A SPRINGBOARD TO CIRCULAR ECONOMY: HOW TO ALIGN ENVIRONMENTAL AND ECONOMIC SUSTAINABILITY

First steps to transform your portfolio for circularity

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Abstract

In March 1972, Meadows et al. published The Limits to Growth [Mea72]. It soon became clear that the century old idea of circularity would be a possible answer to thriving within those limits, or rather, growing without the limitation of resource usage. Yet 50 years later, only 8.6% of the economy were circular (Circularity Gap Report [PAC22]). The presented Circular Economy Springboard approach aims at finding a starting point and easing the path to circularity, thus increasing both the speed and the success rate of doing business the circular, sustainable way. The core of the method is a stepwise identification of products or components with high business potential in circular economy, aligning economic and environmental business success. The result will help business owners, portfolio managers and sustainability experts alike to rationalize, initiate and succeed with circular economy projects. Respecting crucial principles of change management, it will act as a springboard for further Circular Economy projects and circular transformations.

What circular economy (CE) is and why we need it

Linear economy is characterized by a one-way trajectory from take, via make, to waste, and it is also known as “Cradle to Grave” [McD02]. Circular economy strives to bend this line and close the loop by, in essence, making waste a resource, also known as “Cradle to Cradle” [ibid]. As a result, circular economy decouples economic growth from the consumption of finite resources (cf. Fig. 1).

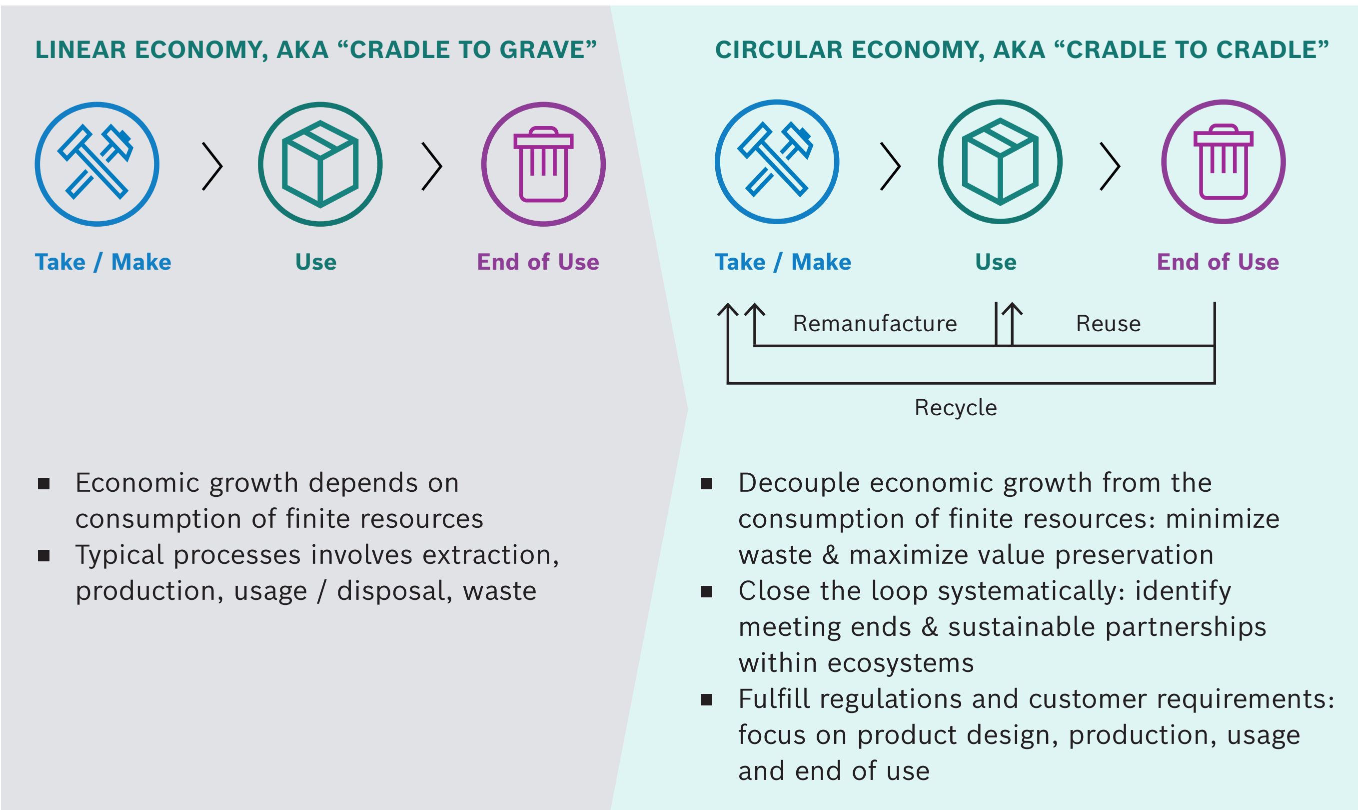


Figure 1: According to our definition, circular economy decouples economic growth from the consumption of finite resources – including the resources land, water, and air. The terms “Cradle to Grave” and “Cradle to Cradle” were coined by McDonough and Braungart [McD02].

Looking to the front end of linear economy, it has been a matter of scientific debate [Jow20], to what extent mineral resources will deplete in the near future [Jow20]. The novel resources mentioned in [Jow20], however, almost always require deeper mining and/or more intense processing, both leading to a higher output of CO2 and significant impacts on land, water, and atmosphere.

At the back end of linear economy, only 13.5% of global waste was recycled in 2018 according to a report by the world bank group [Kaz18]. The annual waste is expected to increase from 2 billion tons in 2016 to 2.59 in 2030 and 3.4 billion tons in 2050 [ibid]. In summary, we use huge amounts of resources at the front end to create huge amounts of waste at the back end, by which we pollute the resources land, water, and atmosphere.

The resulting inefficiency of resource usage could be significantly improved by a shift towards circularity. Circular economy will not only contribute to a thriving survival of humanity, but more mundanely, help businesses to open new opportunities, meet regulations, build, and maintain a reputation, and reduce risks, e.g., in the context of material and supply dependencies. The next section will explore why, despite the numerous benefits, so little of CE has been implemented.

Challenges to overcome

The idea of circular economy emerged from various schools in the 20th century [McA], and is, in essence, not only an old, but also a simple idea. In 1972, with the publication of The Limits to Growth [Mea72], its importance became also clear. Still, only 8.6% of the economy were circular 50 years later (Circularity Gap Report [PAC22]).

Whenever a well-known, beneficial, and seemingly straight forward idea has hardly been put into practice, it is worth looking at the hurdles that hinder its realization. Kotter identified what he calls the "Eight main errors" that stand in the way of many successful transformations [Kot12]:

1. Allowing too much complacency
2. Failing to create a sufficiently powerful guiding coalition
3. Underestimating the power of vision
4. Under-communicating the vision by a factor of 10 (100 or even 1000)
5. Permitting obstacles to block the new visions
6. Failing to create short-term wins
7. Declaring victory too soon
8. Neglecting to anchor changes firmly in the corporate culture

The specifics of challenges #1 – #4 will differ between companies and must be adapted to the respective culture. In the context of circular economy, challenges #5 and #6 have shown common patterns. In our experience, the need to work in ecosystems and the uncertainty of financial benefits (economic sustainability) stand out as inhibitors to the implementation of circular economy and can be seen as examples of challenges #5 and #6. Our approach aims to tackle exactly these challenges and thus become a much-needed springboard for circular economy.

Locating our CE Springboard

The motivation to create the CE Springboard was to close a gap in circular economy business model innovation. Existing tools and methods for CE innovation tend to focus on revolutionary approaches, which, by nature, aim for large impacts and require considerable investments of work, time, and financial means, e.g., HSG with their "Circular Ecosystems: Business Model Innovation for the Circular Economy [Tak20]". By contrast, many public or corporate investors want to see quick wins before they engage in larger investments. This is where the CE Springboard can help to close the gap and start the circular transformation by identifying products and components with which quick wins appear likely, paving the way for more substantial changes.

In essence, the presented portfolio analysis tool ("CE Springboard") supports swift identification of products (components) for which CE is likely to be profitable and viable within existing ecosystems. By addressing and resolving these two core hindrances of CE implementation - uncertain profitability and need to work in (new) ecosystems - it offers an efficient start with promising candidates. These projects with high success probabilities can prepare the organization and ecosystem for more complex cases: both by co-financing them and by establishing experience, knowledge, and acceptance with simpler cases first.

Fig. 2 illustrates three phases a), b), c) of evolutionary circular economy business model innovation. The present paper focusses predominantly on phase a). First, the scope of the analysis needs to be defined, i.e., should a whole product portfolio be analyzed to identify a promising product within that portfolio, or should a product be analyzed to single out a promising component. This is symbolized by the width of the grey funnel. In case of a portfolio analysis, the light and dark green parcels stand for products of that portfolio, in case of a product analysis, they symbolize components of that product. Second, the product(s) or component(s) with the highest potential are selected by help of the CE Springboard. This is symbolized by the tick in one of the parcels. The information and knowledge collected in phase a) will also help to prioritize and proceed in phases b) and c), including candidates for synergy effect ("dark green parcels"). Furthers deep dives into and tools for phases b) and c) can be found in the whitepaper on circular economy Business Model Canvas [Alt23].

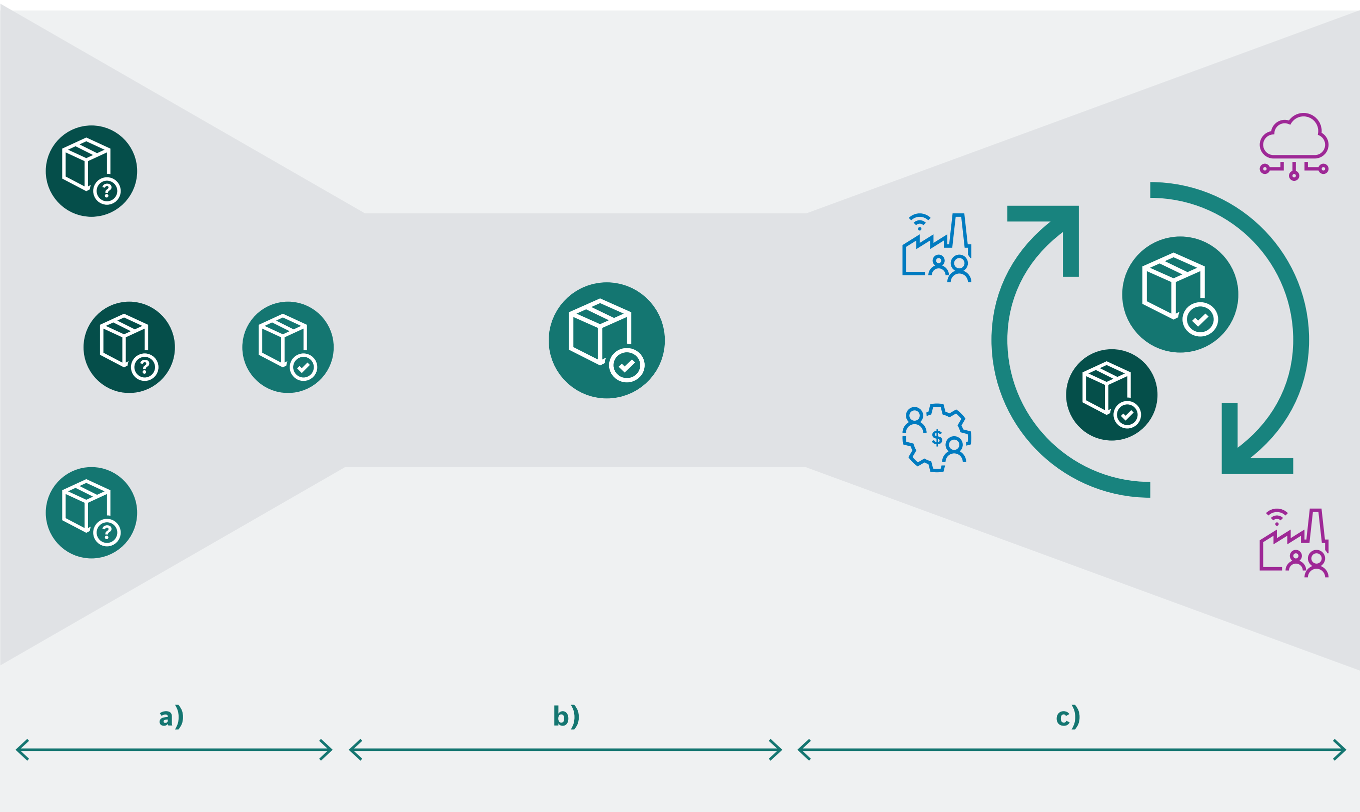


Fig. 2: Circular economy business model innovation can be divided into 3 phases, a), b), c). The presented tool (CE Springboard) focusses on phase a): the definition of the scope (symbolized by the width of the grey funnel and its content), and the selection of the products or components with the highest potential of success (symbolized with the tick instead of question mark in the right bottom corner). It also helps to collect and prioritize valuable information for phases b) and c). Phase b) focusses on diving deeper into the selected product or component, while phase c) helps to establish the circular business case within an ecosystem. Further tools for phases b) and c) are described in the whitepaper on the Circular Economy Business Model Canvas [Alt23]. This ecosystem may be even suitable for further products / components (symbolized by the dark blue box in phase c)).

The CE Springboard – comprehensive analysis made easy

The CE Springboard combines the knowledge and experience from circular economy, raw materials risk management and business model consulting with change management. In particular, it builds on Kirchherr et al.'s definition of R strategies [Kir17], Atasu et al.'s three decisive parameters for successful CE, the information contained in prices, and Kotter's eight steps of leading change [Kot12]. These concepts will be briefly explained before the detailed description of the CE Springboard.

Kotter et al.'s eight steps of leading change

As an answer to the 8 main errors in the context of transformation mentioned above, Kotter developed eight steps of leading change [Kot12]:

1. Create a sense of urgency
2. Build a guiding coalition
3. Form a strategic vision
4. Enlist a volunteer army
5. Enable action by removing barriers
6. Generate short-term wins
7. Sustain acceleration
8. Institute change

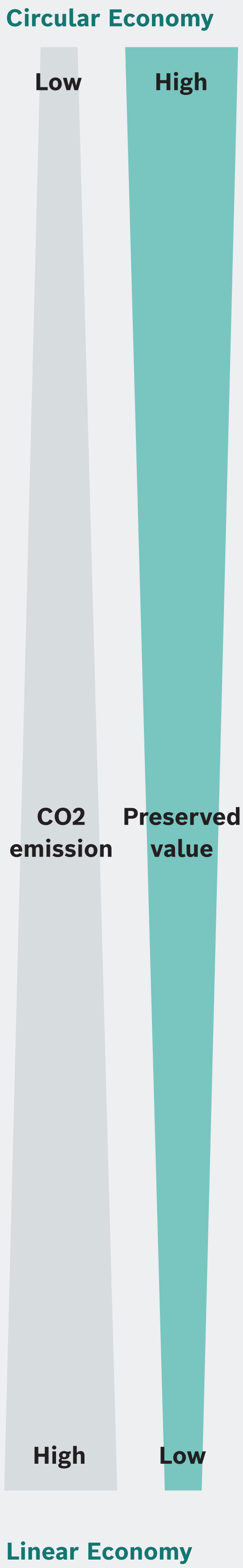
For circular economy transformations, steps 1-4 need to be tailored to each company, institution, or team. Numbers 5 and 6 share the mentioned main root causes: the complications that can arise if new ecosystems need to be generated from scratch and the uncertain economic sustainability of CE. This is where our CE Springboard will help teams and entire businesses to tackle the problem and find a starting point that sets them up for success: it helps to spot products and components with sufficient value for financial benefits and existing ecosystems that support CE.

In Kotter's terms, the presented approach takes steps 5 & 6 first (5: "Enable action by removing barriers" and 6: "Generate short-term wins", see list above), and establishes CE for promising products first. Consequently, the desired change for CE will be accelerated and instituted (steps 7 and 8), sometimes it will even offer synergy opportunities for other products in the portfolio or components in the product – symbolized by the dark blue box in phase c) in Fig. 2.

Kirchherr et al.'s definition of R strategies

Closing the loop from linear to circular economy is typically achieved by applying one or more "R strategies" (also referred to as "Re-"strategies). A notable collection of R strategies has been published by Kirchhoff et al. [Kir17], cf. Table 1. For automotive contexts, we summarize remanufacturing and refurbishing as automative remanufacturing.

Applying Kotter's quick win wisdom to these R strategies, remanufacturing and recycling appear most relevant for industrial implementation in the foreseeable future: they best comply with existing quality standards, warranties and other processes such as development standards. Once the first CE projects are successful in the sense of relatively short-term wins (cf. Kotter's step 6), other strategies can be explored, e.g., R1. This could involve establishing sharing platforms for a company's products and would typically involve higher technical and organizational investment.



Goal	Strategy	Description
Product use and manufacturing	R0 Refuse	Make a product redundant by abandoning its function or by offering the same function with a radically different product
	R1 Rethink	Make a product use more intensive (e.g., by sharing a product)
	R2 Reduce	Increase efficiency in product manufacturing or use
Extend lifespan of products and its parts	R3 Reuse	The repeated use of a product or component for its intended purpose without significant modification and without quality tests
	R4 Repeat	Operation by which a faulty or broken product or component is returned back to a usable state to fulfill its intended use
	R5 Remanufacture (Automotive)	**Automotive Remanufacturing: industrial process by which a used or non-functioning product is restored to a defined qualita standard**
	R6 Repurpose	Use discarded products / components in new function / context
Making use of materials	**R7 Recycle (Material)**	**Transform a product or component into its basic materials or substances and reprocess them into new materials**
	R8 Recover (Energy)	Incineration of material with energy recovery

Table 1: Adapted 9R framework to identify R strategies with quick wins (typically remanufacturing and recycling) for CE

Atasu et al.'s three decisive parameters for successful CE

From a different perspective, Atasu et al. [Ata21] describe three decisive parameters for successful CE:

1. access at end of use
2. recovery process, and
3. embedded value

All three criteria need to be fulfilled to at least a certain degree. We arranged them in a Venn diagram, similar to the UX sweet spot of innovation from IDEO, which is a Venn diagram of desirability, viability, and feasibility. We call the Venn diagram of Atasu's criteria the sweet spot of CE, cf. Fig. 3: only if a product or component contains enough value, and can be obtained at the end of use, and affordable recovery processes are in place, can CE be successful.

Details of the CE Springboard

Synthesizing the essence of the described approaches lead to the CE Springboard, a stepwise analysis tool that identifies promising entry points for circular economy. Its questions are stunningly simple and, in most cases, easy to answer with a sufficient degree of accuracy. Expertise and experience will certainly improve speed and quality of the results. For a complete picture, we recommend to answer all questions before diving deeper.

Its quantifiable parameters have been tested with real products and CE projects. The given treshold values may have to be adjusted for certain business contexts and business interests, or future prices and supply situations. Background and alternatives can be found in the discussion of the process below. Fig. 4 summarizes the 3 x 2 questions (on the left) and their main purpose (on the right), while fig. 5-7 focus on two of the questions according to the overview.

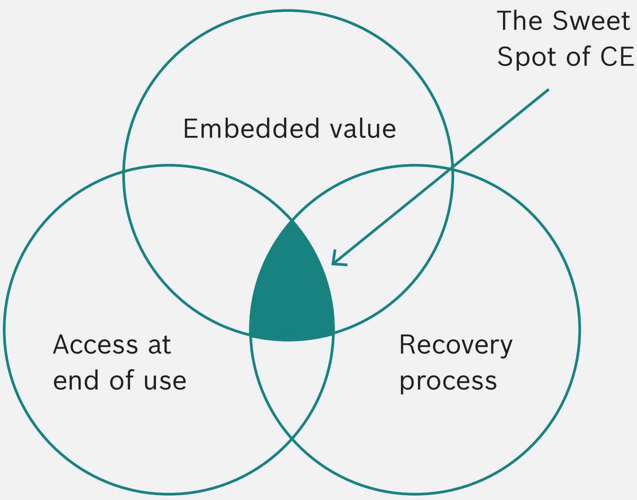


Fig. 3: To reach our "Sweet Spot of Circular Economy (CE)", all 3 of Atasu's criteria need to be fulfilled namely: available recovery processes, sufficient embedded value and access end of use (e.o.u.) [Ata21]. The presented arrangement in a Venn diagram resembles the "Sweet Spot of Innovation" known in the context of design thinking, especially IDEO, which is characterized by viability, desirability, and feasibility.

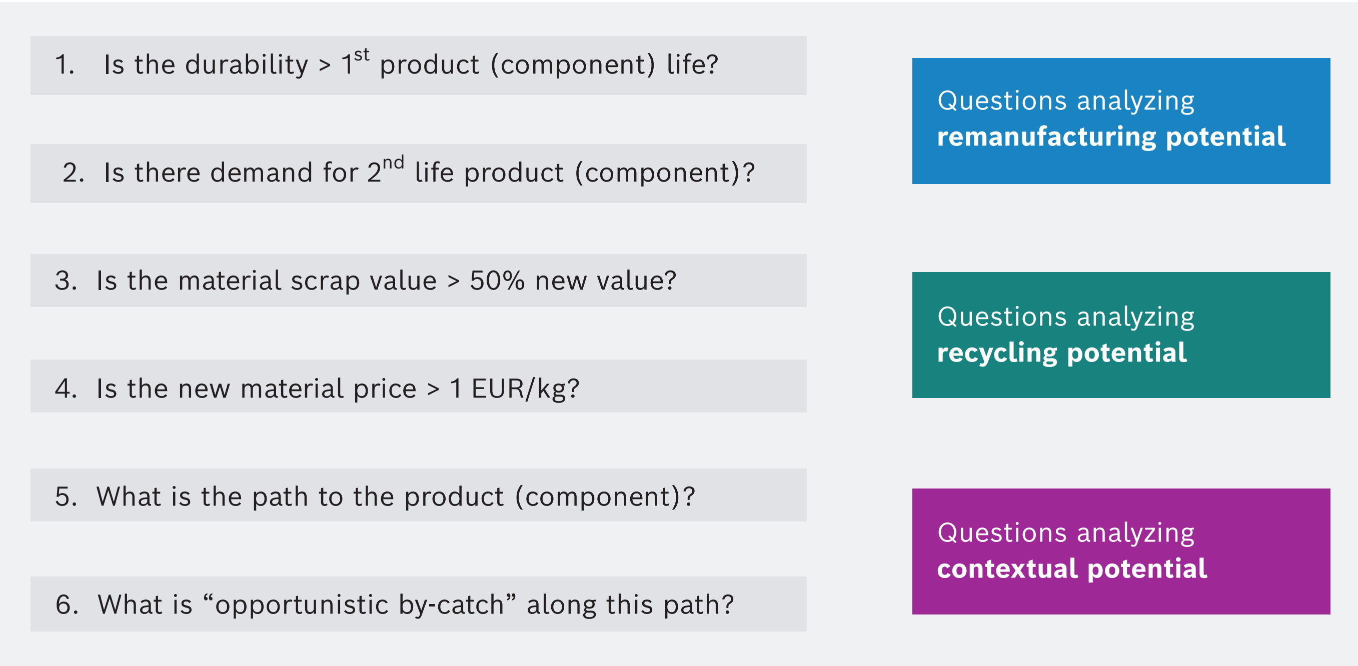


Fig. 4: The six analysis questions can be grouped into 3 x 2, each pair has a common purpose described in the color coded boxes on the right. The following illustrations provide more details for each of the pairs. We recommend to answer all questions to identify all potential benefits.

In most cases, remanufacturing will preserve more value and lead to greater reductions of the carbon footprint than recycling, cf. the Ellen McArthur’s butterfly diagram [McA19]. For this reason, the first questions, numbers 1 and 2, investigate a product’s (component’s) suitability for remanufacturing, cf. Fig. 5. If both questions can be answered with a yes, remanufacturing is likely profitable. However, we recommend to complete all questions to identify further upsides.

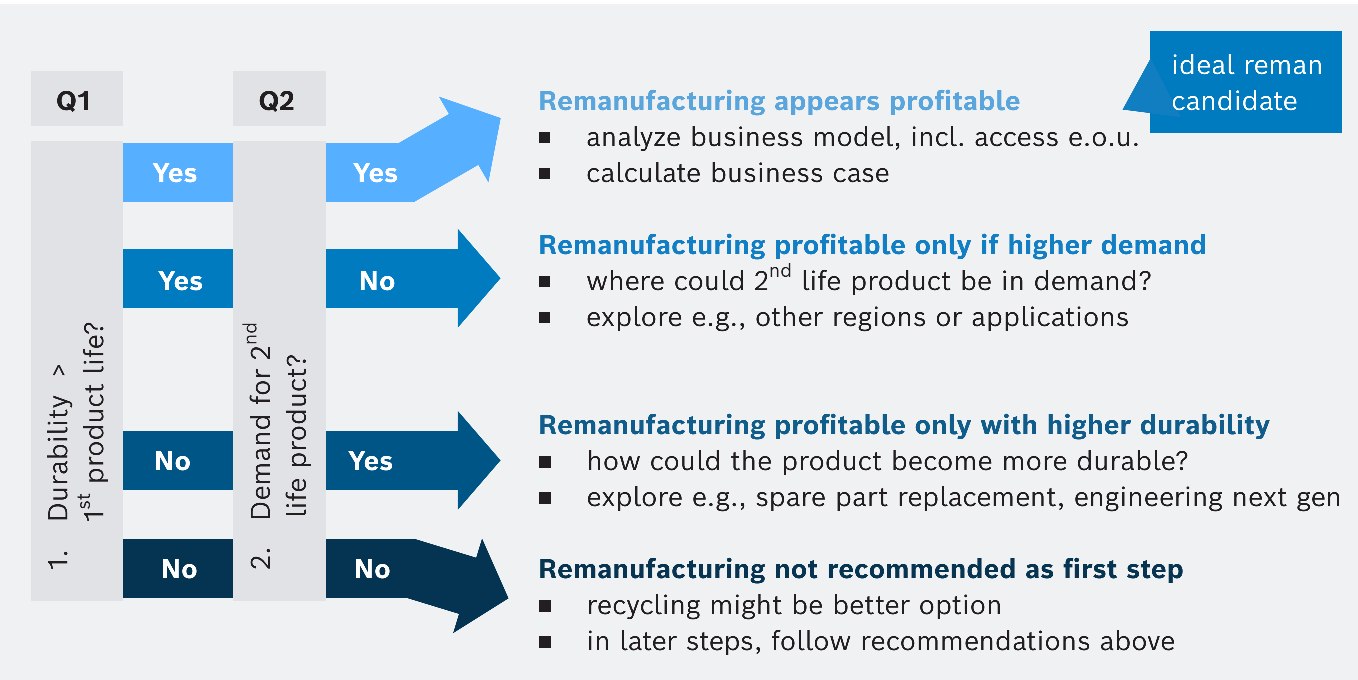


Fig. 5: Questions and recommended actions for answer combinations on remanufacturing: The questionnaire starts with remanufacturing since it typically preserves more value and leads to greater reductions of the carbon footprint than recycling. Key criteria are product (component) durability vs. product (component) lifetime and the demand for 2nd life products (components). If both criteria can be answered with a yes, the product (component) has a high remanufacturing potential – see top line.

The starting point, question 1, investigates whether the product (component) is durable beyond its (average) first product (component) lifetime, at least once wear parts are exchanged. Only then will remanufacturing be technically feasible with reasonable effort.

Next, the demand for the remanufactured product (component) is to be explored with the second question. This is a precondition for economical sustainability. The demand for a certain remanufactured product (component) will be increased by its backward & forward compatibility and may differ regionally. It is recommendable to start with products (components) with existing demand and expand from there, e.g., by considering different regions or establishing increased compatibility across product generations.

For the analysis of recycling potentials (also see Fig. 6), we begin with question 3, which explores the ratio between new material and scrap material prices. This number indicates the added value in the product (component). For instance, 1 kg of new very fine copper wire will be more expensive than a block of copper of the same mass, since it contains considerable amounts of added value (work and energy) compared to the simple copper block. The scrap price will be the same for both or even lower for the fine wire since it has a higher probability for contaminations.

Comparing the new to scrap ratios between materials in constant shape indicates the availability of efficient recovery processes. To give an example, the ratio is much higher for copper when compared to concrete. Recycling copper is an established, relatively efficient process, whereas recycling concrete is not.

Both aspects of the price ratio are crucial for sustainable recycling, as they indicate not only economic parameters but also energy consumption and thus carbon footprint. If the scrap price is only half of the new material price or less, a thorough reconsideration and enablement of remanufacturing is advisable.

The next criterion (question 4) in the context of recycling is the height of the new material price. It should not be too low for a first CE product, since the reverse logistics and recycling will consume revenue. While the threshold of 1 EUR/kg is meaningful in the context and times of writing this paper, it may be different for later times and applications. In this case, we recommend researching materials for which recycling is established and profitable and take that price as a threshold.

Summarizing the first 4 questions, circular economy is best started with remanufacturing of a certain product or component, if questions 1 and 2 can be answered with a yes for it, and recycling, if questions 3 and 4 can be answered with a yes. If all four questions can be answered with a yes for the same component or product, the recommendation is to start with remanufacturing. Ideally, remanufacturing is always combined with recycling in case an individual specimen of the product (component) is too worn for remanufacturing. These combinations come with the best starting points for profitability, which will sustain the circular economy for the analyzed product or component and pave the way for more complex cases. The thus identified products or components are the “sweet spots of circular economy” of this analysis.

Moving on, questions 5 and 6 (Fig. 7) have the potential to make the sweet spots even sweeter: Question 5 investigates how to retrieve a product (component). This may include the dismantling of the product to obtain the identified “sweet spot” component, or a complex reverse logistics process for an identified “sweet spot” product, that typically comes with other products. In answer to question 6, all products that in addition benefit from an already established CE solution” are summarized and then analyzed for their respective recycling or remanufacturing potential. These potentials will create upsides to the circular business case.

Further deep dives into the circular business model of the product (component) will be useful to prepare investment and business decisions [Alt23]. At a later stage, or if no direct sweet spots emerge, the scope can be widened by exploring the potential of different geographical regions or including the development process, especially the redesign of products according to viable business models. Advanced circular economy includes considering material efficiency over all product life times, not just one. This may lead to using relatively high amounts or relatively valuable materials if it is of technical advantage, since then reuse and recycling are frequently more attractive, and the value stays contained over many cycles [Wil14].

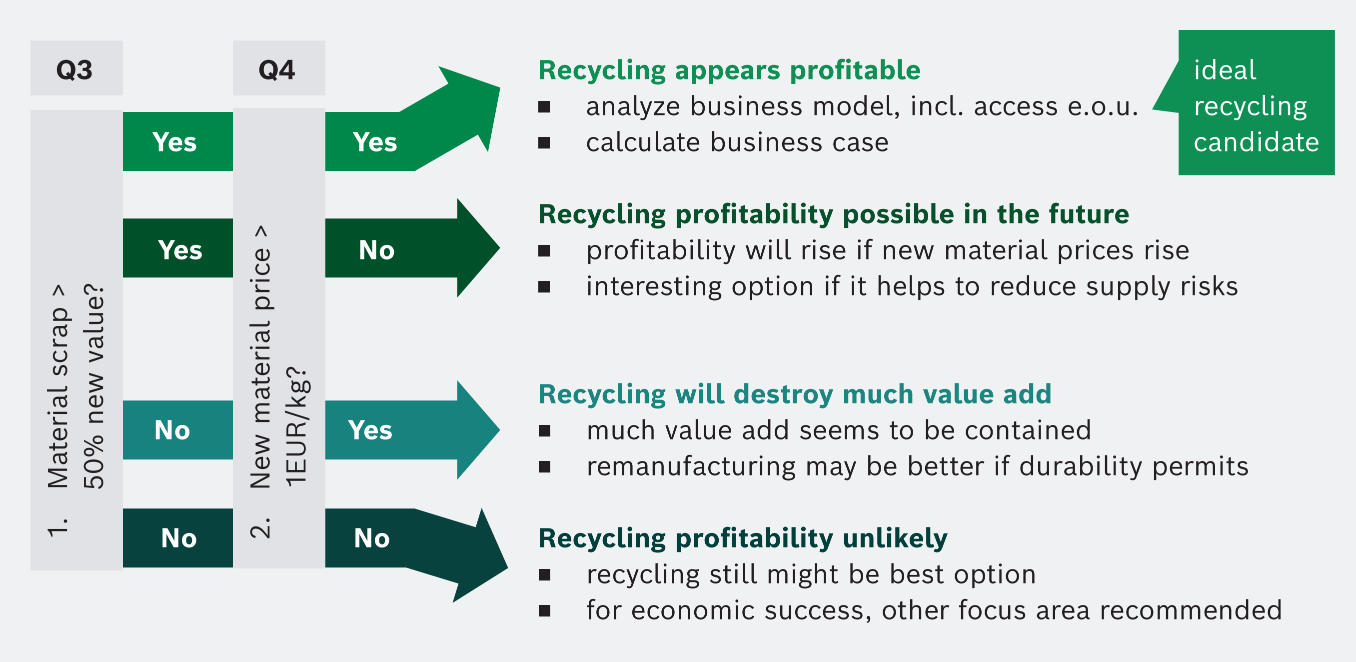


Fig. 6: Questions and recommended actions for answer combinations on recycling: Recycling material often comes with the lowest threshold for integration into existing value chains. The main criteria for its profitability are the price ratio between new and scrap material and the price of new material. The 1 EUR/kg comes from comparing materials with profitable recycling in place, e.g., aluminum and copper at the time of writing and may have to be adjusted accordingly in the future. If both criteria can be answered with a yes, the product (component) has a high recycling potential – see top line.

5. What is the path to the product (component)?

Fictitious example:
Analysis result: the magenta gear (*) is the most attractive component for remanufacturing.
To access it, both the outer housing (1) and inner housing (2) need to be opened. The drill (3) also becomes easily accessible.

5. What is the path to the product (component)?

The income from remanufacturing the magenta gear (*) pays for the dismantling and logistic costs. Since the components (1)-(3) must be dismantled to access the magenta gear, they are obtained “for free”. If e.g., both housings (1) and (2) can also be remanufactured and the drill material (3) can be recycled, further upsides are created.

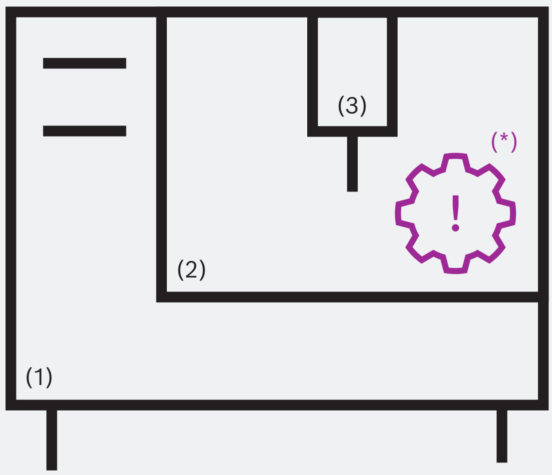


Fig. 7: Once a product or component is identified as the sweet spot of CE, it is time to explore how to get to it and how to create synergies and upsides. The image shows the example of the magenta gear being the sweet spot component. Much of the product must be disassembled to get to it, thus many other components basically come for free and can create further upsides if they are remanufactured or recycled.

Benefits and next steps

Sustainability can be defined as system of qualities and behaviors that support thriving survival. In this sense, most business owners would want sustainability for their business, and most human beings would want sustainability for the planet we live on. Circular economy offers ways to harmonize and align environmental and economic sustainability goals in the long term. The presented CE Springboard identifies where they align and overlap already today, opening immediate business opportunities with benefits for the planet.

As the UN Sustainable Development Goals [SDG15] and the European Green Deal [EGD19] are only the beginning of legal frameworks that require a more environmentally sustainable economy, we can expect increasing pressure to change and react to regulations. The CE Springboard supports co-creation and active shaping of businesses, rather than reacting to regulations. It builds on the knowledge that BMC/IN has gained in multiple projects and shows how a solid business case from CE can be identified.

Reach out to us if you want to explore growth beyond finite resource limitations. Let’s make the world a better place together!

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References

Alt23 Altrichter, L. (2023). Circular Ecosystem Business Model Canvas. Creating sustainable and profitable Circular Economy Business Models in an Ecosystem. Whitepaper.

Ata21 Atasu, A., Dumas, C., and Van Wassenhove, L.N. (2021). The Circular Business Model. Harvard Business Review. https://hbr.org/2021/07/the-circular-business-model

EGD19 The European Green Deal (2019). https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

Jow20 Jowitt, S.M., Mudd, G.M. & Thompson, J.F.H. (2020). Future availability of non-renewable metal resources and the influence of environmental, social, and governance conflicts on metal production. Commun Earth Environ 1. https://doi.org/10.1038/s43247-020-0011-0

Kaz18 Kaza, S., Yao, L., Bhada-Tata, P., Van Woerden, F. (2018). What a Waste 2.0
A Global Snapshot of Solid Waste Management to 2050. World Bank Group. https://openknowledge.worldbank.org/entities/publication/d3f9d45e-115f-559b-b14f-28552410e90a

Kir17 Kirchherr, J., et al. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127 (Dec 2017), 221-232. https://www.sciencedirect.com/science/article/pii/S0921344917302835

Kot12 Kotter, J. (2012). Leading Change. Harvard Business Review Press.

McA Ellen MacArthur Foundation, Schools of thought that inspired the circular economy. https://ellenmacarthurfoundation.org/schools-of-thought-that-inspired-the-circular-economy

McA19 Ellen MacArthur Foundation, Circular economy system diagram, 2019. https://ellenmacarthurfoundation.org/circular-economy-diagram

McD02 McDonough, W.; Braungart, M. (2002). Cradle to Cradle: Remaking the way we make things. Macmillan.

Mea72 Meadows, D. et al. (1972). The Limits To Growth. A Report for the Club of Rome's Project on the Predicament of Mankind. Potomac Associates.

PAC22 PACE, Platform for Accelerating Circular Economy (2022). 5th Circularity Gap report. https://www.circularity-gap.world/2022#Download-the-report

SDG15 17 UN Sustainable Development Goals (2015). https://sdgs.un.org/goals

Tak20 Takacs, F., Frankenberger, K., Stechow, R. (2020). Circular Ecosystems: Business Model Innovation for the Circular Economy. HSG, working paper. https://www.alexandria.unisg.ch/handle/20.500.14171/112456

Wil14 Wilde, A., Schwager B., Quett A., Bartel P. (2014). Ressourceneffizienz: Aktuelle Herausforderungen und Strategien der Robert Bosch GmbH. Sustainability Nexus Forum 2-3.

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