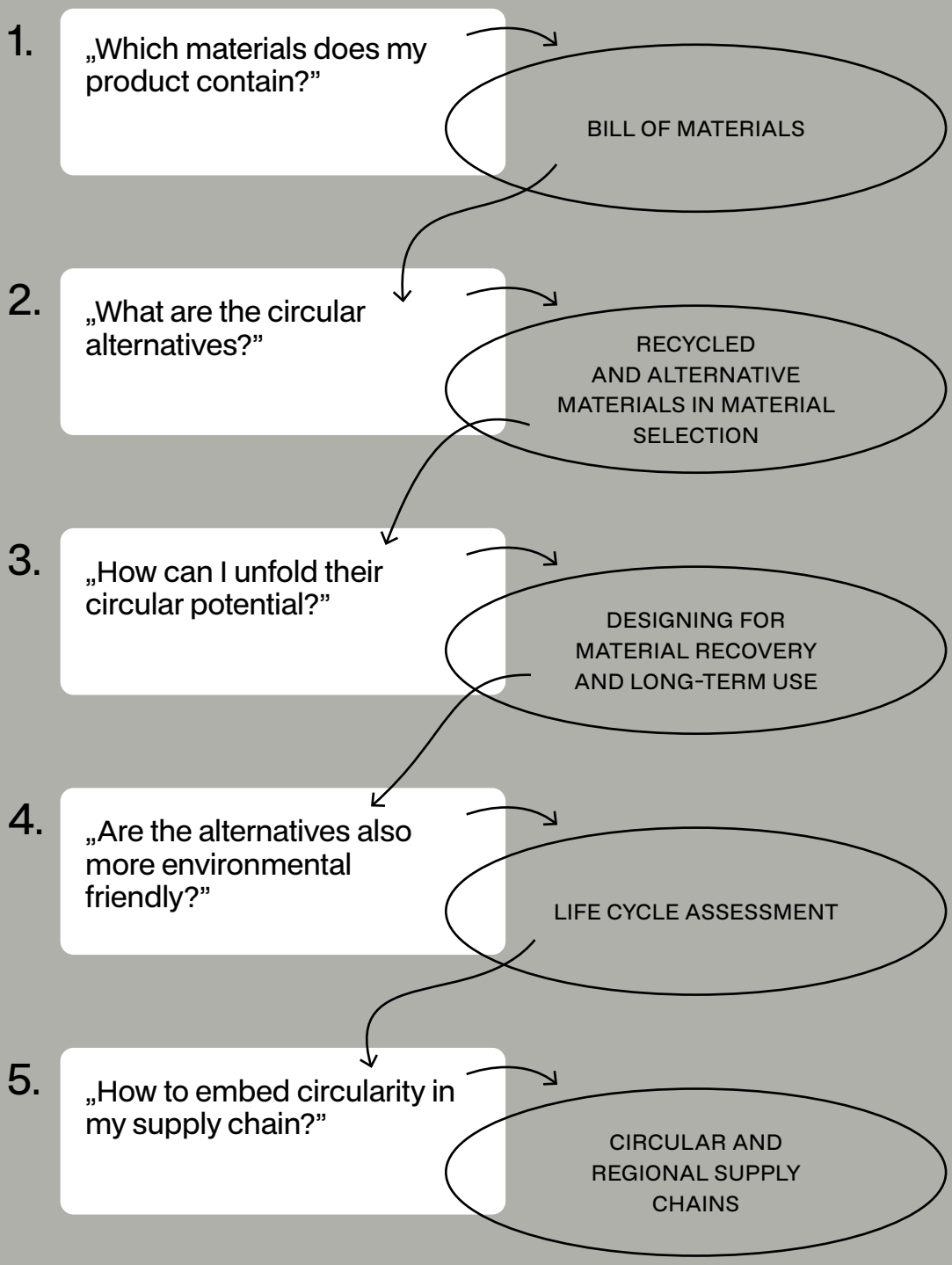


FIGURE 17: STRUCTURE OF CHAPTER 5 (OWN ILLUSTRATION).

Mapping the material baseline: bill of materials

Before improving material circularity, it is essential to understand what materials are currently in use. Electronics manufacturing typically involves a mix of virgin thermoplastics, metal alloys, rare earth elements, and electronic components. Additional materials, such as coatings, adhesives, and packaging, also contribute to the overall material footprint.

Documenting this material composition—down to individual components and assemblies—allows for the identification of circularity barriers. These can include the use of composite materials that are difficult to separate, or substances that prevent recycling due to contamination risks. This baseline assessment is a necessary step before alternative materials or design changes can be meaningfully evaluated.

A practical starting point for this analysis is the product's Bill of Materials (BOM)—a document most companies already maintain as part of their engineering or procurement system. The BOM provides a structured overview of all components and subassemblies and can be extended to include information on material types, sourcing, recycled content, or end-of-life characteristics. This makes it a valuable tool for identifying which materials may pose circularity challenges or offer opportunities for substitution.

By using the BOM as a baseline, manufacturers can systematically examine material composition at the component level and assess which items are recyclable, which are based on virgin inputs, and which might hinder disassembly or recovery. This documentation step is not just administrative—it forms the foundation for more advanced analysis, such as LCAs, circularity assessment, or compliance with upcoming regulations related to eco-design and material transparency.

Recycled and alternative materials in material selection

Integrating recycled and alternative materials into product design is central to achieving material circularity. These strategies reduce reliance on virgin resources, lower embodied environmental impacts, and help close material loops by enabling the continued use of existing material stocks in new products.

In electronics manufacturing, recycled content is already feasible in several areas (**Strategy closing the loop, see chapter "Circular design"**). A notable example is recycled tin, which is used in soldering components onto circuit boards. High-quality recycled tin is available from specialized refiners and can meet the technical demands of modern lead-free soldering processes. Choosing recycled tin not only reduces the environmental burden associated with tin mining—often linked to land degradation and social conflict—but also supports the development of secondary raw material markets [34].

Other common opportunities include using recycled aluminium for housings or heat sinks, recycled steel for structural parts or fasteners, and recycled plastics for casings and non-critical components. In each case, performance standards and long-term reliability must be verified, but many secondary materials now offer comparable mechanical and thermal properties to their virgin counterparts.

Beyond recycled materials, alternative materials offer new pathways for circularity, especially when traditional materials pose recycling, toxicity, or sourcing challenges. For example, biobased polymers derived from agricultural, or forestry waste can replace fossil-based plastics in enclosures or packaging. While biodegradability is not always a goal in electronics, biobased content can still reduce dependence on non-renewable feedstocks and lower life-cycle carbon emissions (**Strategy regenerate the loop, see chapter "Circular design"**).

Other material innovations include mineral-based composites that reduce the use of synthetic polymers and engineered material substitutes that replicate the function of scarce or hazardous materials using more abundant inputs. For instance, alternatives to flame retardants based on halogens—often problematic in recycling—are now being replaced by mineral or phosphorus-based formulations that are easier to manage in closed-loop systems.

The suitability of recycled or alternative materials must always be assessed

case by case, using both technical testing and environmental tools like LCA. In many cases, combining small improvements across multiple materials, such as a slightly thinner housing made of recycled plastic, or a PCB with reduced tin content, can result in significant circularity gains at the product level .

To ensure long-term success, manufacturers should work closely with suppliers to validate material sources, standardize specifications for recycled content, and remain informed about emerging alternative materials that can be integrated as technologies and infrastructure evolve.

Designing for material recovery and long-term use

Achieving circularity through material selection is not only about which materials are used, but also about how they are integrated into the product. Design decisions directly influence whether materials can be effectively recovered, reused, or recycled at the end of a product's life.

To retain material value beyond a single use cycle, products should be designed for easy disassembly, separation, and identification. This includes avoiding complex composite materials, minimizing the use of permanent adhesives, and ensuring that key components are accessible for replacement or removal. The use of mono-material parts, mechanical fasteners, and standardized connectors all contribute to more efficient disassembly and recycling.

However, the success of these design strategies depends not only on technical feasibility, but also on the real-world availability of recycling and recovery streams. Designing a product to be theoretically recyclable is not enough if the required infrastructure or market for a given material does not exist. For example, while certain biopolymers or engineered composites may be technically recyclable, they may not be accepted in regional recycling systems due to limited processing capacity or lack of sorting technology. Similarly, rare or mixed-material components may not be separated at scale, even if recyclable in principle.

Therefore, when designing for material recovery, it's essential to align design choices with existing or emerging recycling capabilities. This includes selecting materials for which recycling infrastructure is already mature—such as aluminium, steel, or standard thermoplastics like Polypropylene (PP)

and Acrylnitril-Butadien-Styrol (ABS) and ensuring that product architecture supports efficient handling within those systems. Where possible, designers should consult recyclers or engage with industry networks and take-back schemes to confirm what will actually be recovered and how.

In parallel, product designers can enhance circularity by planning for long-term use and upgradeability. Modular designs allow components to be replaced or repaired, extending the product's service life and deferring the need for material recovery altogether (**Strategy closing the loop, see chapter "Circular design"**). Durable materials that maintain their function over time—and that remain compatible with future technological updates—help avoid premature disposal and preserve embedded environmental value.

Ultimately, designing for recovery means designing with the full lifecycle context in mind: not just how a product functions during use, but how its materials will behave and circulate after use, given the practical realities of todays and tomorrow's recovery systems.

When recovery is unlikely or technically unfeasible, materials should be chosen for their degradability or compatibility with low-impact disposal pathways. For temporary parts, such as packaging or protective covers, this could mean shifting toward biodegradable or compostable materials, assuming proper waste handling is in place (**Strategy regenerate the loop, see chapter "Circular design")**.

Evaluating circular potential of alternative materials through Life Cycle Assessment

Circular material choices must be guided by robust environmental and functional data. LCA provides a structured method to compare different material options based on their full lifecycle impacts. However, in the context of circularity, LCA should not be limited to emissions or energy use—it should also address factors such as ease of recovery, recycled content, and compatibility with end-of-life treatment systems.

For example, replacing virgin ABS with recycled Polycarbonate (PC)-ABS may offer lower carbon emissions and reduced resource extraction, but must also

be evaluated for performance, durability, and the availability of post-consumer recycled streams. Similarly, using aluminium with high recycled content can significantly reduce embodied energy, provided the recycled supply chain is traceable and the material maintains its required mechanical properties [35].

LCA supports decision-making by highlighting trade-offs and clarifying whether material substitutions genuinely improve circularity or simply shift environmental burdens to another stage of the lifecycle (see chapter “Life Cycle Thinking”).

Increasing resilience through circular and regional supply chains:

Material circularity is not only determined by what is used, but also by where and how it is sourced. A circular supply chain aims to reduce transport distances, rely on secondary (recycled or recovered) materials, and enable material loops at the regional level. In contrast to linear and highly globalized sourcing models, circular and regional supply chains support shorter, more transparent, and more regenerative material flows. Tools like Sourcemap [36] can help businesses to first identify their supply chain and second, make them more circular. In the following Figure 18, the Sourcemap for the supply chain of already discussed Fairphone is shown.

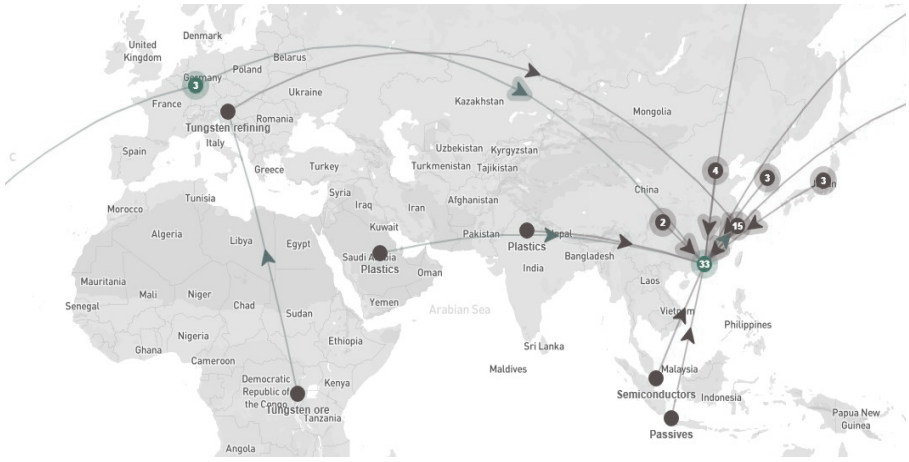


FIGURE 18: SCREENSHOT OF FAIRPHONE SUPPLY CHAIN AT SOURCEMAP [37].

One of the key advantages of this approach is increased supply chain resilience. By sourcing materials locally or regionally—especially those with recycled content—manufacturers reduce their dependence on global suppliers, long shipping routes, and price fluctuations tied to geopolitical or logistical disruptions. This has become particularly relevant in recent years, as many electronics producers have faced raw material shortages or delivery delays due to global supply chain instability like the blockage of the Suez canal [38].

In practical terms, circular and regional supply chains can involve sourcing recycled metals from local smelters, using plastics reprocessed by nearby recyclers, or working with regional partners who offer take-back and refurbishment services. In some cases, components or materials can even be recovered from end-of-life products returned within the same market, creating a closed-loop system that operates within regional boundaries. One best practice example is the German company **Mayerhofer Electronics**, using recycled tin from Feinhütte Halsbrücke [39] making their production process of circuit boards more circular.

Shorter supply chains also enable greater transparency and traceability, making it easier to verify the origin and environmental characteristics of materials, including recycled content, material purity, and compliance with regulatory standards. This transparency is increasingly important for meeting environmental reporting requirements and sustainability targets, particularly in sectors facing strict due diligence obligations.

To fully leverage the potential of circular supply chains, collaboration is essential. Manufacturers need to work closely with suppliers, recyclers, and logistics partners to establish systems for reverse logistics, material sorting, and reintegration. Procurement policies should explicitly prioritize recycled or renewable inputs, and favour suppliers with established circular practices and local presence. The **symtronics ecosystem** is one example of such a successful collaboration ecosystem, as the whole supply chain for several sectors is represented and collaborating with each other [40].

By integrating regional sourcing, recycled inputs, and recovery partnerships, companies not only improve the circularity of their material flows—they also gain strategic flexibility, faster lead times, and reduced exposure to global disruptions. In this way, circular supply chains support both environmental goals and long-term operational resilience.

Supportive tools

To apply circular materials on your product, there is a variety of tools that can be used. In this section, a brief overview of such tools is provided. Q&As of these tools are presented in Part III.

CYRKL TOOL MARKETPLACE

The CYRKL Tool Marketplace is an online platform connecting buyers and sellers of waste, by-products, and secondary raw materials. It enables companies to turn residuals into revenue, reduce disposal costs, and lower environmental impact, while providing optional expert support for complex trades. The platform also helps companies discover new markets for surplus materials, improve resource efficiency, and foster collaboration between businesses across industries and borders.

CIRCULARSUPPLYCHAIN WORKSHOP TOOL

The CircularSupplyChain Workshop Tool is a half-day, facilitator-led workshop conducted on-site or online to map current and future supply chains. Using platforms like open.sourcemap.com, it helps companies identify risks, circular opportunities, and transparency needs related to suppliers, materials, and logistics. Participants leave the workshop with a shared visualization of the supply chain, a clearer understanding of where improvements can be made, and concrete next steps to increase circularity, reduce environmental impact, and improve regulatory compliance.

CYRKL WASTE SCAN

CYRKL Waste Scan is a consultancy-driven assessment that analyses company waste streams to uncover CO_2 and cost-saving opportunities, improve material-flow transparency, and implement practical recycling or reuse solutions. The tool not only highlights inefficiencies and waste, but also provides actionable recommendations, links to potential marketplaces, and strategies to turn previously discarded materials into revenue streams.

Take-away for SMEs: Keep materials in the loop

Circular materials cut impact and boost product life. They already exist, from recycled tin to plastics from old electronics. Post-consumer waste, like Polyethylene terephthalate (PET) bottles, can be reprocessed into new inputs. Pre-consumer waste, like factory cut-offs, can feed into other businesses through industrial symbiosis.

To benefit, understand your supply chain: where materials come from, how far they travel, and which virgin resources you can replace. Circular materials not only protect the environment they can also make your business stronger in the market.

COMPETITION

Circular Business Models (CBM)

WHAT IS THE RESULT?	CBM with a sustainable value proposition where profit is decoupled from resource consumption, based on new value streams.
WHAT DO I HAVE TO DO?	Which services could be provided additionally? Look at unused values along the full supply chain.
WHICH INSTRUMENTS ARE RELEVANT?	• ISO 59010 – Guidelines for the transition of Business Models and Value Networks • Circular Business Model Canvas • Product Service System
WHAT DO I HAVE TO WATCH OUT FOR?	Monitor environmental impacts as they might even be higher.

When circular strategies are developed or maybe already implemented, you need an appropriate business model to make it work on an economic scale. Thereby, you'll get an overview on CBMs in this section - how they can look, what the norms are and how they can be implemented.

At the core of any business model is the **value proposition**, which describes the product or service a company offers. Surrounding this, a business model explains how the company **creates, delivers, and captures value** from its offerings. It identifies the target customers and outlines how value is generated through the delivery and monetization of products or services [41].

Basics of Circular Business Models

A CBM represents a modern, sustainability-focused approach. Unlike traditional linear models based on “take, make, dispose,” CBMs aim to keep products, components, and materials in use at their highest utility and value for as long as possible. CBMs focus on closed-loop systems that reduce environmental impact, enhance resource efficiency, and enable long-term economic value. Circular products are often more service-oriented, requiring proactive collaboration across the entire value chain to ensure sufficient volumes of reused or recycled materials. Digital technologies, such as the Internet of Things (IoT), digital twins, and DPP, simplify this collaboration by enabling better data sharing and tracking of circular value.

Companies that provide value only through product sales focus primarily on the product itself, which limits their ability to influence how long the product remains in use or how it is maintained. In contrast, CBMs emphasize product use and delivered outcomes. The higher the service level—moving from product-oriented to result-oriented—the more opportunities a company has to design offerings that are sustainable, durable, and resource-efficient. The possible service levels of a business are presented in Figure 19. Shifting toward service-oriented models like a leasing model encourages companies to focus on maintenance, repair, and long-term product performance, laying the groundwork for a circular value proposition [31, 42]. Meaning the longer a product last (through repair, maintenance, etc.) the higher the profit.

The ISO 59010 [13] standard guides organizations in shifting their value creation from linear to circular models. It provides practical strategies to apply circular economy practices within companies and across networks. Building on ISO 59004 [12], it helps assess current models, map value chains, and design effective circular strategies, supporting sustainable business and a resilient economy.

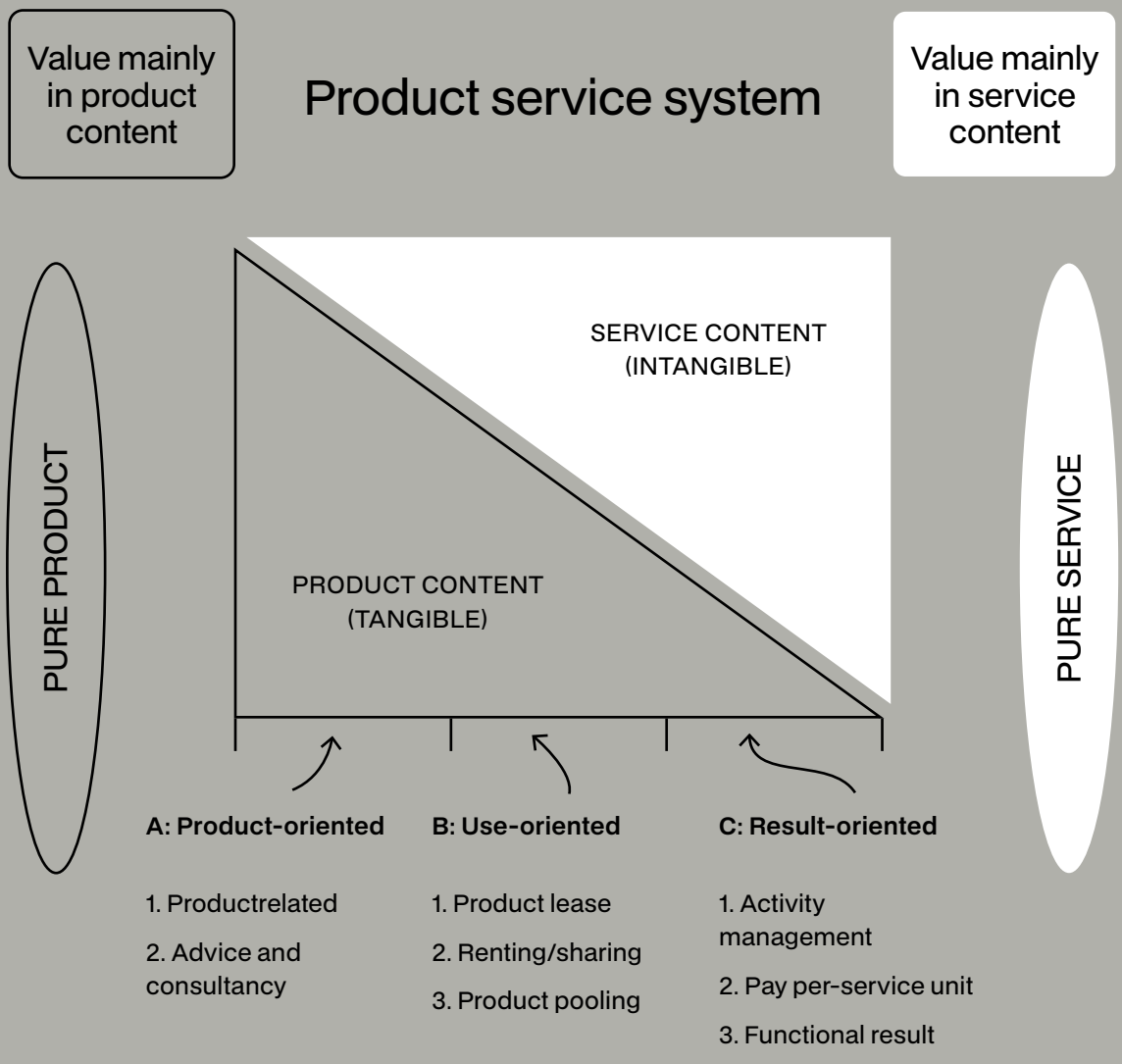


FIGURE 19: SERVICE LEVEL OF BUSINESS MODELS [31].

Defining a Circular Business Model

Now that you have a basic understanding of what defines a CBM, let's take a closer look at how to define the key elements **value proposition, value creation, value delivery, and value capture** to support circularity. You can use the CBM canvas, to gain overview and subsequently develop strategies.

In the CBM canvas [41], presented in Figure 20, the four key elements of a business model are described in detail and clearly arranged. Specific attention is paid to environmental and social aspects in each of the areas. This includes, for example, the use of sustainable resources, the reduction of negative environmental impacts, and the promotion of social justice and inclusion. In the following, an overview is provided what each section describes and how each of them can be addressed.

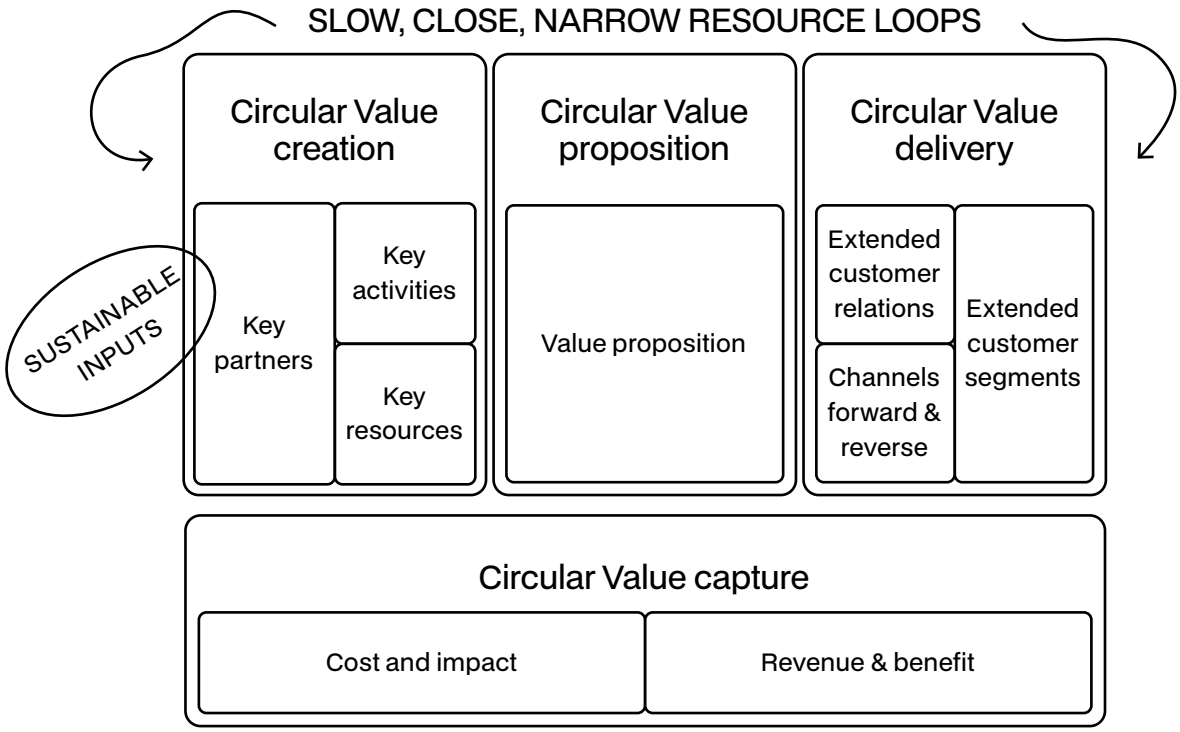


FIGURE 20: CBM CANVAS (ADAPTED FROM [43])

Circular value proposition

The circular value proposition focuses on creating long-term value for customers while minimizing environmental and social impacts. Instead of simply selling products, businesses design offerings that combine functionality with durability, repairability, and reusability. The aim is to satisfy customer needs sustainably, encouraging more responsible consumption and extending the lifecycle of products.

As mentioned before, companies often shift from a product-centric to a service- or result oriented approach. Products are designed to last longer, with potential for repair, refurbishment, or reuse. Ownership may remain with the company, allowing them to manage product lifecycles more efficiently and reduce waste. This approach enhances customer value, minimizes environmental harm, and supports long-term sustainable practices. Examples include durable electronics offered through rental or subscription models, which provide ongoing value beyond a one-time purchase.

Circular value creation

Circular value creation involves designing, producing, and managing products and services in a way that maximizes resource efficiency and promotes collaboration across the value chain. Businesses integrate recycled or renewable materials, optimize reverse logistics, and develop systems for refurbishing and remanufacturing. Value emerges through coordinated efforts among multiple stakeholders, including suppliers, customers, and service providers.

KEY PARTNERSHIPS

Strong partnerships are essential for CBMs. Companies collaborate with suppliers of recycled or bio-based materials, logistics providers, repair and refurbishment partners, and technology service providers. Transparent communication and coordinated actions across these networks enable closed-loop systems and enhance the sustainability of operations.

KEY ACTIVITIES

Critical activities in circular value creation include designing products for durability and modularity, managing reverse logistics for take-back or recycling, and implementing refurbishment or remanufacturing processes. Companies also develop digital platforms to support product tracking, maintenance,

and customer engagement. Emerging technologies like IoT, AI, and blockchain improve efficiency, traceability, and decision-making throughout the product lifecycle.

KEY RESOURCES

CBMs require a mix of physical and non-physical resources. Physical resources include durable materials, modular components, and collection systems, while non-physical resources involve data, software, brand reputation, and specialized expertise. Prioritizing renewable or recycled inputs reduces reliance on virgin materials and supports long-term sustainability.

Circular value delivery

Delivering circular value relies on innovative channels and business approaches that extend product life and encourage responsible consumption. Digital platforms, subscription models, and take-back systems enable a continuous cycle of use, return, and reuse. Businesses must foster long-term relationships with customers and provide convenient mechanisms for participation in these circular systems.

EXTENDED CUSTOMER RELATIONSHIPS

Long-term engagement is central to CBMs. Customers are partners in maintaining products through return programs, repair services, or subscription-based access. “Product-as-a-Service” (PaaS) models strengthen these relationships by encouraging ongoing interaction and collaboration between the company and its users.

CHANNELS FORWARD AND REVERSE

CBMs utilize both forward and reverse channels. Forward logistics deliver products and services to customers, while reverse logistics enable returns for repair, refurbishment, or recycling. Digital tools facilitate feedback collection, product tracking, and service updates, making the system more efficient and responsive.

EXTENDED CUSTOMER SEGMENTS

Circular businesses target consumers who value sustainability, convenience, and long-term cost savings. Engaging these segments may require changes in consumption habits and increased trust in service-based models. Identifying and educating the right audience is critical for adoption and success.

Circular value capture

Circular value capture encompasses how companies generate revenue and optimize costs while aligning financial success with environmental and social responsibility. CBMs often rely on flexible pricing models, multiple usage cycles, and the resale of refurbished products. These approaches create economic resilience while promoting sustainability.

COST AND IMPACT

Implementing circular strategies may increase upfront costs due to investment in durable materials, digital systems, and employee training. However, long-term savings arise from reduced material usage, enhanced operational efficiency, and the creation of new revenue streams. Comprehensive evaluation of environmental and social impacts helps businesses understand risks and potential benefits.

REVENUE AND BENEFIT

Revenue in CBMs can be generated through subscriptions, leasing, pay-per-use, or performance-based contracts. Additional income comes from refurbishing and reselling returned products. Beyond financial gains, companies should assess success in terms of social and environmental benefits, measuring the broader impact of circular practices.

Types of Circular Business Models and examples

To get an idea of how circular business can look like, in the following is a list of non exhaustive common types of CBMs, and a practical example for each. The CBM can also be a combination of these types.

- **Product-as-a-Service (PaaS):** Customers pay for usage rather than ownership, e.g. leasing or subscription models. Relates to **slowing** (extended product use through service) and **narrowing** (more efficient use of assets)
  EXAMPLE: Philips Lighting: Pioneered “Light-as-a-Service,” where customers pay for lighting, not the fixtures.

- **Product life extension:** Products are maintained in the loop longer through repair, resale, refurbishment, or remanufacturing. Aligned with **slowing** – extending product lifespan reduces the need for new production.
  EXAMPLE: Fairphone: Designed a modular smartphone that users can repair themselves.

- **Sharing platforms:** Enable shared access to underutilized assets such as vehicles or tools. Supports **narrowing** (higher asset utilization) and **slowing** (reduces demand for new products).
  EXAMPLE: Hilti: Provides tool leasing and refurbishment services, extending product life and optimizing asset use.

- **Resource recovery/Component Recovery:** Materials or components are recovered and reintroduced through recycling, upcycling, or energy recovery. Directly linked to **closing** – closing material loops by reintegrating recovered resources. Incorporating renewable or bio-based materials supports **regeneration**, allowing returned products to re-enter the cycle in a sustainable way.
  EXAMPLE: Patagonia: Offers repair services, upcycling and resale of used gear, and lifetime product guarantees.

- **Remanufacturing/Retrofit:** Products or components are disassembled, cleaned, tested, and restored to like-new condition using original or new parts. Retrofit refers to the process of upgrading existing products or systems with improved technologies or features to extend their useful life and improve performance. Combines **slowing** (extending product life) and **closing** (reuse of components/materials).
  EXAMPLE: Caterpillar: Offers remanufactured heavy machinery components.

- **Resale:** Used products are sold again, either directly by the original manufacturer or through secondary markets. This model extends product lifespan and may include added services such as inspection, refurbishment, or warranties. Tied to **slowing**, by keeping products in use for longer periods.
  EXAMPLE: Back Market: Marketplace for refurbished electronics, extending product lifespans and reducing e-waste.

Supportive tools

To apply CBMs on your product, there is a variety of tools that can be used. In this section, a brief overview of such tools is provided. Q&As of these tools are presented in Part III.

CIRCULAR BUSINESS MODEL CANVAS

The Circular Business Model Canvas helps companies to see how they create, deliver, and capture value in a circular way. It supports companies to rethink their business model and find opportunities to improve. The canvas, as presented in Figure 20 has parts like Key Partners, Key Activities, Key Resources, Value Proposition, Customer Relationships, Channels, Customer Segments, Cost Structure, Revenue Streams, and Impact. It is used in workshops where participants generate ideas, group similar ideas, discuss, and select the most important ideas.

CONTEXT MAP CANVAS

The Context Map Canvas helps companies to map their environment, including important stakeholders, rules, market trends, and other external factors. It helps to find opportunities for collaboration, innovation, and risk reduction. The canvas collects information about demographics, rules and regulations, economy and environment, competition, technology trends, customer needs, and uncertainties. In workshops, participants fill the canvas, identify the main threats and opportunities, and discuss them.

QUICKSCAN CIRCULAR BUSINESS MODELS

The Quickscan Circular Business Models assesses how a company performs in circular and sustainable practices and provides guidance to improve. The first step is self-assessment, where the company evaluates the importance of circularity, current experience, future goals, and integration into the business model. The results are shown in a spider chart. The second step explores circular business model options, including R-strategies like Refuse, Reduce, Reuse, Repair, Recycle, organizational forms, processes, and revenue models. This helps companies develop a new or improved circular business model.

CIRCULAR BUSINESS MODEL GUIDE

The Circular Business Model Guide provides a complete pathway for companies to move from a linear to a circular business model, integrating different tools and methods. It guides companies step by step through company strategy, current business model, value streams, circular opportunities, value propositions, value creation processes, circular model definition, stress testing, task derivation, and monitoring. Each chapter gives instructions and recommendations, allowing companies to choose which parts to use.

VALUE MAPPING TOOL

This methodology helps companies identify and evaluate value streams, such as resources, data, knowledge, or relationships, which are used, underused, at risk, lost, or overlooked. In workshops, participants map business processes, identify values across relationships, resources, consumers, and data, and assign them in a canvas under categories like Values Captured, Value Opportunities, Value Missed, Value Destroyed/Wasted, and Value at Risk. They then reflect on where risks or waste occur and consider circular strategies such as Repair, Refuse, Reuse, and Recycle to capture missed opportunities and prevent value loss.

Take-Away for SMEs: Circularity is a business advantage

CBMs help companies make profit while protecting the environment. They focus on reusing, repairing, and sharing instead of simply selling more products. This approach reduces waste, meets changing customer needs, and builds competitive advantage.

The shift is not simple — it requires planning, working with partners, and monitoring results—but the benefits are clear: lower costs, stronger resilience, more innovation, and a better reputation. Circularity is not just a trend; it is a new way of doing business that creates value for both companies and society.

Environmental communication

WHAT IS THE RESULT?	Communication strategies to communicate the environmental and circular benefits to my customers
WHAT DO I HAVE TO DO?	Analyze your customer, analyze the marked requirement and select a relevant communication instrument for your product & company.

WHICH INSTRUMENTS ARE RELEVANT?	• Product Circularity Data Sheet acc. To ISO 59040
	• Environmental labels and declarations
	  • Type 1 environmental label (acc. to ISO 14024)
	  • Type 2 self declaration (acc. to ISO 14021)
	  • Type 3 Environmental Product Declaration (EPD acc. to ISO 14025)
	• EU Energy Label

WHAT DO I HAVE TO WATCH OUT FOR?	Communicate based on proved facts, not on exaggerated claims or misleading impressions.

For businesses, whether large or small, the communication and marketing of sustainable and environmental criteria is an important component. Large companies collect sustainability metrics and data as part of their Environmental, Social, Governance (ESG) compliance and publish the results on a product & on a company level in their sustainability reports. In Figure 21 below you will find an example of the criteria under the ESG as per the CSRD [27]. However, this reporting is not mandatory by regulations for SMEs. Yet, on a voluntary basis SMEs can communicate activities which can lead to better client and customer relations, deliver transparency and allow comparability with competitors and establish state-of-art and excellence.

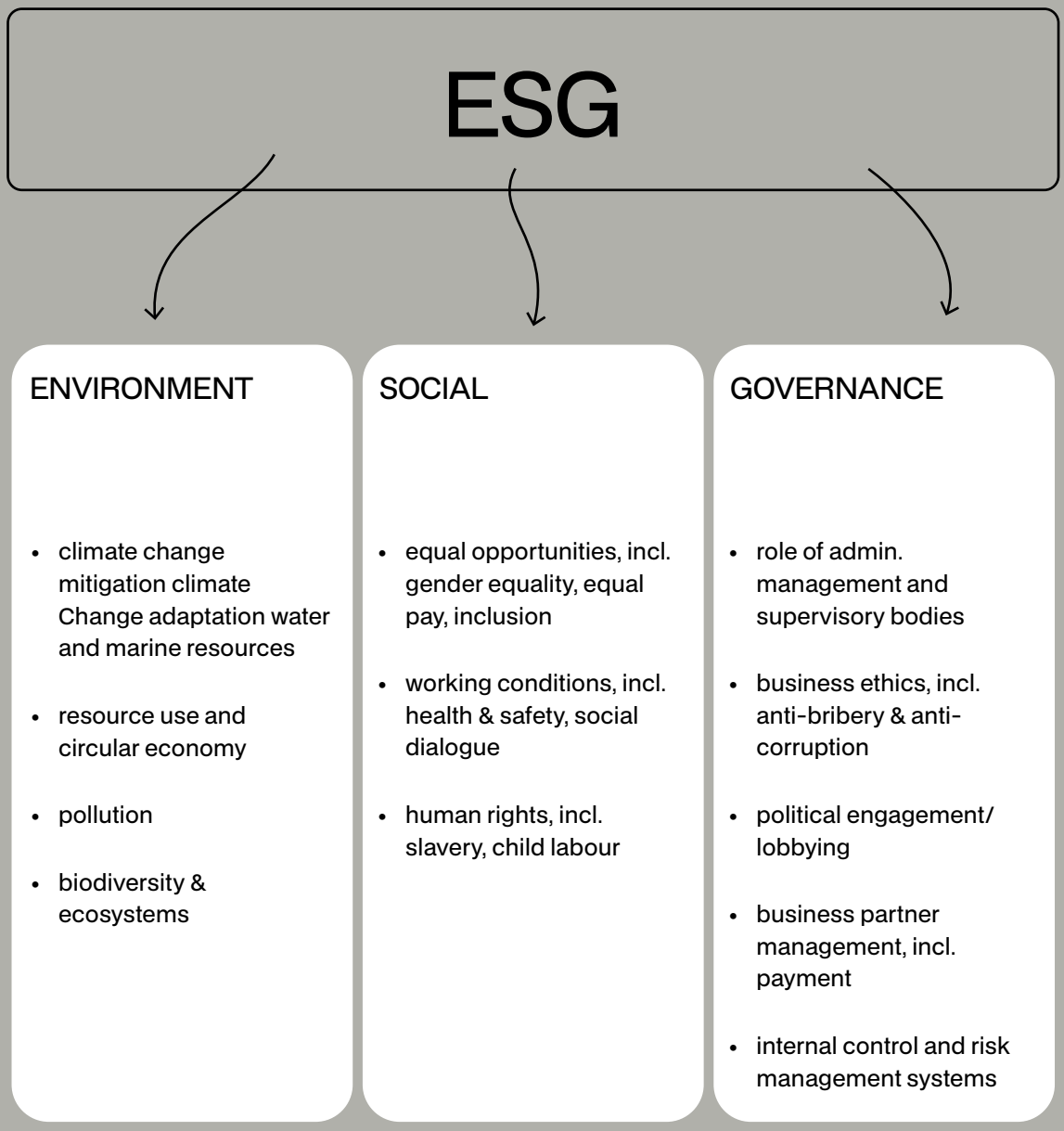


FIGURE 21: OVERVIEW OF ESG CRITERIA AS PER THE EU CSR DIRECTIVE REPORTING [1].

Standards for communication at a product level for SMEs

As compared to a company level, environmental communication is additionally performed on a product level. This includes tools such as circularity certification for a specific product under International Standardization Organisation (ISO) [6], Environmental Product Declarations (EPDs) [7] and finally EU energy labelling of products which is related to the ESPR presented in the chapter "Regulatory framework for Circular Economy in the EU" [8]. We discuss these 3 tools briefly.

ISO 59040: Product circularity data sheets

ISO 59040 [15], titled "Circular Economy – Product Circularity Data Sheet (PCDS)", provides a standardized framework for communicating information about the circularity performance of products including electronics. Developed within the broader context of CE principles, the standard enables manufacturers, suppliers, and other stakeholders to exchange consistent, comparable, and reliable circularity-related data across the value chain.

PCDS offers a structured template that captures factual, product-specific information relevant to CE objectives. This includes details about materials used, design features that enable reuse or recycling, durability, reparability, and end-of-life recovery potential. The key aspects covered in the PCDS include the following aspects graphically represented in Figure 22. ISO 59040 emphasizes data transparency and traceability. The data sheet is intended to be machine-readable as well as human-readable, facilitating digital integration across supply chains and enabling circularity assessment tools, procurement platforms, and DPPs.

By standardizing how circularity data is presented, ISO 59040 supports informed decision-making among stakeholders—ranging from designers and manufacturers to purchasers and recyclers—and promotes the adoption of circular practices globally. The information contained within these data sheets could also be used for communication by SMEs, in case they are not data protected or contain sensitive company information.

Product identification:

Basic information such as product name, manufacturer, and version.

Material composition:

Data on the type and proportion of materials used, including recycled content and substances of concern.

Design characteristics:

Features that support disassembly, repair, upgrading, or remanufacturing.

Use phase:

Information on expected lifespan, maintenance needs, and performance over time.

End-of-life considerations:

Recyclability, reusability, and availability of take-back schemes or recovery options.

Circularity indicators:

Where applicable, the sheet can also include calculated metrics like recycled content percentage or product circularity score, though these are not mandatory

FIGURE 22: KEY ASPECTS OF A PRODUCT CIRCULARITY DATA SHEET PER ISO 59040 (OWN ILLUSTRATION).

Environmental product declarations

In general, EPDs (Type III declarations) according to ISO 14025 [44] follow a sector/product specific product category rule (PCR) including product specific requirements like system boundaries, allocation rules, Environmental indicators, etc. LCAs following such PCRs should lead to comparable results within the specific product group. The results are used to derive an environmental communication in form of an EPD for the business-to-business (B2B) communication. EPDs are often published in EPD-programs such as the one under environdec.com. The European Commission sees EPDs as the appropriate means of communicating the environmental performance of, for example building products and promoting sustainable building construction. But also, regarding electronic articles, EPDs are a state-of-the-art medium for communicating sustainability – in the following an example of the EPD results of an outdoor lighting producer from Italy.

FALKO 1 RESULTS

The following tables summarize the total environmental impacts calculated through AEC Illuminazione proprietary LCA-Tool for the FALKO 1 street luminaire.
Size: **FALKO 1 3P3 XX-XXX YYZZ.060-1M**

Main Environmental Impact Indicators – Results per declared unit

Indicator	Unit of measure	Manufacturing Stage		Distribution Stage	Installation Stage	Use Stage	End-of-life Stage	Resource recovery stage
		A1-A2	A3	A4	A5	B1-B7	C1-C4	D
GWP-Fossil	kg CO2 eq.	2,17E+01	1,35E+00	8,07E-01	1,40E+00	1,27E+02	1,97E+00	-1,90E+00
GWP-Biogenic	kg CO2 eq.	3,44E-01	-6,31E-01	6,66E-04	1,23E-01	6,18E+00	5,01E-02	-4,83E-03
GWP-Land use	kg CO2 eq.	3,70E-02	1,47E-02	4,12E-04	2,10E-04	1,86E-01	3,46E-04	-3,41E-02
GWP Total	**kg CO2 eq.**	**2,21E+01**	**7,29E-01**	**8,08E-01**	**1,52E+00**	**1,33E+02**	**2,02E+00**	**-1,94E+00**
ODP	kg CFC 11 eq.	6,10E-07	3,20E-08	1,73E-08	2,21E-08	2,43E-06	2,53E-08	-4,97E-08
AP	mol H+ eq.	2,24E-01	5,49E-03	4,93E-03	6,71E-03	6,85E-01	7,60E-03	-3,94E-02
EP-Freshwater	kg P eq.	1,49E-02	5,68E-04	5,46E-05	5,33E-05	6,15E-02	9,53E-05	-3,29E-03
EP-Marine	kg N eq.	2,51E-02	2,78E-03	1,64E-03	2,93E-03	1,02E-01	3,54E-03	-2,95E-03
EP-Terrestrial	mol N eq.	2,82E-01	1,69E-02	1,77E-02	3,13E-02	1,04E+00	3,41E-02	-3,46E-02
POCP	kg NMVOC eq.	9,66E-02	1,94E-02	5,89E-03	1,03E-02	3,85E-01	1,12E-02	-1,19E-02
ADPE[(2)]	kg Sb eq.	2,76E-03	6,50E-06	2,47E-06	8,68E-07	1,37E-03	1,94E-06	-3,70E-04
ADPF[(2)]	MJ	2,80E+02	1,57E+01	1,14E+01	1,83E+01	2,13E+03	2,03E+01	-2,69E+01
WDP[(2)]	m^3	1,04E+01	5,66E-01	4,50E-02	4,88E-02	4,80E+01	1,38E-01	-3,56E-01
ACRONYMES	**GWP-Fossil** = One Hundred Year Global Warming Potential - Fossil. **GWP-Biogenic** = One Hundred Year Global Warming Potential - Biogenic. **GWP-Land use** = One Hundred Year global warming potential - Land use and land-use change. **ODP** = Ozone Depletion Potential in the stratosphere. **AP** = Acidification Potential of Soil and Water. **EP-Freshwater** = Eutrophication potential, for freshwater. **EP-Marine** = Eutrophication potential, for salt water. **EP-Terrestrial** = Terrestrial eutrophication potential. **POCP** = Photochemical Ozone Formation. **ADPE** = Abiotic Non-Fossil Resource Depletion Potential. **ADP-Fossil** = Depletion potential of abiotic fossil resources. **WDP** = Water Deprivation Potential (user), deprivation-weighted water consumption.							

FIGURE 23: ENVIRONMENTAL PRODUCT DECLARATION (EPD) OF LIGHTNING EQUIPMENT FROM FALKO [45].

Energy labelling of products and the EU Eco Label

ENERGY LABEL

The energy labelling [46] concept was introduced for household appliances back in 1994. Since then, the EU energy label (compulsory) has been a key driver pushing the market towards more energy efficient products and helping consumers choose more energy efficient products. At the same time the label encourages manufacturers to innovate and use more efficient technologies. Recently the energy label was updated and also includes aspects that address resource consumption corresponding to the ESPR (see chapter “Regulatory framework for Circular Economy in the EU”). For example, the EU energy label for smartphones already considers repairability as well as the break resistance when falling to the ground.

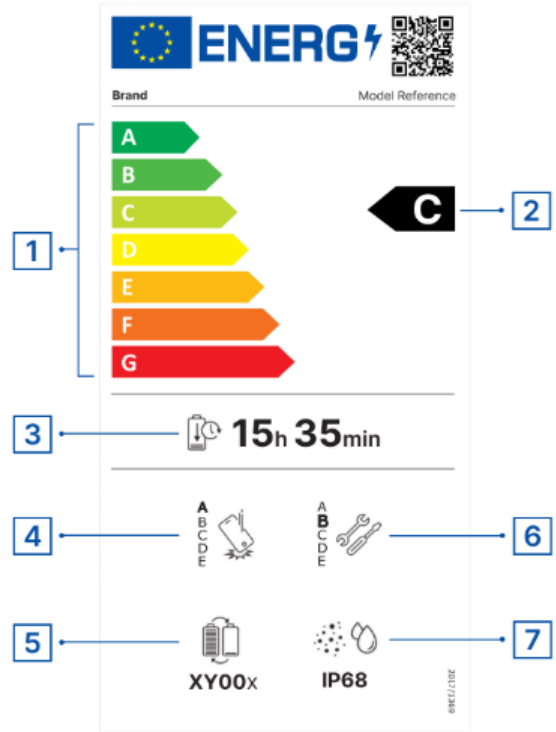


FIGURE 24: NEW EU SMARTPHONE ENERGY LABEL. (1) SCALE OF ENERGY EFFICIENCY CLASSES FROM A TO G. (2) THE ENERGY EFFICIENCY CLASS OF THIS PRODUCT. (3) THE BATTERY ENDURANCE PER CYCLE, IN HOURS AND MINUTES PER FULL BATTERY CHARGE. (4) REPEATED FREE FALL RELIABILITY CLASS. (5) BATTERY ENDURANCE IN CYCLES. (6) REPAIRABILITY CLASS. (7) INGRESS PROTECTION RATING [47].

ECOLABEL

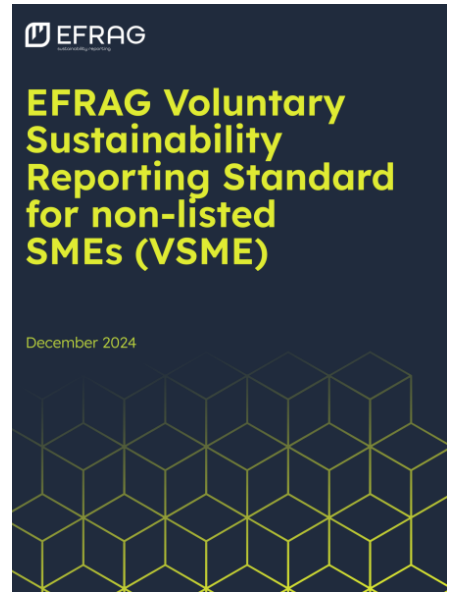
The Ecolabel (a voluntary label) was introduced by an EU regulation in 1992 (Regulation EEC 880/92) and offers a guidance for consumers who want to help reduce pollution by purchasing more environmentally friendly products and services. Up to date, over 100.000 products are certified by the European commission, however only 3 products in the 'electronics' category [48], maybe due to its requirements on reparability, durability and recycling.

FIGURE 25: THE EU ECOLABEL [12].

Standards & guides for communication at a company level for SMEs

Several guidelines, standards, and frameworks exist for reporting sustainability activities and actions. Examples include the Global Reporting Initiative (GRI) [49], the Voluntary Standard for Sustainability Reporting for SMEs (VSME) [50], the IFRS Sustainability Disclosure Standards [51], and the Corporate Sustainability Reporting Directive (CSRD) [27]. These frameworks offer metrics for reporting and publishing data on measures such as energy efficiency, renewable energy use, and water consumption reduction. For SMEs in the electronics sector, applying these metrics can provide a strong foundation for developing an environmental communication strategy. If such measures are not yet in place, this guide recommends starting with the VSME.

FIGURE 26: THE VSME STANDARD PUBLISHED BY EFRAG IN DECEMBER 2024 [50].



The VSME Standard, developed by EFRAG, is a simplified ESG reporting framework for unlisted SMEs in the EU. It enables credible but proportionate sustainability reporting without the complexity of full European Sustainability Reporting Standard (ESRS) requirements. The standard has two modules:

- Basic Module – 11 key disclosures (e.g., energy use, workforce, policies) providing a solid foundation for ESG reporting.
- Comprehensive Module – additional topics such as climate targets and supply chain impacts.

Reporting is voluntary, but designed to meet rising expectations from banks, investors, and larger customers. External verification is not required, though reports should be “audit-ready.” SMEs are encouraged to begin with the Basic Module to identify key gaps and build a reporting strategy, then expand to the Comprehensive Module as needs and capacity grows.

Communication on circular activities for SMEs

In order to develop a communication strategy for environmental communication an SME can adopt two possible communication pathways, firstly, internal communication within the company and to the staff and secondly, external product or company communication to clients, and the public. We deal with the communication pathways and their respective channels below.

Internal communication among employees

Internal communication among the staff members and employees of an SME is as important as the external communication to the public and to the customers and clients. Internal communication should be ideally led by the C-level and the executive level of an SME or organisation. Internal metrics communication, such as the number of kms travelled by bicycle by all employees; can be used as a method to motivate and engage employees about sustainability and environmental goals. Moreover, internal communication can be designed in a more informal and fun manner than the external communication. Employees can be involved in an E-waste race or have yearly prizes for using public transport or even organise visits to the second-hand stores and repair cafes for electronic devices. Such actions can motivate employees to think about how many electronic devices they use every day and how much they stockpile at home in drawers and cupboards. In terms of electronic gadgets consumption, one could encourage the use of refurbished PCs or Laptops instead of sourcing new ones and consider using only one monitor per employee instead of 2 or more. For internal communication, the digital tools that could be used include the organisational internal chat rooms, intranet sites, white boards for daily information, e-mailings, newsletters and boards and banners located in common areas such as the kitchen, toilets, meeting rooms.

External communication to clients

External communication of the SME towards clients, customers and the public is more of a sensitive and needs to be well planned. The responsible person could begin by clarifying why the company is communicating its environmental achievements and targets and to which audience (e.g., Customers and clients, Banks, insurers, or investors, Supply chain partners, Local communities and authorities, etc.)

Objectives could be formulated as follows:

- Build trust with customers or investors,
- Meet value chain or regulatory expectations,
- Attract sustainable financing or partnerships and
- Enhance brand image or competitive edge.
- An example of an external communication for the stakeholders mentioned above could be the "tonnes of CO_2 emissions saved" or "tonnes of material saved in production process through engaging with a marketplace for secondary materials".

Communication channels

The communication leaders should identify the formalized channels to communicate this such as LinkedIn, the company website, other social media, videos, reports and publications. To effectively reach external audiences, SMEs should choose communication channels that align with their resources and stakeholders' preferences. A foundational tool is the company's website, where a dedicated sustainability or environmental section can present the SME's commitments, actions, and progress in a clear and accessible format. For more structured disclosure, publishing a sustainability report—even a short one based on the VSME Basic or Comprehensive Module—can enhance transparency and credibility, particularly with business partners or financial institutions.

Social media offers an informal yet powerful channel to share updates, milestones, and behind-the-scenes stories that make environmental efforts more relatable. Product-focused SMEs may also use labels, QR codes, or packaging to link customers to digital content such as a PCDS based on ISO 59040, to offer specific sustainability data in a user-friendly format.

Beyond digital spaces, direct engagement with customers and suppliers is a key method to for environmental communication in core business activities. Participating in local events, media interviews, or community projects can demonstrate environmental responsibility and build trust with the wider public.

Take-away for SMEs: Communicate your competitive advantage

Applying circular principles isn't just good for the planet, it's a competitive edge. If you can deliver the same product as your competitors but in a more sustainable way, customers and partners will increasingly choose you. That's why it's essential to communicate your efforts clearly, for example through labels or an EPD based on recognized standards. And don't stop at external communication, make sure employees, suppliers, and partners also understand the value of sustainability. Do good and talk about it.

Part II

Best practice examples

In this section three best practice examples of companies that improved their circular performance with the help of the given knowledge and different tools are presented.

BEST PRACTICE EXAMPLE:

Elpro Križnič d.o.o.

Elpro Križnič d.o.o. is a Slovenian company known for its expertise in the development, production, and sale of electrical equipment and metal products. Operating under two core programs, EK Electric and EK Metal, the company delivers low-voltage electrical devices, power assemblies, control systems, and CNC-based sheet metal processing. The company tested the CIRCOTRONIC tool '**Strategy for circularity and sustainability'.**

FIGURE 1: IN-HOUSE SOLAR POWER PLANT AT ELPRO KRIŽNIČ + ELECTRIC VEHICLE CHARGING STATION IN FRONT OF THE ELPRO KRIŽNIČ COMPANY PREMISES [52].

Starting point

At the beginning of its involvement in the CIRCOTRONIC project, Elpro Križnič had already taken significant steps toward circularity and environmental responsibility. The company was largely energy self-sufficient, operating its own solar power plant and battery storage system, which produced more than 800 MWh annually and covered approximately 50% of internal consumption. In terms of material efficiency, over 85% of raw materials were recycled, and hazardous waste had been reduced from 5% to just 3%. A rainwater harvesting system provided a sustainable source of water, further demonstrating the company's commitment to resource efficiency. Operationally, Elpro Križnič had embedded sustainability through certifications such as ISO 9001, ISO 14001, and the DoD label, supported by employee training, lean manufacturing workshops, and stakeholder engagement initiatives. Despite this progress, the company lacked a structured, forward-looking sustainability strategy that could guide its long-term development and ensure compliance with upcoming European regulations such as the Corporate Sustainability Reporting Directive and European Sustainability Reporting Standards.

Process of transformation

The transformation was carefully planned and executed through a series of targeted activities, collaborative engagements, and evidence-based assessments. This enabled the company to identify its most material sustainability issues, define measurable goals, and design actionable plans for the period 2025–2030. The process was characterized by strong internal involvement, use of digital tools, and clear alignment with regulatory and stakeholder expectations, ultimately laying the foundation for long-term resilience, transparency, and sustainable growth.

AIM OF TRANSFORMATION

The transformation process was initiated with the aim of developing a comprehensive and regulation-aligned sustainability strategy for the period 2025–2030.

STEPS OF TRANSFORMATION

- Establishment of a Strategic Group for CSR and Sustainability, responsible for leading the transformation.
- Execution of three Dual Materiality Assessment (DMA) workshops
- Internal survey involving over 100 employees to identify priority ESG topics.
- Integration of findings into the Smarthead platform to visualize and manage the materiality matrix.
- Formulation of strategic goals, KPIs, and action plans across 8 sustainability pillars (aligned with 17 ESRS themes and 65 objectives).
- Validation of the sustainability strategy through iterative workshops and stakeholder engagement.

DATA NEEDED AND EFFORT

- Quantitative data: energy consumption, CO2 emissions (598.2 tCO2 in 2024), waste volumes, water use, recycling rates.
- Qualitative data: employee feedback, stakeholder expectations, risk and opportunity assessments.
- Tools used: Smarthead platform, internal surveys, CSRD/ESRS compliance frameworks, Strategy for circularity and sustainability tool.
- Timeframe: December 2024 to March 2025; total of 3 workshops and multiple consultations (~30 hours of structured engagement).

Result

The result of this intensive transformation was the formal adoption of the Elpro Križnič Sustainability Strategy 2025–2030. The strategy is built upon eight thematic pillars, which are fully aligned with ESG principles and the 17 thematic areas defined by the ESRS. Clear targets have been set, such as achieving 70% energy self-sufficiency from renewable sources by 2030, reducing hazardous waste to below 1%, and expanding the use of recyclable and circular materials. The company has also committed to conducting life cycle assessments (LCA) of its products and processes and to continually modernizing its infrastructure in line with the principles of Industry 4.0 and 5.0.

BEST PRACTICE EXAMPLE:

Mayerhofer Elektronik GmbH

The company Mayerhofer is a small Electronics Manufacturing Services (EMS) provider with 20 employees and 2 locations within Bavaria, Germany. Mayerhofer has already introduced circular practices by using almost 100% recycled Tin in their products; the pioneer and the only one in Germany offering it to the customers. The company has tested the CIRCOTRONIC tool '**Supply Chain Workshop**'.

FIGURE 27: PRODUCT EXAMPLES AT MAYERHOFER ELEKTRONIK [53].

Starting point

Mayerhofer is part of a cooperative network of companies called ”Symtronics” a cooperative initiative in electronics manufacturing whose aim is to manufacture high-performance products in their partner network and develop products that are made exclusively from recycled or renewable materials. Therefore, Mayerhofer has many starting points for sustainable, circular production & design. The starting point for tool testing with CIRCOTRONIC was that the company challenges that all electronics manufacturer’s face are: the (1) prices from competitors, especially in Asia are a lot lower; (2) the supply chains for raw materials and raw metals are often not clear and transparent; (3) The clients’ willingness to pay for sustainable products is lower and (4) the clients are concerned about the durability of recycled and reused materials.

Process of transformation

Before the tool ‘Supply Chain Workshop’ was piloted with Mayerhofer, the starting point and all challenges around supply chain management of an EMS provider were collected. The challenge is that they are in the middle or so –called “sandwich” between the distributers & the OEMs- they do not receive supply chain relevant information about the raw materials / critical metals from the producers. They are not directly in contact with the end-user of their products and therefore have no control concerning where their products are recycled or disposed. Therefore, there is lack of data along the value and supply chain. Another challenge for the EMS producer is regarding the data of products and the product specifics; often large data (for over tens of thousands of articles) is required to be processed which cannot be done manually, therefore they need to buy AI-products or work with databanks which are costly. Another challenge is that in electronics 80-90% of the raw materials are processed in Asian countries and this fact is impossible to change, since it is cheaper to produce in Asia rather than in Germany. Thus, the process of transformation includes finding those materials & products where they could have an impact and start working on 3 –6 key levers in circular economy in small initiatives.

AIM OF TRANSFORMATION

The aim of the company was to receive more supply chain transparency through the 'Supply Chain Workshop' tool, as advised by the CIRCOTRONIC project. The goal was to develop as many synergies with other companies/ initiatives as possible to transition to 100% recycled tin, using soluble fluxes and starting a new working group on recycled PCBs- made in Germany'.

STEPS OF TRANSFORMATION

- Mapping the complex supply chain on a Sourcemap for internal use;
- Using existing networks such as Symtronics- an initiative for electronics manufacturer's to collaborate on material use, sharing machinery, collecting and recycling wastes;
- developing and testing a water-based soldering flux, instead of one based on alcohol.
- Signing the Code-of-Conduct for responsibility by Zentralverband Elektrotechnik- und Elektronikindustrie e. V. (ZVEI);
- Starting an initiative on the Recyclable PCBs- Made in Germany.

DATA NEEDED AND EFFORT

The data needed for a supply chain mapping exercise within the Supply Chain Workshop tool piloting was extensive. A bill of materials (BOM) was received for about 90 raw materials for one type of product & the sources (partially) mapped on a Sourcemap. All such data is confidential and receiving such data is based on individual NDAs with the company. Also, not all companies are open to revealing their supply chain details on an opensource map.

Result

As a result of the piloting with the **Supply Chain Workshop**, the company could identify challenges, risks, and opportunities in circular economy and supply chains within their field of application. Mayerhofer selected 7 levers of action by which they are able to monitor their progress. In an update meeting in June 2025, the company reported the progress of these levers including notably recycling 2600 Kg of electronic waste cables, using and testing a water based fluxing agent (instead of alcohol based ones, cooperating with other companies on joint activities to refurbish old equipment and provide to workshops in African countries.

BEST PRACTICE EXAMPLE:

voidsy gmbh

The company voidsy is a startup founded in 2022 and based in Wels, Austria. voidsy has developed a novel solution for non-destructive material and component testing (NDT) using active thermography. Its core product, the voidsy 3D V-ROX, enables fast, contactless, and imaging-based inspection processes that are up to 80% faster and significantly more cost-efficient than conventional methods. The company tested the tool '**Value Mapping Tool**'.

FIGURE 28: PRODUCT EXAMPLE: VOIDSY 3D V-ROX AT VOIDSY [54].

Starting point

voidsy is positioned at the intersection of research, production, and industrial applications. Their technology supports circular economy principles by enabling reuse, repair, and recycling through reliable non-destructive testing. At the same time, voidsy faces challenges:

- The **complexity of value chains**, with many partners involved in development, certification, and distribution.
- **Resource dependencies**, such as specialized infrared components or spectral filters.
- The need to **establish credibility and trust** with industrial partners regarding the durability and cost-efficiency of new testing methods.
- The challenge of scaling innovations while keeping the sustainability advantages visible and measurable.

Process of transformation

Before the Value Mapping tool was applied, voidsy already collaborated with a variety of partners including universities, research institutions, certification bodies and international sales partners. However, these relationships and the associated resource flows had not yet been visualized in a structured way. To address this, a Value Mapping workshop was first carried out physically with the company and later digitized for further analysis. Through this process, voidsy was able to map out relevant actors and dependencies from R&D partners to international distributors and certification bodies while also identifying critical resources such as materials, patents and production capacities. At the same time, the exercise highlighted voidsy's sustainability strengths including very low energy consumption, the absence of chemicals or ionizing radiation and the potential for cost efficient automation. Furthermore, the mapping revealed new opportunities for collaboration and synergies within the company's ecosystem, providing a clearer strategic foundation for future development.

AIM OF TRANSFORMATION

The aim of voidsy was to use the Value Mapping to achieve greater transparency in its partner and resource landscape, to identify strategic levers for circularity, to strengthen cooperation opportunities with industrial and research partners and to support the scalability of NDT as an enabler for reuse, repair and recycling.

STEPS OF TRANSFORMATION

- Conduct a waste audit of returned and discarded products to identify non-recyclable components.
- Replace **mixed plastic housing** with mono-material plastics that are fully recyclable.
- Switch to **halogen-free flame retardants** to reduce hazardous waste.
- Worked with suppliers to **ensure traceability** and certification of new, recyclable materials.
- Updated **product labeling** and internal documentation to reflect material changes and end-of-life instructions.

DATA NEEDED AND EFFORT

The Value Mapping exercise did not require a full bill of materials but rather focused information about partnerships, material flows, and knowledge bases. The effort was moderate, as most inputs were already known to the company, but the added value came from structuring and visualizing them in a systematic way.

Result

The Value Mapping workshop proved to be highly valuable for voidsy, as it enabled the company to view its business model from a new, circular perspective. The structured identification and assessment of company values along the product life cycle provided important insights and allowed voidsy to pinpoint specific opportunities for circular strategies. This was particularly relevant in the context of their activities within the aviation industry, where resource efficiency and sustainable innovation are critical. Beyond raising awareness of resource flows, the workshop also revealed concrete approaches for future-oriented business model innovations, offering voidsy a clearer pathway toward strengthening its contribution to the circular economy.

Part III

Frequently asked questions (FAQs)

FAQ for general questions/tips

Question	Answer
WHAT WILL HAPPEN IF I DON'T TRANSFORM TO A CIRCULAR BUSINESS?	Companies that do not transform to a circular business will continue to contribute to the problems of a linear economy, e.g. resource depletion, supply risk and waste production. The regulatory pressure will rise, due to increasing policies, taxes and reporting requirements on waste, emissions and resource use. Non circular companies will face higher compliance costs, restrictions or penalties. B2C but also B2B customers are starting to demand more sustainable products. The chances, that a competitor has a circular solution for the same product are high. In the long run, the reputation of a non circular company might be at risk. Furthermore, companies that rely on virgin materials are dependent on volatile supply chains.
WHAT IS THE FIRST CONCRETE STEP TO START A CIRCULAR TRANSFORMATION?	The starting point is to clarify the vision and strategic objectives of the company: why do we want to become more circular and what benefits are we seeking (e.g., cost reduction, market differentiation, compliance, environmental sustainability)? Based on this, the right tool (Canvas, Guide, Ecodesign+, etc.) can be chosen to turn the strategy into action.
WHICH PEOPLE IN THE COMPANY ARE NEEDED FOR THE TRANSFORMATION TO A CIRCULAR ECONOMY?	Ideally, the **commitment of the CEO** is essential to establish the necessary processes and drive change. In addition, a **cross-functional team** is needed to reshape the company's strategy towards circularity. This typically includes representatives from: Product Development, Product Management, Purchasing, Production Management, Marketing, Logistics

WHAT QUALIFICATIONS DO I NEED FOR THE CIRCULAR ECONOMY TRANSFORMATION?	Any motivated and passionate staff of a company could be responsible for circular economy transition. Ideally the persons should be interested in collecting product specific information, enjoy communicating and know the products of the company quite well.
MY CUSTOMERS ONLY CARE ABOUT LOW PRICES — WHY WOULD THEY PAY EXTRA FOR CIRCULAR PRODUCTS?	The price for something only reflects the current market. Circular products are not necessarily more expensive, depending on the business model that is used. For example, if a company retains ownership of products, components, and materials, it is much more independent of suppliers and therefore more resilient and can set fewer volatile prices that may even be cheaper in the long term than non-circular products from competitors.
HOW CAN SMES MEASURE PROGRESS IN THEIR CIRCULARITY TRANSFORMATION WITHOUT COMPLEX TOOLS?	Start with simple, easy-to-track indicators such as material use per product, waste generated, recycled content, or energy consumption. Even basic KPIs can reveal trends and demonstrate improvement to stakeholders. As capabilities grow, SMEs can expand to more advanced metrics (like product carbon footprint or circularity score).
WHAT CAN WE DO IF WE DO NOT HAVE DETAILED DATA ABOUT OUR ACTIVITIES OR PRODUCTS?	It is common for SMEs not to have complete datasets. The first step is to work with estimates, sectoral benchmarks, or order-of-magnitude data. As processes evolve, more accurate information can be integrated. The key is to start, rather than waiting until all data is available.
HOW DO WE GET OUR ORGANIZATION AND PARTNERS ENGAGED IN THE TRANSFORMATION PROCESS?	Engagement requires both a business case and clear communication. Internally, highlight cost savings, compliance benefits, and new market opportunities that circularity offers. Externally, involve suppliers and customers early through workshops or co-creation sessions. Industry partners we worked with emphasized that *quick wins* (like reducing packaging waste or energy consumption) helped create momentum and trust, which made it easier to expand into more ambitious circular initiatives later.

WHAT HAPPENS IF MY PARTNERS ARE UNWILLING TO SHARE DATA NEEDED FOR CIRCULAR PRACTICES?	Start wherever you can. If some data is missing, make reasonable assumptions and adapt if necessary. Unless otherwise specified, assume a product is designed and produced for a linear economy.
HOW CAN I REVEAL PRODUCT SPECIFIC AND SUPPLY CHAIN RELEVANT SENSITIVE INFORMATION WITHOUT GIVING AWAY TRADE SECRETS?	If you are preparing a product carbon footprint or life cycle assessment for a product you will need a Bill of Materials (BoM) for the product as a starting point. Always sign a non-disclosure agreement (NDA) with consultants or external entities which will ensure that your information & data on supply chains is kept confidential & not passed on to third parties.
ARE THE RECOMMENDED TOOLS FOR FREE?	Some of the tools are free, for some tools free trials are available and other tools require payment.

FAQ for tool specific questions

QUESTION	ANSWER
Circularity Assessment Tool	
IS IT POSSIBLE TO ASSESS A COMPANY'S CIRCULARITY?	The tool is designed for product development. Ideally a reference product is selected and assessed.
DO I GET A SCORING THAT CAN BE COMPARED WITH OTHER PRODUCTS?	The result is a list of hotspots for improvement. There is no weighing of results that will give an absolute number.
IS IT NECESSARY TO DO BOTH STEPS OF THE TOOL?	Both steps can be taken individually, but it helps to see which design strategies are most relevant, to reduce the amount of design criteria.
HOW LONG DOES IT TAKE TO APPLY THIS TOOL?	It depends on the available information and the relevant design strategies. Usually, it takes around 4 hours to go through all the points in detail.

Ecodesign+

WHICH ENVIRONMENTAL DATABASE IS USED WITHIN ECODESIGN+?	ECODESIGN+ uses Global Warming Potential (GWP) datasets [kg CO_2 eq.] from the latest Ecoinvent database.
IS IT ALLOWED TO COMMUNICATE THE RESULTS OF ECODESIGN+ TO CUSTOMERS OR PUBLISH THEM ON THE WEBSITE?	For internal communication, ECODESIGN+ provides a one-page summary with all relevant results to support discussions and identify improvement opportunities. External communication of the results (e.g., with customers or on websites) is not permitted.
CAN I SHARE MY PRODUCT MODELS IN ECODESIGN+ WITH COLLEAGUES?	Yes. Product models can be shared with other accounts within the same organization and can also be collaboratively edited.

Future Scenarios

WHAT IS THE ROLE OF FUTURE SCENARIOS FOR BUSINESS?	Scenarios don't predict the future but help businesses test strategies under different plausible conditions. They also support acknowledging what is happening in other sectors and natural systems.
HOW MANY SCENARIOS SHOULD BE DISCOVERED DURING THE WORKSHOP?	Preferable are 3-4 scenarios, to be able to acknowledge business as usual vs radical innovation scenarios, but also to grasp adoption of sustainable, circular technologies and new regulations, or geopolitical tensions.
WHAT IS THE MOST PROBLEMATIC WHILE USING THE TOOL?	The science-fiction approach is often the first that comes to mind when working on the future. This is a natural reflex; this is what already exists in our minds. For this reason, it is essential to ensure thorough preparation before or at the beginning of the workshop. Participants' imagination should be fuelled with diverse stories, narratives, and reliable data, which create a broader context and anchor creativity in plausible developments rather than purely fictional ones.

Strategy for circularity and sustainability

WHAT CAN WE DO IF WE DON'T HAVE DETAILED DATA AVAILABLE?	Many SMEs face data gaps in the beginning. Start with approximate or industry-average data to build a baseline. Tools such as sector benchmarks, material flow analysis, or default datasets can provide sufficient accuracy to identify "hotspots" and priorities. Over time, refine your data collection (e.g., supplier engagement, bill-of-material reviews, customer usage patterns). A phased approach ensures you don't delay progress waiting for perfect data.
WHAT RESOURCES OR INPUTS ARE NEEDED TO USE THE TOOL EFFECTIVELY?	At minimum, SMEs need a basic understanding of their operations, products, and supply chain. Even with limited data, SMEs can start developing a strategy. As more detailed information becomes available, the strategy can be refined. The emphasis is on starting small but building momentum.

Ecodesign - the legislative Framework

WHEN WILL THE NEW ECODESIGN FOR SUSTAINABLE PRODUCTS REGULATION (ESPR) COME INTO FORCE?	The ESPR has been passed in 2024, however the technical specifications for each product category are yet to be published. In the interim, the existing Ecodesign regulations, as clarified in the tool apply.
HOW OFTEN IS THE WEBTOOL UPDATED TO REFLECT NEW REGULATIONS?	The webtool is updated regularly to incorporate the latest EU regulation, delegated acts, and revisions, as they are published in the Official Journal of the European Union - OJEU.
DO SMES NEED PRIOR LEGAL KNOWLEDGE TO USE THE TOOL EFFECTIVELY?	No, the tool was designed with non-experts in mind.

Quickscan Circular Business Model (QCBM)

WHAT IS THE QCBM AND WHO IS THE TARGET GROUP?	The QCBM is a structured self-assessment tool designed to help companies understand their current position toward a circular and sustainable business model. Its main purpose is to guide organizations step by step in defining their sustainability priorities, assessing their current experience and future ambitions, and identifying the most suitable circular business model to adopt or improve. The QCBM is designed for entrepreneurs, SMEs, and innovation-driven organizations, particularly in the manufacturing and service sectors.
HOW LONG DOES THE QCBM TAKE TO COMPLETE?	On average, it takes about 30 minutes for a quick version and up to one hour for a more detailed walkthrough of models and classifications, depending also on the familiarity with circular economy concepts.
WHAT ARE THE MAIN BENEFITS FOR MY COMPANY?	The QCBM offers several key benefits: it helps clarify your company's sustainability position, identify practical circular strategies aligned with business goals, discover innovative revenue and organizational models, and prepare a clear roadmap for transitioning toward a circular economy. In addition, the personalized report serves as a useful reference for internal decision-making or for funding and grant applications related to sustainability.

Circular Business Model Guide

THE GUIDE LOOKS COMPLEX. DO WE NEED TO FOLLOW IT ENTIRELY?	No, the guide is modular. Companies can focus only on the chapters that are most relevant to their current needs. For example, if the strategy is already clear, you can skip the initial chapters and work directly on value streams or the stress test.
WHAT IS THE ADDED VALUE OF THE GUIDE COMPARED TO OTHER TOOLS?	The Guide integrates different methods and tools into a coherent pathway, rather than using them individually. It supports the journey from analysis (e.g., mapping or canvases) to concrete actions, with clear steps and supporting instruments.

Circular Business Model Canvas

HOW CAN WE USE THE CIRCULAR BUSINESS MODEL CANVAS IF WE DO NOT HAVE PRIOR EXPERIENCE WITH BUSINESS MODELS?	The Canvas is designed to be simple and visual. You can start by filling in each section with initial ideas, ideally in a workshop format using sticky notes or a digital board. The goal is not to have perfect answers, but to stimulate circular thinking and identify opportunities.
HOW DOES THE CIRCULAR BUSINESS MODEL CANVAS CONCRETELY SUPPORT AN SME?	It visualizes the entire business model from a circular perspective: showing where waste occurs, which partners can support reuse or recycling strategies, and where new revenue streams could be developed. This provides a practical basis for more sustainable decisions.

Context-Map Canvas

WHY IS IT IMPORTANT TO MAP THE EXTERNAL ENVIRONMENT WITH THE CONTEXT-MAP CANVAS?	Many factors influencing a company's success are external. Technological trends, emerging regulations, or shifting customer needs can open new opportunities or create risks. Mapping the context helps anticipate and prepare more effectively.
IS THE CONTEXT MAP CANVAS JUST A DESCRIPTIVE EXERCISE?	Invite participants with different perspectives (technical, commercial, sustainability) and focus on identifying at least two major threats and two opportunities. This ensures the canvas becomes an actionable strategic tool, not just a descriptive exercise.

Value Mapping

DESCRIBING THE COMPANY'S PROCESSES IS A BIG EFFORT, IS IT REALLY NECESSARY?	Yes, it is necessary – and it provides a clear added value. By systematically describing processes, the company gains a holistic overview of how value is created, where resources and knowledge are used, and where risks or inefficiencies occur. This effort pays off because it reveals hidden potentials for circularity and sustainability that would remain invisible without a structured mapping. The result is not only a clearer understanding of the company's current situation, but also a concrete basis for strategic decisions and future improvements.

WE FIND IT DIFFICULT TO CLASSIFY THE INDIVIDUAL VALUES, IS THERE AN EXPLANATION FOR THIS?	This is a common experience, because many values in a company overlap different categories – for example, knowledge can be both a resource and part of relationships. The purpose of classification is not to find a “perfect” category, but to stimulate reflection and discussion. The added value lies in making hidden aspects of values visible and considering them from different perspectives. Even if a value could fit into more than one category, the process helps the company to better understand its relevance and potential.
AT FIRST GLANCE, WE DON’T SEE A DIRECT BENEFIT, HOW CAN WE MAKE SURE THE EFFORT IS WORTHWHILE?	The immediate benefit may not always be visible, because the tool is designed to uncover long-term potentials and risks. The value lies in creating transparency: companies gain a structured overview of where resources are used inefficiently, where dependencies exist, and where circular opportunities could emerge. By turning these insights into concrete actions, the effort quickly pays off in the form of cost savings, improved resilience, and strategic advantages.

Cyrkl Tool Marketplace

WHAT INFORMATION DO WE NEED TO CREATE A CREDIBLE LISTING?	Material name and composition, estimated volumes and availability windows, photos, packaging and storage details, location, logistics terms, and a contact who replies quickly.
DO WE NEED LARGE QUANTITIES TO SELL?	No—but small volumes attract fewer buyers. Aggregate over time and/or team up with nearby firms to reach commercially attractive lot sizes.
HOW DO WE INCREASE VISIBILITY AND TRUST ON THE PLATFORM?	Publish high-quality listings (clear specs + good photos), use relevant keywords/taxonomy, refresh listings regularly, and answer buyer questions promptly.

Cyrkl Waste Scan

HOW LONG DOES IT TAKE?	Typically 1–4 months, depending on company complexity and data readiness.
WHAT INPUT DATA DO WE NEED?	Volumes and composition by stream, storage/availability windows, current handling/disposal costs, location/logistics constraints, and photos where available.
WHAT KIND OF CHANGES CAN WE EXPECT AFTER A SCAN?	A clearer view of viable routes, better data and listing practices, greater market readiness, and a shift from ad-hoc actions to routine, tracked integration.

Product Carbon Footprint by Ecochain

WHAT PRIOR KNOWLEDGE DOES THE STAFF NEED TO ENTER THE DATA INTO THE ECOCHAIN MOBIUS TOOL?	The staff should be able to collect relevant information on materials/ raw materials and supply chains as in a 'Bill of Materials'. The source of the raw materials could be derived from the technicians at a company or estimated if unknown.
HOW LONG SHOULD I SUBSCRIBE FOR THE TOOL?	Depending on the complexity of the product- a minimum of 6 months license is recommended. The more complex the product, the longer the license should be. We recommend to always receive a demo/ trial from Ecochain.

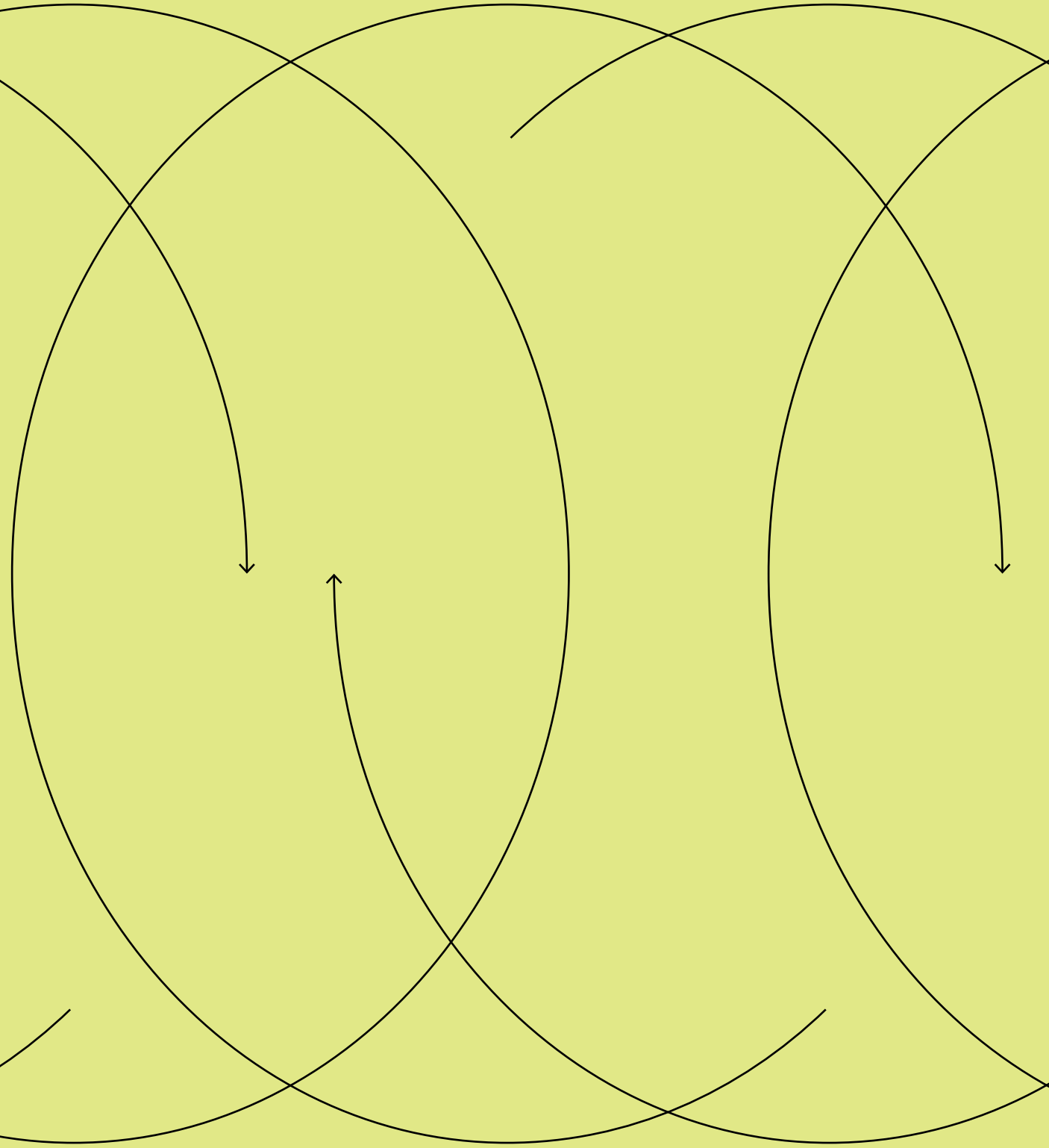
CircitNorden Circular Assessment Tool

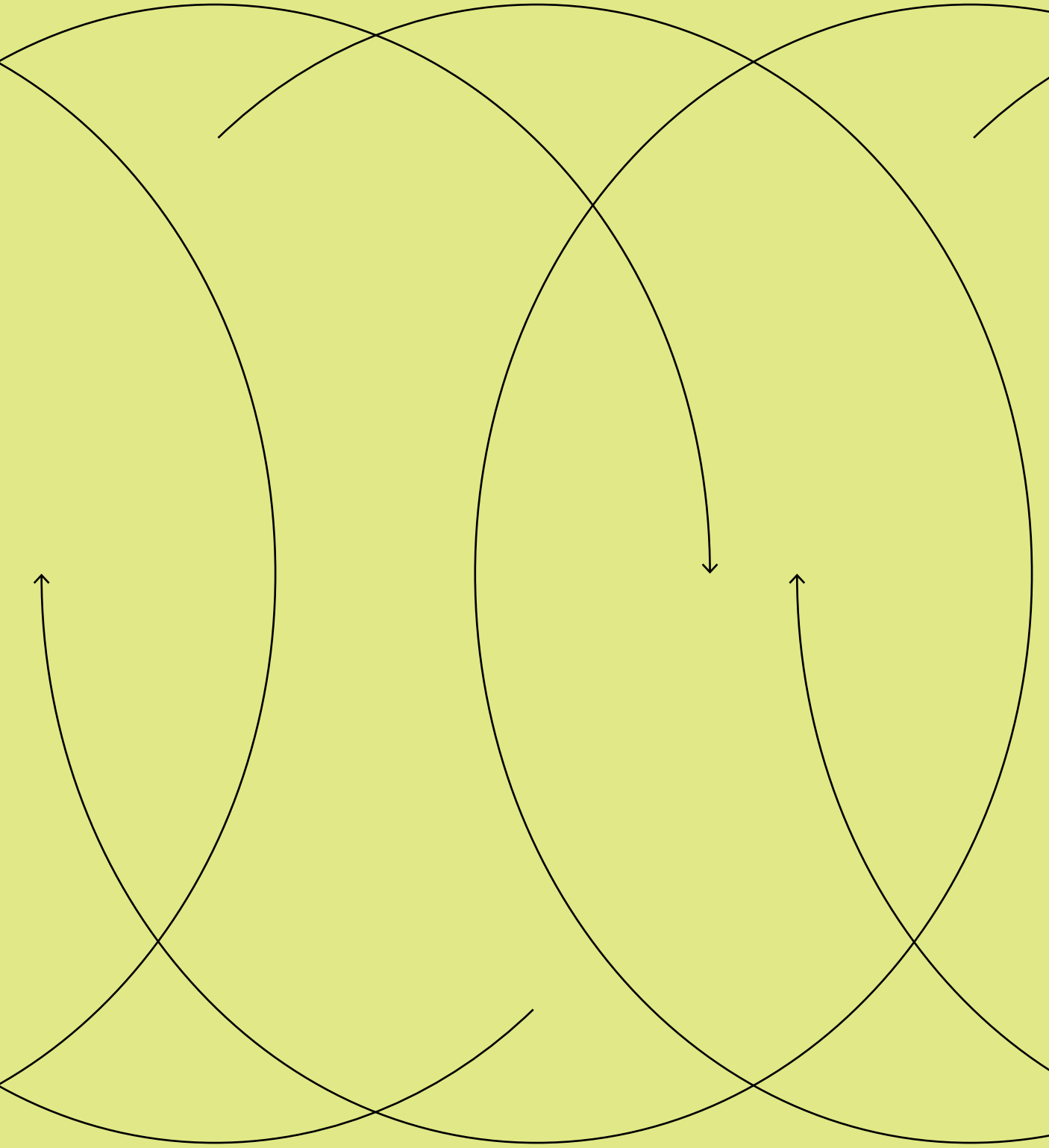
WHEN I HAVE DOWNLOADED THE TOOL, DO I HAVE TO ENTER 3 DIFFERENT CIRCULAR OPTIONS?	The free Excel based tool can be downloaded online (Link) and can be used for 2 or more alternative comparisons. You can add more columns if you have more options than 3 – the one with the lowest score is the most circular.

HOW COULD I DEAL WITH THE SCORING IF IT DOES NOT APPLY TO MY PRODUCT SUCH AS 'INCUMBENT CONFIGURATION' OR 'BOUNDARY MANAGEMENT'?	If you are unsure of the meaning or the application of a particular guideline to your product, just enter a score of zero in the column 'level of fulfilment'.

CircularSupplyChain workshop tool

HOW DO I DEFINE A STARTING POINT FOR THE TOOL?	Prior to the workshop, select one product as an example and prepare a BOM with the source of materials, where possible. You can map this on the Sourcemap for free- however take care not to enter 'sensitive' or non-publishable data there.
WHERE CAN I FIND MORE INFORMATION ON CIRCULAR SUPPLY CHAINS FOR EEE?	Download the Circular Electronics Design Guide from the Circular Electronics Partnership website (Link).





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