Integrated Innovation and Sustainability Analysis for New Technologies: An approach for collaborative R&D projects

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> *"The greatest threat to our planet is the belief that someone else will save it."*
>
> Robert Swan,
> the first person to walk to both Poles

In order to effectively shape the impact of an innovation on sustainability, the early phases of the innovation process are crucial. This is especially true for complex collaborative R&D projects with multiple partners. We have found that there is an increasing need for simple methods that enable partners in such R&D projects to guide them towards sustainability-oriented innovations (SOI). In response, we have developed a methodology called Integrated Innovation and Sustainability Analysis (IISA). It is based on the early involvement of stakeholders, along with a sustainability assessment of the planned innovation to provide feedback loops into technology development. The overall goal of the method is to improve the potential impact on sustainability in the three dimensions: economic, environmental, and social. The IISA method and its application in two collaborative R&D projects with several research and industry partners that serve as practical examples, is presented and discussed in this paper.

Introduction

One of the most well-known definitions of sustainable development was coined in a United Nations report on our common future: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). The concept of "sustainability" can be concretized by using the so-called "triple bottom line" approach, which differentiates it into environmental, social, and economic dimensions (Elkington, 1997, 2006, 2013), for implementation into daily business practices (McElroy & van Engelen, 2012).

Innovation that serves not only to generate economic returns, but also adds social and environmental value can be defined as sustainability-oriented innovation (SOI) (Klewitz & Hansen, 2014). This type of innovation contributes to improved sustainability with respect to production, market, and consumption (Schaltegger & Wagner, 2011).

The social and environmental value of an innovation can be dynamic, rather difficult to quantify, and is often only revealed after a certain time (Adams et al., 2016; Kemp & Pearson, 2007). SOIs can be products, processes, services, or business models that are new to the organization, and characterized by their focus on environmental aspects, specifically material and energy efficiency (Kemp & Pearson, 2007), and/or social aspects. However, the decisive point is a focus on reducing environmental impact over the whole ecological life cycle (Kemp & Pearson, 2007; Schiederig et al., 2012). Drivers of SOIs can be expected improvements in performance, public perception, and legal compliance. Barriers include lack of information, general doubts, legal compliance, and perceived lack of profitability (Cagno & Trianni, 2014; Clausen et al., 2011).

The early phases of innovation are crucial for shaping SOIs. They are characterized by a high degree of possible influences on production, product and service properties, and corresponding environmental impacts (see Figure 1). However, an exact determination of these

impacts is difficult due to the still unknown material composition and physical processes required for production and logistics (Lang-Koetz et al., 2008). Hence, appropriate Life Cycle Thinking methods such as Life Cycle Assessment (ISO 14040, 2006) are difficult to apply in practice, and thus require simplification.

To achieve significant transformations towards sustainability, there is a need for new frameworks, tools, and methods for products, services, and strategic development (Gaziulusoy & Brezet, 2015). Changes should be implemented with respect to an organization's philosophy, values, and "corporate culture" (Adams et al., 2016). Methods for early phases in the innovation phase have been proposed by various authors (Hallstedt et al., 2013; Hansen et al., 2009; Lang-Koetz et al., 2008; Schimpf & Binzer, 2012; Stock et al., 2017), most of which are presented as concepts, and only partially accompanied by demonstrations of practical application. Moreover, they focus on application inside a company. Beyond that, however, an increasing need has been shown for simplified methods that enable partners in R&D collaborations to be guided towards SOIs.

This study addresses a research gap wherein prevalent methods of innovation management and sustainability assessment have so far rarely been considered in an integrated approach. Several authors see the need for better methodological support to integrate sustainability aspects into early phases of an innovation process (Cancino et al., 2018; Charter & Clark, 2007). It is becoming increasingly necessary to have an integrated approach of innovation management and sustainability assessment, since, (i) many sustainability aspects can already be influenced and controlled at an early stage of innovation, and (ii) sound analysis of the sustainable effects of an innovation is essential to help avoid undesirable economic, environmental, and social impacts. Towards a contribution to this topic, the following research question is addressed in this paper: How can the impacts on sustainability of a technology-based innovation at an early stage be analysed in a simple integrated approach?

Stakeholder Involvement in Innovation Management and Sustainability Assessment

Academic engagement in university-industry relations can range from collaborative research, contract research, and consulting, to informal relations for university-industry knowledge transfer (Perkmann et al., 2013). Collaborative research is a common tool for bringing together knowledge from different

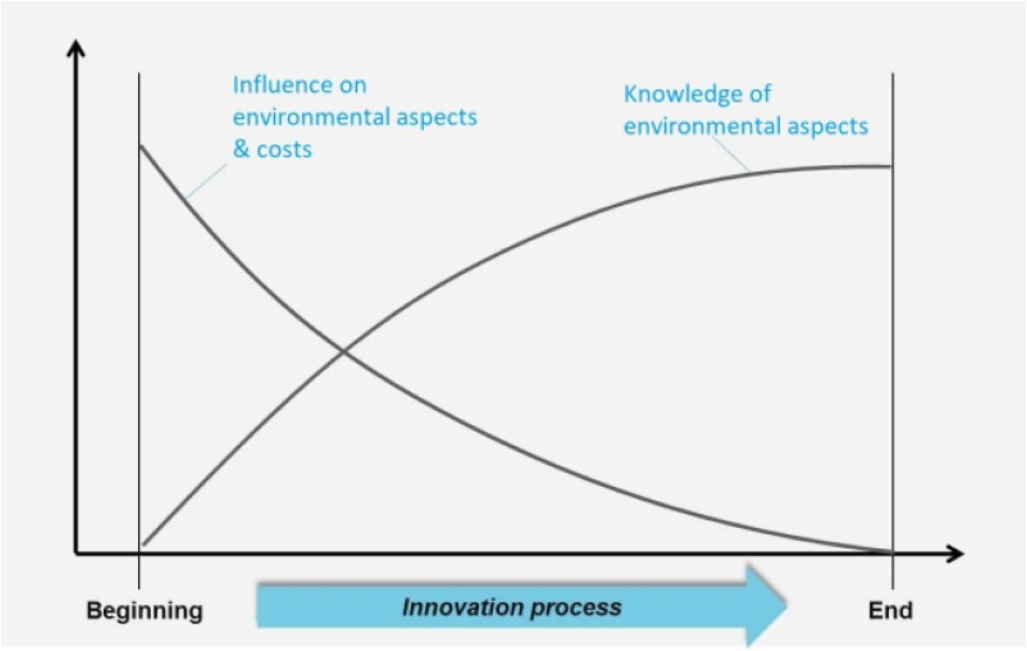

Figure 1. Influence on and knowledge of environmental aspects in an innovation process. (Source: Lang-Koetz et al., 2008, adopted from Züst, 1998)

organisations in academia and industry. It is often used to conduct research and development for complex technologies, and such R&D projects are typical examples of joint/collaborative research (Vahs & Brem, 2015). Technology partnerships are known to be difficult to handle but can have positive effects on innovative performance (Lokshin et al., 2011). Technological capabilities in collaborative R&D projects are developed based on accumulating shared experience and knowledge, mutual dependence, and establishing trustful relationships over time (Bäck & Kohtamäki, 2015, 2016). These findings also appear valid for publicly funded collaborative R&D projects that can help companies to "gain in terms of innovation", if they have the right in-house capabilities and if the project is set up in the right way (Spanos et al., 2015). This paper focuses on such kinds of R&D endeavours, and especially how they can be supported through an integrated stakeholders' perspective on innovation and sustainability involving a new technology or service.

Innovation management can also support the organization of R&D projects with suitable methods. Examples are idea workshops/competitions, customer observation, feasibility studies, creativity techniques, and user integration (Spath et al., 2012; Tidd & Bessant, 2017; Trott, 2012; Vahs & Brem, 2015). The importance of involving stakeholder in innovation management has been recognized widely as crucial (Cancino et al., 2018; Charter & Clark, 2007). All stakeholders perceive various different fostering and hindering factors, which determine their attitude towards the implementation of an innovation. In the context of this study, the term "stakeholder" is considered in a broad sense. Not only direct actors within the collaborative R&D projects are considered as stakeholders, but also all organizations, groups, and individuals in general that affect or are affected by achieving the project's objectives. This understanding of "stakeholder" is based on Freeman (2010).

In the field now known as "sustainability science", there are already some well-established and recognized methods to assess possible effects of products and services, for example, Life Cycle Thinking, Life Cycle Assessment (LCA), and sustainability assessment (Clift & Druckman, 2016; Cucurachi et al., 2018; Guinée et al., 2018; ISO 14040, 2006; ISO 14044, 2018; Jolliet et al., 2016; JRC-IES, 2010; UNEP-SETAC, 2011). However, sustainability assessment for a technology in the early stages of its development is still difficult due to often limited information on the complete physical composition and potential of the future product and its expected life cycle.

Overall, successful stakeholder integration and sustainability assessment are crucial for large-scale SOI projects. We believe this makes a "how to" study on the topic relevant to the field. The approach presented in this paper brings in a new perspective to the existing debate involving sustainable innovation, which brings with it the potential to influence current management methods.

Research Methodology

We address the research question as follows. First, we identified the demand for a methodology to assess the sustainability impact of a technology in its early phases of development from the following sources: a literature review, conversations with practitioners from the German industry, as well as several calls for proposals for collaborative R&D projects from the German Federal Ministry of Education and Research (BMBF). Conceptual research was then conducted to determine how sustainability impact assessment can be conducted in R&D projects in a way that better enables the integration of stakeholders. This resulted in coming up with the methodology "Integrated Innovation and Sustainability Analysis (IISA)", which was then refined while planning two collaborative R&D projects with partners from industry and academia. Both projects received funding from the German government (BMBF). The IISA methodology was adapted to the specific context and then applied in both projects over the course of approximately 3 years. This served to validate the application. Our research was conducted in an action-based setting, which means that the authors were also active members of both project consortia.

Result: A Method – Integrated Innovation and Sustainability Analysis (IISA)

We developed the IISA methodology based on stakeholder involvement in three successive stages, and a sustainability assessment for planned innovation at an early stage. Our principal approach of IISA for SOIs is illustrated in a scheme in Figure 2.

IISA first shows that stakeholder involvement must be systematic based on the characteristics of a planned innovation. The overall goal is to ensure sustainability in all three dimensions (economic, environmental, and social) through stakeholder involvement. Thus, the state

of technological development is regularly discussed with relevant stakeholders. Continuous feedback loops are created in order to enable recommendations for further R&D efforts on the technology. In this context, three elements are used (see Figure 3) and described in the following sections: stakeholder analysis, stakeholder dialogue, and stakeholder integration.

Stakeholder Analysis

The first step is to conduct a stakeholder analysis to obtain a holistic view of the value chain from a life cycle perspective. For this purpose, the following methods are used:

- Stakeholder mapping,
- Interest/influence portfolio,
- Illustration in the life cycle perspective.

Stakeholder mapping can be used to analyze stakeholder groups and their relationships (Bourne & Walker, 2005; Künkel et al., 2016). It is used here to gain a better understanding of the system itself, the flow of information, and the dynamics of the system. The relevance of the stakeholder groups is assessed by classifying them in an influence/interest portfolio (Künkel et al., 2016). This leads to an indication of which stakeholder groups are suitable for further dialogue or integration. Finally, the expected life cycle (from cradle to grave) is analyzed and then illustrated. Depending on available resources different levels of effort are possible in the stakeholder analysis: from one's own experience or internet research (low effort), in-company/project group discussion, or selected interviews (medium effort), to multiple interviews and surveys (high effort).

Stakeholder Dialogue

The next step is stakeholder dialogue. This enables the project team to exchange information with relevant actors, generate acceptance for the innovation, and to attract potential partners for stakeholder integration (Künkel et al., 2016; Lenssen et al., 2006). Furthermore, such a dialogue is crucial to identify expectations, barriers, and drivers for a new technology.

Another important aspect is mediation between competitors or industries. To limit the effort, we suggest prioritizing dialogue activities according to the above-mentioned influence/interest portfolio (Künkel et al., 2016):

Figure 2. Integrated Innovation and Sustainability Analysis (IISA) for sustainability-oriented innovation.

- Powerful stakeholders with high interest: engage in a dialogue,
- Powerful stakeholders with little or no interest: create awareness for technology and potential benefits,
- All other identified stakeholders: stay in loose contact.

The following methods are proposed for dialogue (used in combination, where appropriate): (i) preparation and transfer of information on the new technology/service and its potential benefits, (ii) interview, (iii) survey, (iv) public event, (v) workshop. Further information on the characteristics of these methods is provided in Table 1. A workshop, for example, can be used to present the current developmental status to several stakeholders, and could also generate high-quality feedback loops for further R&D.

For the purpose of evaluating the workshop method, four criteria for a successful workshop were defined in advance: (i) fruitful discussion of actual project status with relevant stakeholders, (ii) reflection of different stakeholder perspectives, (iii) feedback loops into innovation process, (iv) dissemination of the innovation among relevant stakeholders.

Stakeholder Integration

In the third step, stakeholders become integrated with regard to market, environment, and social perspectives. The integration can range from smaller to larger-scale activities. For example, stakeholders can provide data, help to disseminate an innovation, or provide continuous feedback loops for R&D.

As a result, a so-called "innovation community" can be established (Fichter & Beucker, 2012). It involves committed representatives of relevant stakeholders to set up an informal network of initiators and key personnel. Within an innovation community synergies are created by individuals bringing together decision-making power, expert knowledge, innovation management skills, and/or access to other productive networks. This can help to work more efficiently on the implementation of the innovation.

Sustainability Assessment

The widely accepted report of the Life Cycle Initiative (UNEP-SETAC, 2011) states: "To get the 'whole picture', it is vital to extend current life cycle thinking to encompass all three pillars of sustainability:

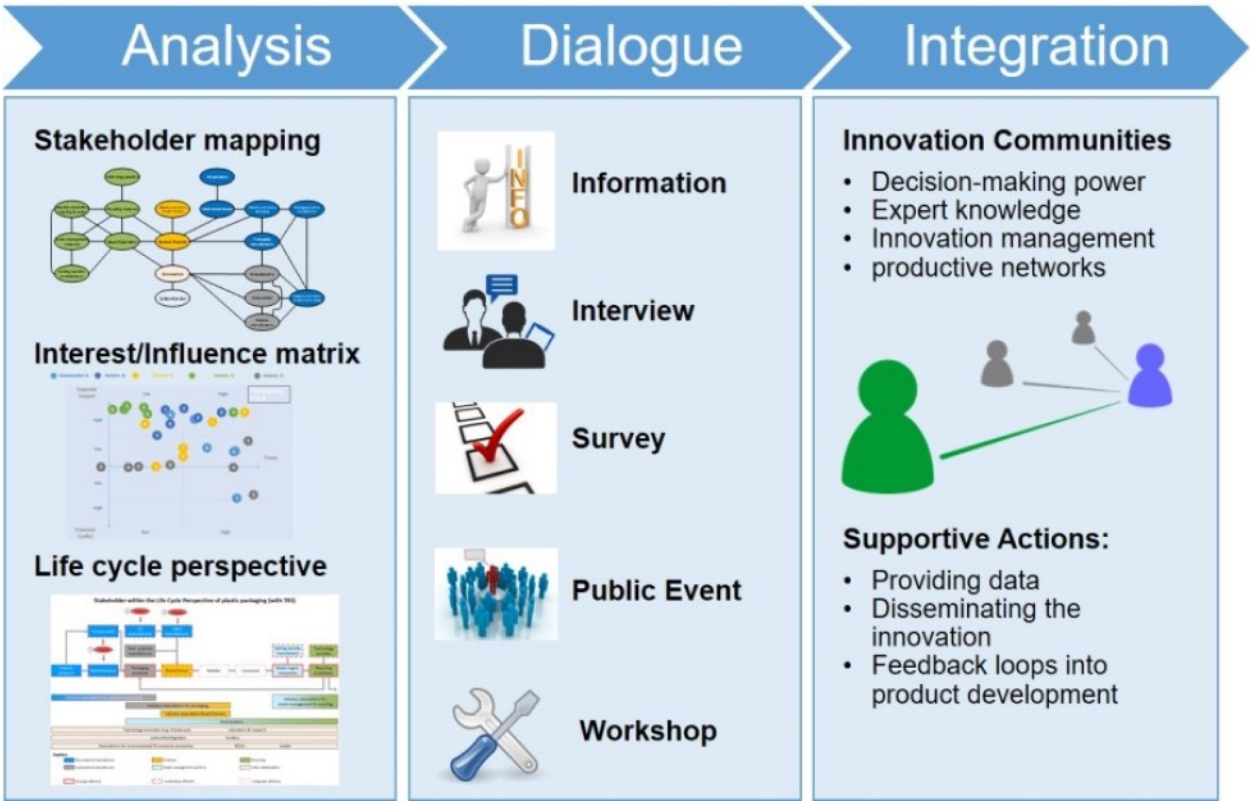

Figure 3. Methodological approach for stakeholder involvement.

(i) environmental, (ii) economic and (iii) social. This means carrying out an assessment based on environmental, economic and social issues — by conducting an overarching life cycle sustainability assessment (LCSA)". Such an assessment consists of an Environmental Life Cycle Assessment (LCA), an economic assessment, and regarding social aspects, which we describe in the following paragraphs.

Environmental Life Cycle Assessment (LCA)
An Environmental Life Cycle Assessment (LCA) relies on a so-called Life Cycle Inventory (LCI). The LCI is based on data on energy and material flows, over the life cycle of a product or service "from cradle to grave". For example, materials used for building various devices must be determined, transport activities considered, electricity procured for operating devices, as well as the final deposition at the end of the lifetime of devices have to be taken into account.

Since much information cannot be exactly measured, a so-called streamlined LCA (using experts estimates for assumptions), with scenarios and hotspot analysis is needed to estimate the potential environmental impact of an innovation at its early stage. Corresponding pollutant emissions are derived using an LCI database such as ecoinvent (Wernet et al., 2016). Such databases contain process data corresponding to present conditions. However, investigating the possible impact of technologies still in development means that an LCA has to consider that the technology will be applied in the near future (about 5 years from now). Hence, any LCI data collected should be adjusted to future conditions. This means that a so-called exploratory LCA method (also called prospective or ex-ante LCA) may also be used (Cucurachi et al., 2018). This approach takes future developments into account, for example, by using a different electricity mix than now.

Economic Assessment
The economic sustainability assessment is done based on the "Total Cost of Ownership" (TCO) approach (Ellram & Siferd, 1998). Analogous to the LCA of environmental issues, it takes investment and operation costs occurring during all life cycle stages into account. The application of TCO approach can help to reveal

Table 1. Appropriate methods for stakeholder dialogue. Own illustration based on Künkel et al. (2016).

Method	*Characteristics*	*Effect*	*Output*	*Effort*
Preparation and transfer of information	Presentation, webinar, mail/newsletter; unidirectional	External	awareness	low
Interview	Open or (semi-) structured, via phone or in person; bidirectional; creativity-promoting	internal; external	feedback for R&D; qualitative data	medium
Survey	standardized questionnaire; unidirectional; low explicability;	Internal	feedback for R&D; quantitative data	medium - high
Public event	Road show or demonstration; unidirectional	external; between participants	awareness; acceptance	medium
Workshop	Presentation, demonstration + SH working groups; multidirectional; creativity-promoting	internal; external; between participants	awareness; feedback for R&D; quantitative & qualitative data	high

costs of the implementation of a technology such as expenditure on additional vocational training or the costs for disposal of waste. Moreover, advantages of an alterative technology with higher initial investment costs but lower energy demand during operation phase can be explained.

Regarding Social Aspects
The methodology for conducting social life cycle assessment (S-LCA) (Benoît & Mazijn, 2009; Goedkoop et al., 2018) is still under development. General standardized indicators that reflect social impacts along a product's life cycle, together with its supply chains, are still not available. Many of the available indicators seem to be rather relevant for developing countries. However, due to global supply chains these can also be relevant for products or services used in more developed countries. The S-CLA methodology is based on stakeholder categories and corresponding indicators (UNEP/SETAC, 2009). The stakeholder categories are worker, consumer, local community, society, and further "value chain actors". For example, for the stakeholder category "worker" there are subcategories such as fair salary, working hours, or child labor listed. Due to its potential complexity and uncertainty, an actual S-LCA is not included in our IISA methodology, at least not yet. However, within stakeholder dialogue for our use case (interviews and workshop), several social aspects were revealed and discussed. Examples of these are characteristics such as personnel requirements (qualifications for operating devices), potential threats, and occupational health.

Integration due to feedback to technical development
Insights and implications from stakeholder involvement and sustainability assessment should be used as feedback for people conducting the project's technical R&D. For example, if a certain process leads to a high energy consumption resulting in CO_2 emissions, efforts of R&D can be focused to try to change the process' design.

The integration of relevant stakeholders and the technology sustainability assessment, thus expands the options and possibilities for feedback loops and overall project optimization at an early stage. The interactions and interrelations between stakeholders and life cycle data (as the basis for sustainability assessment) are illustrated in Figure 4.

Method Validation

The proposed IISA method was applied and evaluated in two practical examples: the collaborative R&D projects DiWaL and MaReK. Both projects have been conducted by consortia of research institutes and companies in Germany. They can be regarded as typical R&D collaborations, characterized by common objectives

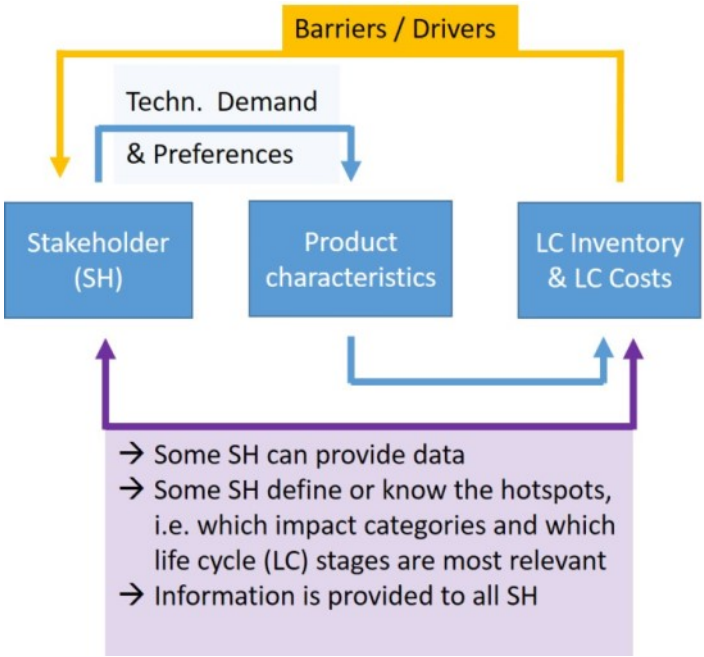

Figure 4. Feedback loops between stakeholders (SH) and life cycle data in sustainability assessment.

such as closing a specific innovation gap, and establishing an explicit division of tasks and responsibilities. The authors of this study, participants in both projects, believe that these projects can have far-reaching effects on several parts of the value chain in their field.

One project focuses on a new process for plastics recycling (MaReK), the other one on a new process for industrial paint shops (DiWaL). See Table 2 for more information.

MaReK – new technology for plastics recycling of the future

In MaReK, the planned innovation is "Tracer-Based Sorting (TBS)". This is a process by which plastic packaging or their labels are marked with small amounts of certain fluorescing substances ("tracers"). The packaging can then be separated, for example, by type or company origin, during the sorting and recycling of mixed plastic waste. Within this project, it is vital to include the entire value-chain of the packaging life cycle. This means packaging design (design for recycling), process development for marker application and packaging sorting, and finally, the recovery of marker substances and recycling materials.

TBS has the potential to become a radical innovation for sorting and recycling packaging, within a targeted circular economy. The innovation can help to generate specification-compliant recyclates with high purity. These can be used to manufacture similar packaging.

Table 2. The two collaborative R&D projects where IISA method was applied (both funded by the German Federal Ministry of Education and Research [BMBF]).

	MaReK	***DiWaL***
Description	**Ma**rker based sorting and **Re**cycling system for plastic pac**k**aging	**Di**sinfection of **Wa**ter and **L**acquer (dip paint), by Pulsed Electric Field Treatment in car body painting plants
Industry & research project partners	Polysecure GmbH; Werner & Mertz GmbH; Der Grüne Punkt – Duales System Deutschland GmbH. KIT - Institute of Microstructure Technology (IMT); INEC - Pforzheim University	BMW Group; Eisenmann Anlagenbau GmbH & Co. KG; Emil Frei GmbH & Co. KG; PPG Deutschland Business Support GmbH; KIT - Institute for Pulsed Power and Microwave Technology (IHM) & Institute of Functional Interfaces (IFG); INEC - Pforzheim University
Budget	2 Mio. € (funded by BMBF)	3.1 Mio. € (funded by BMBF)
Duration	2017-2020	2016-2020
Grant No.	033R195A	02WAV1405C
Website	www.hs-pforzheim.de/marek	www.hs-pforzheim.de/diwal

While expecting to reduce some of the environmental impacts of plastic packaging, the technological implementation remains a complex task. This challenge potentially affects a multitude of stakeholders, and thus if it can achieve a "network effect", may help lead to major changes in the value chain of plastics packaging. Table 3 provides concise information about the results of applying the IISA method in the R&D project MaReK.

DiWaL – renewable electricity instead of chemical biocides for the efficient reduction of micro organisms

In the DiWaL-project, a new Pulsed Electric Field (PEF) technology is the main research focus. It aims to reduce the microbial contamination of paint and other water based processing fluids. It is applied in car body painting plants where there is a high production volume, and a lot of water is consumed. Process fluids in such plants (especially liquid paint) contain microorganisms (MOs) and biofilms. This causes problems regarding the quality of a car's paint finish. Nowadays chemical biocides are applied to disinfect the processing fluids. With a PEF treatment, the MOs are killed with high voltage - a promising alternative that does not rely on biocides, and thus has the potential to be more environmentally friendly. Table 4 provides concise information about the results of applying the IISA method in the R&D project DiWaL.

Table 5 shows how our two practical examples meet the four criteria describing a successful workshop mentioned above. In addition, we provide insights into the strengths and drawbacks of using workshops as a tool for stakeholder dialogue in collaborative R&D projects.

Discussion & Conclusion

We started with a basic question for our research: How can the impacts on sustainability of a technology-based innovation at an early stage be analysed in a simple integrated approach? This question was addressed in the research presented by developing the methodology "Integrated Innovation and Sustainability Analysis". It is based on stakeholder involvement and sustainability

Table 3. IISA validation in the R&D project MaReK.

Method	*Results obtained*	*Recommendations for development*
Stakeholder analysis	- Identification of relevant SHs: brand owners, waste management & recycling companies, packaging producers, politics & regulators. - Communication plan for SH dialogue.	- Address the specific needs of most relevant SHs in further R&D. - Consider circular nature of value-added system in R&D.
Stakeholder Dialogue	- 3 main barriers & drivers identified in interviews with SHs, validated and assessed in SH workshop. - 4 application fields derived in SH workshop.	- Develop for customer-oriented application scenarios. - Innovate existing business models to establish a technology innovation.
Stakeholder Integration	- Enhanced network in the value-added system of plastic packaging.	- Integrate potential partners for further pilot tests/projects.
Sustainability Assessment	- Development of parameterized energy and material flow model. - fluorescing substances do not have significant environmental impacts - Reduction of energy extensive primary production of polymers	- Main benefit lies in reduction of sorting steps and increased use of recyclates in packaging manufacturing.

assessments of planned innovation at early stages. The IISA was applied within two publicly funded R&D-projects in Germany.

As expected, many uncertainties prevailed at the beginning of both projects, for example regarding functional requirements of technological parameters, applicability in the industry, and potential demand from the market. Overall sustainability impact was shown only as a rough estimate, given a lack of information and quantitative data. Nevertheless, we believe that both technologies have the potential to affect a large number of stakeholders, either directly or indirectly. Several stakeholders served as experts for our study, as they were able to estimate technical data, or determine lower and upper limits for crucial assumptions such as energy demand. They also gave valuable input on technical requirements, illustrated new applications of the technologies, and gave hints on how to address possible skepticism towards the proposed solutions in the market. The main barriers for innovation that we found in both projects were uncertainties regarding applicability and specific technical performance parameters.

Table 4. IISA validation in the R&D project DiWaL.

Method	*Results obtained*	*Recommendations for development*
Stakeholder analysis	- Identification of relevant SHs: plant manufacturers, plant operators, PEF and alternative technology developers, manufacturers of paints and chemicals, technical experts and authorities from various subject areas.	- Address specifically the needs of most relevant SHs in further R&D.
Stakeholder Dialogue	- Main barriers include uncertainty about the level of electricity consumption, electricity costs, investment and transaction costs. - Moreover, there is no immediate need for change as conventional process currently provides high quality products and there is no experience of integrating the PEF into existing or new installations. - New & additional requirements have been identified.	- Initiate further references projects / applications. - Explore the potential drawbacks of incumbent technologies and their robustness regarding future regulations. - Include additional requirements in design of the device.
Stakeholder Integration	- Enhanced network. - Important feedback for improvements and actual customer needs.	- Integrate potential partners for further pilot tests/projects. - Search for further applications of PEF treatment.
Sustainability Assessment	- Development of energy and material flow model based on lab scale and demonstration plant. - Understanding of influencing factors for potential environmental impacts. - PEF can reduce water demand and will reduce use of biocides; however, it will increase electricity demand.	- Main benefit lies in optimisation of electricity demand in operation phase. - If future electricity mix includes high shares of renewable and clean energy, the operation on PEF will show smaller environmental impacts.

Assessing the potential sustainability impact of both technologies with the LCA methodology led to valuable results involving potential environmental impact. Although not shown here, concrete recommendations for R&D could be derived from the research to improve environmental impact. We also identified necessary changes in the legal framework, as well as brought into discussion government agencies, since there currently appears to be a high degree of willingness to change the current regulations. Social issues were only addressed to a minor extent.

Scientific Contribution

The scientific contribution of this work lies primarily in the development of the IISA as a simple methodological approach that can assess impacts on sustainability of a technology-based innovations at early stages. It does this in a way that aims to help both identify and integrate stakeholder perspectives. This can serve as a basic method for implementing technology-based SOIs, by integrating an innovation and sustainability perspective. The IISA can be applied for collaborative R&D projects as shown, as well as also other kinds of innovation projects.

Practical Contribution

Applying the IISA method helped to generate valuable feedback about the market environment and user requirements, as well as expected sustainability issues in the early innovation phase. By addressing this in terms of further technological development in two innovation projects, the chances for successfully implementing a SOI increased in both cases. Thus, we believe we have shown that engaging (with) stakeholders successfully and assessing their unique or particular requirements, as well as sustainability factors of (technological) innovations at early stages, are both important for research, and highly relevant for practice. Therefore, we

Table 5. Evaluation of workshops as methodological approach for stakeholder dialogue.

	MaReK	*DiWaL*
Where goals achieved? (++: entirely; --: not at all)	discussion: ++ SH perspectives: + feedback loops: +/- dissemination: +	discussion: ++ SH perspectives: + feedback loops: + dissemination: +/-
What went well?	- Participants from all relevant SH groups. - Fruitful discussion with relevant actors of the value-added system. - Qualitative input for further R&D.	- Participants from all relevant SH groups. - Open discussion with relevant actors; further involvement is welcome.
What did not work out?	- Lack of quantitative data.	- Relatively small number of participants. - Plant operators are either not aware of the potential dependence on alternative solutions or do not see the need or the advantage of collaborating in a R&D project.
Lessons learned (overall)	- There are many other issues in addition to the environmental sustainability which are decisive for certain stakeholders. - Although in the brainstorming on potential barriers and drivers the number of items was quite large, the discussion that followed focused on relatively few main topics. - A very important barrier was and still is the uncertainty of data. - Some stakeholders need "stimulation" for active participation.	

suggest the research calls for further investigations into how the IISA can be applied for other R&D projects.

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Integrated Innovation and Sustainability Analysis for New Technologies: An approach for collaborative R&D projects

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