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How to overcome barriers to business model innovation

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ABSTRACT

The transformation of the energy industry towards a more sustainable production of electricity increases the importance of distributed generation from renewable sources such as solar photovoltaic (PV). German utilities have largely failed to benefit from this development and lost 97% of the distributed PV generation market to investors from outside the electric power industry. Recent studies indicate that utilities have to react to prevent revenue erosion and loss of profits. This study identifies threats and opportunities of distributed PV generation for utilities based on a series of interviews with German utility managers. The key finding is that utilities do not perceive distributed PV as a threat to their current business models nor do they see it as a potential market for them. Relating these findings to the existing literature on transformation processes in other industries leads to the conclusion that the solution for utilities lies in changing their perspective on distributed PV. Utilities could greatly benefit if they did not treat it as just another source of electricity generation in competition with traditional sources (as they do today), but as a strategic gateway into the emerging distributed generation and service market. Distributed PV could function as a basis for further business model innovation in new growth markets such as energy efficiency and distributed storage. A modular value proposition is suggested to help utilities to turn distributed PV into an attractive opportunity.

Keywords: *Business Model Innovation, Utility, Solar Energy, Photovoltaic, Energy Transition, Renewable Energy*

1. INTRODUCTION

Distributed solar photovoltaic (PV) has become a noticeable source of electricity generation in Germany, providing 5.3% of the country's electricity in the first half of 2012 (BDEW 2012). By the end of 2011, the country had an installed PV capacity of some 25,000 megawatts, of which more than 80% is installed on buildings (BSW 2012; Akorede et al. 2010). In the German state of Bavaria, for example, 200,000 out of 2,300,000 electricity users own and operate a distributed PV system (Krägenow 2012). This means that 8.5% of electricity consumers in that region have become independent power producers. If this trend continues, it may well become a problem for the established utilities.

Utilities are by far the largest group of actors in the German electricity market, controlling about 80% of the country's generation capacity. Recent studies on utilities' business models find that the increasing share of distributed PV is a threat to the utilities' current business models (Busnelli et al. 2011; Duncan 2010; Frantzis et al. 2008; Haag et al. 2009; Klose et al. 2010; Nimmons & Taylor 2010; Schoettl & Lehmann-Ortega 2010). It is argued that increased electricity generation by private individuals leads to a decreasing demand for electricity from the utilities and, consequently, an erosion of their revenues (Frantzis et al. 2008; Schoettl & Lehmann-Ortega 2010). There is consensus among authors that utilities need to react and adapt their business models to the current challenges. To date, however, it is far from clear what successful future utility business models for distributed PV could look like (Graham et al. 2008; Richter 2012).

It is important to better understand the role of the utilities in the energy transition for various reasons. From the utility perspective, the increasing share of distributed PV may become a strategic challenge. From a societal perspective, the behavior of the utilities will be decisive for the success of the energy transition. Research must therefore answer the question of *what barriers to business model innovation do German utilities face in the field of distributed PV generation and how these barriers can be overcome?*

The present study identifies opportunities and threats of distributed PV from the perspective of the utilities. Moreover, it reveals utilities' barriers to business model innovation in the field of distributed PV. The results were derived from a series of interviews with German utility managers. A key finding is that the managers are - on average - not very excited about distributed PV generation: They do not perceive it as a threat to their utilities' current business model, nor do they see it as a new business opportunity for their companies. This result contradicts the conclusions of recent studies on utilities' business models. It thus raises the question whether researchers are overestimating the importance of distributed PV or whether the utilities are underestimating the threat to their business model.

The existing literature on disruptive technologies and transition processes in other industries indicates that neglecting emerging technologies such as PV could harm the utilities in the long run (Christensen & Bower 1996; Chesbrough & Rosenbloom 2002). The conclusion of this study is that the solution for utilities lies in changing their perspective on distributed PV. Utilities could greatly benefit if they did not treat distributed PV generation as merely another source of electricity generation in competition with traditional sources (as they do today), but as a strategic gateway into the emerging distributed generation and service market.

The study is organized as follows. Section 2 provides some background to the topic and reviews the different strands of the published literature, thus laying the ground for the analytical and theoretical framework of this study. Section 3 describes the methodology and the data sources. Section 4 displays the results of the in-depth interviews with German utility managers, and discusses them in section 5. Section 6, finally, gives a brief summary and concludes.

2. BACKGROUND

2.1 Distributed PV generation

Distributed electricity generation is gaining increasing interest in current research and practice (Akorede et al. 2010). The Institute of Electrical and Electronics Engineers (IEEE) defines distributed generation as the generation of electricity in facilities that are sufficiently smaller than central generating plants and thus allow interconnection at nearly any point in the power system (Dondi et al. 2002). Ackermann et al. (2001) define a distributed generation source as an electric power generation source connected directly to the distribution network or to the customer side of the meter. The feature common to all definitions of distributed generation is the generation of power in small-scale generation units close to the point of consumption (Pepermans et al. 2005). The main technology for distributed generation from renewable sources is PV (Onovwiona & Ugursal 2006). What is, therefore, understood as distributed generation in this study is electricity generation from PV in residential or small and medium-sized commercial environments.

2.2 The business model concept

The increasing challenges posed by the energy transition have started a debate about utilities' business models for renewable energies (Duncan 2010). A business model can be understood as a structural template that describes a firm's organizational and financial architecture (Chesbrough & Rosenbloom 2002). Teece (2010) explains that the essence of a business model lies in defining the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit. Osterwalder and Pigneur (2009: p.14) define a business model as *"the rationale of how an organization creates, delivers, and captures value"*. A review of the literature shows that many authors favor a conceptualization based on four elements (Osterwalder & Pigneur 2009; Ballon 2007; Johnson 2010): the value proposition, the customer interface, the infrastructure, and the revenue model:

Value proposition:	refers to the bundle of products and services that creates value for the customer and allows the company to earn revenue;
Customer interface:	comprises the overall interaction with the customer. It consists of customer relationship, customer segments, and distribution channels;
Infrastructure:	describes the architecture of the company's value creation process. It includes assets, know-how, and partnerships; and
Revenue model:	represents the relationship between costs to produce the value proposition and the revenues that are generated by offering the value proposition to customers.

Researchers find the business model concept to be a valuable new tool for analysis and management in research and practice (Zott & Amit 2008). In terms of analysis, the concept enables the examination and comparison of companies and markets in a structured way (Boehnke 2008). In addition, using the business model as a classifying device to build generic categories helps to understand business phenomena (Baden-Fuller & Morgan 2010). As a management tool, the business model helps managers to design, implement, operate, change, and control their business (Wirtz et al. 2010). Business models can also function as blueprints suitable to be copied or be used for further improvement through innovation (Baden-Fuller & Morgan 2010).

2.3 The German energy market and PV

The German electric power market is currently in a major transition process towards a more sustainable production based on renewable energy technologies (the so called "Energiewende"). In 2010, the German federal government decided to have 80% of the country's electricity produced from renewable sources by 2050 (BMWI & BMU 2010). In addition, last year's decision to phase out nuclear energy in Germany by 2022 increases the need to replace existing electricity generation capacities through renewable energy technologies.

In the first half of 2012, Germany had produced 25% of its electricity from renewable sources. PV accounted for 5.3% of the total electricity supply (BDEW 2012). Until (very) recently, electricity generation had almost exclusively been the domain of the utilities. This is now dramatically changing with the increasing share of renewable energies. Today, the largest share of the renewable generation capacity installed in Germany is owned and operated by private investors like farmers, project development companies, investment funds, and private individuals, while the utilities own only 13.5% of the overall renewable generation capacity (Trendresearch 2011). The lowest involvement of utilities can be observed in the field of PV where utilities own and operate only 3% of the installed capacity (Trendresearch 2011). The vast majority of small and medium-sized PV systems (< 500 kilowatt) is owned by private individuals (41,8%), farmers (22,5%) and small and medium-sized enterprises (20,3%). To put it in other words: Utilities have already lost 97% of the PV electricity generation market.

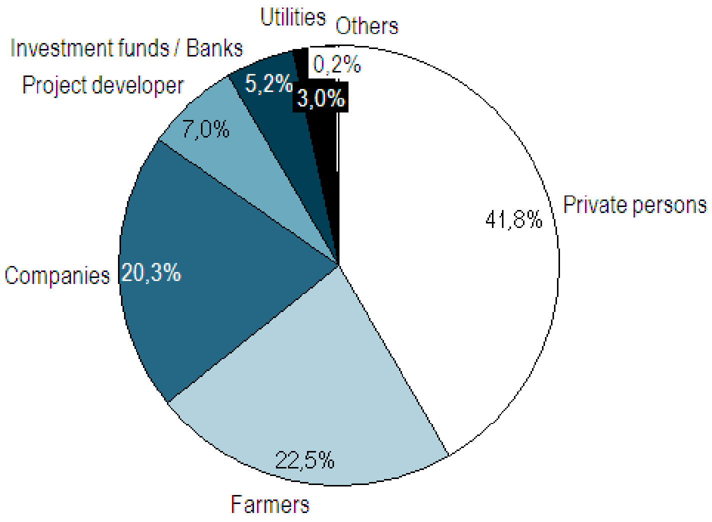

Figure 1: Ownerships structure of PV systems in Germany*

* Ownership of PV systems (<500 Kilowatts) in Germany (per end of 2010)
(Source: Trendresearch 2011, 24)

The legal framework for tariffs in the electricity generation from renewable sources in Germany is provided by the Renewable Energy Sources Act ("Erneuerbare Energien Gesetz"). In recent years this generation was exclusively remunerated using a fixed feed-in tariff per kilowatt hour fed into the grid. Technically speaking, German utilities have not lost revenues from electricity sales due to distributed PV generation in Germany so far. This is because the owners have not used the electricity directly for their own consumption, but fed it into the grid to obtain the feed-in tariff. However, the regulations of the Renewable Energy Sources Act increasingly encourage the direct use of electricity from PV. This means that incentives are provided to use the electricity directly close to where it is produced. Excess electricity can still be fed into the grid, and excess demand that cannot be met by the owners' PV system can be supplied from the grid. The increasing share of direct use reduces the electricity demand from the grid, i.e. from the utilities and consequently leads to lower revenues per customer for the utilities.

2.4 Utilities' business models for distributed PV

The academic debate on utilities' business models for renewable energy is mainly focused on PV (Duncan 2010; Frantzis et al. 2008; Schoettl & Lehmann-Ortega 2010; Nimmons & Taylor 2010; Lüdeke-Freund & Loock 2011). Researchers argue that the current way of using PV constitutes a threat to the utility business model, because *"the organizational structure of today's utilities does not facilitate the adoption of the new business models"* (Frantzis et al. 2008, p.80). This is a problem for utilities because the environment in the electric power sector witnesses increasingly accelerated change. Old traditional value propositions are becoming less important, while a space for new value propositions and business models is opening up through new technologies and regulations.

Utilities have traditionally covered the complete electric power value chain from power generation through transmission to distribution (Valocchi et al. 2010). Distributed PV generation is located on the consumption side of this chain, constituting a new market that has not been covered by the utilities so far: To date, utilities have practically no value proposition for this segment of the value chain.

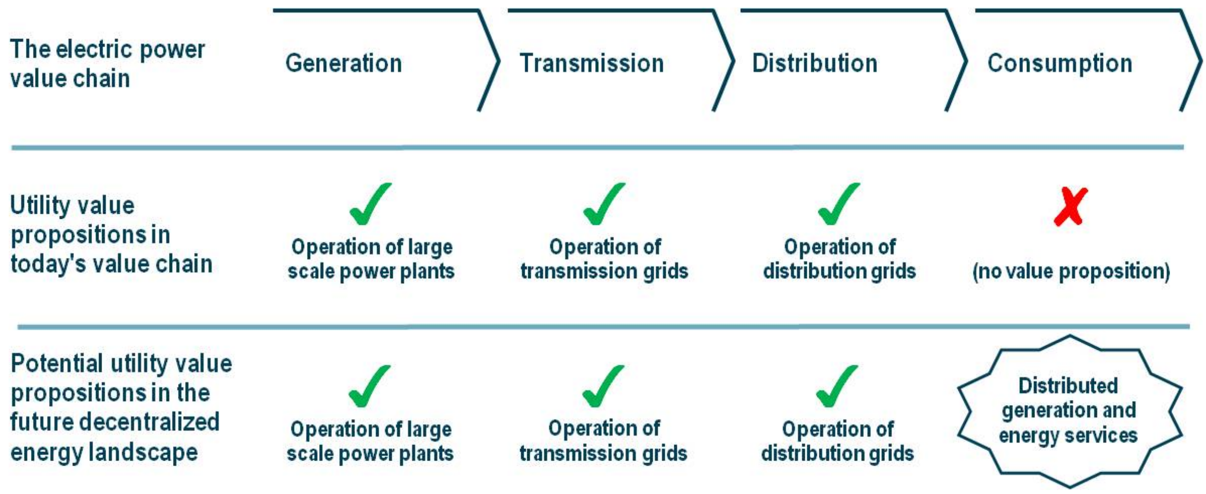

Figure 2: Utilities' value propositions in the electric power value chain

Research on commercializing new technologies underlines the fact that the economic, environmental and social value of technological innovation remains latent until the technology is successfully commercialized through a business model (Chesbrough 2010; Johnson & Suskewicz 2009; Gordijin & Akkermans 2007). The central question for utilities is, thus, how they can develop profitable business models for this emerging segment in order to turn the threat from increasing shares of distributed PV generation into an opportunity (Schoettl & Lehmann-Ortega 2010; Taylor 2009).

2.5 Business model innovation

Business model innovation as a term remains largely unspecified in the current academic literature although first attempts have been made to provide a theoretical grounding. Thus, Sosna et al. (2010) understand business model innovation as a strategic renewal mechanism for organizations facing changes in their external environment. Following this understanding, the present study defines business model innovation as the *development of new organizational forms for the creation, delivery, and capture of value.*

Chesbrough (2010) relates business model innovation to classical innovation research to identify opportunities of and barriers to business model innovation. This approach appears very helpful for the purpose of this study, because innovation research has been concerned with the consequences of radical technological changes for incumbent firms in various industries. The research on disruptive innovation (Bower & Christensen 1995; Christensen 2006) and the theory of organizational ambidexterity (Raisch et al. 2009; Tushman &

Andersen 1986; Tushman & O'Reilly 1996) were found to contribute to the understanding of the fundamental changes in the electric power industry.

Disruptive, as opposed to sustaining, technological changes describe innovations that disrupt the established trajectory of performance improvement. The new technologies follow a different logic of performance redefining the meaning of performance in the process. Thus, disruptive innovations often destroy the value of existing competencies (Tushman & Andersen 1986). A major characteristic of disruptive technologies is that they are rarely directly employed in established markets. They change the architecture of the market in the medium and long term (Christensen & Bower 1996). In contrast, sustaining technological changes -- the majority of technological innovations -- are innovations that maintain the existing performance logic. As the term suggests, they are basically improvements on an existing system or technology. The theory of disruptive and sustaining technological change will be applied to analyze the opportunities and threats of distributed PV for utilities.

The theory of organizational ambidexterity, on the other hand, claims that organizations are successful in the long term if they are able both to exploit their existing capabilities and develop new competencies at the same time (Raisch et al. 2009; Tushman & O'Reilly 1996). O'Reilly and Tushman (2004) describe ambidexterity as a mental balancing act for managers of maintaining the current core business while developing radically new products and services for the future of the firm. Evidence suggests that successful incumbent companies often struggle to develop new competencies to master disruptive technological changes (Christensen & Bower 1996). Thus, this theory will be applied to investigate the barriers to business model innovation for distributed PV.

3. METHODOLOGY

The study is based on a series of interviews with German utility managers to identify their perspective on the opportunities and threats of PV for the utilities' business models. An explorative qualitative research strategy was applied for this study because research in this field is still at an early stage (Silverman 2009). The data was derived from a series of 20 semi-structured interviews with representatives of 18 German utilities. Germany was chosen because the country is the world's largest market for PV. Thus, opportunities for and threats to utilities arising from an increase in the market share of distributed PV should be observable here first.

Table 1: List of interviewed German utilities

Category (Revenues in m€)	Interviewed utilities	Revenues (in m€)
1. Multinational Utilities (> €10,000m)	E.ON AG	79,974
	RWE AG	47,741
	Vattenfall AB	20,036
	EnBW Energie Baden-Württemberg AG	15,564
2. Regional Utilities (€10,000m - €1,000m)	EWE AG	5,798
	Stadtwerke München GmbH	4,900
	Stadtwerke Düsseldorf AG	1,918
	Mainova AG	1,611
3. Large Local Utilities (€999m - €100m)	Stadtwerke Karlsruhe GmbH	997
	HEAG Südhessische Energie AG Stadtwerke	603
	Aachen AG	419
	Elektrizitätswerke Mittelbaden GmbH	202
	Stadtwerke Tübingen GmbH	155
4. Small Local Utilities (< €100m)	Stadtwerke Uelzen GmbH	100
	GWS Stadtwerke Hameln GmbH	82
	Technische Werke Schussental GmbH	70
	Stadtwerke Munster-Bispingen GmbH	26
	Hamburg Energie GmbH	n.a.

The sample selection was done by theoretical sampling (Eisenhardt & Graebner 2007): From the roughly 800 utilities active on the German market, four categories were selected based on the size and scope of the utilities. Their size was defined in terms of annual revenues, their scope of activity with regard to the utilities' activities in the field of renewable energy. The four categories are in line with the view of most practitioners in the industry. As the adopted qualitative research approach does not allow deriving statistically relevant information on the subject, the selection of the utilities within in the four categories focused on the most relevant companies from the point of view of their renewable energy engagement. The utilities were identified through internet research and the consultation of industry experts from utilities, industry associations, and consulting. This was done to cover as many different utility business models as possible (Yin 2003).

The data collected comprises 20 in-depth interviews with representatives of 18 German utilities. The participants were directors, department heads, and senior managers, mainly from a company’s renewable energy or the business development department. It should be noted that all interviewees were involved in their company's renewable energy activities and thus had practical experience with the topic. All participants were provided with a semi-structured questionnaire before the interviews, which were partly conducted face to face and partly via telephone. Interview length ranged from 45 to 90 minutes, with the interviews being tape-recorded and subsequently transcribed into written protocols. As the interviews were conducted in German, all quotes in this study are translations by the author. Because the participants asked to remain anonymous, the quotes in the results section are given without the respective company’s name.

Data analysis of the transcripts proceeded in two steps: First, the answers were put into two groups according to whether they referred to opportunities or barriers. This helped not only to organize the data but also to get an overview of the variety of results. Second, the answers in the two main categories were clustered under different headings in order to distill the most important issues in each category.

4. RESULTS

This section presents the findings from the interview series with the German utility managers about distributed PV generation. The first part lists opportunities and threats of distributed PV from the perspective of the utilities, the second details barriers to business model innovation.

4.1 Distributed PV for utilities: opportunities and threats

Opportunities

The identified opportunities of distributed PV for utilities comprise growth potential in a quickly expanding market, benefits from long-term customer relationships, and positive effects for stakeholder management. However, the interview results provide a wide spectrum of opinions: The majority of interviewed managers sees practically no business opportunities for utilities in the field of distributed PV. Only few managers identified distributed PV as an important field with opportunities for future business.

A manager of a leading German utility was convinced that there is a huge market with a volume of several billion Euros for distributed PV generation already today:

> *"Just consider the 7,400 megawatt of PV capacity installed in 2010. And PV is just one technology. The market is huge and will further increase in importance".*

For him the question was merely which companies will address the emerging PV generation market:

> *"The future energy landscape will be much more decentralized, and distributed residential generation will play a much more important role, regardless of what we do. Therefore, we want to offer products and services to benefit from this development. Either we will do it, or others will do it."*

He further elaborated that distributed PV technology is at a comparatively mature stage and has been commercialized on an increasing scale in recent years. He argued that the market volume in the field of distributed PV generation is harvested by private investors and companies from outside the electric power sector. Thus, a huge market potential is not seized adequately by the utilities. He explained his utility’s approach in these words:

> *"Today we are not offering any products or services in the field of distributed generation. As we see this as an increasingly important market, we think about offering our customers a range of products and services for residential generation. We intend to offer a broad set of technologies such as PV, micro CHP, heat pumps, and micro wind turbines. Only, so far we have not found a good way of how to do it. We will start to offer consulting services to our customers just to get a foot in the door of the market."*

Thus, this manager saw distributed PV as a new market for utilities, which offers exciting new opportunities for growth, if adequately addressed. However, his view is shared by only very few of the other managers.

Another manager, this time from a municipal utility, drew attention to another opportunity from distributed PV. His utility installs PV systems on roofs of small and medium-sized corporate customers and has gained positive experiences concerning the customer relationship:

> *"I do not force a contract on the customer [of the PV system] to buy my electricity, but usually he does for as long as we have the PV system on his roof. Even if we are a bit more expensive than others, he is also interested in a good relationship with us."*

The interviews revealed that a great deal of value of customer-side business models comes from a long-term relationship with the customer. As competition among utilities increases and customers become more critical and willing to switch their supplier for reasons of sustainable production, managers are increasingly concerned about their "green image" and customer relationships. Thus, a third manager, who works for a major German utility, explicitly stated: "We see it as a form of customer-relationship management." His experience supports the view of the municipal utility manager: A long term contract for distributed PV generation prevents customers from lightly switching their supplier. Distributed PV generation, then, can help utilities to keep existing customers or attract new ones which can be offered further products and services. This would clearly be a good way for utilities to capture additional value from customer-side value propositions.

A third opportunity for utilities is the improvement of stakeholder relationships. Distributed PV allows addressing important stakeholders, such as communities and the neighbors of renewable energy plants. The interviewees confirmed that public acceptance of renewable energy becomes increasingly vital for the utilities' future operations. The German energy transition with the goal of producing 80% of the nation's electricity needs from renewable energy sources by 2050 (BMWI & BMU 2010) will require a substantial increase of installations. Experience shows that new renewable energy projects or high voltage lines often face strong resistance from the local population. Although the German public generally supports the energy transition, most people favor not to have renewable energy plants close to their home. They display the classical "not in my backyard" attitude ("NIMBY"). One manager of a small local utility pondered:

> *"What if people oppose our investments in wind farms or biomass plants in the region? Such discussions can increase resistance against projects and ultimately result in a danger to our business."*

Experience from the wind energy sector shows that including affected stakeholder in the planning process and ideally in the project itself can help to reduce opposition. This has proven to be helpful in northern Germany where neighbors have often been offered stakes in wind farms. Another manager of a municipal utility explained that his PV activity is driven by political ideas rather than business "We do it to demonstrate political goodwill and offer our customers an attractive opportunity to invest in solar energy." Thus, distributed PV generation is a means to increase public acceptance of the energy transition, because utilities and customers share the benefits of the new technology.

Threats

While most managers did not see distributed PV as an opportunity, the majority neither did perceive PV as a threat to the utilities' current business models. While some acknowledged the growing importance of distributed PV only two out of 20 interviewed managers see distributed PV generation as a threat to their utility's current business model. Thus, a manager of a large municipal utility uttered his concerns in this way:

> *"A severe threat to utilities is arising. There will be major changes in the housing infrastructure and this will have a major impact on our business model. We see the first major impact in the market for heating energy. Zero-energy homes are available and there will also be plus-energy homes in the future. We see that in areas where new houses are built, heating energy demand is significantly lower than in areas with older houses. There is a threat that, for example, district heating infrastructure will not be profitable anymore, because houses do not use enough energy for us to be able to maintain the grid in an economically sustainable way. This is a slow process, but it will have major effects on the utilities in the long run. Similar problems might soon occur in the field of electricity generation as well."*

The second manager, from one of the large German utilities, added in the same vein:
"We do not exactly know about the effect on the electricity supply yet, but in the field of energy for heating we expect the demand for gas to decrease between 20 and 33% by 2020."
Both managers agreed that the increasing use of distributed renewable technologies leads to structural changes in the energy industry that will negatively affect utilities. Their arguments are in line with the conclusions of recent studies on utilities' business models for PV (Duncan 2010; Frantzis et al. 2008; Schoettl & Lehmann-Ortega 2010).

Surprisingly, the vast majority of interviewed utility managers actually opposed this view and did not perceive distributed PV generation as a threat to their utility's current business model. This is even more surprising as all interviewed managers were involved in the renewable energy activities of their companies. Many interviewees acknowledged the growing importance of distributed PV generation, but did not expect distributed PV generation to be a threat to the existing business model of their utility. One manager thought that "distributed PV generation will increase in importance", but "small-scale generation will remain a niche market. The largest amount of electricity will be generated in large power plants." Another manager summarized the view of the majority:

> *"We would not support the hypothesis that distributed PV generation is a threat to our business model. Overall, customer-side PV generation will not play an important role in the electric power market, because the projects are too small and too fragmented to contribute significantly to electricity production."*

The main reasons for this view were the small size of the generation units and the high production costs. PV was generally not seen as a full-fledged source of electricity that moves towards price competitiveness, but as a source that is heavily dependent on current feed-in tariffs:

> *"Distributed PV generation will remain a niche market, because the feed-in tariff for PV is likely to be reduced further and it will not be financially attractive anymore. We don't see a trend towards distributed PV generation."*

A manager for one of the largest German utilities concluded:

> *"We see this as a question of technology. If PV becomes as cheap as or even cheaper than conventional energy sources, a market will develop naturally. But today we do not see that PV is able to deliver that. Therefore, we do not see any threat from distributed PV generation."*

Market view of the practitioners

The opportunities identified for utilities in the distributed PV market comprise growth potential in a quickly expanding market, benefits from long-time customer relationships, and positive effects for stakeholder management. However, the interview results provide a wide spectrum of opinions: while some interviewees expected attractive new business opportunities from a growing new market, the majority acknowledged the increasing importance of PV, but nevertheless neglected business opportunities for utilities in this market.

The picture is even clearer concerning a potential threat to the utility business model from distributed PV. While two out of 20 managers expected a strong impact on utilities' business operations, the other 18 thought that distributed PV would remain a "niche technology" without much effect on the overall electricity production. Consequently, they did not see distributed PV as a major issue that needed to be considered in the utilities' strategies.

Overall, the managers regarded the distributed PV market without much excitement, because they did not expect this market to be of much economic relevance to their companies. However, recent studies on the utilities' business models for PV identified a threat to the utilities' current way of doing business (Frantzis et al. 2008; Schoettl & Lehmann-Ortega 2010; Nimmons & Taylor 2008; Taylor 2009). Moreover, experience from other industry transformation processes shows that established companies often underestimate the disruptive effect when new technologies enter a market (Christensen & Bower 1996; Tushman & Andersen 1986). Hence, there are indications that utilities may miss an important development, which makes it worthwhile to further investigate this issue.

4.2 Barriers to business model innovation for distributed PV

Four main challenges for distributed PV generation can be distilled from the interviews: (i) lack of products and services, (ii) lack of customer demand, (iii) lack of competences, and (iv) lack of profitability.

Lack of products and services

The interviews show a clear result: The utilities struggle to offer attractive and economically sustainable products and services in the field of distributed PV generation. There are utilities that already provide products or services for distributed PV: Several make available consulting services to assist their customers to install a PV system, others provide direct investment grants, and three utilities even offer a full "rent-a-roof-package" in which the utility installs and operates a PV system on the customer's building and pays a rent for the roof (two offer this service only to corporate customers, while one also delivers it to private customers). This can lead to paradoxical situations for the utilities: consulting services and investment grants help customers to become more energy independent or to consume less electricity, which eventually results in lower revenues for the utility that can usually not be compensated with the one-time income from the consulting service.

The manager of the one utility that offers the full rent-a-roof package to private house owners stated:

> *"We see this as a form of customer relationship management. We clearly do not want to expand this model and offer it on a broad scale. We just have it in case somebody asks for it."*

The manager of another major German utility who currently works on developing a distributed PV generation business model for his company explained:

> *"The main problem is to develop a product or service that offers sufficient value to the customer to be attractive, but at the same time generates sufficient value to be profitable for the utility."*

The interviews clearly reveal that utilities cannot yet answer the question what products and services to offer that will be profitable. The manager who had been developing a distributed PV business model for his utility admitted: *"I have been working on this for two years now and so far I haven't found a satisfactory solution."*

The existing literature can help to analyze and understand barriers to business model innovation. The general challenge for incumbent companies to cope with new technologies in the market has been studied in other industries, such as the disc drive industry, the newspaper industry, or the photo industry (Christensen & Bower 1996; Chesbrough 2010; O'Reilly & Tushman 2004). A new technology is considered a disruptive innovation when it changes an existing market or value network by offering a totally new solution or a technology that eventually displaces the existing solution or technologies in the long run (Raisch & Tushman 2011). Distributed PV can be considered a disruptive technology for utilities, because it comprises very different characteristics of value creation from conventional large-scale power technologies.

Organizations can be successful in the long term, according to the theory of organizational ambidexterity, only if they manage to exploit their current business while developing new competencies and new business at the same time (Raisch et al. 2009; Sosna et al. 2010; Tushman & O'Reilly 1996). Such a challenge may currently arise for utilities in the field of distributed PV generation. The traditional utility value proposition is the production and delivery of electricity for a fixed price per unit. As electricity is a commodity good, competition focuses mainly on its price, which is the reason that the utilities' main focus is on economies of scale in order to reduce production costs. However, electricity generation from distributed PV is not (yet) cost-competitive with large-scale power plants. To develop an economically sound business model for distributed PV, utilities would have to offer new products and services beyond the mere delivery of electricity for a fixed price per kilowatt hour (Schaltegger et al. 2012). Different approaches have been suggested in recent studies, such as the sale and delivery of hardware, installation services, operation and maintenance services, financing options, and consulting services (Klose et al. 2010). By not developing new value propositions for distributed PV, utilities currently fail to reach organizational ambidexterity.

How can this failure be accounted for? Chesbrough and Rosenbloom (2002) found that it are cognitive barriers that often create a strong hurdle for business model innovation, because subjective judgments strongly influence the information that is used for corporate decisions. A cognitive barrier is defined as the mental inability of humans to use information objectively. O'Reilly and Tushman (2004) add that the ability of executives and senior staff to understand the needs of very different businesses is the most crucial element if company success is to be realized at two frontiers at the same time. The interview results suggest that cognitive barriers are also a problem in developing new products and services for distributed PV generation. It was found that the interviewed managers still applied the old measures of success (i.e. economies of scale/ production costs per unit) to the new field of business. To repeat a quote mentioned above:

> *"We see this as a question of technology. If PV becomes as cheap as or even cheaper than conventional energy sources a market will develop naturally. But today we do not see PV to be able to deliver that. Therefore, we do not see any threat from distributed PV generation."*

The traditional business model of utilities still seems to dominate the view of most managers interviewed. Distributed PV is compared to large-scale renewable energy and conventional energy sources in terms of production costs per unit. From this perspective (production costs), PV looks the least attractive form of electricity generation among current alternatives. This cognitive barrier makes it difficult to develop new products and services for distributed PV that go beyond the delivery of electricity for a fixed price per unit. The challenge is rather to identify new value contributions of distributed PV and exploit them through new business models. Distributed PV is less a question of technology (as stated by an interviewee) for utilities than a matter of new organizational forms to exploit the new technology, i.e. of new business models. In summary, understanding and reducing current cognitive barriers is a valuable first step towards the development of new products and services for distributed PV.

Lack of demand

Several managers see no need for utilities to become active, as long as - in their perception - customers do not demand utility activity in distributed PV generation. One manager reported from his experience with a full-service offering for residential heating. His utility started to offer heating systems on a full service contracting basis, only to find that customer demand turned out to be limited. In his view, the limited interest arises from customers' resistance to enter into long-term contracts with their energy supplier. Another reason was, he claimed, that operating costs are too high when an external service provider is involved, and he foresaw the same problem for electricity generation from distributed PV.

Another manager elaborated that the utility is actually in competition with the customer as a private investor. He explained that as a rule it is economically more attractive for home owners to buy and operate the PV system themselves, because

> *"private investors usually accept lower rates of return than utilities, because return is not the only decision criterion for private investors, especially when they invest in their own home. Private investors only look at investment costs. They usually do not include in their calculations of costs their own time, which increases their rate of return. We as utility cannot do things like that. For us, project development costs are also costs".*

Several larger utilities offer contracting services to corporate customers. This means that the utility installs and operates an electricity generation system at the customer's site and directly provides the customer with electricity from the installed system. This has proven to be a successful business model which has been expanding in recent years. According to one interviewee (the head of a regional utility's contracting division), contracting service models are usually not attractive to private home owners, because operating costs are too high for small-scale generation systems at private customers' sites. Private home owners would prefer not to enter into an expensive service contract with their utility. Therefore, the executive expected no customer demand for maintenance or contracting services for distributed PV.

To sum up, in the eyes of most managers there is no sufficient customer demand to justify the development and establishment of a distributed PV business model, as is well expressed in this statement:

> *"Customers don't want to enter into long term contracts with their energy supplier. Most people that are able to finance a building prefer to finance the investment and earn the return of a distributed PV system themselves."*

Evidently, customer demand is a precondition for successfully selling products and services in the market, but it should not have the same importance when it is a matter of introducing innovative products. Bower and Christensen (1995) found out that incumbent firms often fail to bring new technologies to the market because they listen to their customers too much. The authors argue that customers usually show little interest in disruptive technologies that do not directly address their current main need within the given environment. They also claim that the average customer is not able to see the potential benefit of a totally new product before it has come on the market, and that customers do not demand radical innovation, but improvement of existing value propositions. So, radically new products and services cannot be developed based on customer surveys or market research, but require brave decisions by management.

We find a similar situation in the field of distributed PV. So far, customers have not asked their utility to supply them with a PV system, because they are familiar only with the existing supply structures in the market which work without the utilities. When installing a distributed PV system, the utility is currently only needed to connect the PV system to the grid. Hence, customers see no need for any further involvement of the utility. If utilities wanted to enter the distributed PV market, they would have to introduce new offers to the market and convince customers of their products and services. They either need to solve problems better than the companies currently serving this market, or they need to create a new demand. In either case, a pro-active rather than a re-active approach would be required to enter the distributed PV market.

Lack of competencies

The traditional business model of utilities is focused on electricity generation in large-scale power plants as well as on distribution and retail. In recent years, contracting solutions for corporate customers have evolved as a market in which several utilities have made offers. A few have established a separate venture to develop a contracting business model. Still, these experiences obviously can inspire business models for distributed PV generation only to a very limited extent. As a manager explained:

> *"The experiences from contracting [for corporate customers] cannot easily be transferred to private customers, because the value proposition of contracting solutions depends on the size of the generation system. The value proposition of contracting has two main characteristics: first, energy is produced directly at the point of consumption. Second, the energy system is tailored directly to the needs of the customer and thus allows an economic advantage compared to a standard supply contract. This advantage can be shared between the customer and the provider. Hence, contracting is profitable when the economic advantage from the tailored system is higher than the cost for the adaption of the energy system. Because of the small investment volumes of distributed PV, the advantages from the individualized system do not cover the effort to develop, install, and operate such a system."*

Various studies have suggested potential new products and services for utilities: sale and delivery of hardware, installation services, operation and maintenance services, financing options, and consulting services (Duncan 2010; Haag et al. 2009; Klose et al. 2010). None of these options has convinced managers that they constitute a potential path to enter the market:

> *"Distributed PV projects are outside of our core competency. There are others who are well established in this field. For example: installation services are performed by local handicraft enterprises. Favorable financing conditions are offered by public*

business development banks. Operation is usually not very comprehensive and is performed by the manufacturer of the PV system."

Hence, the market for distributed PV generation is already occupied by other actors and several managers asked themselves what utilities would have to offer in this market. Many did not see how utilities can contribute at this front. They rather saw their core competency in managing large-scale energy investment projects.

For decades the utilities' business model was very stable. Utilities have concentrated on realizing production cost reductions through economies of scale (Valocchi et al. 2010). There was no need develop new fields of business. Consequently, change and business model innovation are not part of their "corporate DNA". Christensen and Bower (1996) conclude that the primary reason why incumbent firms fail to maintain their leading positions in radically changing environments is their inability to allocate sufficient resources to new technologies that initially cannot find application in the mass market but later invades them. Utilities may currently be in danger of missing the chance to build up competencies for distributed renewable generation. Thus, they could fail to reach ambidexterity and secure competitiveness for future developments. So there is not only a lack of products, but also a lack of competences: it is cognitive barriers and the inability to allocate sufficient resources to the new technology that endanger the company's future competitiveness when the market environment changes towards a more distributed energy system. Applied to this context, the theory of ambidexterity suggests that utilities need to further exploit their core business of operating large-scale power plants, but at the same time they also need to explore new competencies in the field of distributed electricity generation and distributed asset management.

Lack of profitability

The majority of interviewed managers did not see distributed PV generation as an attractive future market for utilities, because in their opinion the technology lacks sufficient return potential. According to the managers, the lack of profitability has two main reasons: generation costs and project size.

The costs of electricity production in distributed PV systems are significantly higher than the production costs of conventional power sources or large-scale renewable energy projects. As the manager of a large German utility explained:

"The problem is that we cannot realize economies of scale. When size cannot create cost reductions, they have to be realized through increased efficiency of the technology. […] It is possible that major advances in the PV technology open a new market, but we do not expect this at the moment."

There is a debate about which price level has to be reached to make PV economically attractive. While solar proponents argue that production costs of electricity from distributed PV need to reach a level below the electricity wholesale price ("grid parity") to make customer-side generation economically attractive, others argue that the costs need to be much lower, because costs for grids, storage and taxes would also have to be included. In the opinion of one of the managers:

> *"If small-scale systems became economically competitive to centralized production, this would totally change the game for utilities. This would require a radically different utility business model. But in the case of PV we would see this in other countries like Spain or Italy with higher solar radiation before the level is reached in Germany."*

He therefore concluded that no action need to be taken by German utilities. Moreover, he questioned the overall economic viability of PV in Germany:

> *"At current levels of production costs of distributed PV it is questionable if PV can be profitable at all without massive subsidies. With subsidies everything can become profitable for an investor. But you have to ask if that makes sense for society as a whole."*

The second problem is the small size of the individual projects. *"Investment volumes per installed system are too small to allow a sufficient profit"* for the utility. The interviewed managers argued that the revenues of distributed renewable systems are too small and too fragmented to be able to contribute significantly to the earnings of a company. *"You just can't earn money with that."* It was argued that, even if the rate of return on an individual PV project were sufficient, the small investment volume would create a problem, because the return in absolute terms would be too low to cover the effort:

> *"For example, if you install and operate a PV system on a residential house, you may achieve a return of let's say 10%. That is a good rate of return. But when the investment volume is only 10,000 Euros, you earn no more than 1,000 Euros in absolute terms. That is not enough for a utility."*

Compared to other opportunities, this small-scale business does not appear attractive to the managers. One manager responsible for the renewable energy investments of his utility said:

> *"I have to invest some hundred million Euros into renewable energy in the next years. So, I need large projects, otherwise I can't do it."*

The lack of profitability is arguably the main barrier to commercializing distributed PV generation. Existing research on innovation and commercialization of new technologies shows that new technologies usually have a disadvantage in terms of costs compared to more mature and established technologies (Christensen et al. 2011).The direct comparison of costs per kilowatt hour from distributed PV to those per kilowatt hour from conventional power sources or large-scale renewable energy plants thus shows a massive disadvantage for PV in terms of generation costs. In a recent study Christensen et al. (2011) addressed the problem of direct competition of generation costs between cleantech technologies and established generation technologies. To overcome the cost barrier, the paper suggests, companies should address markets that are not yet served with the established technology. In the case of distributed PV, this would mean addressing customers which are not yet consumers of electricity, e.g. in rural areas where the alternative is to use an expensive fuel generator or to install a grid connection. However, this approach is no solution for established markets like the U.S., Germany or other European countries where almost every consumer has a connection to the grid. Christensen et al. (2011, p.32) therefore conclude:

> *"Even with significant government subsidies to encourage adoption, the percentage of total electricity derived from wind and solar in the United States remains tiny, illustrating the barriers these technologies face to displacing the existing grid"*

If cost per kilowatt hour were the only decision criteria, there would be no market for PV in developed countries like the US or the European nations. However, the basic idea – the avoidance of direct competition with established technologies – remains valid and offers a starting point for business model innovation in developed markets as well.

5. DISCUSSION

Recent studies of utilities' business models find that the increase in the market share of distributed PV creates a threat to the utilities' current business models (Duncan 2010; Frantzis et al. 2008; Schoettl & Lehmann-Ortega 2010; Nimmons & Taylor 2008). Market data from Germany has underlined this finding by showing that utilities have already lost 97% of the distributed PV generation market to investors from outside of the electric power industry. At the same time, the present investigation has revealed that German utility managers neither perceive distributed PV as a threat to their utility's business model nor do they see distributed PV as a new business opportunity. Given the fact that Germany is the world's largest PV market with more than 25 gigawatts of installed PV capacity, this is a surprising result. It raises the question whether it is the researchers who are overestimating the importance of distributed PV, or the utilities who are underestimating the threat to their business model.

Relating the result from the interviews to the existing literature on disruptive innovation and organizational ambidexterity, however, indicates that utilities may currently be missing out on a chance to adapt their business models to the increasing importance of distributed PV and other distributed sources of electricity generation. Four main barriers to business model innovation for distributed PV generation have been distilled from the interviews: lack of products and services, lack of customer demand, lack of core competencies, and lack of profitability. The research so far suggests that many of the problems have occurred in other industries in similar ways. Incumbent companies usually underestimate the disruptive power of new technologies and eventually struggle to adapt their business models to new technologies before they disrupt the conventional way of doing business in an industry (Christensen & Bower 1996). In the case of distributed PV, this study has shown that German utilities do not follow established rules of innovation management, although they could greatly benefit from making use of the relevant experience. Therefore, the insights obtained indicate that German utilities are currently foregoing a valuable opportunity to pro-actively prepare for a more decentralized energy future.

To date, it is unclear what a successful utility business model for distributed PV could look like (Graham et al. 2008; Richter 2012). Christensen et al. (2011) even concluded that the percentage of electricity from wind and solar in established markets would have to remain tiny due to the existing barriers to innovation. However, the key finding of this study is that business model innovation could help to overcome this barrier. A precondition is that utilities would have to change their perspective: The solution lies in not treating distributed PV generation as merely another source of electricity generation in competition with traditional sources, but as a strategic gateway into the emerging distributed generation and service markets. As The generation cost of distributed PV cannot compete against conventional fuels or large-scale renewable projects in terms of production costs per kilowatt hour, utilities need to develop and offer new value propositions based on distributed PV. Fields for innovation are direct use of electricity, of energy efficiency and distributed electricity storage. For instance, price stability over a period of twenty years through a distributed PV system on the customer's roof could be an attractive new value proposition. Even if this business model were not profitable for utilities, it could nevertheless be a worthwhile investment because distributed PV could be the first step into a more comprehensive decentralized generation business model. As the most advanced technology, distributed PV could be the door opener for utilities. Figure 3 proposes a modular approach for a comprehensive distributed electricity value proposition.

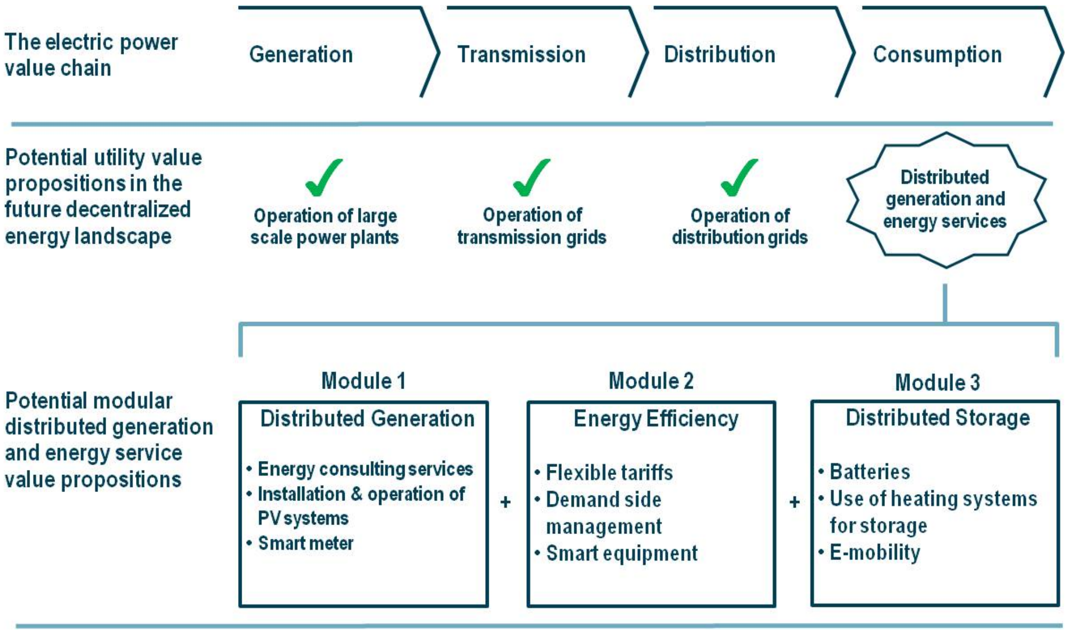

Figure 3: Potential modular distributed energy value proposition

Module 1 comprises products and services related to distributed PV generation. The module could, for example, consist of consulting services, the installation and operation of a distributed PV system, as well as the installation and maintenance of a smart meter. This distributed generation module could be a first, easy step into the distributed generation market, as the technology for this module is already available. The current problem of lack of profitability, on the other hand, could be addressed by the standardization of processes, the aggregation of volume and the enrichment of the value proposition through further modules.

Module 2 comprises energy efficiency products and services. It can be seen as an extension of module 1 and enriches the utility's customer-side value proposition. This module could comprise flexible electricity tariffs and demand side management, such as the automatic use of electricity when prices are low. As the technology for an energy efficiency package is at an earlier stage of development than the technology for the distributed PV generation package, module 2 could be offered as an extension to module 1 at a later stage. Energy efficiency is generally expected to become a separate major business model issue for utilities, because revenues per customer decrease when customers systematically save electricity (Hinkle & Schiller 2009).

Module 3 comprises products and services related to electricity storage. With the increasing share of renewable generation, the storage of electricity will become a major issue and indeed a new market (Eghtedarpour & Farjah 2012). First studies and scenarios suggest that distributed storage could become important, because opportunities for further large-scale pump storage hydropower plants are limited (Pieper & Rubel 2010). Distributed storage could include batteries, or the use of heating systems for storage. Another widely discussed option is the use of electric cars as electricity storage devices. Seizing business opportunities from the new demand for distributed electricity storage could be much easier when storage-related value propositions can be connected to products and services from the first two modules (He et al. 2011).

A modular value proposition comprises a series of possibilities for utilities: first, it allows the bundling of different products and services to increase revenues and profitability per customer. Second, this business model remains flexible for future developments. New technologies, products and services that are not available today can be integrated as new modules and expand the value proposition. Third, new sources of value creation arise from the combination of different packages and modules. Thus, the direct use of electricity from customer-side renewable generation systems would allow utilities to overcome the problem of revenue erosion from energy efficiency. When the utility is able to feed excess electricity into the grid for a higher price than the wholesale price (as is the case today under the German regulatory framework), the utility benefits from customers' energy savings because more electricity can be sold for a higher price. Another example is the use of electric cars for the decentralized storage of electricity. Fourth, this business model allows utilities to enter completely new markets. Going beyond the traditional delivery of electricity creates new opportunities for growth. If utilities actively embrace these opportunities for new business on the consumption side, they may well end up earning much more from each customer than today. The range of utility products and services could be extended beyond today’s mere delivery of electricity. Finally, the utility as the provider of the overall energy service system takes on a "gate keeper" position for all energy matters (Haag et al. 2009). New technologies, products or services could not be integrated into the home energy system without collaboration with the utility.

To realize such a business model, utilities would need to change their activities in the electricity value chain substantially. Following established rules of innovation management could greatly help them to overcome the current barriers to business model innovation. There are two generic approaches that could be applied. The first approach concerns the organizational structure. Innovation literature suggests that utilities would benefit from establishing a separate venture, or at least a separate and independent business unit, to address the distributed PV generation market. A separate and specialized unit helps to overcome internal barriers in the parent company and creates a more flexible environment that is open to new ideas (Boscherini et al. 2011). The new unit can focus on the new field of business and is more independent from the rest of the company. This approach has already been successfully applied by utilities in the field of large-scale renewable energies. All major German utilities have in fact established separate entities to manage their renewable energy activities. However, it should be pointed out that distributed PV generation has different characteristics than large-scale renewable generation, such as offshore wind energy. Utilities would benefit, therefore, from explicitly differentiating between small and large-scale renewable generation. It is a finding of this study that none of the interviewed companies had established a separate unit exclusively devoted to distributed PV (or other distributed renewable) generation. Following the established innovation management approach of creating a separate unit could assist utilities to overcome cognitive barriers and develop these business models independently from their current core business.

The second promising path is external cooperation. External partnerships provide a good way to foster the accumulation of know-how and innovation capabilities. Boscherini et al. (2011) argue that external partnerships allow the sharing of information and knowledge in order to improve innovation capabilities with which to face radical changes in a firm's environment. Collaboration can comprise external stakeholders, like universities, suppliers, research centers, competitors, customers, or NGOs, and can range from research projects to equity joint ventures. In the case of distributed PV generation, utilities could benefit from existing know-how of small independent project development companies. A somewhat similar process is currently taking place with regard to large-scale renewable energy projects, where utilities are forming joint ventures with independent project developers to increase their renewable energy portfolio. The independent project developers bring in their experience and contacts, while the utilities provide the funds for the realization of large projects. In this way both sides benefit from each other’s strengths with utilities reaching their goal much quicker than by building up all necessary know-how and experience internally. Thus, utilities would benefit from applying this strategy to the field of distributed PV generation as well.

The present study contributes to the discussion about utilities' business models for PV by providing some first empirical evidence from Germany, the world's largest market for PV. The investigation has revealed that there are differences in the perception of possible threats to the utilities' business models between researchers and practitioners. The existing research indicates that utilities may face massive challenges, and that distributed generation could become an important pillar of future energy systems. Moreover, further business model challenges resulting from energy efficiency and electricity storage are on the horizon. Therefore, a new perspective on distributed PV is suggested in the form of a modular value proposition to help utilities turn possible threats into an opportunity.

The method of conducting qualitative, semi-structured interviews has proven well suited for the purpose of gaining a first insight into the issue, but the findings are subject to some limitations. One is that the study does not provide a general picture of the utilities' activities in PV, but highlights current ideas and developments. Furthermore, the high level approach analyzing PV business models may lead to over-simplification. Also, business models are highly dependent on the respective regulatory framework, so the results may not easily transfer to other markets. Nevertheless, the methodology allowed some valuable insights into the issue and provided suggestions on how to address future challenges in distributed renewable generation.

This article combines two separate discussions: the role of utilities in the field of distributed PV and business model innovation. Both issues revealed avenues for promising further research. First, given the dimension and complexity of the energy transition as well as the possible future role of distributed PV for electricity generation, further research on the utilities' business models for PV could make an important contribution to utilities and to society at large. Further research might focus on supporting the development of distributed renewable generation products and services in order to facilitate the transition towards a more sustainable energy system. Concerning the second topic, further research on business model innovation appears full of promise. First insights indicate the huge potential of the business model concept and business model innovation as a strategic tool to address external challenges in the utility sector as well as in other industries.

6. CONCLUSION

This paper investigated the opportunities and threats of distributed PV for German utilities, as well as the utilities' inherent barriers to business model innovation in this field. It was found that in contrast to recent studies most of the utility managers interviewed did neither perceive distributed PV generation as a threat to their utility's current business model nor did they see distributed PV generation as a potential future market. Four main barriers to utilities' business model innovation for distributed PV were identified. Relating these findings to the existing business model innovation literature showed that similar problems have occurred in other industry transformation processes as well. Despite these existing experiences, German utilities mainly fail to adapt adequately to the quickly changing environment in the electric power market. Developing new business models and entering new markets has not been part of the corporate DNA of utilities in the last decades. However, this paper provides approaches to overcome utilities' barriers to business model innovation. A first step could be the creation of separate units for distributed PV generation and related services. In addition, a stronger emphasis on external partnerships could help to build up know-how in these fields. It becomes clear that improving their business model innovation capabilities would allow utilities to adapt to the new realities much quicker and more successfully. Business model innovation needs to be used as a strategic tool for the development of new organizational forms for the creation, delivery, and capture of value from renewable energies such as distributed PV. The main conclusion of this study is that utilities could greatly benefit from changing their perspective on distributed PV. When seen as no more than just another source of electricity production, PV is far from being cost competitive to other technologies. Seen as a strategic gateway into a new distributed electricity generation and service market, however, distributed PV unfolds a new strategic value for utilities. It could become the first module of a more distributed and sustainable utility value proposition and be the first step into promising future growth markets for utilities. Following the path of consequently expanding the value proposition module by module could, in the end, allow utilities to earn higher revenues per customer as they do today.

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