

Open Innovation Processes as Drivers for Business Model Developments Enabling a Successful Energy Transition

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ABSTRACT

Renewable energy systems are a key enabler for a successful transition of our current energy systems. However, in every transition process numerous different interests and requirements, often diverging or opposed to each other, must be considered. “Open Innovation” approaches overcome this divergency and increase one’s own innovation potential by involving all relevant actors along the value chain. This work presents approaches, experiences, challenges, and results of Open Innovation processes applied to stakeholder groups in three different use cases. In these use cases, multi-stage, iterative processes for stakeholder integration are applied. The results of the first use case stages show a high degree of diversity in terms of different stakeholder treatment. These conflicts are tackled by the Open Innovation process, proving that a fruitful collaborative business model development is feasible.

KEYWORDS

Open Innovation, participation, business model development, stakeholder integration

INTRODUCTION

The transition of classical top-down and centralized energy systems is a major strategy to obtain a sustainable and future-fit energy infrastructure. One key enabler for a successful transition are renewable energy systems (RESs). Photovoltaics and wind turbines are amongst the most promising technologies for building a sustainable and climate friendly future energy system. As the implementation of RESs into the energy systems is progressing, more and more challenges need to be overcome in order to pursue the path into sustainability. Due to the different characteristics of RESs (e.g., volatile production) novel strategies and business models are necessary to foster the ongoing transition processes [1].

However, as every transition process concerns numerous stakeholders, highly different and often significantly diverging interests must be taken into account. This has a substantial impact on the development of business models for RESs. In general, stakeholders are defined as those persons or entities, who affect or are affected by a decision or action [2]. Primary categories of stakeholders include i) those who have an influence on the activity (e.g., other regulators, the press), ii) those who have (or are perceived to have) an impact on the resource (e.g., resource users, communities adjacent to resources), iii) those who have a common interest in the activity (e.g., other indirect beneficiaries of the resource like consumers), and iv) the broader public [3]. In the traditional, producer-centered development of business models and products, the innovation process takes place within the boundaries of the company. In such “closed innovation” processes, consumers play only a passive role. Their needs are identified or

assumed by the company and satisfied by developing new business models - a concept that often leads to failure [4].

A well-proven alternative is a participative approach, namely the so-called “Open Innovation” (OI) method. OI can be explained as an opening of the innovation process and active strategic use of the *outside world* to increase one's own innovation potential by involving all relevant actors along the value chain [5]. An OI concept with stakeholder participation can be transferred to a wide variety of areas related to the involvement of people [6] and is utilized in numerous areas and types of action [7]. If affected target groups get the chance to be involved in planning procedures and to share their experiences, perspectives, and ideas immediately, recent studies show that win-win solutions will be achieved [8].

Over the past two decades participation procedures gained more and more popularity. The research on participation in sociotechnical transformation processes like climate change has become an independent research field [9]. In recent literature, a comprehensive framework for stakeholder participation structured as a process is proposed [10, 11]. This framework is based on a literature review regarding stakeholder participation in the environmental field, whereas the framework design was derived from analyzing and discussing literature findings of more and less suitable procedures in stakeholder participation. The framework is considered as system with processes including inputs and outputs. The described process for stakeholder participation includes six steps: i) *stakeholder identification*, ii) *stakeholder characterization*, iii) *stakeholder structuration*, iv) *choice of participatory techniques*, v) *implementation of participatory techniques*, and vi) *evaluation and monitoring*. Depending on the project context and stakeholder characteristics, the degree of participation is identified and the specific participatory technique (e.g., workshops [10, 12], focus groups [10, 12, 13], multicriteria analyses [10] like the analytic hierarchy process (AHP) [14], and consensus polls [15]) is selected subsequently.

Although OI is already considered effective, there is still no proven set of rules for an effective stakeholder integration process. The design of the process depends on the project context, the stakeholders themselves, the project management objectives, and the available resources. Furthermore, external factors such as economic or social costs (e.g., trust), regulations, and time may limit the involvement of stakeholders [3, 16].

Furthermore, the effectiveness of different participation processes can vary tremendously. Previous studies concluded that it is very beneficial to conduct face-to-face participation methods, as these approaches enhance trust among participants and lead to longer-lasting solutions. Moreover, it is necessary to include all relevant stakeholders resulting in better solutions. On the contrary, it has adverse effects to include only certain stakeholders, because this approach is more restricted. Most likely, this would lead to consciously or unconsciously expected outcomes and not generate any further information [17].

Due to the previously discussed arguments, it is important to investigate a favourable framework for OI processes experiencing a broad acceptance by all stakeholders in the field of energy transition. This framework is required to foster the transformation of classical energy systems into sustainable solutions, with benefits for both, the environment and the economy. Therefore, this work presents an overview of the applied OI processes conducted in three different use cases focusing on topics in the field of energy transition. These use cases serve as testbed for applying OI processes in the presented work and address the development and implementation of

- i) *business models for a hybrid district heating supply in connection with wind production*,
- ii) *business models for innovative cooling technologies in existing buildings* and
- iii) *an integrated approach to optimize the interaction between existing heating devices/ storages of all sizes and wind production*.

In these use cases, multi-stage, iterative processes for stakeholder integration are applied. The detailed methodical process for the stakeholder integration is individually designed depending on the specific use case. The remainder of the article is organized as follows: The next section describes the different use cases, the applied OI processes, and the use case-specific stakeholder characterization. Subsequently, the results are summarized and compared. Finally, a short conclusion is provided together with an outlook on planned future research and potential metrics for measuring the impact.

USE CASE 1 – HYBRID DISTRICT HEATING SUPPLY

In Austria, more and more wind turbines must be distributed on the free market without feed-in tariffs, as the tariff subsidies are limited in time. However, suitable business and financing models are still missing. Therefore, this use case considers the *development and implementation of business models for a hybrid district heating supply in connection with wind production*.

Method

In this use case, a multi-stage, iterative process for stakeholder consensus is applied. This increases the probability that the developed business models will not only be accepted by the stakeholders, but that even an identification with the collaboratively developed business models will emerge.

All decisions during the conducted participation process are made according to the method of systemic consensus [15]. The approach seeks for improvements that are least rejected by participants and therefore result most likely in a consensus. The systemic consensus method of this use case consists of several stages (see Figure 1).

Stage 1 (*survey*) includes stakeholder identification and a first survey about requirements of stakeholders yielding a first draft of business models. Starting with the identification of target groups according to stakeholder mapping, stakeholders are characterized and addressed. They get informed about the project plan with application for participation. After recruitment first data about requirements are collected from participating stakeholders. Depending on the accessibility of the stakeholder groups, suitable quantitative or qualitative social science methods (e.g., focus groups) are chosen for data collection. To guarantee consistency in the stakeholder survey, checklists and guidelines are prepared. If necessary, the planned methods may differ for individual stakeholders and are adapted to the respective situation (e.g., talks with technology providers according to a technical checklist, or in-depth interviews with external experts). The data collection resulting from stage 1 is used for a first draft of business models, which will be fed back to the stakeholders in form of prepared factsheets in stage 2 (*consensus*). Feedback on the potential for improvement is then incorporated into the drafts of business models. With the involvement of the stakeholder groups, the business models are going to be tested in stage 3 (*monitoring*) and evaluated in stage 4 (*evaluation*) of the systemic consensus approach. Thus, business models with the highest possible acceptance throughout all stakeholder groups will be obtained.

Results of stakeholder identification and characterization

Right from the start of the project, the focus was on seamless planning for a systemic involvement of stakeholders. The involvement of stakeholders follows the three-clusters-approach of Holifield and Williams [11].

A list of relevant actors was compiled and about 58 stakeholders were identified. Those were characterized by various attributes like type, involvement, role, sector, attitudes towards the project (with sub-categories advocacy, interest, influence, and impact) and relationship to project data. Based on their attributes, all stakeholders were divided into six stakeholder groups: technology providers (T), business users (BU), private users (PR), political entities (G), external

experts (E), and lobbying institutions (L). Finally, strengths and weaknesses of stakeholder groups as well as opportunities and risks that can arise from participation were analysed. Based on these analyses, target contents (e.g., how to use renewables, load shifting potentials) were defined for each stakeholder group that describe how the respective group can contribute to the development of business models by means of appropriate participatory techniques (see Figure 1).

In order to ensure a controlled procedure for stakeholder recruitment, a document was created addressing all listed actors by the project team. At the beginning of the survey regarding stakeholder groups, templates were created to ensure that information is passed on uniformly throughout the project team. Contacting the stakeholders was done by telephone, e-mail, or personally.

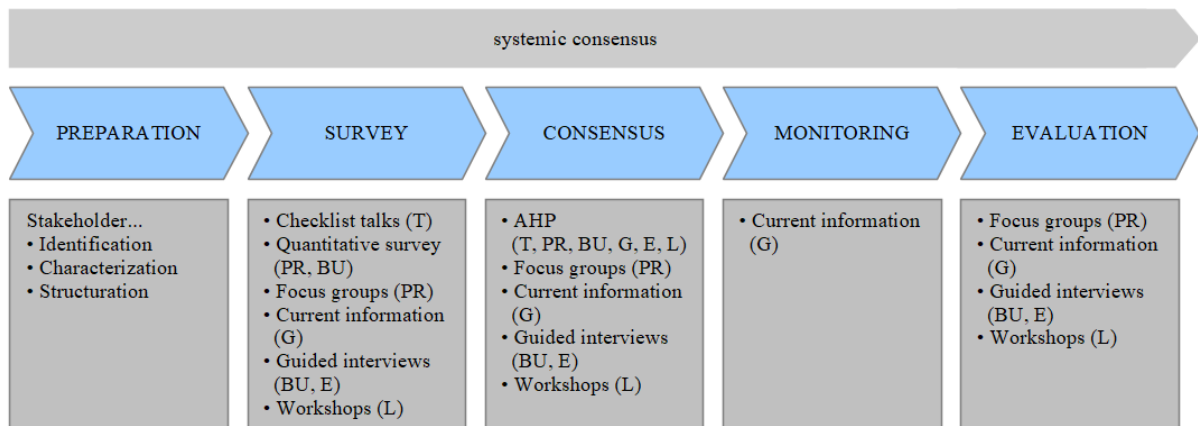


Figure 1: Use case 1 procedure and choice of participatory techniques

USE CASE 2 – INNOVATIVE COOLING TECHNOLOGIES

Cooling measures that are not based on conventional retrofit air conditioning units are difficult to implement in existing buildings. Due to overheating in summer, in this use case *business models for energy-efficient and innovative cooling technologies in existing buildings are to be developed and implemented* for users in the business, private and public sector.

Method

The main content in this use case is on the one hand to define important stakeholders who can be considered as implementer and technology provider, and on the other hand meet the diverse needs of the users in the demonstration buildings at the best. In order to gain their trust, the strategy is to involve the different users directly in their setting (e.g., public buildings like schools and kindergarden, private households, companies).

To reach the highest possible acceptance of all stakeholders, the design thinking approach is used during this OI process. Design thinking is a design methodology to promote creativity and transfer design-methods, -tools and -processes from different disciplines [18]. The approach enables iterative processes that focus on the users' needs in their everyday world [19].

Figure 2 shows the important tasks of the iterative stages in this use case. At the beginning of the design thinking approach the stakeholders are defined and divided into groups (stage *preparation*). Interview guidelines for the different demo building users (business, private, public) are created in order to collect the stakeholders' needs and technical data. Measuring equipment is installed in the buildings to collect these technical data, like air humidity and air temperature. This ensures a proper collection of the different requirements and needs of

different stakeholder groups. To keep the involvement of all users on a high level throughout the project, a continuous measurement of comfort is implemented in the stages *observation*, *definition of point of view*, *brainstorming & prototyping* and *testing*.

Results of stakeholder identification and characterization

Right from the start of the project, all relevant stakeholders should be integrated systematically. The prepared stakeholder portfolio was considered as an active document and can be adapted during the project.

Comprehensive research in the framework of a stakeholder analysis is essential to identify the relevant stakeholders and to achieve a high level of acceptance for the project. A total of 57 stakeholders were identified for use case 2. After identification, the stakeholders were divided into a total of six groups with different characteristics: T, BU, PR, public users (PU), G, and E. This differentiation into groups was important, as the specific participation methods had to be chosen with respect to the characteristics of each group. These characteristics include, for instance, the level of participation, the impact on the actor, the support for the project, or whether the stakeholders are integrated passively or actively.

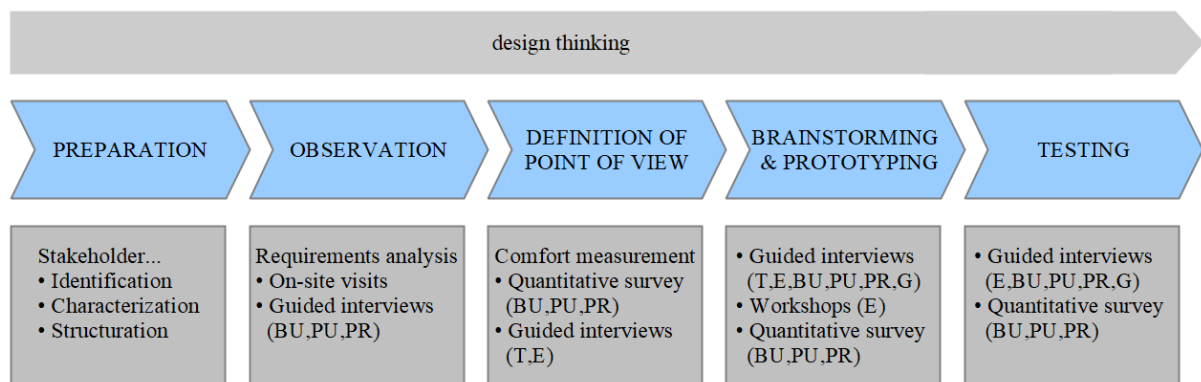


Figure 2. Use case 2 procedure and choice of participatory techniques

USE CASE 3 – HEATING DEVICES/STORAGES

In order to reduce negative effects resulting from the volatility and forecasting inaccuracy of electricity generation by wind turbines, this use case considers the *development of an integrated and holistic pooling approach for different heating storage systems of various sizes and its demonstration as flexibility for the local use of wind energy*.

Method

In order to consider the economic requirements and demands of all stakeholders, a multi-stage OI process is utilized. The aim of this OI process is to create feasible business models for the operators of the heating network, the owners of heat storages and the users of the flexibility. Compared to the other use cases, use case 3 is the most straightforward in terms of OI process complexity.

A co-creation process is conducted using different OI methods (see Figure 3). After the *preparation* stage, the *requirements analysis* is crucial to achieve a consistent view on system goals and functionality. Thus, an online workshop is held with representatives of all stakeholder groups. Requirements and restrictions regarding different scenarios in the various storage levels are collected, summarized and evaluated.

In a next stage, a quantitative *survey* on environmental consciousness, energy consumption behavior, attitude towards new technologies, intention to participate in the project, knowledge and access to energy-related information and requirements and motives regarding participation in the project with residents of single-family houses are carried out. Any remaining ambiguities are resolved in follow-up qualitative guided interviews (*consolidation*). Furthermore, a comparison of the attitudes of the test users to the attitudes according to the quantitative survey is provided. To define appropriate business models based on the survey, a workshop and interviews with residents and district heating network operators is held.

Based on the first three steps, the co-creation process finishes with a *creation* stage comprising: i) focus group discussion with end-users, ii) brief interviews with end-users, iii) interviews with owners of multi-party apartments, and iv) interviews with district heating network operators.

Results of stakeholder identification and characterization

Due to the straightforward co-creation approach of stakeholder integration in use case 3, stakeholder identification and characterization was conducted efficiently.

Stakeholders from different domains with possibly conflicting objectives and incentives had to be considered. Starting from a technical point of view, nine actors could be identified and classified as follows: i) Providers of flexibility (local and district heating network operators, multi-party apartment buildings, and single family houses), ii) demand carriers of flexibility (energy providers offering wind, and photovoltaics, and network providers), and iii) technology carrier (storage systems, heat pumps, information and communication tools, virtual power plants, and direct heaters). Several types of users with different storage sizes and motivations should be involved in the design process of business model creation. Consequently, use case 3 comprises four stakeholder-groups: T, BU, PR, and further demand carriers (D).

The interview guidelines were created on the basis of existing literature for the different demo objects. The measuring method started with a questionnaire to demonstrate the status quo. This initial survey was conducted personally by the project team. During the visits of the demo buildings, some users could already be personally interviewed and the comfort measured. In order to reach more users, shortened interviews were sent by email. This was important in order to have enough data from the different users of the demo buildings. The data of the users were then collected in order to have the comfort before the installation.

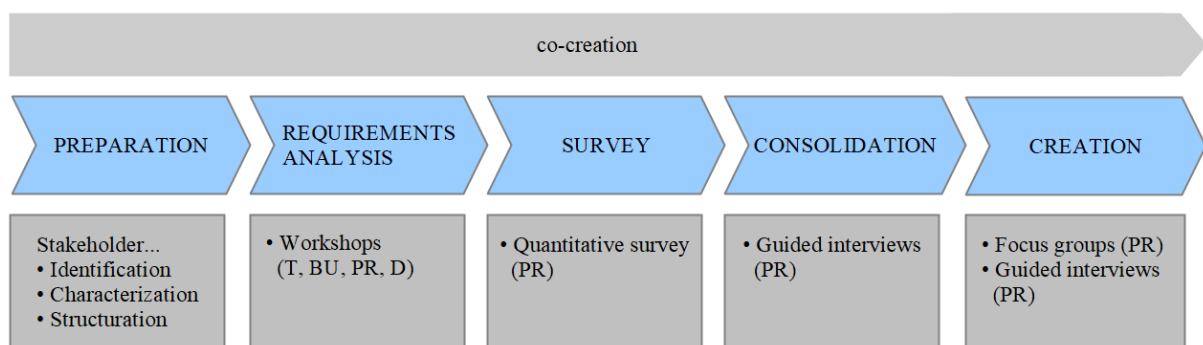


Figure 3: Use case 3 procedure and choice of participatory techniques

SUMMARY OF THE RESULTS

This section summarizes the results of the stage *preparation* of the chosen use case-specific OI processes and indicates the consequent choice of participatory techniques. Relevant stakeholders were systematically identified and characterized by various attributes. Based on

their attributes, all stakeholders were clustered into homogeneous stakeholder groups. The categorization into these groups depended on the project context, so did the choice of group-specific participatory techniques (see Table 1).

Table 1. Summary of stakeholder characterization and participatory technique choice

Use case	Stakeholder groups	Main participatory techniques
1 - Hybrid district heating supply	BU, PR, G, E, T, L	AHP, interviews, focus groups, survey (mixed factorial design)
2 - Innovative cooling technologies	BU, PR, PU, G, E, T	Interviews, focus groups, survey (within-subject design)
3 - Heating devices/storages	BU, PR, D, T	Workshops, interviews, survey (mixed factorial design)
BU...business user, PR...private user, PU...public user, D...other demand carrier, G...government/political entity, E...external expert, T...technology provider		

As use case 1 is the most comprehensive project, various participatory techniques had to be chosen to assess both the users' and even political requirements. Therefore, social science techniques (e.g., interviews, focus groups, survey) as well as a decision making approach (AHP) were chosen to create stakeholder-appropriate business models.

Use case 2 is focused on existing buildings, the users' view is essential to reach stakeholder acceptance. Hence, both qualitative social science methods (e.g. interviews, focus groups) and quantitative social and technical measures (survey with within-subject design of subjective comfort level, and objective air conditions) were chosen.

Use case 3 is most straightforward due to the complexity of the stakeholder environment. However, this use case partly required a differentiated stakeholder treatment, as further demand carriers of flexibility have to be considered next to BU and PR. The stakeholder integration should be done using social science methods (e.g. interviews, survey) and moderated workshops.

CONCLUSION AND FUTURE WORK

Due to the described process for stakeholder participation according to Holifield and Williams [11], first the stakeholder identification and characterization has to take place. Then, the real stakeholder integration (including choice and implementation of participatory techniques) can be carried out.

The results seem to be kind of homogeneous in terms of the identified stakeholder groups. However, the stakeholder characterization tasks show a high degree of diversity in terms of different needs and requirements of the use case-specific stakeholder groups and thus the treatment of the stakeholders. In this respect, the project context has to be considered carefully in order to obtain exploitable contributions from the OI actors.

The subsequent steps will be to implement the chosen participation methods specifically for each use case and to choose a meaningful measurement of the outcome. For example, "resistance scores" from the systemic consensus method can be used to measure stakeholder consensus [15] in use case 1. In this process, different opinions are accepted in their diversity, because stakeholders collectively search for a solution that is rejected the least and thus enjoys the greatest acceptance. One aspect of consensus building is to have the business models evaluated by the stakeholders by means of using AHP weights [14].

To measure the quality of life in use case 2, existing valid questionnaire instruments can be adapted to the use case objective, like the SF36 [20]. One disadvantage of such questionnaire instruments is that many of them are relatively time-consuming to fill in and are concentrated

too deeply on health aspects. Nevertheless, there are other possibilities to picture the quality of life, depending on the specific topic, for example, by measuring the level of comfort in the room/building [21], where people of the demo-objects spend their time (e.g., working, living, learning). Using such a method, a statement about the quality of life in the personal environment can be done, by asking a few targeted questions about well-being, user behaviour, and the general existing of heat spots in the object. To measure the level of user acceptance, proven models like the technology acceptance model [22] can be used.

In use case 3, an integral business model must be found that ensures the technical-economic operation of the examined pooling approach for each storage tier. Particular attention has to be paid to the active involvement of all user groups in the development of such a model. The Campbell Paradigm [23] can be used to evaluate energy consumption behavior and intention to participate in the project. This method suggests a compensatory relation between a person's latent attitude and costs that come with that specific behavior. Thus, it offers an explanation of why and when individuals engage in particular behaviors.

In closed innovation processes, many important aspects in terms of business model development cannot be identified properly or their importance would not have been recognized accurately. These conflicts are tackled by the OI process, proving that a fruitful collaborative business model development in the complex course of energy transition is feasible.

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REFERENCES

1. Wainstein, M. E., and Bumpus, A. G., Business models as drivers of the low carbon power system transition: a multi-level perspective, *Journal of Cleaner Production*, Vol. 126, pp 572-585, 2016.
2. Freeman, R. E., *Strategic Management: A Stakeholder Approach*, Financial Times Prentice Hall, Upper Saddle River, New Jersey, 1984.
3. Mease, L. A., Erickson, A., and Hicks, C., Engagement takes a (fishing) village to manage a resource: Principles and practice of effective stakeholder engagement, *Journal of Environmental Management*, Vol. 212, pp 248-257, 2018.
4. Cooper, R. G, *Profitable product innovation: the critical success factors*, The International Handbook on Innovation, Elsevier, Oxford, 2003.
5. Chesbrough, H. W., *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston, Massachusetts, 2003.
6. Cornwall, A., Unpacking ‘participation’: models, meanings and practices. *Community Development Journal*, Vol. 43, pp 269–283, 2008.
7. Radtke, J., Holstenkamp, L., Barnes, J. and Renn, O., *Concepts, Formats, and Methods of Participation: Theory and Practice*, Handbuch Energiewende und Partizipation, pp 21-42, Springer VS, Wiesbaden, Germany, 2018.
8. Liebe, U. et al., A turbine is not only a turbine: The role of social context and fairness characteristics for the local acceptance of wind power, *Energy Policy*, Vol. 107, pp 300-308, 2017.
9. Chilvers, J. and Kearnes, M., *Remaking participation: Science, environment and emergent publics*, Routledge, Abington, New York, 2016.
10. Luyet, V., Schlaepfer, R., Parlange, M. B., and Buttler, A., A framework to implement Stakeholder participation in environmental projects, *Journal of Environmental Management*, Vol. 111, pp 213-219, 2012.

11. Holifield, R., and Williams, K. C., Recruiting, integrating, and sustaining stakeholder participation in environmental management: A case study from the Great Lakes Areas of Concern, *Journal of Environmental Management*, Vol. 230, pp 422-433, 2019.
12. Richards, C., Blackstock, K. L., and Carter, C., *Practical Approaches to Participation*, SERP Policy Brief 1, Macaulay Institute, Aberdeen, 2004.
13. Reed, M.S., Stakeholder participation for environmental management: a literature review, *Biological Conservation*, Vol. 141, pp 2417-2431, 2008.
14. Saaty, T. L., How to make a decision: The Analytic Hierarchy Process, *European Journal of Operational Research*, Vol. 48, pp 9-26, 1990.
15. Paulus, G., Schrotta, S., and Visotschnig, E., *Systemisches Konsensieren: der Schlüssel zum gemeinsamen Erfolg*, Danke-Verl, Holzkirchen, 2017.
16. Pfeiffer, C., and Rabelhofer, M., Participation in Energy Transition – Challenges within the Scope of Smart Grids, *Proceedings of the 3rd South East European Conference on Sustainable Development of Energy, Water and Environment Systems*, SEE.SDEWES2018.0051, 1-9.
17. De Vente, J., Reed, M. S., Stringer, L. C., Valente, S., and Newig, J., How does the context and design of participatory decision making processes affect their outcomes? Evidence from sustainable land management in global drylands, *Ecology and Society*, Vol. 21, No. 2, 24, 2016.
18. Digmayer, C., and Jakobs, E. M., *Integration von Open Innovation-Plattform-Methoden in Design Thinking-Prozesse*, Digitalisierung und Innovation. Planung-Entstehung – Entwicklungsperspektiven, Springer Gabler Verlag, Wiesbaden, 2013.
19. Schröder, A., *Design Thinking*, Innovationen für die Gesellschaft: Neue Wege und Methoden zur Entfaltung des Potentials sozialer Innovationen, Systemedia, Wurmberg, 2017.
20. Tarlov, A. R., Ware, J. E., Greenfield, S., Nelson, E. C., Perrin, E., and Zubkoff, M., The Medical Outcomes Study: An application of methods for monitoring the results of medical care, *Journal of the American Medical Association*, Vol. 262, No. 7, pp 925-930, 1989.
21. Humphreys, M. A., Quantifying occupant comfort: are combined indices of the indoor environment practicable? *Building Research & Information*, Vol. 33, No. 4, pp 317-325, 2005.
22. Venkatesh, V., and Bala, H., Technology Acceptance Model 3 and a research agenda on interventions, *Decision Sciences*, Vol. 39, No. 2, pp 273-315, 2018.
23. Kaiser, F., and Wilson, M., The Campbell Paradigm as a Behavior-Predictive Reinterpretation of the Classical Tripartite Model of Attitudes, *European Psychologist*, Vol. 24, No. 4, pp 359–374, 2019.