Business Models for Distributed Energy Technologies –

Evidence from German Cleantech Firms

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ABSTRACT

Global demand for heating and electricity relies heavily on fossil fuels, which contribute significantly to global warming and climate change. There is an urgent need to accelerate the diffusion of clean energy technologies such as solar thermal collectors and micro CHP (combined heat and power generation). One important bottleneck is the identification of adequate business models. Building on a thorough review of business model literature, we identify important aspects of successful business models for distributed energy. The second part of the paper reports on empirical evidence from a survey of 64 German distributed energy firms.

Keywords:

Business Model, Renewable Energy, Sustainable Innovation

Business Models for Distributed Renewable Energy Technologies –

Evidence from German Cleantech Firms

In large parts of Europe and North America, winter 2006/07 is characterized by "unusually" high temperatures. A wide public increasingly starts to realize that we are facing the consequences of climate change. One of the key areas for action against the climate change challenge is **energy**. Two-thirds of all Greenhouse Gas (GHG) emissions worldwide and more than 80 % of all GHG emissions in industrialized countries are directly related to the use of energy (Stern 2006, UNFCCC 2006). Electric power generation is the single most important contributor to climate change, accounting for 24 % of all GHG emissions, followed by transport (14 %), industry (14 %) and buildings (8 %). While there has been some progress with regard to energy efficiency in manufacturing, GHG emissions related to power generation and heat remain on high levels. Therefore, there is an urgent need for more sustainable ways of providing heat and power to buildings.

One possible vision of a sustainable energy future has been coined the "energy internet" by the Economist, and is based on increasing use of distributed and renewable forms of energy. These systems, also referred to as micropower or clean energy, include technologies such as solar cells, solar thermal collectors, heat pumps (for using geothermal energy), wood pellet stoves, and micro combined heat and power generation (micro CHP) based on either renewable fuels or natural gas and using conversion technologies such as internal combustion engines, stirling engines or fuel cells. Significant progress has been made in technological research and development, as well as design of energy policies to support clean energy. Venture capitalists are also starting to discover this as a promising growth area, and with that investment inflow comes

the search for adequate business models. Very similar to the early days of e-commerce more than 10 years ago, the public excitement about the new technological opportunities has created a lot of entrepreneurial experimentation, but truly sustainable business models have yet to emerge for distributed energy ventures. Our research is addressing this void by first clarifying the terminology around business models, and then identifying some of the key open questions with regard to successful business models for distributed energy. The second part of the paper reports on empirical evidence from a survey of 64 executives of German distributed energy firms.

THE BUSINESS MODEL CONCEPT

The Business Model as a New Unit of Analyis

The business model concept has emerged as an important addition to the predominant dichotomy of the *market-based view* (Porter, 1979, 1980; Brandenburger and Nalebuff 1996) and the *resource-based view* (Wernerfelt 1984, Prahalad and Hamel, 1990, Teece, Pisano and Shuen, 1997) in management research. These views evolved against a particular background of traditional economic structures and processes. Today, however, the underlying assumptions of these traditions are no longer valid. The breakthrough of information technology in general and e-commerce in particular has radically altered the way business is conducted. The resulting revolutionary innovations in structures and processes tend to escape the traditional analytic frameworks, making it difficult to explain how firms create value and compete in the market (Bettis, 1998; Zott and Amit, 2004). Moreover, industry as well as company boundaries become increasingly blurred (Osterwalder, Pigneur and Tucci, 2005), which calls for a new analytic framework that takes into account the changes brought about by e-commerce. A framework that answers this call is the business model concept (Hedman and Kalling, 2003; Stähler, 2001).

Over the last years, the business model concept as a tool for analysing commercial structures and processes has become increasingly popular in management theory and practice (Magretta, 2002; Osterwalder et al 2005; Shafer, Smith and Linder, 2005). In general, a business model can be defined as a description of a planned or an existing business and its specific characteristics with respect to value creation on the one hand and market-orientation on the other hand (Hedman and Kalling, 2003; Osterwalder et al, 2005; Stähler, 2001). The business model concept combines elements of the two traditional perspectives sketched in the previous section and thus takes an integrated point of view (Kalling, 2002; Morris, Schindehutte and Allen, 2005).

Initially, research on business models was to be found almost exclusively in the field of e-commerce (Mahadevan, 2000; Morris et al, 2005). The first attempts of definition and application accordingly appeared in publications related to information technology (eg Afuah and Tucci, 2001; Alt and Zimmermann, 2001; Mahadevan, 2000; Tapscott, Ticoll and Lowy, 2000; Timmers, 1998). More recently, the business model has made its entry into management-related publications as well (eg Chesbrough and Rosenbloom, 2002; Rentmeister and Klein, 2003; Shafer et al 2005). E-commerce activities seem no longer to be a prerequisite for applying business model analysis to explain value creation (Magretta 2002, Sillin 2004). Nonetheless, the level of attention in academic research does in no way match the emphasis that the business model has experienced in practice (Morris et al 2005). Although a considerable number of publications have tried to explain the business model concept, no generally accepted definition has evolved so far (Osterwalder et al 2005, Porter 2001, Shafer et al 2005). Most practitioners are not able to explain the concept either (Linder and Cantrell 2000). Yet, researchers seem to agree upon the fact that a business model somehow describes how a business creates value. They also agree that it is an important new unit of analysis, highly relevant to both management theory

and practice (Belz and Bieger, 2004; Chesbrough and Rosenbloom, 2002; Morris et al, 2005; Rentmeister and Klein, 2003). Business model analysis can help to understand and communicate the key success factors of value creation. Furthermore, it can be used to measure, compare or even change the business logic (Morris et al, 2005; Osterwalder et al, 2005; Shafer et al, 2005).

Defining Business Model Components

While there is no clear consensus about what a business model is, this section explores some of the definitions suggested as well as their main similarities and differences.[1] Timmers (1998) was among the first to put forward a prominent formal definition of a business model, viewing it as a description of the architecture of value generation (across firm boundaries), of the potential value generated for partners and final consumers, of the sources of revenue and of the marketing strategy.[2] Another early definition was given by Hamel (2000) who proposes four business model components: core strategy (including the product or service), strategic resources (ie competences, assets and processes and their configuration), customer interface (by which benefits are delivered) and value network. According to Mahadevan (2000), a business model consists of a value stream for partners and final consumers, a revenue stream and a logistical stream. Other original definitions are, eg, offered by Amit and Zott (2001), Chesbrough and Rosenbloom (2002), Linder and Cantrell (2000), Mitchell and Bruckner Coles (2003) and Wallin (2000). Besides the large number of original business model definitions, the literature also shows many secondary definitions that are based on syntheses of earlier work. Although most

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[1] A number of publications provide summaries and comparisons of different business model definitions (eg Belz and Bieger, 2004; Hayes and Finnegan, 2005; Morris et al, 2005; Osterwalder et al, 2005; Shafer et al, 2005; Stähler, 2001). Most of these publications also propose own definitions as a synthesis.

[2] Actually, this definition refers to what Timmers (1998) calls a marketing model, an extended version of a business model. His original definition does not include a description of the business's marketing strategy and therefore is – also in Timmers' opinion – insufficient to explain how a business captures the value it creates.

definitions to some extent differ from each other at first glance, there seems to be a common underlying intention, namely to depict a business's core logic for value creation (Chesbrough and Rosenbloom, 2002; Osterwalder et al, 2005; Shafer et al, 2005; Wallin, 2000). Also, the definitions illustrated above show some overlap with respect to several business model elements. Consolidating the commonalities of the different definitions, the following paragraphs explore *market components* as well as *configuration components* of a business model.

The **market components** of a business model define how a firm delivers value. Four market components can be distinguished: value proposition, strategy, customers and revenue model. The *value proposition* illustrates the benefits a business generates for its customers and final consumers (Mahadevan, 2000; Stähler, 2002).[3] It also includes the products and services that mediate those benefits (Chesbrough and Rosenbloom, 2002; Osterwalder et al, 2005). The *strategy* component encompasses the competitive strategy of a business, which is closely related to the value proposition, as well as transformational strategies that are directed towards changing the market environment (Bieger et al, 2002; Morris et al, 2005). *Customers* constitute an important part of a firm's business model. It is crucial to be aware of actual and potential target groups in order to formulate a coherent value proposition (Hedman and Kalling, 2003; Stähler, 2002). The *revenue model* describes how the value delivered to the market is translated into sales revenues and, ultimately, profits. It therefore secures the economic bottom line of the business (Alt and Zimmerman, 2001; Timmers, 1998).

The **configuration components** of a business model describe how a firm creates the value it derives its revenues from. Configuration components are a firm's value partners, value creation

[3] For conceptual reasons, the potential benefits for partners are not included as a part of the market component 'value proposition' as opposed to Mahadevan (2000) and Stähler (2002). Instead, they are incorporated in the configuration component 'value partners'.

architecture and strategic resources. *Value partners* are external actors that – either directly or indirectly – are involved in the value generation of a particular business. In turn, they also benefit from the business's activities. Suppliers and distributors are typical examples for direct value partners whereas complementors, for instance, can rather be characterised as indirect value partners (Bieger et al, 2002; Osterwalder et al, 2005). The *value creation architecture* indicates which steps of the value chain are performed by the firm and whether it specialises on certain value steps or integrates larger parts of the value chain. This culminates in the formulation of core processes and the description of interfaces between value steps (Alt and Zimmermann, 2001; Hedman and Kalling, 2003). The value creation architecture is highly dependent on strategic resources and vice versa. *Strategic resources* are unique sources of value that cannot easily be copied by others. They consist of a business's core competences and strategic assets like production capacity or intellectual property (Hamel, 2000; Hedman and Kalling, 2003).

Figure 1 illustrates the market and configuration components of a business model as described above.

Insert Figure 1 about here

Table 1 below shows which elements of the business model definitions discussed earlier in this section are covered (at least partially) or extended by the components proposed in previous literature.

Insert Table 1 about here

When applying business model analysis, it is important not only to look at the components separately but also at the fit between them (Belz and Bieger, 2004; Hedman and Kalling, 2003; Morris et al, 2005). Strategy, customers and revenue model, for instance, must be consistent with the value proposition if the firm's activities are to be successful. Likewise, value partners and value creation architecture have to fit the firm's strategic resources. Furthermore, there is also a strong interplay between market and configuration components that has to be reflected in the design of a business model.

Discussion of the business model concept

The business model concept is a valuable addition to the pool of analytic tools in management science (Belz and Bieger, 2004; Morris et al, 2005). It combines elements of the market-based and resource-based perspectives of analysis and views the business as an intermediary between market factors on the one hand and resource factors on the other (Hedman and Kalling, 2003; Morris et al, 2005). Although the business model framework extends beyond firm boundaries, it neither considers all market factors nor covers every aspect of a firm.[4] Instead, its scope includes (and is restricted to) all internal and external factors relevant and necessary for explaining a particular value stream from the viewpoint of a particular firm (Belz and Bieger 2004; Chesbrough and Rosenbloom, 2002; Hedman and Kalling, 2003; Zott and Amit, 2004). The following paragraphs explore possible *applications* of the business model concept as well as its *advantages* and *limitations*.

The business model framework as presented in the previous section is very useful for various **applications** in management research and practice. Most importantly, it is a valuable tool for

[4] The latter is especially true for large diversified companies.

analysis, communication, decision-making and planning. The *analysis* of a particular business's operations with the help of the model permits, in the first place, to identify the composition of market and configuration components underlying value creation (Morris et al, 2005). In other words, it provides a snapshot of strategic choices made in the past and thus enables researchers and practitioners to understand the business logic (Osterwalder et al, 2005; Shafer et al, 2005). Applying business model analysis can help to define indicators for measuring and monitoring purposes (Osterwalder et al, 2005). Besides being suitable for investigating an individual business, the concept can also be used as a means of comparison (ibid). For instance, managers can compare their own business model to those of competitors. Researchers can use comparative analysis to determine critical success factors for different industries or to define and categorise generic business model configurations (Linder and Cantrell, 2000; Morris et al, 2005; Timmers, 1998). *Communication* is another important function of the business model concept. The concept offers a clear structure for capturing the essence of value creation. Explaining and visualising a business's core logic is key to sharing it with other stakeholders such as employees, customers, value partners and, especially, investors (Möller and Rolf, 2003; Shafer et al, 2005; Stähler, 2001). In some cases, a clearly communicated description of a business model can also be used to patent one or more of its aspects (Hedman and Kalling, 2003; Osterwalder et al, 2005). Facilitating *decision-making* for managers and employees alike is a third vital application of the business model framework. It enables to make decisions in accordance with the market and configuration components and hence provides a basis for cohesive management and operations (Linder and Cantrell, 2000; Osterwalder and Pigneur, 2004). When extending decision-making to the long run, business model analysis can also assist in *planning* the future. The holistic approach makes it possible to detect and evaluate effects of fundamental strategic choices in advance and

thus provides the foundations for scenario analyses as well as subsequent strategy formulation (Morris et al, 2005; Rentmeister and Klein, 2003). Business models can also be used to improve the design of core processes or to assess the viability of additional strategic assets (Hedman and Kalling, 2003; Osterwalder and Pigneur, 2004). Last but not least, the business model concept can be a starting point for building a new business from scratch (Osterwalder et al, 2005).

The business model has some inherent **advantages** that make it highly suitable for the applications described above. A very important conceptual strength of the business model is its *appropriate scope*. It extends the view beyond company boundaries and enables to capture configurations based on value networks. Furthermore, interdependences between components can be detected and analysed. At the same time, the framework avoids complexity by concentrating only on aspects that constitute central parts of the business logic (Hedman and Kalling, 2003; Rentmeister and Klein, 2003). This *simplicity* makes it easy to grasp the 'big picture' and, moreover, to compare the business models of different firms (Osterwalder and Pigneur, 2004). Yet, the structure of the framework also permits to investigate the market and configuration components of a particular business in great detail (Stähler, 2001). Another benefit of using the concept to analyse existing businesses is its *completeness* in the sense that it makes explicit all relevant strategic choices. This includes not only the choices made by intention but also those made subconsciously (Morris et al, 2005; Shafer et al, 2005). When applied in practice, a special quality of the business model is that it fosters *consistency*. It encourages managers to coherently align strategic choices with the business logic. Likewise, it provides guidance for managers and employees in everyday decision-making and thus strengthens the business's focus (Hayes and Finnegan, 2005; Linder and Cantrell, 2000). Furthermore, the business model concept also facilitates *customisation*, ie the process of developing a unique

constellation of decision parameters which distinguishes a business from its competitors and, hence, is a potential source of competitive advantage (Mitchell and Bruckner Coles, 2003). This is possible due to the fact that the concept enables to identify and exploit opportunities as starting-points for innovation (Morris et al, 2005; Rentmeister and Klein, 2003; Zott and Amit, 2003).

As appealing as the business model framework is, it nevertheless suffers from a number of **limitations** that have to be kept in mind when using it to analyse and manage businesses. The boundaries of the framework result mainly from its *conceptual limitations* on the one hand and *potential flaws in its application* on the other. **Conceptual limitations** are constraining factors that researchers and managers must be aware of in order not be misguided in their analytic efforts. First of all, the business model itself *must not be mistaken as a strategy* or as a replacement of strategy (Magretta, 2002; Porter, 2001; Stähler, 2001). Although it contains strategic elements, it is rather a reflection of strategic choices than it is an elaborated strategic plan (Chesbrough and Rosenbloom, 2002; Morris et al, 2005; Osterwalder et al, 2005). However, as indicated before, it can be a very useful tool for strategic planning due to its ability to depict the effects of different strategic decisions (Shafer et al, 2005). Another boundary of the concept is its restriction in scope. Since it concentrates on explaining a particular value stream, it *does not include a full description of the environmental setting*[5] which may be necessary for understanding entirely why this model is successful or not. Although it does not impair the concept's value for the analysis and communication of a particular model or for the comparison of models set in the same context, this limitation must be considered when comparing business

[5] The environmental setting can be described in terms of policies, technological development, consumer behaviour, competition etc.

models in different markets (Chesbrough and Rosenbloom, 2002). Therefore, for the purposes of comparing or planning a model, business model analysis has to be complemented by an investigation of the environmental setting (Porter, 2001; Zott and Amit, 2004). Besides environmental aspects, there are also *company-internal factors that escape the scope of the concept*, namely financing and ownership issues as well as the way the model is embedded in the context of the firm as a whole. These aspects may, however, well be important decision variables with respect to business model design in some cases (Bieger et al, 2002; Linder and Cantrell, 2000). One more important conceptual limitation of the framework is its *static nature*. It shows a snapshot of a business in a certain state and does not incorporate dynamics per se (Linder and Cantrell, 2000; Osterwalder et al, 2005).[6] This problem can be coped with by looking at a sequence of models that represent different points in time, eg the present and the future.[7] Thus, changes in the real-life business model can be mapped or simulated, which even makes it possible to trace the evolution of a firm's core logic in a business model lifecycle (Betz, 2002; Linder and Cantrell, 2000; Morris et al, 2005).

In addition to conceptual limitations, **potential flaws in the application** of the business model concept constitute a second category of boundaries. The most frequent flaw is probably a *confusion of the terminology*. Many researchers and managers use the term business model when actually referring to only a small part of it, such as eg a new value proposition (Linder and

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[6] Note that this does not imply that a business model is the picture of an inflexible business. – Hedman and Kalling (2003) include a longitudinal process component in their version of the business model concept to cover dynamic aspects. However, this component is not a part of the framework proposed in this paper since it does not contribute to understanding the business logic as it is. Therefore, its inclusion would reduce sharpness as well as increase complexity. As will be shown, dynamics can be included otherwise.

[7] Betz (2002) uses the term 'strategic business model' to refer to a model that describes the future of a business. Linder and Cantrell (2000) identify 'change models' that show according to which parameters a business model is changed over time.

Cantrell, 2000; Rentmeister and Klein, 2003).[8] This may lead to serious problems since important aspects of the business's core logic for value generation are simply left out of the analysis (Belz and Bieger, 2004; Shafer et al, 2005). How risky this can be has been demonstrated impressively by the downfall of the so-called new economy, where a lot of money had been spent on businesses with innovative ideas without regard to the flaws in their business models (Porter, 2001; Shafer et al, 2005). Problems in the application of the business model for planning purposes can also occur when relying on *wrong assumptions about the future*.[9] If future developments are predicted incorrectly, strategic choices may turn out to be hazardous to the firm. Therefore, it is vitally important to constantly check the validity of the underlying assumptions to ensure consistency in strategic planning (Shafer et al, 2005). Another potential source of trouble is rooted in *failure to adapt the business model to new conditions*. A business model can never be considered to be optimal (Hedman and Kalling, 2003; Magretta, 2002). It is constantly subject to external influences and can become obsolete soon, especially in a dynamic environment (Osterwalder et al, 2005; Sillin, 2004). In order to respond to changing conditions, the business model has to be conceived as the outcome of an iterative and heuristic planning process (Hedman and Kalling, 2003; Morris et al, 2005). The fact that the business model concept does not fully cover the context of a business may lead to a complete *neglect of contextual factors* by researchers or managers. If business model analysis is performed without a complementing look at the context, results are likely to be incomplete. This can be especially problematic for managers who try to improve their business model by copying features from another business (Linder and Cantrell, 2000; Morris et al, 2005). Diversified firms may also have

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[8] Sometimes, the term business model is also used to denote the modelling of business processes (Osterwalder et al, 2005).

[9] This is, of course, a problem of most tools for strategic planning.

a hard time achieving consistency across different business models if they omit to consider the company level in the design of a business model (Bieger et al, 2002).

All in all, it can be said that the business model does not replace the traditional analytic approaches but, instead, complements them as a new, valuable unit of analysis in its own right (Morris et al, 2005).

BUSINESS MODELS FOR DISTRIBUTED ENERGY SYSTEMS IN GERMANY

This chapter provides empirical insights into existing business practice and possible success factors in the emerging German market for distributed energy systems, particularly for solar thermal energy and micro CHP.

Data and Methodology

For both market sectors, a questionnaire-based survey was conducted. A list of companies active in the German markets for solar thermal and micro CHP was compiled through internet research. Subsequently, a total of 403 questionnaires were sent out by e-mail to CEOs or Heads of Division of 311 solar thermal businesses and 92 micro CHP businesses. These companies comprise manufacturers, wholesalers, retailers, planners and installers. The survey-based approach enables to cover a broad range of companies and represents a well-structured high-level approach to business model analysis, thus ensuring good comparability of the results. Altogether, 60 solar thermal companies (19 %) responded to the survey. Of these, 23 (7 %) explicitly refused to fill in the questionnaire. A total number of 37 completed questionnaires were returned, indicating a return rate of 12 %, which is a reasonable value for an internet-based survey (Porter and Whitcomb, 2003). The sample for the analysis consists of 22 German, 13 Swiss and 2 Austrian businesses. For micro CHP, 40 companies (43 %) responded, 13 (14 %)

were unwilling to participate in the survey and 27 companies returned completed questionnaires, which represents a return rate of 29 %, a good value for such a survey considering current market dynamics. For micro CHP, the final sample consists of 25 German and 2 Swiss businesses. 25 % of the solar thermal businesses and 35 % of the micro CHP businesses are diversified firms with residential micropower being only one small part of their activities. On the opposite side, 19 % and 35 % concentrate exclusively on the solar thermal and micro CHP markets, respectively. The solar thermal companies carry out various activities: 54 % of them are manufacturers, 46 % are system planners, 40 % perform service and maintenance activities, 37 % are wholesalers, 34 % are installers and 23 % pursue further activities.[10] In the micro CHP sample, 73 % perform service and maintenance activities, 46 % are manufacturers, 38 % are installers, 27 % are wholesalers and 23 % are system planners. Fuel supply and utility services are each delivered by 12 % of the sample, while 8 % offer building management services and 12 % still pursue further activities. On average, the solar thermal businesses generated an annual turnover of approximately EUR 3 million in 2005 and employed 26 persons by the end of the same year, while the micro CHP businesses achieved a turnover of approximately EUR 2.7 million in 2005 and employed 15 persons.[11] The average growth rates of the solar thermal sample for the past five years lie between 28 % in the year 2005 and 10 % in the year 2002. For 2006, the average estimated growth rate is 27 % while, thereafter, an average annual growth rate of 22 % is expected until 2010. As indicated in Table 2, a comparison with latest data published by the sustainability research department of Bank Sarasin (2006) shows that our sample is reasonably representative of the German solar thermal industry. As for micro CHP, the firms in our samle

[10] Some firms pursue more than one activity, therefore the total adds up to more than 100 %.

[11] Only 25 solar thermal businesses and 20 micro CHP businesses provided turnover figures. Numbers of employees were revealed by 30 and 20 firms, respectively.

achieved average growth rates between 25 % in the year 2002 and 12 % in the year 2004. For 2006, the average estimated growth rate is 27 % while, thereafter, an average annual growth rate of 29 % is expected until 2010. Table shows the average historic and expected growth rates for the years 2001 to 2010 as well as the number of companies that disclosed growth figures for the respective years.

Insert Table 2 about here

The following sections present the results of the survey regarding the market and configuration components of a business model and thus provide insights on the existing business practice in the micropower market.

Value Proposition

The value proposition of a business is of the utmost importance. It is the key to revenue generation as it gives consumers a reason to opt for solar thermal systems and become micropower users. As a consequence, it is vital for businesses to design their offering in accordance with consumer preferences. The survey investigates how managers perceive the preferences of three different consumer groups, ie eco-active, eco-balanced and eco-passive consumers (Villiger, Wüstenhagen and Meyer, 2000). Eco-active consumers actively seek environmentally beneficial products, eco-balanced consumers view environmental aspects and cost-related aspects as equally important, and eco-passive consumers do not consider environmental aspects to be particularly relevant. For each of these groups, survey participants were asked to estimate the importance of different aspects of a solar thermal system or micro CHP system, respectively on a five-point scale ranging from ‘highly important’ (1) to

'unimportant' (5). Considering solar thermal systems, an aspect that seems to be very important to all three groups alike is that the systems facilitate independent heat supply (with average values of 1.7 to 2.1). Furthermore, advising and planning services (2.3 to 2.6) as well as installation and maintenance services (2.4) are perceived to be equally important for all three segments of solar thermal consumers. This holds also for another aspect, the positive image associated with owning a solar thermal system (2.3 to 2.7). Not surprisingly, suppliers perceive eco-active consumers as placing the highest emphasis on the avoidance of harmful emissions (1.2) as well as on the utilisation of renewable energy (1.2) whereas, for eco-passive consumers, these aspects are perceived to be fairly unimportant (4.0 and 3.9, respectively). In turn, capital and upfront costs of solar thermal systems are of the highest relevance to the eco-passive group (1.4) while they only play a moderate role for eco-active individuals (3.2). Interestingly, eco-active consumers are the only ones who are considered to view operating costs (3.0) as being more important than upfront costs.[12] All in all, eco-active consumers seem to perceive all criteria of a solar thermal system as more important than the other two groups – with the exception of costs and visual aspects. The preference profiles of the three different consumer groups as perceived by survey participants from the solar thermal industry are illustrated in Figure 2 below.

Insert Figure 2 about here

In the micro CHP sample, the importance of the various aspects for final consumers is perceived slightly different. For all three groups alike, advising and planning services seem to be

[12] This is consistent with the results of a survey among German fuel cell pioneers, who can basically be categorised as eco-active consumers. Fischer (2006) finds that, for pioneers, low operating costs are significantly more important than low capital costs.

of great importance (with average values of 1.6 to 1.8). The same also holds for installation and maintenance services (1.6 to 2.0). Another aspect that is perceived to be rather central to all types of consumers is that micro cogeneration facilitates an independent energy supply (2.1 to 2.3). For eco-active and eco-balanced consumers, the positive image associated with owning and operating a micro CHP system appears to matter equally strong (2.0) while being slightly less important for eco-passive consumers (2.5). Not surprisingly, suppliers perceive eco-active consumers as placing the highest emphasis on the avoidance of harmful emissions (1.2) as well as on the utilisation of renewable energy (1.4) whereas, for eco-passive consumers, these aspects seem to be a great deal less important (3.4 and 3.6, respectively). In turn, capital and upfront costs as well as operating costs are highly relevant to the eco-passive group (both 1.7) while they only play a moderate role for eco-active individuals (3.1 and 2.8, respectively). The latter ones are the only group of consumers considered to attribute a noteworthy value to eco labels (2.5) and local or regional value generation (2.7). Visual aspects (3.1 for all), in general, do not seem to be a factor capable of tipping the scale in one direction or another. All in all, besides an increased independence of residential energy supply, advice and planning as well as installation and maintenance services are perceived to be fundamental for all types of consumers. This indicates that residential energy supply systems are complicated and need thorough explanation. Furthermore, eco-active consumers are viewed as regarding criteria concerned with environmental benefits and local value generation as more important than the other two groups while placing less emphasis on costs. The preference profiles of the three different consumer groups as perceived by survey participants from the micro CHP industry are illustrated in Figure 3 below.

Insert Figure 3 about here

For solar thermal systems, an average estimation for the payback period that eco-active consumers are willing to accept is 9.7 years. Eco-balanced and eco-passive consumers are thought to accept 8.4 years and 6.6 years, respectively. For micro CHP, the average estimated payback period for eco-active consumers is 13.5 years. Eco-balanced and eco-passive consumers are thought to accept 9.6 years and 7.0 years, respectively. 65 % think that eco-balanced consumers as well accept at least ten years, and 23 % also expect eco-passive consumers to do so. Obviously, the payback times accepted in the micro CHP market are longer than those in the solar thermal market. In designing their value propositions, businesses must diligently take into account the preferences of their target group. Otherwise, their products and services may not appeal to consumers, which could ultimately result in failure to capture the created value. In addition to a strong service orientation, businesses should find a way to offer products with environmental benefits and competitive upfront and operating costs. In this way, they stand a good chance of being able to recruit customers from all three consumer groups.

In order to investigate the relative importance of product quality and costs in the value proposition, survey participants were asked to indicate the roles these two aspects play in the communication activities of their businesses (with reference to the same five-point scale as above). Regarding the solar thermal sample, both aspects are quite important in general, quality reaches an average importance of 1.8 in communication and clearly dominates cost-related aspects (2.6). The same is true for the micro CHP sample with values of 1.4 for quality and 2.4 for costs. 71 % of the solar thermal firms and 89 % of the micro CHP firms rated quality as highly important (1) or important (2) in their communication activities whereas, for costs, just 34 % and 50 %, respectively, did so. Only one of the solar thermal companies puts more

emphasis on costs than on quality in its communication.[13] In general, companies tend to set a focus on quality, which seems to be considerably more promising with regard to an appealing value proposition. However, a comparison of growth figures yields slightly different results for solar thermal businesses and micro CHP businesses. Solar thermal businesses that regard quality aspects as important in their communication achieved an average annual growth rate of 15 % between 2001 and 2005 and expect a growth rate of 24 % for the years 2006 to 2010. Solar thermal businesses that regard costs as important in this respect achieved an average growth rate of 11 % between 2001 and 2005 and expect a growth rate of 20 % for the years 2006 to 2010. This suggests that a focus on quality with respect to the value proposition is more beneficial in the solar thermal industry. Micro CHP businesses that regard quality aspects as important in their communication achieved an average annual growth rate of 14 % between 2001 and 2005 and expect a growth rate of 22 % for the years 2006 to 2010. Micro CHP businesses that regard costs as important in this respect achieved an average growth rate of 18 % between 2001 and 2005 and expect a growth rate of 23 % for the years 2006 to 2010. This may lead to the conclusion that, in terms of revenue growth, a communication focused on costs has a higher potential. As indicated by

[13] This is backed by another observation: altogether, when asked about the unique selling proposition of their business, 38 respondents mentioned service-related aspects, 23 respondents mentioned product-related aspects, and only five respondents mentioned cost-related aspects.

Table , there seems to be a trade-off between quality and costs for solar thermal businesses. Businesses that concentrate on quality exclusively outperform those who concentrate on costs as well as those who treat quality and costs as equally important. Yet, concerning the performance of micro CHP businesses, the figures reveal another interesting insight. In the cogeneration sample, the fastest growing companies by far are those reporting that they regard neither quality nor costs as important in their communication. That said, it must be noted that only three businesses fall into this category, all of which are fairly new to the market and, therefore, still have rather low revenues and grow much faster than others. What is more, they might only fall into this category because, at this early stage, their value proposition is not fully elaborated yet. All other micro CHP businesses emphasise product or service quality when addressing their customers. The majority, who also regard costs as being important, outperform those businesses that neglect the importance of costs. Between 2001 and 2005 they achieved a 9 % higher average growth rate. For the years 2006 to 2010, their expected performance will still be better by 3 % on average.

Insert Table 3 about here

Customers

The targeted customers constitute another business model component that must be taken into consideration in order to formulate a coherent value proposition. In the questionnaire, companies were asked to define their target customers on the basis of the three groups of eco-active, eco-balanced and eco-passive consumers. 32 % (31 %) of solar thermal (micro CHP) firms indicated eco-balanced consumers ("beyond the eco-niche") as their primary target group, while 68 %

(69 %) address the eco-passive mass market. None of the firms indicated eco-active customers as their primary target segment.

In terms of geographical focus, there is an interesting difference between the solar thermal and micro CHP companies in our sample. Only 18 % of the solar thermal, but 56 % of the micro CHP companies generated their entire 2005 revenues in Germany, pointing to a strong domestic exposure of micro CHP firms. Internationalisation appears to be an issue on their agenda though, as these figures are expected to decrease to 15 % and 36 %, respectively, by 2010. The weighted average geographical distribution of revenues in the sample for the years 2005 and 2010 is shown in Table 4. The majority of 2005 revenues was generated in Germany (51 % for solar thermal and 94 % for micro CHP). Austria and Switzerland are further target markets. In the years to come, the share of the German market can be expected to decrease in both industries, as other European markets become more attractive.

Insert Table 4 about here

Revenue Model

The revenue model is one of the crucial components of a business model as it describes how the value created translates into sales and, ultimately, profits. It therefore secures the economic bottom line of a business. As can be seen from Figure 4 below, 89 % of the solar thermal sample and 85 % of the micro CHP sample at least part of their turnover simply by selling hardware. Other common ways to generate revenues in the micro CHP market are installation and maintenance as well as planning services. The former are performed by 43 % of the solar thermal

businesses and 69 % of the micro CHP businesses, while the latter are performed by 54 % and 46 %, respectively. 23 % of the micro CHP firms, but just 6 % of solar thermal firms offer financing solutions, thereby trying to reduce initial costs for their customers – a major barrier to a wider diffusion of micropower. Other innovative sources of income like contracting or leasing services are less popular, especially with the solar thermal sample. In the micro CHP sample, 12 % of the businesses offer fuel supply services. As this overview shows, the traditional ways of revenue generation in the heating market, i.e. particularly hardware sales, installation and maintenance as well as planning services, dominate among the surveyed solar thermal and micro CHP businesses. Yet, in the micro CHP market, more innovative ideas seem to be emerging as is suggested by the share of companies that use financing schemes to generate revenues.

Insert Figure 4 about here

Value Partners

Almost always, value partners from outside the company are integrated in a business's process of value creation. In addition to suppliers and distributors, which are mainly determined by the value creation architecture (and vice versa), complementors can also play a significant role. In the case of micro CHP, additional value for the final consumer can, eg, be created by teaming up with banks or other financial institutions in order to provide financing services that reduce initial costs for the final consumer. In the survey, companies were asked about existing or planned cooperations. 14 % of the solar thermal businesses and 65 % of the micro CHP businesses already cooperate with financial institutions. Additionally, 26 % of the solar thermal businesses and 19 % of the micro CHP businesses plan to do so in the future. This is an

unmistakable sign that, especially with respect to micro CHP, partnerships with the aim of jointly offering innovative financial services along with the actual systems are a key factor for successful commercial activities in the micropower market.

Value Creation Architecture

A central pillar of each business model is the value creation architecture. It describes which steps of the value chain are performed by a firm and whether it specialises on certain parts of the value chain or integrates vertically. In the sample, 33 % of the solar thermal companies and 35 % of the micro CHP companies are specialised on one or a few parts of the value chain. 19% of the solar thermal businesses and 4 % of the micro CHP businesses follow a contrary path and are more vertically integrated. Vertical integration appears to be more common in solar thermal than in micro CHP, possibly due to the lower complexity and capital intensity of the product. Comparing average revenue growth rates between 2001 and 2005 shows that specialised solar thermal energy firms were also slightly less successful than integrated ones (16 % and 18 % respectively), whereas specialised businesses were significantly more successful in the micro CHP sample (23 % vs. 12 %). The difference between the two sectors extends into the future, where solar thermal firms expect annual growth rates (2006-2010) of 18 % for specialized and 22 % for integrated firms respectively, as opposed to 31 % vs. 28 % for micro CHP.

In designing the value creation architecture, micropower businesses have to decide on how to deliver their product or service to the final consumer. Table 5 below shows the actual and expected shares of different delivery configurations in the two samples. The current solar thermal market appears to be dominated by two variations of the traditional boiler delivery chain with a combined share of two thirds of the market. 33 % of solar thermal firms' revenues are generated in a configuration where manufacturers sell their products to wholesalers who supply installers

who set up the systems at consumer sites. Another 33 % come from a shorter version of this configuration that excludes wholesalers, which means that manufacturers of solar thermal systems directly supply installers. As for micro CHP, the first observation is that there is more variety, pointing to more experimentation in this early market. The configuration with the largest share (39 %) is the abbreviated boiler delivery chain without wholesalers. However, the five other options have fairly similar market shares of between 9 and 15 %, respectively. A striking difference between the two sectors is that the delivery through energy suppliers, which accounts for 14 % of the micro CHP revenues, is almost negligible in the solar thermal market. One explanation is of course that solar thermal collectors do not generate electricity and are therefore seen as outside their core business by many electric utilities. Nevertheless, there seems to be some unused potential for electric or gas utilities in entering the solar thermal market as a possible platform for creating long-term customer relations.

Insert Table 5 about here

Strategic Resources

Strategic resources (such as core competences) are unique sources of value that cannot easily be copied by others. Therefore, survey participants were asked to name their key strengths. 69 % (56 %) of the solar thermal (micro CHP) businesses highlighted their friendly and competent service, whereas 34 % (44 %) mentioned well-designed products as their unique feature. Longstanding experience and knowledge of the market was highlighted by 11 % of the solar thermal companies and 44 % of the micro CHP companies. Costs for the final consumer, however, do not appear to play as important a role: only 6 % of the solar thermal sample and

12 % of the micro CHP sample explicitly listed core competences that contribute to a reduction of costs. This again portrays both sectors as emerging industries that are for now mainly engineering and high-quality driven and serving customers with relatively low price sensitivities, leaving room for later entry of larger and more low cost-focused suppliers.

Success Factors, Experience So Far And Future Potential

This picture is mirrored by Figure 5, which shows what survey participants consider to be key success factors for business models in their industries. 71 % (59 %) of the solar thermal (micro CHP) businesses view good product quality and performance as highly important prerequisite for success. Aspects related to service quality were mentioned by 38 % and 59 %, respectively. Other important factors are a fair price as well as know-how and reliability. Interestingly, none of the solar thermal businesses and only 4.5 % of the micro CHP businesses referred to low manufacturing costs as a success factor.

Insert Figure 5 about here

Summary and Discussion

The investigation of the German solar thermal and micro CHP markets yields some interesting results with respect to business models for distributed energy. Surveyed firms indicated that cost is a key aspect for final consumers. Initial cost is perceived to be a major concern, particularly for mainstream customers, while operating costs is less important on average, but still relatively important for eco-active consumers and in the case of micro CHP. An attractive value proposition seems to be the idea of increasing the independence of residential energy supply. Regarding the communication towards final consumers, most firms currently

focus on quality rather than cost in the case of solar thermal, while cost is more of an issue for micro CHP. A general conclusion than can be drawn from the survey with respect to the value proposition is that, in addition to a strong service orientation, businesses should find a way to offer products with competitive upfront and operating costs as well as environmental benefits. The revenue models of micropower businesses are still dominated by income streams traditional to the heating market. Yet, more innovative revenue models emerge – particularly in the market for residential micro CHP. Consequently, value partnerships with financing institutions are considered an important success factor for micropower businesses. With respect to the value creation architecture, specialized micro CHP tend to be more successful than vertically integrated ones, while the opposite is true for solar thermal. Regarding the delivery configuration, businesses in the solar thermal sample prefer the traditional boiler value chain, which includes manufacturer, (wholesaler,) installer and final consumer. The shorter version of this, without wholesalers, is also common for micro CHP, but firms in this sector seem to be experimenting with a wide variety of delivery configurations, including distribution partnerships with energy suppliers which are almost absent in the solar thermal market. When asked about key success factors in the market for residential micropower, both solar thermal and micro CHP businesses mainly think about product and service quality, while manufacturing costs are rarely considered. All in all, the sample businesses attribute a high potential for success to the markets for solar thermal and mirco CHP, as evidenced by the strong past and expected future growth rates. However, the market potential seems to be far from being fully captured. This also opens up opportunities for new business model configurations that break with traditional ways in the micropower market.

LIMITATIONS AND FURTHER RESEARCH

This paper has contributed to the conceptual clarification of business models and provided an empirical application of this concept to the emerging market for distributed energy technologies. As any research, it is subject to some *technical* and *practical limitations*. Technical limitations mainly result from the high level approach of the questionnaire-based analysis. Differences between business models can often only be detected by taking a close look at crucial details (Linder/Cantrell 2000). Those, however, cannot be fully captured by a standardised questionnaire. Another technical shortcoming is that growth and revenues may not be sufficient measures to quantify success. Finally, we mainly worked with self-reported measures of success, and this should be complemented by other measures, as we started to do in table 2. Practical limitations of the research are mostly related to the sample investigated. First of all, the analysis is restricted to the German market. The conclusions drawn might not be transferable to markets with significantly different characteristics. Furthermore, the survey suffers from a survivorship bias. Looking at failed business models may be an important complement and can probably be best captured by taking a longitudinal approach. Finally, the market for residential micropower is still young in absolute terms, which makes it difficult to evaluate long-term success. In the end, this may also lead to neglect of the true potential of innovative business model configurations.

As indicated at the beginning of this paper, there is an urgent need for successful market introduction of more sustainable energy technologies, therefore there is clearly room for more research in this important area. Also, we are convinced that the discussion about business models, which until now had a strong bias towards e-businesses, will be enriched by adding business models for the emerging "energy internet" to the debate.

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TABLE 1
Comparison of business model components to other definitions

Source	value pro-position	strategy	customers	revenue model	value partners	value creation architecture	strategic resources
Alt/Zimmermann (2001)	value proposition	strategic goals	strategic focus	revenues	actors and governance	processes	-
Bieger et al (2002)	value system	communication concept	value system	revenue concept	cooperation concept	configuration of competences, organisation	core competences
Hedman/ Kalling (2003)	offering	offering	customers	-	supply of factor and production inputs	activities and organisation	resources
Hamel (2000)	core strategy	core strategy	core strategy	customer interface	value network	strategic resources	strategic resources
Mahadevan (2000)	value stream	-	-	revenue stream	-	logistical stream	-
Morris et al (2005)	products and services	competitive strategy factors	market factors	economic factors	-	value chain architecture	internal capability factors
Osterwalder et al (2005)	value proposition	-	target customer	revenue model	partner network	value configuration	core competency
Shafer et al (2005)	value proposition, offering	strategy	customer	capture value	value network	processes	resources
Stähler (2002)	value proposition, products or services	-	market design	revenue model	external value architecture	internal value architecture	internal value architecture
Timmers (1998)[14]	potential value	marketing strategy	-	sources of revenue	architecture	architecture	-

[14] This overview refers to Timmers' (1998) definition of a 'marketing model'.

TABLE 2

Average growth rates for micropower businesses

	2001	2002	2003	2004	2005	2006e	2007 to 2010e
CAGR[15] solar thermal sample	12.6 %	10.2 %	18.0 %	16.0 %	28.1 %	26.5 %	21.8 %
n	*18*	*21*	*27*	*27*	*28*	*29*	*27*
For Comparison: CAGR of overall German solar thermal market (source: Sarasin 2006)	N/A	N/A	N/A	N/A	27.6 %	34.0 %	19.2 % (2007e)
CAGR micro CHP sample	14.8 %	24.8 %	17.5 %	11.7 %	12.0 %	36.0 %	29.0 %
n	*11*	*12*	*13*	*15*	*17*	*22*	*21*

[15] CAGR: Compound Annual Growth Rate

TABLE 3

Communication priorities and average historic and future growth rates

Communication priorities		costs important (1-2)			costs less important (3-5)		
quality important (1-2)	solar thermal businesses	2001-2005:	10.7 %	(n = 9)	2001-2005:	20.1 %	(n = 9)
		2006-2010e:	20.0 %	(n = 9)	2006-2010e:	27.5 %	(n = 11)
	micro CHP businesses	2001-2005:	18.1 %	(n = 9)	2001-2005:	8.7 %	(n = 7)
		2006-2010e:	22.6 %	(n = 13)	2006-2010e:	20.0 %	(n = 7)
quality less important (3-5)	solar thermal businesses	2001-2005:	n/a	(n = 0)	2001-2005:	15.7 %	(n = 8)
		2006-2010e:	n/a	(n = 0)	2006-2010e:	17.8 %	(n = 8)
	micro CHP businesses	2001-2005:	n/a	(n = 0)	2001-2005:	[32.5 %]	(n = 2)
		2006-2010e:	n/a	(n = 0)	2006-2010e:	[76.7 %]	(n = 3)

TABLE 4:

Geographical distribution of revenues in the sample (weighted average)

Share of revenues in	**Solar thermal sample**		**Micro CHP sample**	
	2005 (n = 34)	2010e (n = 34)	2005 (n = 25)	2010e (n = 25)
Germany	50.8 %	42.0 %	94.4 %	81.4 %
Austria	13.4 %	6.4 %	2.2 %	4.5 %
Switzerland	11.5 %	12.3 %	1.0 %	2.3 %
Rest of Europe	22.1 %	36.4 %	2.4 %	11.8 %
Rest of World	2.2 %	2.9 %	0.0 %	0.0 %

TABLE 5

Revenue share of different delivery configurations

Delivery configuration	Solar heating sample		Micro CHP sample	
	2005	2010e	2005	2010e
manufacturer → intermediary → installer → final consumer	13.5 %	13.5 %	15.3 %	16.5 %
manufacturer → wholesaler → installer → final consumer	32.8 %	31.1 %	8.9 %	13.1 %
manufacturer → installer → final consumer	32.6 %	29.4 %	38.7 %	34.4 %
manufacturer → energy supplier → final consumer	0.6 %	1.4 %	14.0 %	13.5 %
manufacturer → intermediary → final consumer	9.2 %	11.3 %	11.5 %	11.4 %
manufacturer → final consumer	7.2 %	8.9 %	11.6 %	11.1 %
other configurations	4.1 %	4.4 %	0.0 %	0.0 %

FIGURE 1

Business model components

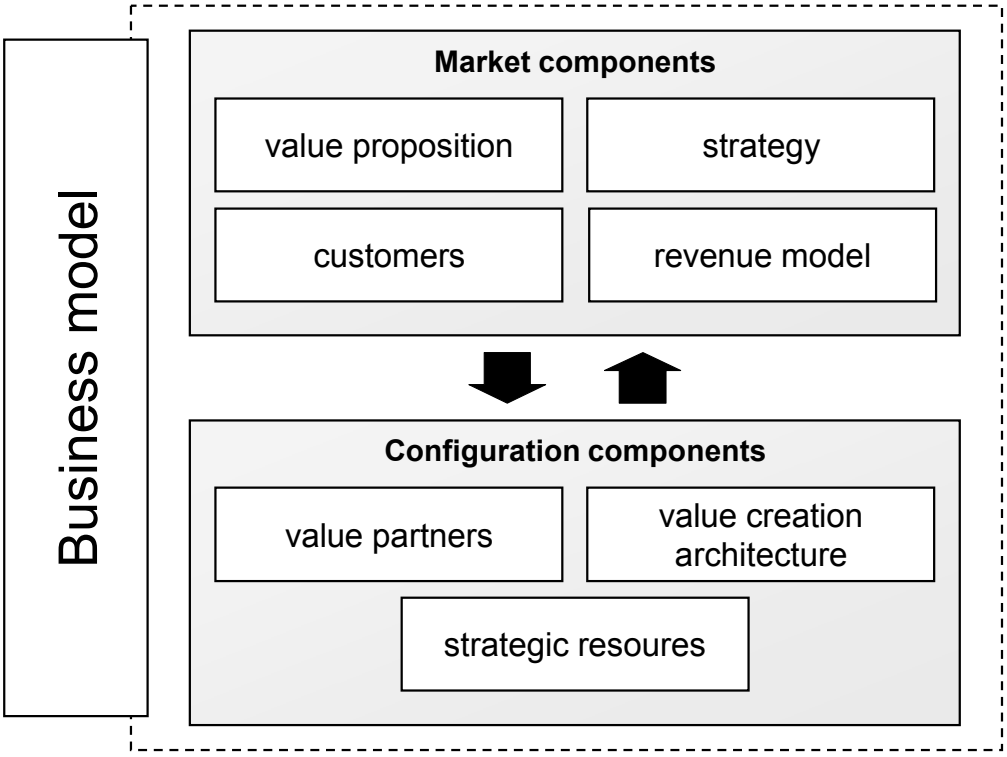


FIGURE 2

Importance of micropower attributes for different customer segments as perceived by solar thermal businesses

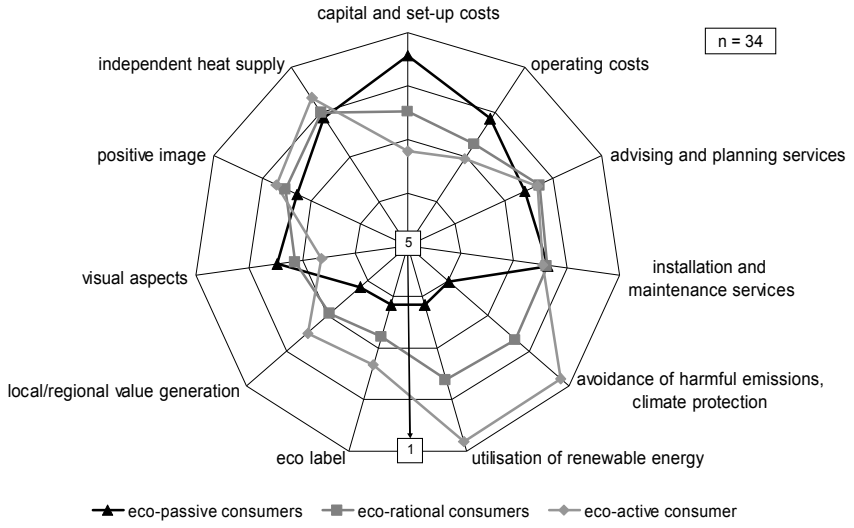


FIGURE 3

Importance of micropower attributes for different customer segments as perceived by micro CHP businesses

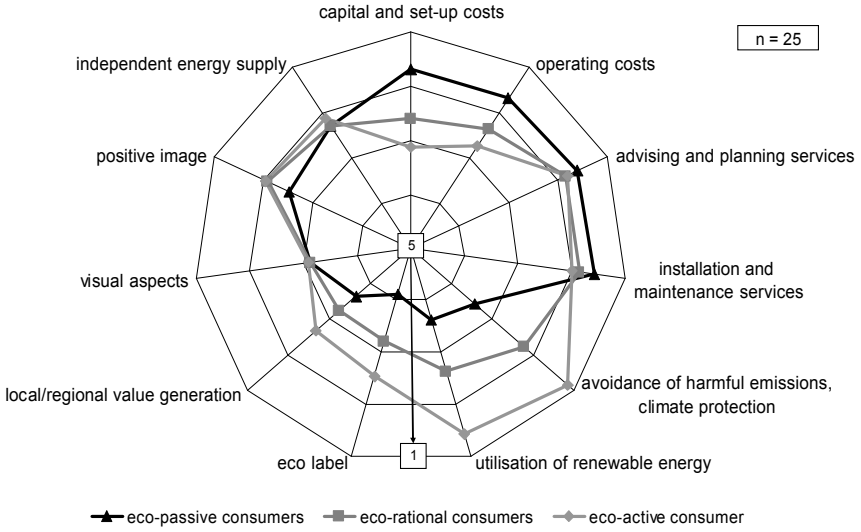


FIGURE 4

Revenue models of micropower businesses

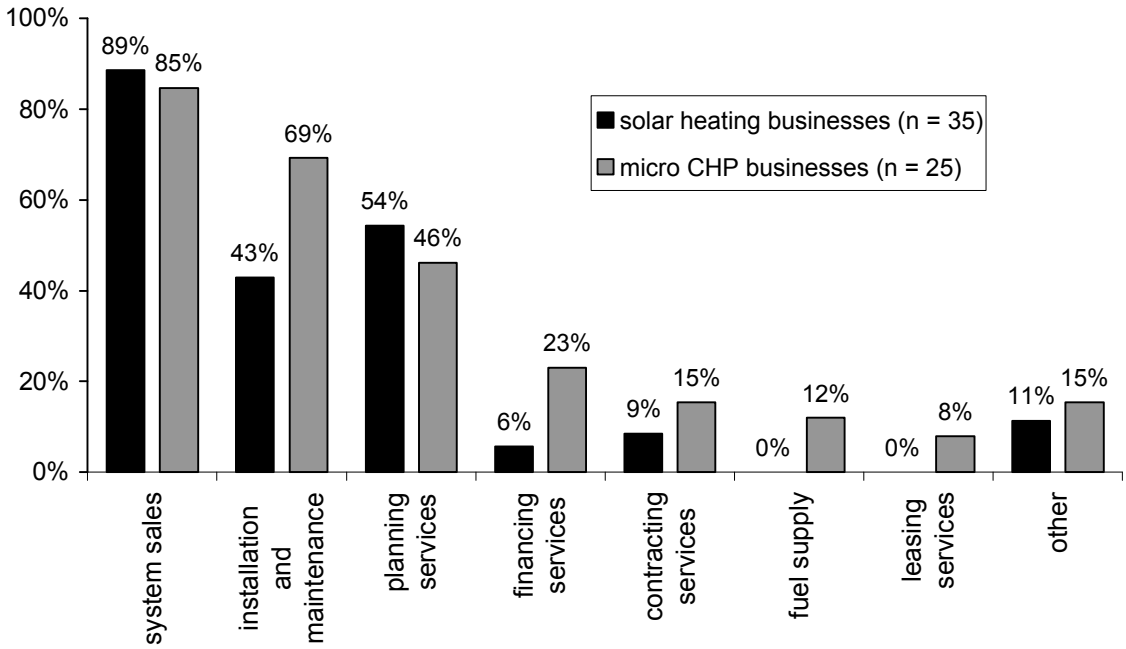


FIGURE 5

Success factors for micro CHP businesses as cited by respondents

