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Steps from Zero Carbon Supply Chains and Demand of Circular Economy to Circular Business Cases

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Abstract

The European Green Deal requires a zero carbon Europe until 2050. Consequently, all processes conducted, and actions taken need to ensure zero carbon emissions. Beside the areas of energy systems, logistics and living, it certainly also includes industry sectors, industrial processes, and their entire supply chains. Zero carbon supply chains mean net zero carbon emission from scope 1, 2 and 3. The key question for future business is therefore how to reduce the carbon emissions of all procured components down to zero, beside all procured and consumed energies (scope 1 and 2). A promising approach is a circular economy if primary produced materials will not be provided carbon neutral or will increase in price.
However, today the development of circular business models often is a chicken and egg problem. It needs a clear business case to invest into changes, adaptions, substitutions, or life cycle system adjustments of linear products (take, make, dispose) to turn them into circular products or product systems (avoid, re-use, recycle, recover).
The paper presents approaches and companies seeking carbon neutral products in a carbon neutral Europe via identifying business cases for circular products. An evaluation matrix is presented allowing the identification of circularity status depending on the selected products or sector perspective. The matrix contains evaluation criteria based on the circularity building blocks by the Ellen MacArthur Foundation. Based on the results, hot spots and weak points are identified and allow entering a six-step-approach for business-case identification. The steps refer to life cycle thinking, quantitative environmental assessment, simulation, creativity methods and end up identifying profitable business cases for circularity. The goal is to avoid trade-offs and to consider economic and environmental factors side by side. The presented approach combines life cycle assessment, circular economy and the development of business models and is partly developed and applied during the European H2020 project AVANGARD.

Keywords: net zero, circular economy, zero carbon approach, business case, zero carbon supply chain, life cycle thinking

1. Introduction

In recent years, incentives as well as outside pressure are rising for companies to lower their carbon footprint. The Paris agreement adopted by the United Nations in 2015 aims to limit the temperature increase to 1.5 °C above pre-industrial levels. This means that the emission of greenhouse gases (GHG) has to be reduced significantly. In December 2019 the European Union (EU) announced that it wants to be climate-neutral by 2050 (European Commission, 2019). Already before that more and more companies like Volkswagen, BP, Microsoft, Apple and others committed to produce carbon neutral products or want to become carbon neutral or even carbon negative as an organisation as a whole. At the beginning of 2021, the Science Based Targets (SBTi) initiative reports over 1200 companies acting, over 600 companies having science-based targets and over 400 companies which explicitly commit to a maximum increase of the global average temperature below 1,5 °C (SBTi,2021).

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The Paris Agreement states that finance flows as well should be consistent with a pathway towards low GHG emissions and investing companies like BlackRock publish statements that sustainability should be a new standard for investing. By including social and environmental aspects of sustainability into his Letter to the CEOs in 2018, the chairman and CEO of BlackRock Larry Fink takes part in a shift from soft and sometimes greenwashed approach towards sustainability to a hard and essential factor of business (Fink, 2018).

All these actions, announcements and developments cause that over the last few years, sustainability efforts are changing from purely voluntarily published and often superficial sustainability reports to an important part of risk mitigation and a transparent positioning towards costumers and investors. At the beginning of 2021, the investment bank Goldman Sachs joined BlackRock by publishing its own sustainability efforts including climate-related considerations towards investing (Solomon, 2021). Driven by the governmental initiatives mentioned above and a rising pressure by customers, other businesses as well as end consumers, net zero carbon emissions and other aspects of environmental and social aspects of sustainability as well as publishing transparent information become an important part of conducting business.

Due to the demand of various stakeholders, companies are searching for business models which offer reduced environmental impacts as well as profitability. It must be assured that the way a company conducts business is aligned with global goals to address climate change while earning money. Additionally, a company should be able to communicate the implemented measures in a comprehensible way and to disclose emissions and reduction targets. This paper presents a way to address these needs answering the question “How can profitable circular business models be developed ensuring lower environmental impacts aiming for net zero emissions?”

1.1 Net zero

What does net zero really mean? For businesses, net zero includes the elimination of GHG emissions throughout the entire value chain (Schulz, 2020). According to the Greenhouse Gas Protocol published by the World Resource Institute (WRI) together with the World Business Council for Sustainable Development (WBCSD) the GHG emissions of a company can be categorized into three scopes: Scope 1 includes the direct emissions from the facilities and vehicles of the reporting company. Scope 2 represents the emissions linked to electricity, heating and cooling and steam purchased for own use. Those are often already assessed and reported by companies. However, the analysis of scope 3 is not yet widespread, although it often can include the largest part of emissions related to operations depending on the sector (SBTi, 2018). Figure 1 presents the three scopes graphically. Scope 3 includes 15 sub-categories upstream and downstream, e.g., purchased goods and services, capital goods, business travel and employee commuting (Greenhouse Gas Protocol, 2011). To be a truly carbon neutral company, an assessment of the hotspots of scope 3 emissions must be conducted and according to an ambitious target setting the emissions must be reduced to net zero carbon emissions.

Especially the sub-categories 1 (Purchased goods and services) and 11 (Use of sold products) of scope 3 might be orders of magnitude larger than scope 1 and 2. If a company sources most of the components of its products from its supply chain, as for example many OEMs e.g., in the automotive or consumer electronics sectors do, category 1 is related to more emissions than the assembly of the final products. If a product sold consumes fuels or electricity, the related emissions belong to category 11 and might, for example in the case of cars, planes, and many electronic goods, exceed scope 1 and 2.

The reduction of emissions linked to these categories can be addressed by ecodesign of products and services considering material usage and emissions during use phase. Typical approaches and measures consider efficiency, not only during use, but also during production and over the entire supply chain. This is often referred to as resource efficiency. But actually, the avoidance of resource use should be the goal rather than only lowering depletion and GHG emissions. This applies to the avoidance of wasted energy as well as wasted materials and avoidance of scrap production. It includes the shift to power production from green or renewable sources and bio-based fuels. An approach to maximize efficiency and use intensity and to avoid resource use might include a shift to more service-related circular business models, changes in material composition of products and optimizing emissions during use as well as options to prolong the lifetime of products. The longer a product is used the later the production of a new product which substitutes the old one is necessary. For this statement to be true, a product must fulfill the intended demand over its entire lifecycle so that the actual lifetime matches the duration of the technologically possible service life.

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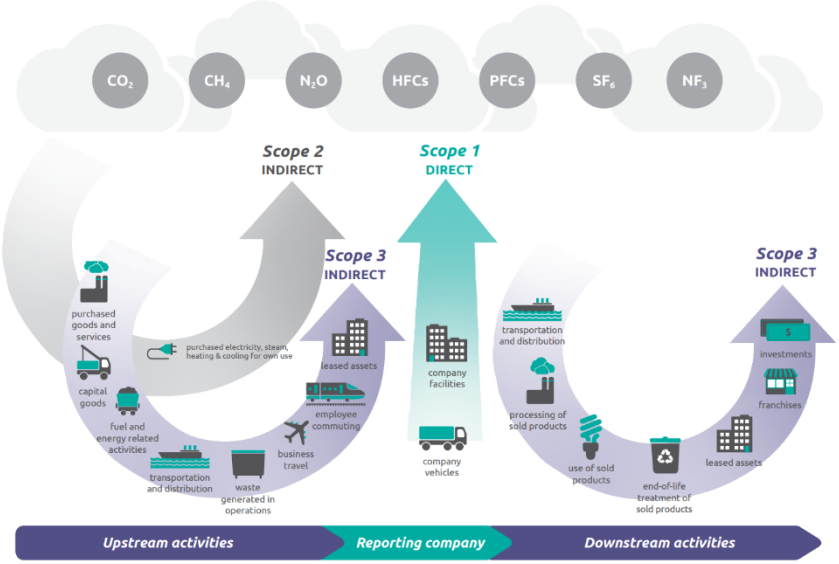
Figure 1. Graphical representation of scope 1, 2 and 3



Source: Greenhouse Gas Protocol. (2011). Corporate Value Chain (Scope 3) Accounting and Reporting Standard, S. 7.

The complexity of the various options and measures for a reduction and the avoidance of unnecessary use of resources and GHG emissions, which can be summarized as ecodesign, needs to cover all effect over the entire life cycle. This can only be achieved by a bottom-up approach looking at the details of each individual product and how costumers are using them. This might allow for a more feasible way to identify how to reduce emissions compared to a pure top-down approach often focused on calculations of scope 1, 2 and 3 of an entire company.

While scopes 1 and 2 and some sub-categories of scope 3 could be brought down to zero or nearly zero by technological development like electricity solely from renewable sources or carbon neutral fuels, materials to manufacture products or build facilities are still linked to emissions. Therefore, an inclusion of all 3 scopes and all related aspects is necessary to achieve net zero emissions.

1.2 Circular economy

One way to reduce or negate the emissions linked to materials and consumption is the implementation of a circular economy (CE). CE can be defined as "…an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes […] with the aim to accomplish sustainable development…" on different levels. (Kirchherr et al., 2017) To establish a CE and for companies to be a part of it, business models which lower emissions and use less or no primary materials, but also generate profit are needed. As business models must be economically sustainable to ensure future success, keeping materials in the loop must be more attractive than simply continuing business as before and paying for carbon offsets. Additionally, organisations like the SBTi initiative (SBTi, 2020) or CDP (former Carbon Disclosure Project) (CDP, 2021) and even companies which provide carbon offsetting opportunities (Southpole, n.d.) state that avoidance of emissions should be the goal rather than offsetting. Additionally, the price for offsetting carbon is and will most likely keep rising. This can be illustrated by the example of emissions related to fossil fuels in Germany: From 25 Euros per released ton of CO2 equivalents in 2021 an increase to 55 Euros in 2025 will be followed by an auction system. The German Environment Agency even suggested 180 Euro per ton (Matthey & Bünger, 2019) as a fair and compensating price for damages indirectly caused by the effects of rising temperatures. Avoiding the release of GHG in operations as well as over the value chain might offer business cases beyond energy efficiency and a shift to renewable energy.

The EU Circular Economy Action plan as part of the European Green Deal includes measures to make sustainable products the norm in the EU and to make circularity work for people, regions and cities (European Commission, 2020). In its first iteration it already focuses on various sectors including electronics and ICT, batteries and vehicles, packaging, plastics, textiles,

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construction and buildings, food as well as water and nutrients. Beside the political agenda, the Ellen MacArthur foundation, a leading organization in the field of CE, defines four essential building blocks for a CE. The four blocks are: Circular design, new business models, reverse logistics and cycles as well as enablers and favourable system conditions (Ellen MacArthur Foundation, n.d.).

After a short overview of the applied methodology, Chapter 3 presents an approach to analyse the current status of business models and processes within a company towards their readiness for CE in the format of an evaluation matrix for approaching CE. Chapter 4 explains a six steps approach to identify weak points and hotspots as well as deriving possibilities to address business cases including an evaluation of the environmental impacts of the circular solution. The goal is to support companies to transform their business in accordance with the challenges of a more circular and sustainable future and to create a safer, more sustainable and productive world.

2. Methodology

The approaches in this paper have been develop based on theoretical analysis and on the practical experience of the authors. While no single qualitative or quantitative study is the basis of this text, it summarizes the findings of several case studies and takes projects conducted together with various companies and partners into account. As it is the goal to allow for fact-based decision making, quantitative methods to evaluate the businesses models and to assess environmental impacts are include in the presented approaches.

3. Evaluation matrix

Before a company can develop circular business models, it should assess the current way of its operations to identify hotspots and opportunities. Figure 2 shows a schematic matrix to support the assessment. The matrix was developed by Sphera and is refined over the course of the AVANGARD Project (www.avangard-project.eu). The four main categories are derived from the four building blocks for CE by the Ellen MacArthur Foundation as mentioned above. The sub-categories and indicators should be adapted to the company and its respective industry or market sector. The evaluation can be carried out internally but might be supported by external experts. It is helpful to bring together employees from different departments to get a comprehensive overview. When analysing the status quo and filling out the matrix, the entire life cycle of the product or product group must be considered. This is equivalent as considering scope 1, 2 and 3 as explained in section 1.1 of this paper.

To further develop the matrix shown in Figure 2, multiple case studies have to be conducted. By doing this, general and industry specific indicators can be developed. Different scales (e.g., five- or seven-point Likert scales) could be tested and can be colour-coded to allow for a concise and self-reflective evaluation of the status quo of products and business models within a company and their potential for circularity. Hotspots like totally linear operations or chances to further develop existing offerings (e.g., refurbishment, the use of recycled spare-parts or changeable components like batteries) into fully circular business models can be identified. While filling out the matrix, it is important to consider the full life cycle of the products and their impacts on the environment. This might be challenging for employees and executives who are not yet familiar with life cycle thinking, but it is a pre-requisite to understand cause and effects per aspect of various stages relevant for CE (e.g., logistics, user behaviour, ability for repair, maintenance, disassembly and fractionising for optimized recyclability). As soon as it is fully developed and tested, the matrix should be accompanied by a written guide, or the process could be moderated by external environmental experts.

The presented approach serves the purpose and offers an opportunity to start a process of self-reflection. The matrix enables a comparison with competitors from the same industry or companies and business models from other industries. Of course, currently there are no reference values for different industries. Therefore, companies and consulting experts must use their own understanding of the situation and be careful not to over- or underestimate the scores of competitors and the company itself. A comparison to other, similar industry sector supports the process by highlighting gaps and opportunities.

In summary, the matrix can be used for self-reflection which can be the basis of further assessments, benchmarking against competitors or other industries and for the development and proof of concept. If the matrix itself is not enough to come up with sustainable and functioning business models, a structured process presented in the next chapter can follow.

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Figure 2. Schematic assessment matrix

Main categories	Subcategory	Indicators an sub-indicators (Examples)		Comment	Value
Design: Technical aspects & design					
	Materials				
		Material declarations available / identification of materials easily possible			
		Identification of modules easily possible			
		Hazardous / toxic substances (during handling, danger to employees)			
		Environmentally critical and hazardous substances (potentially with legal restrictions on recirculation)			
	Modularity				
		Efficient removal of modules that are not used			
		Efficient exchange and handling of individual product components (sorting, preparation, exchange)			
		Ease of disassembly (to be able to use modularity)			
			High degree of standardization of disassembly		
			High degree of automation of disassembly		
		Durability / long service life of components and modules (for further use)			
			Durability of components and modules		
			Ease of updating / compatibility with new product generations		
Technical aspects reverse logistics					
	Identification				
		Information on the whereabouts of the product / availability for return			
		Unique product assignment			
		Materials clearly identifiable (if no material declaration available)			
		Age and condition identifiable (technical / documentation)			
	Collection & Return				
		Low transport effort per product unit			
		High value in relation to collection costs			
		established / functioning collection or return system			
		Legal requirements for collection and return			
	Storage				
		Good storability			
		Plannable stock (consistent flow of in-/outgoing products)			
		Good sortability of removed modules			
		High standardization of the modules			
Business models					
		Constant and plannable return quantities			
		Constant and predictable sales quantities			
		Established and reliable take-back system with influence on the quantity of returned products and sales volume (product stewardship)			
		Structured framework (laws, regulations) of the market for old goods / goods for remanufacturing			
		Structured framework conditions (laws, regulations) of the sales market such as e.g. admission criteria			
		Market acceptance of remanufactured products			
		Competitive situation in the sales market due to new products			
		Competitive situation in the sales market due to many other remanufactured products			
System conditions and other aspects					
		Safety / default risk from remanufatured products			
		Brand risk (in case of premature failure of remanufactured products) / branding (quality perception) as remanufactured product (B2C)			
		Value perception of remanufactured products (up- / downcycling, same quality)			
		Availability of qualified staff			

Source: Based on Herrmann, Constantin. (2020, November 19), From Zero Carbon Supply Chains to Circular Electronics: Steps to More Sustainability [Conference presentation]. E-Waste World Conference & Expo, Frankfurt, Germany. http://www.avangard-project.eu/event/e-waste-world-conference-expo/

4. Six-step-approach to develop circular business models

After an assessment of the status quo, gaps and potential changes using the matrix presented in the previous chapter, companies know their status regarding to upside and improvement potentials towards a CE. Now they need a process to shift their operations towards circularity while making sure that this shift does not actually lead to more GHG emissions or more harmful environmental impacts in general. The development of circular business models might present itself as a chicken and egg problem. Often the linear business models will not reveal a circular and profitable business case and vice versa, theoretical business cases might not work using the existing linear products. Therefore, Figure 3 presents a process to develop new business models while assessing and comparing the resulting potential environmental impacts from simulated circular products and business models.

Step 1 includes a life cycle analysis, e.g., using the Life Cycle Assessment (LCA) methodology according to ISO 14040 and 14044 (ISO 2006a, 2006b). It can refer to the linear product or the business models identified for potential change using the matrix presented above. The analysis should include all impact categories relevant to the company and to the respective industry and not solely focus on GHG emissions even though this might currently be the impact category which receives the most public attention. But while less noted impact categories should not be neglected, a so-called screening LCA based on publicly available databases such as the GaBi database (Sphera Solutions GmbH, 2021) should be sufficient. This allows for the identification of environmental hotspots (step 2) of the current situation. Based on the identified hot spots and weak points to be improved,

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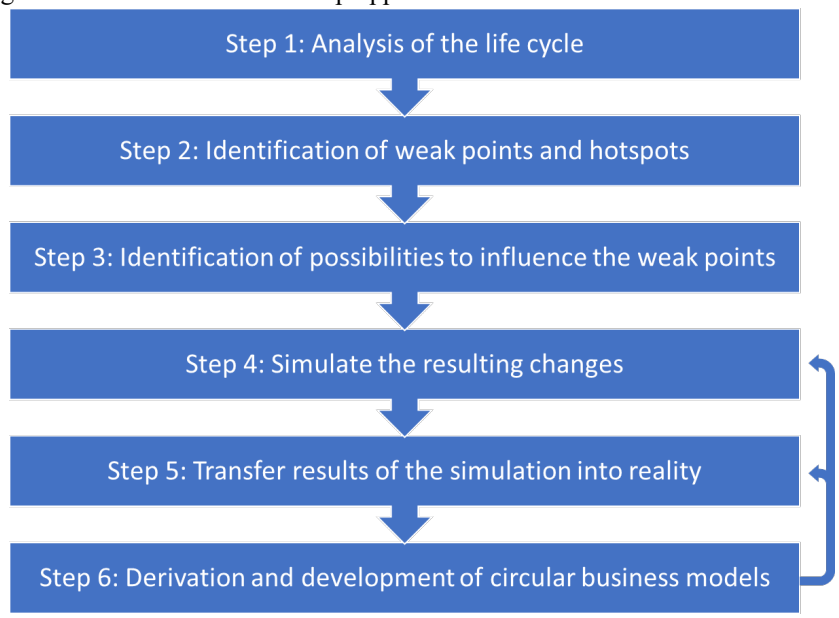
possibilities to influence should be discussed and specified (step 3). There is no need to spend the same amount of effort and time which would be needed for a comprehensive LCA including the collection of primary data from suppliers. The identified starting points for changes and measures might include a wide range of options from a change in distribution processes or market access, a change of materials (e.g., the use of secondary material or the substitution of environmentally impactful materials by others suited for the intended application) used or even the discontinuation or addition of an offer, a service or a product.

The findings and aspects from step 3 allow entering steps 4 to 6, which are highly iterative and interlinked. The concrete procedure depends on the people involved, the timeline, the identified hotspots and how vast the possibilities to influence these are as well as the willingness of the parties involved to implement changes.

Step 4 includes an assessment of the potential environmental impacts based on the findings from step 3. This allows to compare the resulting impacts with the baseline from step 1, if the identified weak points were changed. A comparative analysis like this is necessary to make sure that no trade-offs occur, meaning that benefits in one impact category are overcompensated by more harmful impacts in another, and to prevent a change which actually leads to higher harmful impacts overall.

Figure 3. Overview of the Six-step-approach.



Source: Based on Herrmann, Constantin. (2020, November 19), From Zero Carbon Supply Chains to Circular Electronics: Steps to More Sustainability [Conference presentation]. E-Waste World Conference & Expo, Frankfurt, Germany. http://www.avangard-project.eu/event/e-waste-world-conference-expo/

Step 5 can include a broad range of methods to come up with ideas and concepts but is guided by the facts and figures of the hot spot assessments and the possibilities to influence the identified weak points. These methods can refer to for example Brainstorming (Clark, 1989), the 635 method (Higgins & Wiese, 1996), Design Thinking (Sachse & Pecker, 1999), the morphological box (Higgins, 1966), the relevance tree analysis (Schmidt, 2000) or the Walt Disney Method (Dilts et al., 1991). As a broad range of creativity methods is available, companies should choose a method which suits the complexity of the process, the characteristics and the number of the people involved as well as the facts and figures developed during steps 1, 2, 3 and 4. The process should take the results of the previous analyses into account but must not be limited to the options and ideas derived from the hotspot analysis. If the process is set up in the right way, it might even be possible to assess the potential environmental impacts results or preliminary results of the business models and measures developed using the creativity methods over the course of the development. This may necessitate the setting up of a process that is iterative and takes place over several days or weeks. It could be supported by a predesigned tool which allows for parameter variation showing the

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resulting impacts from changes suggested. The inclusion of environmental experts is another possibility to analyse potential environmental impacts during the development of business models.

Step 6 concludes the presented methodology to develop circular business models, which are already tested for their environmental benefits and applicability on CE. Based on the results of several assessments of environmental impacts as well as the collaborative techniques, a decision in which direction the company and its operations and offerings should be developed must be made. As the process is iterative, these decisions will be monitored and solutions for identified weaknesses can be developed and implemented.

5. Benefits from a shift to circular business models

The change to more circular and overall, more sustainable ways to conduct business offers various advantages. Lowering GHG emissions, material use, and other environmental impacts related to the business on the one hand has benefits for the environment and on the other hand lowers the risk of costs directly (e.g., CO2 taxes) or indirectly (by necessary changes due to climate change) related to GHG emissions.

As it satisfies demands from various stakeholders, a shift to innovative business models can be used in communications to investors, business partners and to the public. Measures regarding sustainability will be received positively by rating agencies and other players in the financial markets. As more companies pledge to source their materials and goods from sustainable suppliers, this is an advantage when selling to other companies. Additionally, more sustainable offerings can attract end consumer groups which did not buy a company's products before or did not use its services. Circular business models align a company with the Circular Economy Action Plan of the European Commission (2020) which relates to other European strategies to benefit the economy and the environment.

An LCA study conducted before implementing the developed circular business models ensures that there are environmental benefits. Lower GHG emissions help companies to contribute to the targets set in the Paris Agreement and achieve their own goals (developed e.g., in cooperation with the SBTi).

By implementing a structured, iterative process which includes several sustainability assessments and should involve people from different departments, it is ensured that the new business models lower environmental impacts and that they can become economically sustainable as well.

6. Discussion, conclusion, and further research

The approaches developed in this paper are based on practical experience and theoretical development. They have been fully or in parts applied in projects with various companies and partners and are based on established methods like LCA and several creativity methods. Therefore, the presented approaches have been proven to be feasible and of practical relevance. However, this research does not evaluate the suggested methods based on a comprehensive literature review of other possibilities and ways to develop new business models. The approaches should be further developed by implementation of findings from related research as well as experiences from future case studies.

As sustainability becomes more important and emerges from a "nice to have" to a fundamental pillar of conducting business, the need for carbon neutral or net zero business models is rising. Circularity offers a path to minimize the emissions linked to the use of materials to produce tangible goods.

This paper presents an approach to develop circular business models using a matrix approach. If the matrix approach does not lead to a successful development of business models, a six-step-approach can be used which includes LCA and creativity methods embedded in a structured process. Independent whether the creativity methods are used, a sustainability assessment should make sure that trade-offs are avoided. The presented approaches address the need for sustainable ways of conducting business and combines self-assessment and creative methods with LCA and other sustainability assessment methods (Peña et al., 2021). As the Circular Economy currently receives global attention, it empowers companies to develop and change their business models.

The six-step-approach enables a structured process to develop more sustainable business models and ensures that they de facto lead to lower potential environmental impacts. Several possibilities to adapt the process to the circumstances within a company are mentioned. As the matrix presented is still under development, more examples from case studies are needed. This would offer an opportunity to develop the scales used and will allow for a comparison to other companies and industry averages

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