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Foresight by online communities – The case of renewable energies

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ABSTRACT

Web 2.0 offers manifold ways in order to integrate community members via online communities (OCs) for innovation processes. OCs prove to be a valuable and dynamic source of information. External information sources are also important for foresight in order to be able to identify and monitor all relevant changes. However, traditional foresight methods are rather static in comparison with dynamic OCs. Thus, this study gives first insights into the use of OCs for foresight. First, based on literature, it is conceptually shown that OCs can contribute to foresight. Second, the question of how to assess the potential of OCs for foresight is considered. Renewable energies OCs are identified using a netnographic approach. One selected OC is analyzed in-depth by applying a prior developed criteria catalog which is based on Popper's (2008) foresight diamond. Each of its four dimensions – creativity, expertise, interaction, and evidence – is operationalized with measurement items taken from literature. In particular, the evidence dimension is supported by a text mining approach. Lastly, a focus group interview proves the usefulness of OCs for foresight. The findings show that OCs can contribute to each dimension of the foresight diamond and serve as an additional source of information for foresight.

1. Introduction

In today's complex and competitive business environment, companies are faced with several challenges. Amongst others, one of the main challenges is the company's ability to respond quickly to competitive trends as well as technological, political, economic, and social changes – and, in particular, being faster than competitors. Shorter product life cycles, technology diffusion between previously independent branches, business model innovations, dynamic customer expectations, and merges of existing technologies into new solutions are the daily business of technology-based companies (Förster and von der Gracht, 2014; Heger and Rohrbeck, 2012; Rohrbeck and Gemünden, 2011). In order to adapt to these ever-changing conditions, seize new opportunities, and avoid threats, companies need to be able to detect these changes early and, in particular, react to these quickly. Consequently, they need to include these changes into their process of corporate foresight and strategic planning (Koller, 2009).

Thus, for maintaining a strong competitive position not only innovational capability but also technology and corporate foresight are needed and crucial. The term foresight comprises all efforts to measure and evaluate future developments that are regarded as significant for the organization and its economic prosperity. Furthermore, foresight is directed at the derivation of reaction patterns or proactive behavior, respectively, based on the collected information (Ansoff, 1975).

Foresight is a complex task, especially for small- and medium-sized enterprises which are mostly overwhelmed with their daily business. Several studies have already shown that companies facing these changes have issues in mastering foresight on their own (Burgelman et al., 2004; Martin, 1995).

In order to react to the aforementioned changes in the business environment, one beneficial and pragmatic possibility is to open up the foresight process. Open and user innovation showed the potential of expanding value creation to external knowledge and information sources (Chesbrough and Appleyard, 2007; von Hippel, 1986, 2010) such as communities, lead users, and suppliers, amongst others (West and Bogers, 2014). Since these external sources possess implicit knowledge and sticky information (von Hippel, 1994), we assume that this knowledge can be useful for foresight processes as well (Ehls et al., 2016). Combining the concepts of corporate foresight with the research on open and user innovation leads to a recently developed process described by Daheim and Uerz (2008) and Ehls et al. (2016), called open foresight. According to Ehls et al. (2016, p. 12), open foresight is "the systematic use of distributed information sources in order to anticipate the future corporate business environment and support an organization's strategic decision making."

Considering, in particular, customers' dynamic demands (Förster and von der Gracht, 2014), online communities (OCs) (Chesbrough, 2004; Janzik and Raasch, 2011; Zeng, 2014) are a valuable information source for future developments and upcoming changes. By monitoring, for example, the discussions amongst product-related OCs, companies are very close to the end user of their products and can identify how they use, improve, and modify their products. Using this knowledge and

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information through interaction between firms and OCs, trends and market conditions can be derived (Ansoff, 1975). With those gained insights, a basis for a decreased risk of product failure or missed business opportunities or changes in business models is achieved (Bogers and West, 2012; Janzik and Herstatt, 2008). In doing so, companies are able to react quickly to upcoming changes, develop reaction patterns, and become faster than their competitors (Ansoff, 1975; Koller, 2009).

Transferring OCs as one means of open innovation to foresight shows, especially, the flaws of traditional foresight methods (Popper, 2008). Based on new IT-enabled systems, OCs can support companies to identify trends and changes in real-time and also update those trends once the discussions in OCs change. Thus, OCs are more dynamic than most traditional foresight methods which are rather static and are only updated within certain timeframes (Janzik and Raasch, 2011). In comparison, changes and future developments discussed by OCs can be updated more or less immediately. Ultimately, by employing IT-enabled systems such as OCs, less internal resources are needed when compared, for example, with expert foresight consortia but trends can still be explored to a similar quality (Jeppesen and Lakhani, 2010; von Hippel and von Krogh, 2015; Zeng, 2014). Using OCs for foresight and moving towards open foresight approaches, results in a knowledge and information advantage in comparison to companies not using such "open methods".

As described, we know from the open and user innovation research that expert knowledge and innovative solutions can be found in OCs. However, the extent to which this knowledge and information can be beneficial for foresight and if OCs also discuss future developments rather than only innovative ideas remains unclear. Based upon the literature, this paper firstly shows the benefits of conducting foresight with OCs in general. After the general appropriateness of OCs for foresight is shown, this paper aims to answer the research question of how to assess the potential of OCs for foresight. Since a mass of OCs exist in the Internet, several steps are necessary in order to identify the 'right' OC. First, a criteria catalog for assessing the potential of OCs and their future developments for foresight is developed by using prior literature. Secondly, with a netnographic approach (Kozinets, 2002, 2006), this criteria catalog is empirically tested with one selected OC. Additionally, text mining is executed using a topic modeling approach in order to show which topics are discussed by OCs, how they change over time, and how this is useful for companies' foresight approach. Based on those findings from the OC, a focus group interview (Armstrong, 2006; Krueger and Casey, 2015) takes place in order to assess the insights from the netnography and prove the assumption about the usefulness of OCs for foresight from a practical management perspective.

The remainder of the paper is structured as follows: After the understanding of open foresight is clarified, the idea of using OCs for foresight is described in Section 2. In Section 3, the criteria catalog is developed. The mixed-methodological approach is described in Section 4. The developed criteria catalog is then used to evaluate one exemplary OC from the renewable energy industry in Section 5. Subsequently, the results of the topic modeling approach are presented. The findings section closes with the report on the focus group interview. In Section 6, the findings are discussed. Based on this, implications for research and managerial implications are derived and some limitations leading to future research are described in Section 7.

2. Conducting foresight with online communities

The fast moving business environment makes it necessary for companies to be able to detect changes early and able to react to these (Rohrbeck, 2010). The aim of foresight is to secure the ability for action while reducing uncertainties. This is done by a systematic search and use of information. The focus lies in the identification of possible future developments (trends) and influencing factors (Carlson, 2004). In sum, the generated knowledge is used for reducing the complexity and uncertainty and raising awareness of future scenarios. Foresight, however, aims not at predicting the future; instead, foresight supports individuals to think about different future directions and developments (Cachia et al., 2007; Vecchiato, 2012).

In traditional foresight processes, experts play an important role and are the basis for the use of many methods. Their expert knowledge generates harmonized descriptions about possible future directions (Schatzmann et al., 2013). Instead of simply relying on experts discussing future developments, new approaches also include external sources, e.g., suppliers, research institutes, users, OCs. By integrating such external sources, the potential of different points of view can be integrated into the foresight process, resulting in collective intelligence (Ehls et al., 2016; Gattringer and Strehl, 2014; Miemis et al., 2012).

The technological development of the Internet in the direction of a participative approach, the so called Web 2.0 (O'Reilly, 2007), changed usage behavior dramatically. This evolution is characterized by user-centered and interactive websites and forums which foster user activities such as co-creation and communication, as well as content sharing and creation (Janzik and Herstatt, 2008). With these developments, OCs emerged. In OCs, individuals are unified by shared interests or common goals and discuss these using an Internet platform on the Web 2.0 (Janzik and Raasch, 2011; Zeng, 2014). Their knowledge makes them especially valuable for foresight processes. A systematic integration of OCs, therefore, might reduce uncertainty about future changes.

Cachia et al. (2007) made a first attempt in the direction of open foresight in the field of online tools by examining the potential of online social networks for foresight. Taking Ferebee and Davis (2009) into consideration, the study by Cachia et al. (2007) neglects to consider the community architecture. Ferebee and Davis (2009) describe the Web 2.0 as consisting of a system architecture – representing the technical features – and the community architecture – representing the community members' content, values, and shared ideas. A social network is the mere system architecture while the community layer is missing. In contrast, OCs unite both architectures and enrich the technical features of a social network by discussing their needs and goals.

Another attempt in this direction is the study by Woo et al. (2015) which focuses on the community architecture and the content of web forums on medical issues, especially Alzheimer disease patients, using data mining. They determine the main needs of the affected patients and, additionally, recognize that these needs have changed over time. The researchers also claim that the 'survival' of different topics in the forums can be used to classify their future significance. Furthermore, they found that peoples' attitudes change over time. Thus, they recommend companies monitor specific communities of different areas for a certain period of time and, in particular, check if the focuses of topics change in the progress of discussions. Based on this, it might be possible to recognize certain trends which can, thereupon, also be applied to company practice. Summarized, communities could generate valuable information regarding future customer needs and complete the 'picture of the future'.

OCs are characterized by a number of features that make them attractive for foresight. One is the generally young mean age of the members which makes OCs in general open towards future-oriented themes (Da Costa et al., 2006) and attractive for creative tasks. Furthermore, their expert knowledge (Chesbrough, 2004; Janzik and Raasch, 2011; Zeng, 2014) is a crucial factor for foresight (Popper, 2008). In addition, it should be noted that the members are able to communicate free of charge and without delay. This encourages intense interaction with others and provides additional data generation. Since most of the discussions and articles in these OCs are free of charge, this is an advantage for companies. Moreover, most of the posts are publicly available which makes the data easily accessible. Further beneficial is the size of the community: The number of members can grow to several million members. Correspondingly large is the amount of communication and data volume (Da Costa et al., 2006). However, besides the quantity of data, the quality of the discussed future developments plays

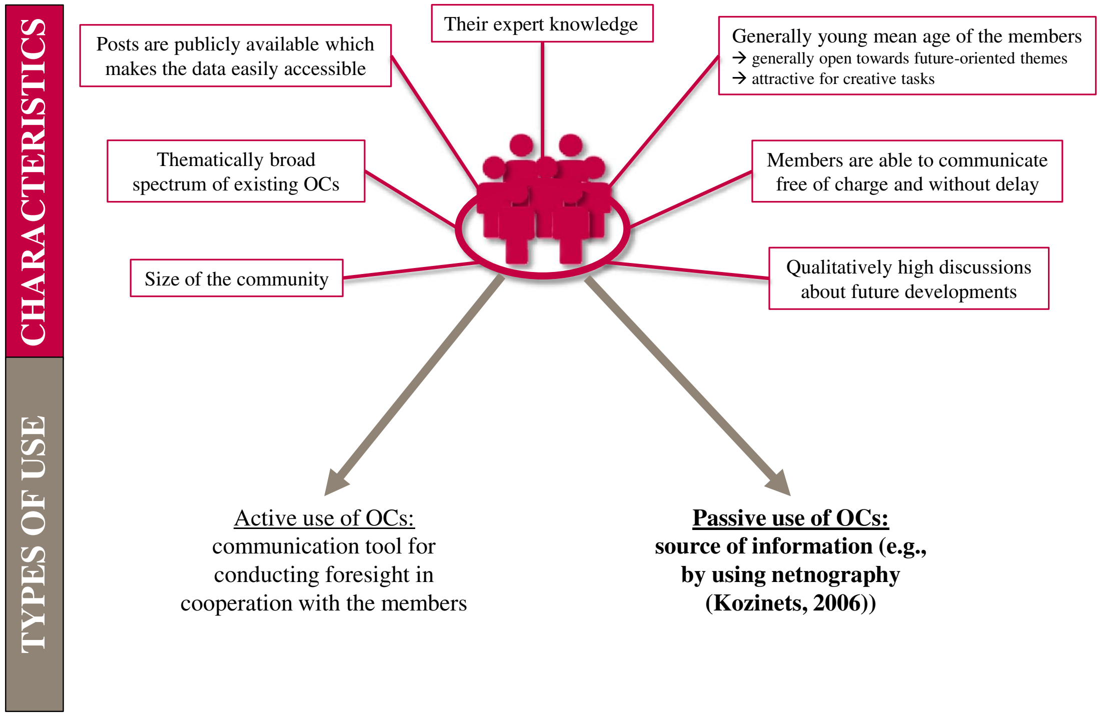

Fig. 1. Useful characteristics of OCs for foresight and types of use of OCs.

a crucial role for foresight in order to gain a coherent view of the future (Daheim and Uerz, 2008). Lastly, the thematically broad spectrum of existing OCs allows for conducting foresight with OCs in many areas. (Da Costa et al., 2006).

According to Da Costa et al. (2006), there is a distinction between an active and passive use of social networks for foresight. This can be transferred to OCs. An active use of OCs means using OCs as a communication tool for conducting foresight in cooperation with other members. These OCs can be used for testing future concepts or products or for developing scenarios by providing a specific task around one theme as a stimulus. A passive use of OCs implies that the community is used as a source of information. Here, methods like netnography can be employed (Kozinets, 2006). An interaction with members is not necessary. The information generated in the OCs is used to create new insights. All this is summarized in Fig. 1.

After clarifying the general appropriateness of OCs for foresight as a basis for this paper, the following aims at the second part of this study, i.e. the research question, how to assess the potential of OCs for foresight. Using the classification of Da Costa et al. (2006), this paper focuses on the passive use of OCs for foresight. While Cachia et al.'s (2007) work was rather descriptive, this paper aims at identifying valuable information given by OCs and evaluating the information and OCs with a systematic, self-developed criteria catalog regarding their foresight potential. In this study (future) user innovations are of special interest because they are, per definition, ahead of the market and trend (von Hippel, 1986). In addition, future developments and concepts as well as scenarios are taken into consideration.

To execute foresight in terms of detecting changes early (Rohrbeck, 2011), a plethora of foresight methods have evolved in the past. While Cachia et al. (2007) use the classification of foresight methods according to Georghiou (2001) for determining the potential of social networks for foresight, this paper uses the advanced model of Popper (2008) – the so-called foresight diamond. The aim of Popper's (2008) study is to show how to select foresight methods. For doing so, he categorized foresight methods and developed the foresight diamond which has four dimensions: creativity, expertise, interaction, and evidence. With the characteristics described above, OCs can contribute in diverse ways to all of these four dimensions: Creative and knowledgeable members are united in OCs and interact with each other by exchanging information. Using Popper's (2008) classification can determine whether OCs have the potential to be used as a valuable foresight method and, if so, to which dimensions they contribute. Hence, in the following operationalization of the four dimensions with established measurement items from literature is explained.

3. Criteria catalog

3.1. Creativity

When considering innovations and product development, several creative consumers can be found in OCs (Jawecki et al., 2011; Jeppesen and Frederiksen, 2006; Muñiz Jr. and Schau, 2005). Devising new and unique solutions reflects the creative thinking of the members of OCs (Jawecki et al., 2011). Bringing this creative potential from innovation to foresight research leads us to the definition of creativity by a well-known foresight scholar, Rafael Popper who defines creativity as "the mixture of original and imaginative thinking and is often provided by artists or technology 'gurus', for example. These methods rely heavily on the inventiveness and ingenuity of very skilled individuals […]" (2008, p. 65).

A variety of studies examine the differences between the creativity of an individual and creativity within a group of people (Perry-Smith and Shalley, 2003; Pirola-Merlo and Mann, 2004; Taggar, 2002). It was found that specific group characteristics promote the creativity of the individuals in this group. These characteristics include the freedom to make an independent contribution, the diversity of members' skills, openness to new ideas, mutual challenge, support, recognition, and common cultural norms (Amabile and Gryskiewicz, 1987). These characteristics were initially developed through studies on groups that were physically in one place, but these can also be transferred to OCs (Amabile et al., 1996; Füller et al., 2007). If this creativity in OCs is used for creating different future developments and scenarios, there is a huge potential for enlarging the scope of different views for foresight. Certainly, it is imaginable that OCs discuss future scenarios upon a particular event, share their views about future developments as well as creative thinking (Cachia et al., 2007).

For evaluating the creativity of an OC, the contributions within an OC will serve as a basis for the measurement of creativity as this reflects the creativity of each member. This approach has been used in several studies (Füller et al., 2007; Jawecki et al., 2011).

Once the future concepts are selected, these are evaluated by experts of the respective field (Amabile, 1983; Amabile et al., 1996). Following Dean et al. (2006), a creative approach is a quality approach which is also novel. In their study, expert judges rated ideas regarding novelty with originality ("The degree to which the idea is not only rare but is also ingenious, imaginative, or surprising") and paradigm relatedness ("The degree to which an idea preserves or modifies a paradigm") and secondly regarding workability with acceptability ("The degree to which the idea is socially, legally, or politically acceptable") and implementability ("The degree to which the idea can be easily implemented"). This assessment of ideas is transferred to future concepts. They used a four-point Likert-scale, where four is the highest score and one is the lowest score. This creativity scale is used in order to determine the creativity of the OC.

3.2. Expertise

According to Popper (2008, p. 65), "expertise refers to the skills and knowledge of individuals in a particular area or subject […]. These [foresight – author's note] methods rely on the [tacit] knowledge of people with privileged access to relevant information […]." Thus, people – and also collectives, such as OCs – can be assessed in terms of their expertise (Gubanov et al., 2014). According to Bagozzi and Dholakia (2002), OCs are an agglomeration of collective expertise which creates a unique knowledge-base and increases the value for every member. OCs are places where user experts can gather their knowledge on specific topics (Bagozzi and Dholakia, 2002). Some of these user experts even possess lead user characteristics (Belz and Baumbach, 2010; Jeppesen and Laursen, 2009). The members of the OCs give access to their knowledge to the community for free without demanding anything in return (Harhoff et al., 2003). Through this free exchange of knowledge, OCs are able to develop a collective intelligence. This collective intelligence surpasses the individual intelligence of each member. Due to these circumstances, OCs considerably combine expertise (Johnson, 2001; Luo et al., 2009).

Expertise, in turn, is important for foresight because the factors affecting the future are manifold and complex and thus lead to a high degree of uncertainty. To reduce this uncertainty, sound knowledge from different areas is needed (Karlsen, 2007; Popper, 2008). Using experts for foresight, increases the accuracy of the results (Rowe et al., 2005). Furthermore, Popper (2008) shows the importance of expertise for foresight by the high number of applications of the expert panel method (e.g., Miles, 2010; von der Gracht et al., 2015).

As shown, OCs possess the required expertise for foresight and might help by contributing to a more comprehensive understanding of the future. It is advantageous for foresight that OCs unite different kinds of knowledge from several areas (Cachia et al., 2007; Janzik and Raasch, 2011; Zeng, 2014).

Expertise is measured in this paper with several indicators. First, this paper uses some lead user criteria referring to studies which have already identified lead users online. Since this study does not aim to identify lead users but to identify expertise in OCs, this paper solely uses the criterion regarding user expertise according to Bilgram et al. (2008) and Brem and Bilgram (2015). Thus, user expertise is distinguished in use experience and product-related knowledge. Use experience is measured by the total amount of posts. Product-related knowledge is measured by the amount of technical terms.

Second, members' profiles are used, providing information such as professional background (occupation) and hobbies. Other useful information provided by the members' profiles are also taken into consideration.

In order to evaluate the activity, the post per day behavior is analyzed. This is done to cluster members into three groups: innovator/activist (> 0.5 posts per day), tourist/crowd-follower ($\geq 0.1 \leq 0.5$ post per day), and lurker ($> 0 < 0.1$ post per day) (Janzik and Raasch, 2011).

3.3. Interaction

In terms of interaction, Popper (2008, p. 65) recognizes "that expertise often gains considerably from being brought together and challenged to articulate with other expertise (and indeed with the views of non-expert stakeholders)." In particular, OCs and the Web 2.0 possess the ideal conditions for bringing the knowledge of experts and non-experts interactively together.

The Internet, and especially the evolvement of the Web 2.0, has changed usage behavior dramatically: Today, the Internet is built around users and the interaction with others on a platform. Thus, this is an evolution rather than revolution of the Internet (Janzik and Herstatt, 2008; Janzik and Raasch, 2011; Zeng, 2014). The focus of the interaction lies in the discussions between users. In comparison to private messages, these are openly available – at least within the OC. Furthermore, users can connect independently from their geographical position. In addition, OCs allow the interaction of a large number of people which would not be possible in a non-digital setting (Dahan and Hauser, 2002). This is explained in detail with Ang's (2011) 4Cs model of Community Relationship Management: (1) Connectivity describes the technical features of a web-based platform which enables the connection between users and, in doing so, the development of a larger community. The form of (2) conversations on social networks are primarily short messages and status updates. This communication is asynchronous, i.e., one community member writes a message and another follows later on (Fuchs, 2008). The (3) content is created by the users themselves, the so-called user-generated content, through blogs, groups, or videos, amongst others. Users can also create content in (4) collaboration with others on a platform.

In summary, the Web 2.0 has a system and community architecture: The system architecture (1) connects users and supports highly interactive communication which fosters unique (2) conversations. The community architecture gives the community members the chance to evolve from a passive consumer to an active producer of (3) content (4) collaboratively with other members (Füller et al., 2004; Janzik and Raasch, 2011; Zeng, 2014). Thus, these two elements of the architecture of the Web 2.0 offer the basis for collaborative work in foresight projects.

As part of foresight activities, interaction plays an important role. The complexity of today's problems requires an inclusion of different perspectives. Individual experts often have limited capability to solve complex and interdisciplinary problems alone and are therefore dependent on interactions (Saritas et al., 2013). In addition, the inclusion of diverse participants leads to a greater variety of solutions (Nikolova, 2014). A plethora of foresight methods relies on intensive interaction and participatory processes: workshops and brainstorming, amongst others (Popper, 2008).

Since foresight activities require interactive processes and OCs offer a mixture of different experts as well as the interaction promoting features of the Web 2.0, OCs seem to be a promising way for interaction in foresight activities.

This paper measures interaction in OCs with several indicators. First, it looks at the amount of members involved and the amount of posts in one thread. Second, the average amount of posts per member is analyzed. The average amount of posts per member is calculated by dividing the amount of posts by the number of members who have written a post in one thread. This number shows how strongly the active members are involved in the discussion.

3.4. Evidence

According to Popper (2008, p. 65), "evidence recognises that it is important to attempt to explain and/or forecast a particular phenomenon with the support of reliable documentation and means of analysis of, for example, statistics and various types of measurement indicators." The methods of this category are mainly based on data collection and the analysis of these data. Popper assorts to this category methods like extrapolation, bibliometrics, patent analysis, etc. Recent foresight approaches discuss the Internet as a potential source of data. Especially, Big Data or Data Mining are common methods. Both concepts deal with the use of very large amounts of data that are obtained primarily via the Internet (Hand, 2009; Hassani and Silva, 2015). OCs can be a useful source of data, too. OCs were identified several years ago as quantitative data sources in trend analysis and market research (Da Costa et al., 2006).

Regarding evidence, this paper examines whether the future concepts are confirmed or illustrated using data, literature, or other figures or numbers. For example, community members could illustrate their future concept or development using the aforementioned information materials. Additionally, text mining in the form of topic modeling is used, here, to further dig into Popper's (2008) definition of evidence by using reliable documentation in order to determine trends and changes.

The criteria catalog is summarized in Fig. 2. With the help of the developed criteria catalog using Popper's four dimensions, I explore and evaluate OCs regarding their potential contribution to these four dimensions.

4. Method and data

4.1. Netnographic approach

Netnography has its origin in ethnography (Arnould and Wallendorf, 1994). It is a qualitative research method for observing OCs. In comparison to offline ethnography, it is a faster, simpler, and cheaper version for market research (Kozinets, 2002). It allows investigation of the members' behavior and interaction, without requiring researchers to actively participate in the respective OC (Kozinets, 2002, 2006). Freely available data on the Internet is used. The particular OC is monitored during a specific time frame. No bias and no direct influence from researchers appears due to the natural setting of the community (Jawecki et al., 2011). Thus, 'grounded knowledge' regarding certain research questions is gained (Glaser and Strauss, 1967).

For gathering answers to the research question regarding the foresight potential of OCs and their contribution to Popper's (2008) four dimensions, all postings in an OC with respect to foresight are selected. It is necessary to analyze members' content, their interactions, as well as their profiles in-depth.

4.2. Text mining approach

As a support to the qualitative netnography, text mining is used in order to generate more insights on the usefulness and assessment of OCs for foresight, in particular in the 'evidence' dimension. Since this is an exploratory study, I chose probabilistic topic modeling using the Latent Dirichlet Allocation (LDA) algorithm (Blei, 2012) as an appropriate research method in order to inductively discover patterns of the future discussed by OCs. Probabilistic topic models identify topics by labeling documents with a suitable topic (Blei et al., 2003). It follows the 'distributional hypothesis', i.e., words co-occurring in similar circumstances likely have related meanings (Turney and Pantel, 2010). Thus, sets of words which co-occur frequently can be labeled with the same topic (Boyd-Graber et al., 2014). It overcomes the human boundaries of manual text analysis regarding quantity and reduces human biases in terms of content (Urquhart, 2001). This text mining method is suitable for supporting and triangulating the qualitative netnography thoroughly but it cannot replace the human analysis of netnography or the interpretation of the text mining analysis (Debortoli et al., 2016).

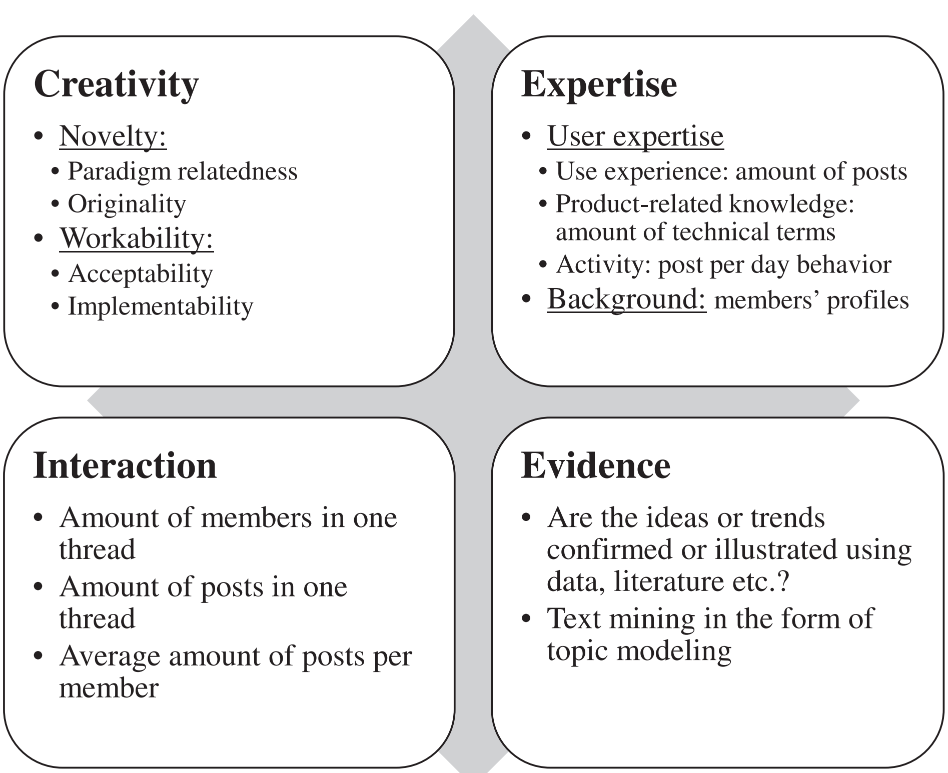

Fig. 2. Developed criteria catalog for assessing the potential of OCs for foresight.

4.3. Empirical field: selected online communities

This paper analyzes OCs dedicated to the field of renewable energies. These communities were chosen for several reasons. First, renewable energies are a future-oriented industry. Second, this industry is affected by different conditions regarding social, technical, economic, ecological, and political (STEEP) trends and regulations. Third, through the explorative search in different industries, it was found that there is a huge potential for user innovations. Thus, renewable energies OCs seem to be an appropriate empirical field in terms of combining the two research fields of open and user innovation and foresight.

The investigation for OCs was undertaken by two researchers using search engines such as Google and boardreader.com or social networks like Facebook, Google+, and LinkedIn in order to guarantee that the same OCs were selected. The search focused on standalone OCs using social software (e.g., board forums) or groups on social networks. Furthermore, mainly publicly available OCs were considered. To reduce the number of OCs, various selection criteria such as community size, activity and interaction, as well as quality of the content (Hara et al., 2009) were used. 27 OCs were identified. To narrow this number down, a more in-depth analysis of the OCs' content was conducted. It was evaluated whether the OCs spawn foresight potential in terms of future concepts, trends, and scenarios as well as user innovations. The second criterion was the open access to the members' profiles in order to use this as a proxy for members' expertise. Following discussion by the researchers, three OCs (see Table 1) were identified which might be relevant for this study. Those three OCs were read and scanned in detail, especially in the field of do-it-yourself projects, future developments and concepts. Green Power Talk (2017) was classified as the most suitable OC for the purposes of this study. Thus, this OC was chosen for further consideration. According to the ethics of netnographic research (Kozinets, 2002), I asked and was given permission by the web administrator of Green Power Talk to observe the OC and quote it in this paper.

4.4. Assessment of Popper's creativity dimension and expert involvement

In order to ensure validity of the results, the summarized descriptions of the future developments and concepts from the OC were shown to and evaluated by company representatives from the renewable energies industry. The focus, here, was on the assessment of creativity. Creativity was measured by experts' assessment of the four dimensions originality and paradigm relatedness (which describe novelty) as well as acceptability and implementabilty (which describe workability). The assessment was carried out during a workshop in November 2016 with a focus group (Armstrong, 2006; Koller, 2009; Krueger and Casey, 2015) consisting of nine renewable energies experts. The experts covered different fields of renewable energies, such as solar, hydro, and wind, but also included experts from traditional energy supply. After the individual assessment of the creativity of the community members' approaches, the experts filled out questionnaires regarding the usefulness of OCs for foresight in general. This was followed by a focus group interview (Kitzinger, 1994). The focus group interview was semi-structured, guided by moderators with previously developed questions using an interview guideline, and lasted for about an hour. It was audio-recorded with the permission of each participant and afterwards transcribed verbatim (Calder, 1977; Carey, 1994; Kitzinger, 1994; Merton et al., 1990). In the focus group interview, the experts discussed the approaches from the community members, their own assessment regarding creativity, and the usefulness of OCs for foresight in general. Data gathering was enriched by observing the group (Morgan, 1996).

4.5. Data collection and analysis

The OC was observed over a period of four months. First, the structure of the OC was analyzed in-depth regarding members and activities. This gave an overview of different member types and their characteristics as well as their levels of activity.

Next, the posts, pictures, and videos by the OC's members were read and analyzed by two independent researchers going back to 2010 at the latest. Since the aim was to identify future-oriented concepts and developments, threads older than 2010 were not considered. In sum, more than 4800 posts in almost 530 threads were read. All relevant discussions were downloaded as text files for the following analyses. In order to gain an overview of the members' backgrounds, the user profiles were also analyzed. In addition, field notes of interesting observations and findings were taken.

The data – both the discussions from the OC and the focus group interview material – was imported into a qualitative text analysis tool – MaxQDA v. 12 (MAXQDA, 2016) – and then coded by two independent researchers. This paper follows the content analysis approach according to Kuckartz (2014) which comprises of qualitative text analysis with coding and memos. The category system for the qualitative text analysis was, on the one hand, developed inductively from the data by extracting meaningful units using an open search procedure (Glaser and Strauss, 1967) and, on the other hand, deductively derived from the literature (Maxwell, 2008). The generated units were classified into one coherent category system with superior-categories and sub-categories. As soon as a statement did not fit into one category, the category system was extended to include a new category. The main categories for the content analysis were based on Popper's (2008) foresight diamond and the operationalization of these dimensions developed in this paper. Additionally, interesting comments were also marked and saved as field notes, in particular comments regarding the usefulness of OCs for foresight. Each statement with a relevant topic was allocated to a category. In order to achieve inter-rater reliability, the coders continuously negotiated the meaning of each category.

Also for the quantitative topic modeling, posts no older than 2010 at the latest were extracted from the OC using the web-based platform import.io (Import.io, 2017). The final data set comprises the posts,

Table 1
Overview of the renewable energies OCs.

Community	Members	Posts	Language	Operator (since)	Structure
Green Power Talk	1498	8787	*English*	*Firm-hosted* (2006)	▪ *Start page, forum, groups, photo gallery, calendar* ▪ *Forum with five main categories* (*Renewable Energy*, *Sustainable Building*, *Sustainable Transportation*, *Other Areas of Interest*, *Forum Information*) ▪ *Focus on main category* "*Renewable Energy*"
Navitron	6779	296,691	English	Firm-hosted (2006)	▪ Forum only ▪ Forum with 14 main categories (Announcements & News, General Renewable Topics, Green Building & Design, Buying/Selling/Trading, Solar Thermal, Sustainability, Solar Photovoltaic, Wind Turbines, Energy/Electricity Storage & Use/Grid Connection, Hydro Turbines, CHP, Heat Pumps & Geothermal Energy, Transport, Biomass)
Fieldlines	6011	219,294	English	Firm-hosted (2003)	▪ Forum only ▪ Forum with nine main categories (Homebrewed Electricity, Microcontrollers, Remote Living, Image Gallery, Newbies, Product Reviews, Logged in users, Notices, User guides and contact email)

including other metadata such as date, time, user name, section, and sub-sections and spanning a timeframe from January 2010 to August 2017. The cleaned data set (i.e., checked whether only posts until 2010 are in the data set, removed duplicates) was then uploaded to the cloud-based tool MineMyText.com (Debortoli et al., 2017) which uses the LDA algorithm. First, some preparation cycles were performed in order to determine an applicable number of topics. Different numbers of topics ranging from 5 to 20 were qualitatively evaluated. Eight topics were chosen because more topics produced similar or duplicate results and less topics led to unclear distinction between topics (Debortoli et al., 2016). Then, after a couple of rounds of fine-tuning the topic model, the final topic model was cleaned from noise in the following way: (1) removing frequent but uninformative words ('stopping'), (2) reducing inflected words to their word stem ('stemming'), reducing words to their dictionary form ('lemmatizing'), (3) removing remained HTML tags, (4) filtering part of speech (POS) (placed on their part of speech, such as noun, adjective, adverb, or verb are removed), (5) removing numbers, and (6) n-gram tokenizing (documents are split into single words or into groups of two successive words).

Enriching the data collection of netnography with the text mining approach of topic modeling and the focus group interview as well as questionnaires and observations enabled triangulation between different types of data (Yin, 2014) in order to widen the understanding of using OCs for foresight (Eisenhardt, 1989).

5. Findings

5.1. Green Power Talk

5.1.1. Community structure and members

Green Power Talk is a standalone OC using bulletin board forum technology. This OC was established in November 2006. It is a firm-hosted OC by the Canadian company Solacity Inc., which is a provider of renewable energies technologies for home appliances. In total, this OC has approximately 1700 members of which circa 700 members posted at least once. It contains 1554 threads with 9649 posts (September 2017). Green Power Talk has several categories such as renewable energy, sustainable building, sustainable transportation, amongst others, with corresponding sub-categories. As the focus of this paper lies in renewable energies (1085 threads, 7283 posts), the analysis was focused on the same named category with the subsections *Solar Electricity*, *Solar Heating* & *Cooling*, *Hydro Power*, *Wind Power*, *Do-It-Yourself*, *Balance-of-Systems*, *Biofuel*, and *Government Incentives*. Threads were read and scanned for future concepts or developments, scenarios, or user innovations. Altogether, 18 threads were found that might have an impact on the future. The discussions were broken down into different approaches discussed by the community members and classified into three types: (1) future concepts, (2) user innovations (von Hippel, 1986), and (3) frugal approaches (Tiwari and Herstatt, 2012). In total, 22 future-oriented approaches in these 18 threads were found and 73 unique members participated. Details of the classification can be found in Table 2. Subsections in which no relevant thread was selected are not listed here.

5.1.2. Creativity

As described in Section 4.4, creativity has been assessed by experts. Since experts are always hard to reach at short notice, I had to find a way to present the community members' approaches. Thus, the 22 future-oriented approaches were summarized into descriptions and clustered into six topics with the help of other researchers. The descriptions were developed by reducing the length of discussions but keeping the key facts of those approaches. The six topics included solar power (six approaches), hydro power (six approaches), wind power (six approaches), power supply in general (two approaches), cooling (one approach), and heating (one approach) (see Table 3). The heating approach had to be deleted due to validity reasons because only one rater assessed this approach; thus, 21 approaches were available for assessment. Each approach was rated by two to seven experts on a four-point Likert-scale, where 4 is the highest score and 1 is the lowest score. The test for inter-rater reliability using Cronbach Alpha resulted in 0.8369; thus, good reliability is given.

It seems that five of the solar power approaches, three from the hydro power approaches, three from the wind power approaches, one from the power supply in general as well as the cooling approach were the most original (score of above 2.0). In total, 13 of the 21 approaches were rated with a score above 2.0. Regarding paradigm relatedness, seven of the 21 approaches were rated with a score above 2.0. Hence, they seem to be incremental rather than radical improvements. In general, in terms of novelty, all approaches were rated on average with a score of 2.6 in the category originality and a score of 2.0 in the category paradigm relatedness. Thus, the approaches were above average in terms of novelty.

Regarding workability, 20 of the 21 approaches were acceptable (score of above 2.0) and rated in the mean with 3.3 as well as 14 of the 22 approaches being implementable (score of above 2.0) and rated in the mean with 2.6. For example, the approaches in terms of solar panels in space or a nuclear power plant on the moon were rated with 4.0 and 3.0 regarding originality but when considering implementability the approaches were rated with a score of 2.0 and 1.0, implying that those approaches were original and even future-oriented; however, with such a high amount of originality, it seems to be difficult to implement those approaches in the future. Another reason of the low score of implementability might be that it is hard for the experts to imagine that those approaches are possible in the future because such approaches are yet to be implemented somewhere and there remain open questions regarding the approaches; for example, how the energy will be transported from space or the moon back to the earth. Based on those findings and the mean values of above or equal to 2.0 in all categories, this OC seems to be above-average in creativity.

5.1.3. Expertise

The usage of technical terms ranged between 12 and 336; on average the members of the OCs used 111 technical terms per thread. Regarding the members' profiles, several items of information were useful for describing their expertise. Concerning the location, the contributing members were mainly from the USA and Canada, some from Costa Rica, Australia, Sweden, The Netherlands, and Ireland. Other information about the community members regarding occupations and

Table 2
Analyzed threads and different types of future developments.

		Solar electricity	Hydro power	Wind power	Do-It-Yourself
Analyzed threads	Amount of threads analyzed	200	32	136	75
	Amount of posts analyzed	1468	208	1992	448
	Amount of selected threads	3	4	5	6
	Total amount of persons involved in selected threads	40	25	22	47
Types of future developments	Future concepts	4	2	1	4
	User innovations	2	2	3	4
	Frugal approaches	1	–	1	–

Table 3
Approaches evaluated by experts regarding creativity.

			Novelty		Workability	
			Originality	Paradigm relatedness	Accept ability	Implement ability
Solar power approaches	1	Home-made solar cells[c]	2.7	1.8	3.5	3.0
	2	Inclined solar tower[a]	3.5	3.0	2.5	2.0
	3	Solectria PVI serial comms protocol[a]	1.0	1.0	4.0	3.0
	4	Solar panels in space[a]	4.0	2.5	3.5	2.0
	5	Tracker on a timer[a]	3.0	1.5	3.5	3.0
	6	Using old CDs as reflector[a]	4.0	3.5	3.0	3.0
Hydro power approaches	7	Hot water recirculation[a]	2.0	1.5	3.5	2.5
	8	Hot box storage[a]	2.5	2.5	2.5	2.0
	9	Paddlewheel power and pumping[a]	3.0	2.0	4.0	3.0
	10	Axial flow turbine (approach 2)[a]	2.0	1.0	3.0	3.0
	11	Pelton wheel setup[a]	3.0	2.0	4.0	3.0
	12	My waterwheel design and questions[a]	2.0	1.0	3.0	3.0
Power supply in general	13	Bicycle power[b]	1.6	1.8	3.8	3.4
	14	Nuclear power plant on the moon[a]	3.0	2.0	1.0	1.0
Wind power approaches	15	Savonius Picoturbine[d]	1.8	2.6	3.9	3.1
	16	Imitation “Skystream” project[a]	3.0	2.0	3.0	2.0
	17	Help with unconventional turbine[a]	3.5	2.0	2.5	2.0
	18	Wooden tower for SWTs?[a]	1.0	2.0	4.0	3.0
	19	Windspot “hangs” on 46 volts with aurora[a]	2.0	1.0	4.0	4.0
	20	Logic of giant kites[a]	2.5	3.0	3.0	2.5
Cooling approach	21	Use of a trombe as air condition[b]	3.0	2.3	3.3	1.3
Mean			2.6	2.0	3.3	2.6

Approaches evaluated on a four-point Likert-scale.
[a] Evaluated by two raters.
[b] Evaluated by three raters.
[c] Evaluated by four raters.
[d] Evaluated by seven raters.

Table 4
Occupations, interests, and biography of community members.

Occupations	Engineers, entrepreneurs, accountant, navy submarine officer, director, waste manager, truck driver, maintenance manager, battery specialist, inventor and designer, flight simulation technician, solar integrator, master mariner, uni teacher, retired, technical sales, inventor, designer
Interests	plants, (do-it-yourself) renewable energies (forum), inventing, trombonist, development of new technologies, wind, hovercraft, woodworking, machining, solar, all things creative, electronics, wind generator, working, pumps, human-powered boats, DIY, RE harvesting, hunting and fishing, sailing, local politics, martial arts, music, books, greenhouse, e-mail with other cultures, racing, geothermal power, sailing, ballroom dancing, volleyball, aircraft flying

interests can be found in Table 4. In terms of the use experience, the total amount of posts per member ranged between 1 and 1760 (mean = 78.9).

Regarding members' activity, the posts per day behavior was in consideration instead of the total posts because this is a more appropriate proxy for the activity level: Long-term members with decreasing interest in the OC are classified as tourists and not as activists, whereas new members with a high posting behavior are not inevitably classified as activists (Janzik and Raasch, 2011). Regarding the members' ($n = 73$) post per day behavior in the considered threads, one was an innovator/activist (> 0.5), four were tourists/crowd-followers ($\geq 0.1 \leq 0.5$), and 68 lurkers ($> 0 < 0.1$). Except for two threads, each thread at least one tourist/crowd-follower or innovator was involved.

5.1.4. Interaction

Regarding interaction, there were between two and 13 persons (mean = 5.8) involved in one thread and the amount of posts ranged between 4 and 36 (mean = 19.2). In total, in these 18 threads, 73 members were involved with four members participating in two threads, nine members in three threads, one member in four threads, two members in five threads, one member in six threads, one member in seven threads, and one member in 18 threads. The average amount of posts per member ranges between 1.0 and 6.0 (mean = 2.68) in the 18 threads.

5.1.5. Evidence and topic modeling

The contributors to these 18 threads used several different kinds of information material to describe their future concepts or developments as well as to show what they read, before they shared their future concepts: They used encyclopedias (5 times), a diagram (1 time), statistics (3 times), circuit diagrams or construction plans (4 times), links to weblogs or websites (7 times), studies/reports (4 times), links to descriptions of components/technologies (58 times), patents (3 times), other discussions (3 times), other user innovations (3 times), and newspapers (3 times). In each of these 18 threads were – except for two threads – between one and 15 references to one of the aforementioned materials. On average, 4.1 sources were used per thread.

In addition to the netnography, the topic modeling provided the following results for the evidence dimension. As a beginning, 195,744 words with 4289 unique words were used for the topic modeling. The time span was from January 2010 to August 2017. The final eight of the topic modeling approach with the 10 most probable words can be found in Table 5. Based on the most probable words and the most probable documents encompassing those words, labels were sorted into the topics. The text mining tool produces flower-like world clouds represented by size and color the probability of a term in the respective topic. An example is depicted in Fig. 3. Furthermore, the tool provides the timelines of the topics (see Fig. 4).

The list of topics in Table 5 gives a good overview of the topics discussed between 2010 and 2017, spawning current issues in renewable energies but also discussions around future topics (Schmid et al., 2016; Stafford and Wilson, 2016). In addition to the assessment and

Table 5
Final topics of the text mining approach.

Topic	Words	Labels
1	Tower, make, blade, turbin, wire, put, cabl, foot, good, rum	Wind and solar tower
2	Work, turbin, post, good, wind, find install, forum, invert, buy	Finding the right wind turbine with the help of the OC
3	Power, energi, solar, electr, make, generat, water, wind, build, system	Different energy systems to generate power
4	Batteri, panel, watt, power, system, invert, run, day, charg, volt	Battery power systems
5	Turbin, wind, power, wind_turbin, rpm, wind_spe, blade, altern, motor, good	Wind turbines and their characteristics
6	Invert, voltage, power, control, turbin, grid, connect, switch, work, set	Inverter and power controller
7	Instal, year, roof, cost, panel, system, microfit, price, OPA, number	Installation costs of solar panel systems
8	Solar, project, pv, market, develop, industry, company, energy, pv_guangzhou, China	The solar energy market

discussion on some more concrete future concepts using the netnographic approach, topic modeling can help companies to identify future topics and developments. First, simply considering the topics and the most frequent words can be used as a starting point on what the discussion is about in this renewable energies community and how this is influencing the company and its foresight process. Of course, at first, there are topics which seem not that useful for the future such as topic 2 ‘finding the right wind turbine with the help of the OC’ or topic 5 ‘wind turbines and their characteristics’. However, by observing the discussions assorted to those topics, companies can identify what characteristics are important from the point of view of community members and on what factors they decide which wind turbine to choose in the future. This is not about looking at the improvement of a concrete wind turbine but, rather, seeing the bigger picture and including this into companies' future wind turbine or foresight process in general. And, in doing so, being ahead of the market.

Taking as another example topic eight, ‘the solar energy market’, here companies can observe, on the one hand, the very concrete community members' projects and, on the other, the general discussion about the future solar market. When considering the timeline of this topic, it can be seen that this topic was not really on the agenda of this community until the beginning of 2015. Then, suddenly, at the beginning of 2015, there was a peak on this topic; the topic subsequently fell again but reached another peak in the middle of 2015. Latest at the second peak in 2015, a company should have realized that this seems to be an important topic which needs to be observed in the foresight process from now on. Finally, in the third quarter of 2016, there was the biggest peak followed by repeated peaks; indeed, this topic never went back to the low status experienced between 2010 and 2014. Companies, which were aware and monitored this topic, could have a competitive advantage in comparison to companies not considering such issues. This OC gives a good overview of the current discussions going on in renewable energies with an additional view on details which are important for this OC and which may lead companies to identify previously uncovered future developments.

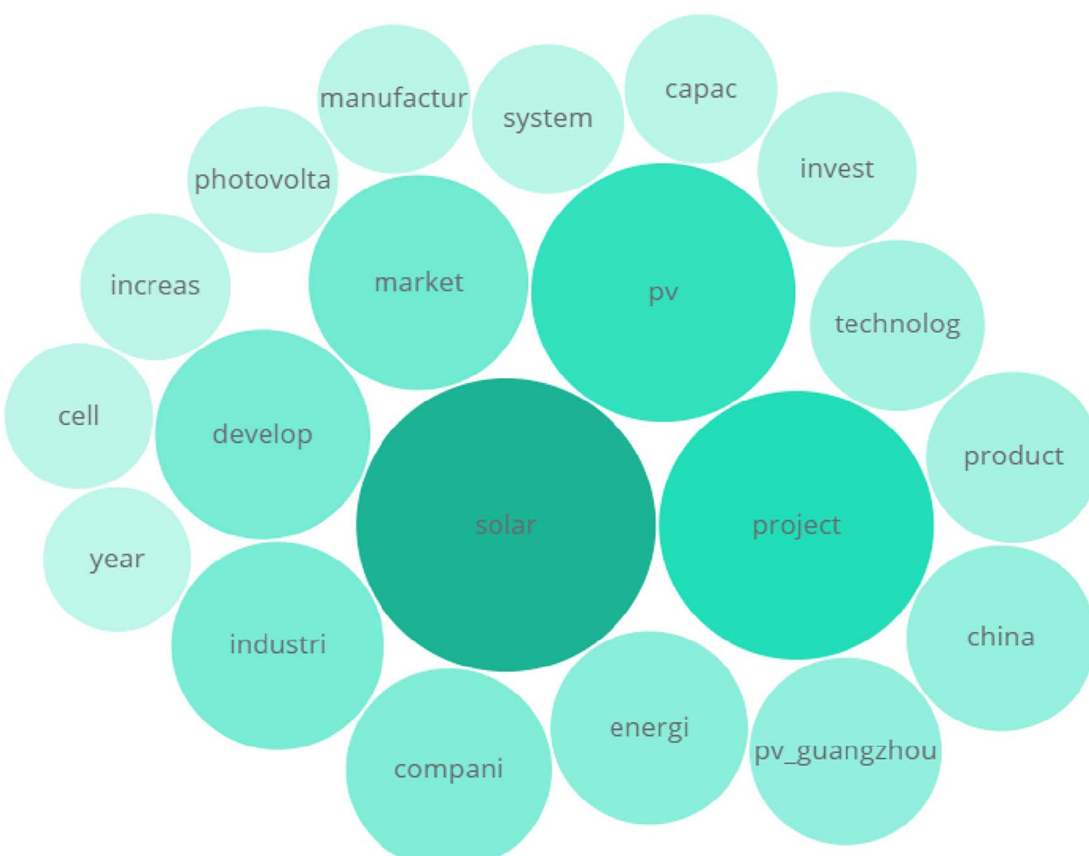

Fig. 3. Word cloud for topic eight.

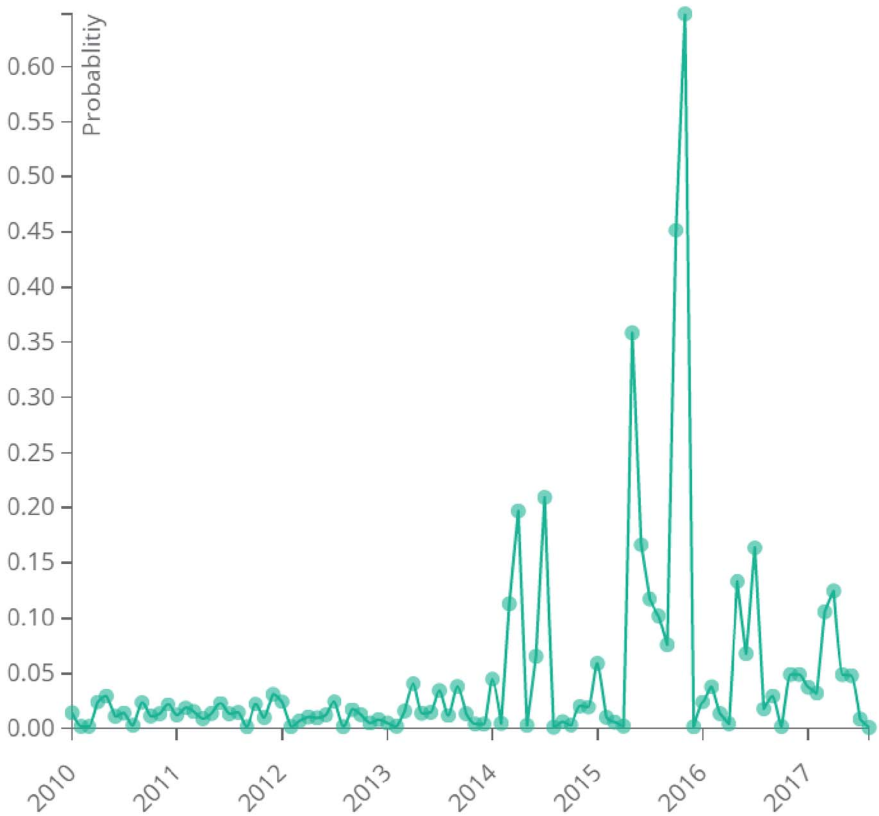

Fig. 4. Timeline of topic eight.

5.1.6. Trends derived from community members' future concepts & user innovations

After analyzing the OC Green Power Talk using the criteria catalog, some of the future concepts and user innovations from the netnography are highlighted in more detail for deriving future conditions and trends. This section shall show the essential aspects of how companies can use such future concepts as a starting point for their foresight process as well as highlighting some of the interaction between the community members. The selected threads from the section *Do-It-Yourself* are sorted to the corresponding topics on solar and wind. The numbers in brackets correspond to the approaches rated by the experts in Table 3.

In the group of the three solar threads, four future concepts, two user innovations, and one frugal approach were found, enriched with two threads from the section *Do-It-Yourself* encompassing two future concepts. In one interesting thread, the members discuss ‘nuclear vs. solar vs. wind’. So, they compare a traditional energy supply with two renewable energy supplies and talk about disadvantages and advantages of those technologies. One future-oriented concept is contributed by one member: He came up with the future concept to put nuclear reactors in space or on the moon [14]. With this future concept, he used a traditional method of generating energy in a new manner. Nuclear power is, of course, not a renewable energy source. Nevertheless, by putting a reactor in space [14], the risk of harming humanity is decreased tremendously. He also described putting solar panels in space and, in doing so, generating a lot more solar power than on earth without requiring any real estate on earth:

> *“Put the reactor in space, or on the moon. Then you can operate the partially-enriched reactor for 10 times as long. If it melts down nobody will care. Or, better yet, put solar panels in space where they will be 5 × as productive, and not take up any real-estate.*
>
> *In the end solar wins. We will eventually run out of fissile material, but we will never run out of silicon. The problem just comes down to who wants to spend the billions to put the first solar power plant in orbit?”*

Another community member in the same thread wrote the following:

> *“Producing solar panels is labour-intensive, slow, but there are automatic production techniques that may help in the future. Repeat: in the future.”*

Those statements combined from both members might suggest that with automatic production techniques in future it might be cheaper to set solar panels in space.

In this thread, they also talked about the grid; one member suggested that “*non-grid tied local generation becomes a real possibility for pretty much everywhere*” and that new storage-solutions might be the future. But another member answered:

> *“I expect the grid will be with us for many years to come and will become even more important rather than less.”*

This shows that opinions vary significantly in this community which is interesting for companies to observe because this allows the creation of different future paths and scenarios as well as complementing companies' own future scenarios. However, other members also believed in storage systems in the future for renewable energies:

> *“Storage and handling baseload is the key issue. From an engineering perspective, nuclear is king for baseload. This is why I too believe storage systems are the holy grail of renewable energy. I'm convinced that today's panel efficiencies are enough. What we need is a way of dealing with the uneven supply, rather than generating more electricity at a single point in time.”*

One thread from the section *Do-It-Yourself* started with a user innovation and encompassed three more future concepts. In the thread, one member brought up the concept of the inclined solar tower to produce electricity [2]. Another member added the comment:

> *“Hey […] that was a really interesting post that you shared. I wonder if in the near future this type of technology will be taken into consideration by major corporations.”*

This comment, as well as others in this thread, shows that the members themselves have already identified the potential of their concepts in the future. They recognize the possible integration of their future concepts into companies' product portfolios or at least that their concepts are taken into consideration as a trend or future development.

In the five relevant wind threads, one future concept, three user innovations, and one frugal approach were found; enriched with one user innovation from the *Do-It-Yourself* section. In the following some of these are described.

One user innovation in the thread 'Wooden Tower for SWT' was to build smaller wind wheels made out of wood [18] because the community member mentioned the following advantages:

"Wooden towers have a lot of advantages compared with steel tower: no amplification of vibration as the steel pipe, 12 m tower fit on an EU pallet, no corrosion problem, sustainable material which adsorbed CO_2 and beauty of design (depends on the taste...)"

Then they embarked on a discussion about those advantages but also problems with those wooden towers. One community member said at the end:

"There are good steel towers, there are very bad steel towers. Wood will be no different. I think it's a great idea that's worthy of trying!"

This contributor is the innovator of this OC and, at the same time, the administrator. One can see with this quote that he really tries to encourage the members to try new and futuristic things. Also, in other threads of this community, he motivates the members but also expresses his concerns if there are any. This user innovation also shows companies how to use other materials for future concepts.

5.2. Experts' assessment of using online communities for foresight

The focus group interview encompassing the discussion about the approaches of the community members and their creativity assessments as well as the use of OCs for foresight in general revealed useful insights on the potential of OCs for foresight.

First, the experts discussed the approaches from the community members at a higher level, i.e., the main topics. In the set concerning the solar approaches, they intensively discussed the approach about solar panels in space [4]. It was assessed as safe and that solar sails are getting lighter. Thus, the implementability is possible. Nevertheless, they raised the question how the energy will be transported from space to earth. The same accounts for the future concept about the nuclear power plant on the moon [14]. The self-programmed protocol was rated as not very original because this is state-of-the-art today [3]. Regarding the tracker on a timer [5], the experts said that it is novel and interesting. However, there is no real potential for innovation. Using old CDs as reflectors [6] was evaluated as inventive from the point of view of recycling.

In terms of the hydro approaches, the experts found the future concept interesting concerning the use of components for hydro which were originally used for solar facilities [11]. Furthermore, they found the future concept of 'Paddlewheel power and pumping' [9] quite original because it contained some useful impulses to use for other purposes. In sum, in the field of hydro approaches they were able to recognize future trends.

The wind approaches were assessed as partly helpful for foresight. The unconventional, horizontal turbine [17] gave the experts impulses for further ideas and possibilities; for example, they mentioned that such turbines could be hung between houses. The wooden towers [18] were assessed as not really inventive because such approaches already exist. Nevertheless, from an environmental point of view, this approach was considered good in terms of using less steel. Using the wind facility also with less wind [19] was assessed as not original and that damage can be caused to the facilities when it is running permanently. Concerning the approach using giant kites [20], the experts said that companies already had those concepts but they did not go into mass production. Building your own wind facilities for a cheaper price [16] is interesting for third world countries but the experts raised the question of how to connect such facilities to the grid.

Second, the experts were asked how useful they assessed the insights from the OC for foresight in general. The experts stated that an exchange of thoughts and a mutual fertilization between the community members took place. This led to stimulations for further developments within companies. Furthermore, they said that by reading the approaches from the community members, trends are identifiable:

"Whether the wind turbines become bigger or smaller, that is completely uninteresting. Deriving the trend from that is rather important. I believe this is the interesting thing that the development of the entire energy sector can be deduced from those discussions."

Such trends can be identified by taking the 'sum of all approaches' and observing in which directions those approaches are heading in order to be able to recognize future directions. The question arises of whether the further development of those approaches is carried out in an OC or, rather, if the companies are doing it themselves and evolve those concepts further by using the knowledge gained from OCs:

"The question is, to do it directly in the community in order to keep the community in the discussion. Or rather take the idea out of the community and then develop the ideas on your own further. These are the two ways to go."

Nevertheless, there might be risks if future concepts are taken from OCs and are further developed outside the OC:

"The community wants everyone to be involved but if you now take things out and develop for yourself, then sometimes a community dies."

Another quote highlights that it is possible for companies to receive some input regarding foresight from OCs but the final solution needs to be developed internally in the innovation management process of the company:

"The innovation process is what happens behind closed doors. From my point of view, the foresight before the innovation process takes place in the community during their discussions. […] The brilliant thoughts have to be pulled out by oneself and develop them further. That is to say, it is a kind of consumption of quite a lot of ideas."

This means that the experts see a foresight capability in the community members. They are willing and able to discuss future developments to a certain degree but the final solutions need to be developed by the company itself.

Another aspect of the focus group interview is that the discussions in the OCs are referring to 'today' and 'tomorrow' rather than to the long term:

"In the time horizon, however, we are usually more in the present day until tomorrow. [...] For foresight, on the other hand, it is more important that you really have these long-term issues. And the ideas that we have received here show that there was hardly anything that is really relevant in the long term."

Another expert suggested enriching the discussions amongst the community with experts who take part in the discussions and share their knowledge within the community. This is in line with Popper's (2008) definition of the interaction of bringing experts and non-experts together:

"I think it is very important for such forums that not only laymen and hobbyists discuss, because […] then the topic is very short term oriented […]. Instead, people have to take a little bigger horizon […]. A discussion, e.g. in 20 years, can I actually still rear in my brook a water wheel, because […] the water may be so scarce in 20 years [...]. I mean the discussion, which we now had based on the ideas, which were only

described very shortly, have already produced new ideas. I find it very interesting, when you start discussing, then you get new ideas […]. But everything is rather in the now and tomorrow but not in the day after tomorrow. If you really want to use something like foresight, and if you want to look a bit longer in the future, then maybe a community and such a forum has to be completely different."

This statement also highlights that the approaches by the community members stimulate thinking in different directions.

Another expert suggested using the 'wisdom of the crowd' by asking them a specific question and allowing them to discuss, similar to idea contests with specific questions (Piller and Walcher, 2006). In line with the future concept of solar panels in space: How to get the electricity back to the earth?:

"What I could imagine, for example, that if we […] put in a future energy community the question: How do we get the electricity we produce back to earth? And then they discuss and perhaps different ideas come up. [...] I believe that this is exactly the space we need in order to have a 'the thoughts are free'-like discussion about the future."

By giving the community members a creative space for discussing a future-oriented question, more insights about the future can be retrieved and feedback can be gained. In turn, the OC becomes sensitized concerning future developments. Furthermore, a shared discussion between community members and experts takes place.

The experts also discussed the problems in conducting foresight with OCs. Here, they talked about the motivation of community members regarding participation in foresight issues. A main reason to participate is the own affection concerning a problem and this affection is missing in terms of foresight:

"Own affection is actually an important prerequisite for people in order to participate in something like this. This means you have to create an own affection. Then the participation in such forums is much higher."

6. Discussion

This piece of research shows the potential of OCs for foresight conceptually by using prior literature and empirically by using a netnographic and a text mining approach as well as a focus group interview.

First, this paper shows the general appropriateness of using OCs for foresight using literature. Second, it shows how to assess the potential of OCs for foresight and how they can contribute to the four dimensions of the foresight diamond (Popper, 2008) using a netnographic and text mining approach. In doing so, OCs are proven to be a reliable foresight method which can be used as an information source by extracting information both qualitatively and quantitatively.

Regarding the netnography, the excerpts of the exemplary OC showed that even in a sophisticated field like renewable energies it is found that community members develop and discuss future concepts. It is possible to derive trends from these future concepts. Building on this, future society might be open to 'do-it-yourself' solutions instead of solely relying on companies' solutions. Furthermore, the discussions in this OC showed that the community members are looking for green and clean energy as well as sustainable use of technology.

In terms of the topic modeling, only a few topics were elaborated in this paper. However, this shows the potential of OCs' discussions for foresight. By considering the timelines of the topics, trends can be determined. Furthermore, topic modeling helps to identify current and future core areas. These core areas might also be areas which were not in primary consideration of companies' foresight process. Such areas are especially important for companies to identify in order to be ahead of the market. Here, OCs can help companies to become aware of issues which are not in consideration in their daily business.

In this OC, devising a future concept is not a straightforward process. It is, rather, an evolutionary and joint process in which the community members from different backgrounds interactively share their knowledge and where a concept is improved upon step by step. These future concepts or user innovations seem not to be the final solution. Instead these solutions seem to be quite open for future and further development – either in the OC itself or companies could adapt the concepts from this OC.

The focus group interview highlighted these insights. The experts stated that fruitful discussions take place in the OC. It is possible to derive trends from those discussions and further develop the community members' approaches and use them either for foresight issues or develop them further in order to use them for companies' innovation management. Nevertheless, they stated that discussions in OCs also have their limitations: The discussions are useful for first insights but the realization of a concrete solution or innovation has to take place in the company itself. Thus, the conditions under which it is useful to integrate an OC into foresight processes are revealed: OCs are valuable to use as a starting point for a following internal discussion regarding foresight in the company but they do not deliver a ready solution. Furthermore, some discussions seem to be too short-term and solely focus on own problems.

7. Implications and outlook

7.1. Implications for research

Combining the two research fields of foresight and open innovation remains an underexplored field with many future research avenues. Especially in the field of OCs, the potential of the members' future-oriented and user knowledge has not been considered in the research field of foresight until now. The aim of this paper was to show the potential of OCs for foresight in general as well as develop and test one possible and efficient method to assess the potential of OCs for foresight. To my best knowledge, this seems to be the first study assessing the potential of OCs for foresight by operationalization of the four dimensions of Popper's (2008) foresight diamond. Furthermore, it provides insights on how OCs and their knowledge, future concepts, as well as user innovations, can be beneficial for foresight from an expert view.

This study, in particular, contributes to the discussion on new foresight methods (Cachia et al., 2007; Popper, 2008). As described, the open and user innovation literature has already shown the potential of 'open methods' (Randhawa et al., 2016; West and Bogers, 2014); applying this to foresight, led to the research setting at hand. It shows, on the one hand, a procedure to select suitable OCs for foresight using the proposed criteria catalog and, on the other hand, with the empirical material from one exemplified OC the potential of the information gained from OCs for foresight. The research field on foresight methods is enlarged by one more modern approach which draws on dynamic sources of information rather than static methods, such as focus groups which can usually only produce a snapshot of the current view on the future (Raford, 2015).

Web-based and online procedures executed in OCs enable simultaneous inclusion of different external partners from different places which were not possible and neglected before. The range of externals to be included into foresight purposes is widened and, in doing so, the scanning of the environment and the future solution space as well – which leads to very participatory foresight approaches and actively shaping the future in different directions which is in line with the description of foresight by Cachia et al. (2007). More possible future developments and trends can be collected (Carlson, 2004) and, based on that, reaction patterns are derived (Ansoff, 1975). Thus, also, in the methodological field of environmental scanning a modernization takes place.

This paper shows that OCs, with their discussions about future developments, can contribute to each of the four dimensions of the foresight diamond using both a netnographic analysis and a text mining

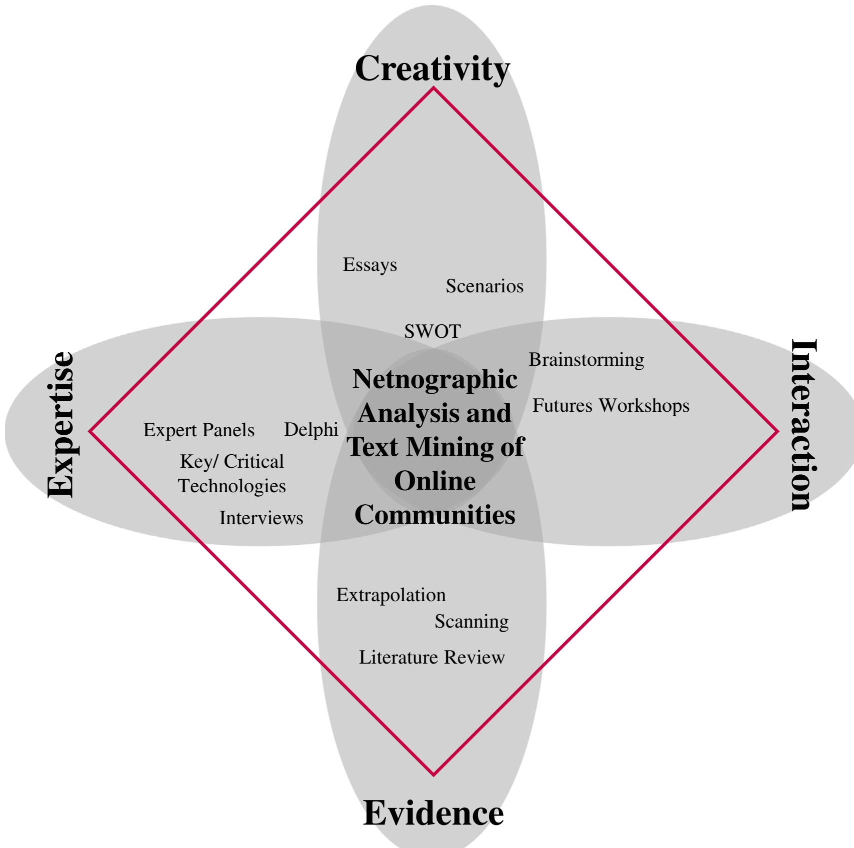

Fig. 5. Integration of netnographic analysis and text mining of OCs into Popper's (2008) foresight diamond.

approach (see Fig. 5): OCs develop *creative* concepts and scenarios with their *expert* knowledge, and elaborate these even further by *interaction* and the use of *external information material*, e.g., patents, videos, and other descriptions about components. Thus, it is shown that applying Popper's (2008) foresight diamond to OCs is one way to assess the potential contribution of OCs to foresight and OCs are useful tools for the foresight diamond which shall be added to it.

The contribution of OCs to all four dimensions of the foresight diamond also determines, in turn, the characteristics of an OC used for foresight: the study at hand implies that an OC suitable for foresight is required to follow and fulfill in parts the paths of creativity, expertise, interaction, and evidence. It can be assumed that OCs contribute more to one dimension than another. However, the data of this study did not provide any insights into this.

7.2. Managerial implications

Observing OCs by applying the developed criteria catalog leads to an additional source of information for companies' foresight processes besides their usual way of gathering information about future developments. Deriving possible trends from OCs' future concepts and user innovations and, in doing so, overcoming today's challenge of rapid change as well as being ahead of the market in comparison with competitors can be beneficial for every technology-based company. This deduction takes place as an interaction between the firm and the information provided by the OC through collective thinking and collaborative work, as suggested by the experts in the focus group interview. Based on this collected information, reliable reaction patterns (Ansoff, 1975) can be derived. This may lead to decreased risk of product failure and missed business opportunities (Bogers and West, 2012; Janzik and Herstatt, 2008).

Although their environment is not so turbulent and changes not so rapid, those findings not only account for technology-based companies but also for non-tech and low-tech firms. As described in Section 2, for almost every topic an OC exists in the Internet (Da Costa et al., 2006). Thus, also, companies operating, for example, in the field of fast moving consumer goods or toy manufacturers – such as in Janzik and Raasch's (2011) case of Playmobil – can try to identify useful OCs with the described procedure in this paper and use their knowledge for their foresight processes and, based on this, for new products.

The outlined procedure is a good starting point for companies to work closely together with OCs in the field of foresight and, in doing so, open up their foresight process. Employing the procedure of the paper, companies can identify a suitable OC for their foresight field. By extracting information from the OC about the future, they can get a glimpse into the future and some impressions of what community members discuss. Based on this first step of identifying a suitable OC and extracting information, companies are enabled to work closer together with OCs regarding future-related topics by, for example, opening and hosting an own online thread and discussing the future together with the OC. Working together with OCs regarding future-related topics allows for a more coherent and broad view on the future and the scanning of the environment is eased and widened.

The findings, as well as the outlined procedure of selecting a suitable OC for foresight, are especially important for companies' divisions which deal with the future development of the respective company, thus, foresight-related issues. The results and the procedure might also be interesting for technology and innovation managers because this study has shown that future concepts as well as incremental improvements of, and problems with, products are described in OCs. Thus, innovation managers are also able to identify improvements of their existing products. Hence, when using this procedure it seems to be especially important that the foresight and the innovation divisions work closely together in order to extract the most information and knowledge from the OCs.

Since most of the discussed future concepts and approaches in the examined OC are, rather, discussions about current problems with products and their further development, it seems that innovative and future-minded community members appear seldom in OCs. Thus, it is especially interesting for companies to identify those community members which have very future-oriented concepts, such as solar panels in space, and integrate those members in companies' foresight processes. Those community members can act as early indicators for changes and trends. This integration of future-minded members and online tools like OCs can be combined with classical foresight methods like scenario analysis or somewhat newer methods like design thinking. This cooperation with OCs can lead to multiple directions in the future.

7.3. Limitations and future research

Netnography and text mining gave us the first insights into the potential of OCs for foresight. Those insights were enriched with further insights from the focus group interview with experts. Since this study relied mainly on observations of textual statements from one OC and is explorative in nature, it has its limitations which lead to future research.

First, it is hard to generalize from one OC of one industry. Thus, interpretations within this case were necessary. Future research could investigate OCs for other market segments, products, or industries. Furthermore, other methods fitting in this context of OC observation should be applied. For example, a social network analysis could be conducted for expert findings and for the measurement of the interactions between the community members.

Second, companies have to derive trends from OCs' discussions because most of the discussions concern current problems with products, modifications of products, or reports on own projects. Nevertheless, some are interesting future concepts and companies can use them as a starting point in order to think in different directions. Moreover, community members are, therefore, discussing future developments which will be realistic at the earliest in 20 or more years. Thus, future research could focus on those very innovative and creative community members and how to integrate such community members into companies' foresight processes.

Third, since those community members' approaches are purely concepts or small own projects, it would be interesting to observe such concepts over a longer period of time in order to identify whether those future concepts lead into joint innovation initiatives or even start-ups and, finally, into innovative solutions. This would lead to an interesting study on the edge between foresight and innovation management (Rohrbeck and Schwarz, 2013; van der Duin, 2006; von der Gracht et al., 2010).

Fourth, the approach for this paper was to observe the open conversation in an OC and describe how such open conversations can be useful for companies' foresight processes similar to ongoing idea-box systems in innovation research (e.g., Björk et al., 2014). In comparison, future studies could examine survey-based collaborative foresight approaches such as Delphi studies (e.g., Förster and von der Gracht, 2014) where OCs are asked to assess different future projections. Based on this, the conditions under which an open conversational or survey-based foresight approach with OCs suits best can be determined.

Fifth, the future concepts, user innovations, and frugal approaches were assessed by renewable energies experts regarding creativity, encompassing dimensions such as originality, acceptability, or implementability. It would also be interesting to further explore how other community members would rate those future concepts. Unfortunately, the examined OC does not offer the possibility to score discussions with ratings or a reputation system. Thus, future research could investigate online reputation systems (e.g., Jeppesen and Frederiksen, 2006; Lakhani and von Hippel, 2003; Piller and Walcher, 2006) for foresight issues. This could be a starting point for incentives (Leimeister et al., 2009).

Another interesting research area might be in the field of governance of OCs (Störmer and Herstatt, 2014). How and under which conditions might it be useful for a firm to host its own OC especially for foresight? Might it be useful to run future contests on this OC and use them actively rather than passively? Or, rather, develop entire online foresight platforms (Raford, 2015) for scenario planning and discussing future developments? What about incentives for participation? Are similar incentives from open innovation research (e.g., Boudreau et al., 2011; Bullinger et al., 2010; Füller, 2006) applicable to open foresight approaches; or, in which ways do they need to be altered and changed?

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