

MICROPOWER IN RESIDENTIAL BUILDINGS - AN ANALYSIS OF CUSTOMER PREFERENCES AND BUSINESS MODELS

presented at IAEE International Conference, Potsdam, June 7-10, 2006 (<http://www.gee.de/2006-IAEE/>)

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1. Introduction

One vision of future energy systems is based on an increasingly decentralized supply of electricity and heat in small-scale systems that are installed on the individual building level, which we refer to as micropower. Our understanding of micropower includes systems that provide electricity (such as photovoltaics), heat (such as wood pellet stoves, heat pumps, or solar thermal collectors) or both heat and electricity (micro-CHP, either based on natural gas or biomass). Our focus is on micropower systems that have lower environmental impact than incumbent technology, which tends to be oil heating and conventional electricity from the grid in most European countries. While the technological potential of micropower has been widely acknowledged and some policies are explicitly trying to support this market, the market adoption of micropower systems ultimately depends on customer decisions to buy them, and on adequate business models (Chesbrough and Rosenbloom 2002, Stähler 2001) for suppliers of micropower systems to successfully meet demand. Compared to other aspects of micropower, research on customer preferences and business models are two relatively underdeveloped streams of research. Our project uses a two-step approach to investigating customer preferences: In a first phase (which is the subject of this paper), we are using qualitative research methods (interviews and focus groups) to gain a comprehensive understanding of underlying attitudes and other factors influencing customers' buying decisions, while in a second phase, a quantitative survey (using conjoint analysis) will be conducted to assess the relative attractiveness of different systems. On the supply side of our research, we are investigating key aspects of successful business models.

Based on the findings of the first phase of our research, this paper aims at answering the following research questions:

- What are the attitudes, values and beliefs of Swiss residential customers towards various micropower systems?
- Which attributes of micropower systems are most relevant for customers' buying decisions?
- Who else plays an important role in the decision process for or against micropower systems, and what are the most relevant sources of information for preparing buying decisions?
- What are promising target segments for marketing various micropower systems to Swiss consumers?
- What different types of business models for micropower can be identified in the micropower market (with an emphasis on solar thermal collectors) and how successful are they?

2. Methods

The methodological approach for the two parts of our research distinguished above, namely the demand side (customer preferences) and the supply side (business models) of the micropower market, is described in this chapter.

On the demand side, the current paper reports on the initial findings from our qualitative research on customer preferences. At this point, we have conducted 12 individual interviews and 8 focus groups (with a total of 42 participants) with homeowners, tenants and installers in Switzerland and Germany. Focus groups, moderated group discussions around a given topic, have been widely used in marketing for various consumer goods (Morgan 1996, Krueger 2000). Research in the area of sustainable energy has only recently discovered this method, e.g. focus groups are found in research by social psychologists or scholars in science and technology studies on consumer preferences for green electricity (Wortmann 1996, Truffer, Bruppacher, Behringer 2001) or in the design of electricity disclosure labels (Tutt and Davis 1998, Markard and Holt 2003). The advantage of focus groups is that they provide information about emerging customer preferences for micropower systems, and also on the interactions between various consumers as

they form their attitudes and opinions towards new innovative micropower technologies. When using attitudes for the elaboration of recommendations the attitude-behaviour consistency needs to be checked. Consumers often do not behave consistently with their attitudes for several reasons (Perner 2004): Ability (he or she may be unable to do so), competing demands for resources, social influence, and measurement problems. Measuring attitudes is difficult. In many situations, consumers do not consciously set out to enumerate how positively or negatively they feel about products, and when a market researcher asks them about their beliefs about products, how important these beliefs are, and their evaluation of the performance of products with respect to these beliefs, consumers often do give socially desired answers. Thus, the consumers may act consistently with their true attitudes, which can only be uncovered by careful investigation. Focus group results do not provide for representativeness, they will provide a good basis for our following quantitative research.

On the supply side, the research presented in this paper is based on a survey conducted among players in one particular subsector of the micropower market, namely suppliers of solar thermal collectors. An e-mail questionnaire has been sent out to the executives of 311 manufacturers and retailers of solar heating equipment in Germany, Switzerland and Austria that were identified by internet research. Thus, it has been ensured that the sample represents a significant share of the market under consideration. The questionnaire was designed in a way that allows drawing conclusions on the different aspects of a business model as will be explained in the according section below.

3. Results

3.1. Customer preferences for micropower systems

As for our **demand-side** research, the main results include four aspects: consumer attitudes towards different micropower systems, hindering factors, aspects of the decision process (including information and buying habits), and the most relevant product attributes in consumers' buying decisions.

Hindering factors

Customer unawareness about renewable energy systems is one of the most important hindering factors. Most of our focus group participants knew only oil and gas based heating systems and heat pumps. Some mention solar, but cannot distinguish between solar thermal and photovoltaics. Wood pellets are not widely known. Very few mention micro-CHP, and almost nobody can explain how it works. Therefore we concur with similar market research that has been done in the US (Keane 2006) that there is a major lack of knowledge when it comes to understanding clean energy, and that this may constitute a serious barrier to market penetration of micropower. Another hindering factor for micro-CHP and photovoltaics in Switzerland is the considerable administrative effort in order to get the permission to sell and feed electricity in to the grid.

Attitudes: beliefs, affects and behavioural intentions

The analysis of **consumer attitudes** reveals a wide variety among customers and important differences between countries. Results are compared to those of similar focus group research carried out in Germany (Pehnt et al. 2004) and the UK (Jones 2003). For instance in Switzerland heat pumps have achieved 20 % market share in existing buildings and were being built into 72 % of all new single family houses in 2005 (FWS 2006)¹, but only 3.4 % in Germany (BDH 2006).

In this chapter insight into focus groups research is provided by looking at different statements of participants. Focus groups started with open questions such as: What do you associate with heating and power production systems in residential buildings? Participants were asked to write down and answer quickly in order to capture the most familiar and the most deep-rooted associations. An example of a cumulated association chain is the following:

Dependence from foreign countries, pollution, greenhouse effect, basic need, failure, comfort, price, wood, electricity, nuclear (a lot), hydropower (less), gas (even less) ... solar (nothing), heating oil (business as usual), wood (old fashioned and modern furnaces, local), electricity grid, hydropower in the mountains, service, network, local production, cogeneration etc..

Some citations for illustration:

L5 (engineer, 30): My father didn't want solar thermal panels, he said that would waste the aesthetics of the building. L3 (researcher, 35): But this is very subjective, it is a question of fashion.

¹ http://www.fws.ch/zahlen_04.html

S3 (engineer, 60): First you have to better isolate the building, then reduce the energy demand to a minimum and only in third priority chose a heating system, that's a procedure to follow.

L3 (researcher, 35): I am tenant, I can't influence the heating system at all.

L4 (former caretaker, 75): Each time I can make a difference for the environment, I do it, because there are only small differences.

The latter statement is very general and required further questioning, which interestingly revealed that the this person consumes 5000 litres of heating oil a year for a two person household.

Many statements illustrate that oil is no longer a socially accepted energy source for heating in Switzerland. Those focus group participants using oil heating almost apologized for it. By contrast, natural gas has a surprisingly good image and is seen positively as an efficient and clean energy source.

Many participants said they could imagine to use district heating or to share a heating system with neighbours. In terms of who would be an appropriate supplier for heat, most home owners expressed more trust in a governmental organization (such as the municipal utility) than in private companies. Sharing the heating system with neighbours is perceived as risky and problematic, especially when the initial partner moves out and contracts need to be renewed with new neighbours.

Asked about their preferences for green electricity, many participants were quite critical, pointing to the critical importance of eco-labelling and independent verification (Truffer, Markard and Wüstenhagen 2001).

L16: Why should I pay more for green electricity from hydropower for instance and basically get the same as everyone else? I mean who guarantees that the surplus I pay is really used to bring forward renewable energy production?

In summary it can be said that knowledge on micropower systems is limited. Presuming that there has probably been some self-selection bias during the recruitment of the focus groups, we must assume that participants were more interested than the overall population, and average knowledge might even be lower. Very few persons know what combined heat and power is and even less know that there exist already commercialized CHP-units for residential buildings. An important conclusion for power supply is that people do not really think about electricity. For most of the consumers the electricity supply is convenient as it is today.

Decision-making process - Information and buying decisions

In the Northern hemisphere heating and electricity is used for almost all human activities at home, from nutrition to hot water for personal hygiene. In Switzerland consumers spend about 360 Euro for heating supply and 250 Euro for electricity per capita every year (Bundesamt für Statistik, 2003). Together this makes up for about 2.5 per cent of the average budget per capita; in other European countries this share is higher (Eurostat 2001).

Consumer research studies how people make choices regarding a variety of products. Typically consumer research uncovers decision schemes that consumers routinely use to make choices and tends to generalize the populations relevant to the specific applications. In this paper we are interested in how house owners make choices among different micropower products and services.

This project focuses on house owners and on buying decisions concerning heating and electricity. To analyze consumer behaviour we use a theoretical framework based on the model of Hawkins et al. (1998) and we identified important actors and factors for the decision-making process.

A fundamental concept underlying this research is that all humans possess needs and desires, some of which can be satisfied through the purchase of goods and services. Consumer behavior is the study of individuals, groups, or organizations and the processes they use to select, secure, use, and dispose of products and services to satisfy their needs and the impacts these processes have on the consumer and society (Hawkins 1998). To frame the study theoretically, the model of consumer behaviour from Hawkins' et al. (1998) as presented in Andersen and Hansen (2004) has been adapted (cf. Figure 1).

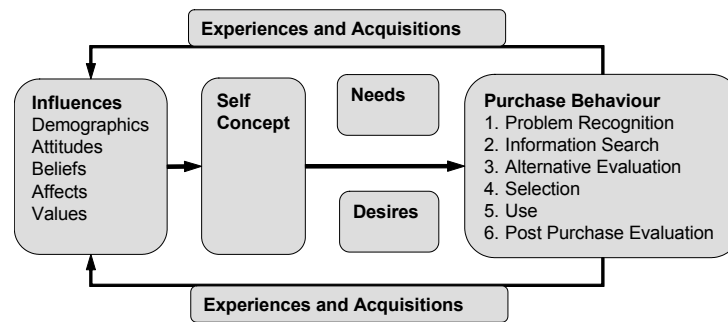


Figure 1: Theoretical framework adapted from Andersen and Hansen (2004) based on Hawkins et al. (1998)

According to the model, **needs** and **desires** drive an individual's purchase behaviour. Needs and desires are influenced by each person's self-concept, which in turn, is formed by influences in that person's life, i.e., values, beliefs, and attitudes. **Values, beliefs and attitudes** are influenced by numerous actors such as advertisement, friends, neighbours, family, campaigns, etc. As we gain life experiences our **self-concept** and lifestyle change based on what we have learned. Acquaintance, friends with experience in the field, family members and neighbours seem to have a important influence on the self-concept of the persons that participated in the focus groups or have been interviewed. However a focus group in Lausanne with many participants around 30 years old showed that sons had tried to influence the choices of their parents as far as micropower systems are concerned. The majority did not succeed and parents bought the same system as they already had before.

Needs could be a convenient room temperature, hot water and desires are probably best summarized in the following section on attributes of micropower systems relevant for consumers. As far as the **purchase behaviour** is concerned, several steps can be differentiated. The first step is the problem recognition. As stated by many of the persons participating in the focus groups, it must be distinguished between new buildings and owners of existing houses. In the planning phase of new buildings, almost all kinds of micropower system can be considered while refurbishing of existing buildings implies some constraints and is more complicated. For instance a replacement of an existing radiator heating system by a heating system using heater mat entails heavy reconstruction activities. Additional system components such as solar thermal systems for hot water and photovoltaic panels are less complicated to install on existing buildings than central heating and combined heat and power units.

For the analysis of information and buying decisions the available time for the second step towards the purchase, the information search, is of relevance. Information sources mentioned in focus groups and interviews range from neighbours, friends, family, colleague from work, fairs, and independent energy consultants to commercial companies (cf. Figure 2).

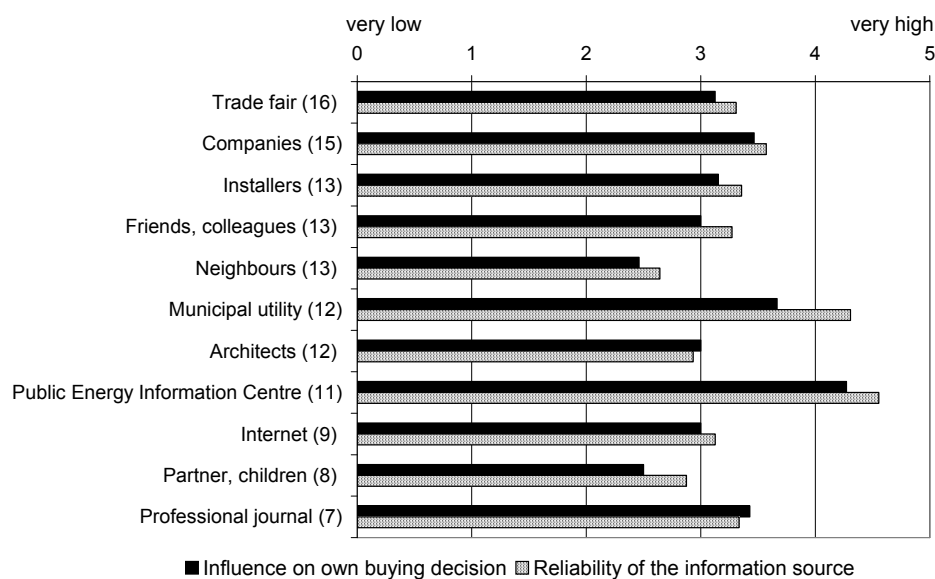


Figure 2: Information sources influencing the buying decision for micropower (numbers in brackets indicate frequency of consideration of the specific source, N=23)

The analysis of statements of 19 Swiss house owners and 4 tenants shows that the most frequently considered sources of information for preparing buying decisions are trade fairs, companies and installers, friends, colleagues, and neighbours, municipal utilities and public energy information centres. Internet sources are commonly used by younger

persons. Asking for the perceived reliability of information sources, it is striking that municipal utilities and public energy information centres appear to be by far the most trusted sources. On the other hand, architects and professional journals are also seen as relatively important sources of information, but people perceive information provided by them as less reliable.

In the case of a failure in cold days when heating is a constant need, the available time for the information search is very short and customers will tend to buy the new version of the product they had before and they know. Another reason for the replacement of a central heating system and a combined heat and power unit is the non compliance with regulation and norms as they get older. In this situation there is no immediate constraint to change the system rapidly as in the case of the failure where people need a new system in order to get warm. If the reason for a replacement is a desire for a new technology with certain attributes, the available time for the decision making process increases. But even in these cases the decision process is short. Summarizing it can be stated that many participants expressed a clear wish for an independent energy information centre (such as a regional energy agency). Fairs did not really satisfy customers.

L4 (former caretaker, 75): If you go to Living&Gardening (fair) you get a dozen of offers and it's a fight, you don't know what to do, how to do it. There are thermal solar panels, different heating system, you check gas - it's a jungle and I don't know what to choose, what to do and in which direction to start.

As a third step of purchase behaviour, customers might look for one alternative evaluation. As energy consultants stated, customers rarely look for more than two offers from micropower system vendors.

According to installers and vendors the consulting process corresponds often to the selection process, the fourth step of purchase behaviour. This implies that selection normally does not take more than one to three hours and that customers easily accept the propositions of the vendor. This is a major difference to the selection of a car for instance, which has a shorter lifetime than micropower systems and a somewhat higher price. Therefore micropower products and services might not be considered high involvement products although the initial investment and the operating costs are high. In one of the focus groups the participants were asked to estimate their heating and electricity cost per annum. Even though participants of this particular focus group were well informed persons as far as energy issues are concerned and several even work in the energy sector, the estimations were not at all accurate. Typically enough people do not have real costs of heating and electricity in mind.

Experiences during the fifth and the sixth step of purchase behavior, use and post purchaser evaluation have a high influence on the next micropower system buying decision. Several participants reported their experiences and outlined the consequences for their next purchase. Good experiences are almost a guarantee that customers will ask the same vendor next time, whilst bad experiences increase the chances of competitors to sell their product.

Figure 3 illustrates general choice options for residential building owners with regard to their energy supply.

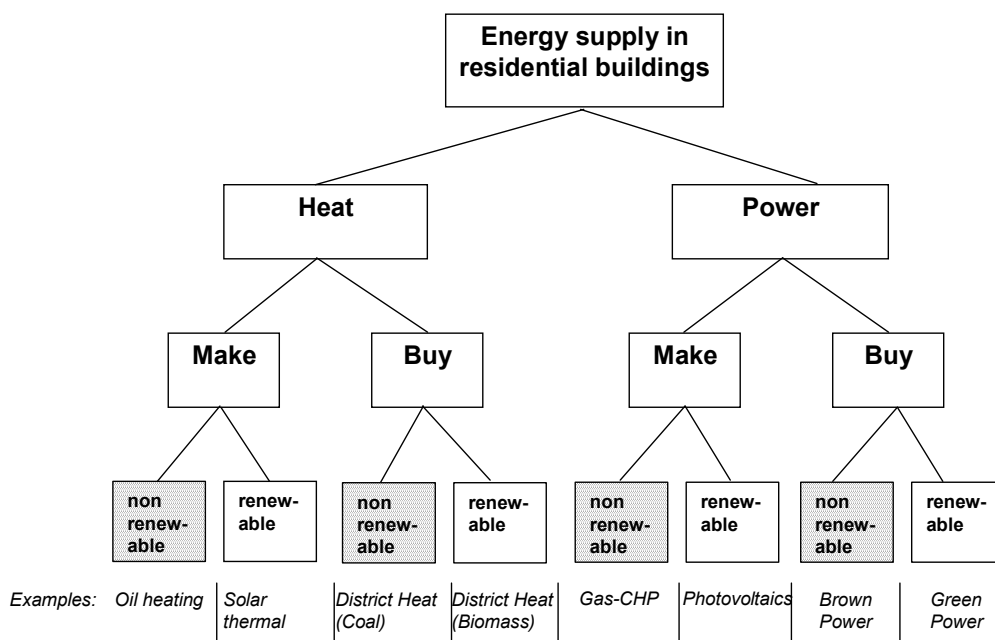


Figure 3: Choices in residential energy supply (adapted from Ziegler et al. 2005)

Attributes of micropower systems relevant to customers

In this section relevant **product attributes** of micropower systems with regard to consumers' buying decisions are listed and ranked.

We tested different procedures to identify the most relevant attributes of micropower systems in the focus groups conducted with home owners. In five focus groups a questionnaire was distributed and filled out at two points of time during the session. To capture the uninfluenced attributes in the beginning, participants had to list their expectation towards a micropower system when they arrived even before the start of the discussion. Towards the end of the discussion, they were asked to name the system they would buy, if they had to buy a system within the next week. Immediately thereafter, they were asked to list advantages and disadvantages of the chosen system. With this procedure we intend to avoid bias due to higher or lower social acceptance of certain attitudes. We assume that their could be a inconsistency between stated preferences for single attributes and real preferences when choosing and counterbalancing all the different attributes of a micropower system, analogous to the inconsistency between environmental awareness and environmental behaviour. Results of the analysis of the most relevant attributes are summarized in Table 1.

Group ID	St. Gallen 1	Lausanne	St. Gallen 2	Minfeld near Karlsruhe (Germany)
Participants	2 house owners 2 tenants	6 house owners 2 tenants	4 house owners	4 installers
Attributes mentioned by many participants	- Costs (4) - Environmental friendliness (3) - Ease of operation (1) - Reliability (1) - Oil price (1) - Fuel typeⁱ⁾ (2), Use of biomass (1)	- Costs (6) - Environmental friendliness (3) - Local productⁱⁱ⁾ (4) - Ease of operation (3) - Renewable energy (4) - Aesthetic (Solar panels) (3) - National independence	- Costs and cost evolution - Space requirements - Comfort (surface temperature, humidity) - Energy consumption - Fuel (heating oil, natural gas, geothermal energy) - Independence - Service (competent installation in order to guarantee reliability)	- Price (initial investment) - Energy-saving - Ease of operation - Imperceptible - Local trade
Attributes mentioned by few participants				

Group ID	St. Gallen 3	St. Gallen 4	Lausanne 2	Lausanne 3
Participants	5 house owners	4 tenants (women)	10 house owners	3 house owners
Attributes mentioned by many participants	- Costs (5) - Environmental friendliness (5) - Operating costs (3) - Cost-performance ratio (2) - Noise (1) - Ease of use (1) - Efficiency (1) - Safety (1)	- Costs (3) - Environmental friendliness (4) - Operating costs (1) - Ease of use (3) - Space occupied (1) - Reliability (1) - Efficiency (1) - Independence (1)	- Costs (8) - Environmental friendliness (9) - Operating costs (6) - Ease of use (5) - Space occupied (3) - Reliability (2) - Cost-performance ratio (2) - Efficiency (1) - Independence (1)	- Costs (3) - Space occupied (3) - Environmental friendliness (2) - Operating costs (2) - Cost-performance ratio (2) - Ease of use (1) - Efficiency (1) - Safety (1) - Independence (1) - Low emission level (1)
Attributes mentioned by few participants	- Low emission level (1) - Independence (1) - Space occupied (1)			

(): The number in brackets indicates the number of participants who considered an attribute to be most relevant their buying decisions.

ⁱ⁾ This attribute had been considered as one of the three most important for two participants but when it came to choose the three most important of all other attributes mentioned by participants, it was not any more considered as one of the three most important.

ⁱⁱ⁾ None of the participants listed this attribute as important before the discussion but at the end of the discussion four out of seven participants wrote down that this is a major advantage. This might therefore be an example that shows how participants can influence each other.

Table 1: Most important attributes of micropower systems identified in eight focus groups

In all focus groups, cost was the attribute that was mentioned by most of the participants. Additionally it has been chosen the most important attribute by many participants. Installers believe that private customers do not calculate life-cycle cost, taking into account operating costs, but that instead they are very much focussed on upfront cost of the micropower system. While several of the residential customers argued that environmental aspects are an important attribute for their buying decision, the four installers in the German focus group perceived the opposite, namely that

environmental aspects do not play an important role when it comes to taking actual buying decisions. According to them, the choice of the company or the installer by customers is based on recommendations by other persons. Additionally customers may prefer local installers, because they assume that in case of problems with the micropower system, it might be fixed more rapidly.

When comparing the presented attributes to findings of Pehnt et al. (2006), who surveyed pioneering customers participating in a fuel cell field test in Germany, we find that there are both similarities and differences. In Pehnt et al.'s sample of pioneers, reliability was mentioned as the most important attribute of micropower systems, which was less explicitly stated in our focus groups. However, several respondents alluded to the inconveniences that a failure of their heating system on a cold winter day would cause, therefore indirectly pointing to the importance of reliability. Environmental aspects such as energy efficiency, low pollution and climate protection were ranked highly in the fuel cell survey as well as in our sample. A remarkable difference is that the German pioneer customers surveyed by Pehnt et al. explicitly stated that low operation costs were very important for them, while low capital costs was considered significantly less important. This might indicate an interesting difference between the innovators, who actually consider costs more comprehensively over the life-cycle of the micropower system, and the mainstream consumers in our sample, who are primarily concerned with upfront cost. If this preliminary result holds true, then it should show in our future quantitative analysis as an interesting differentiating element between early and later target segments. It would also indicate that new financing solutions that would lower upfront cost might be effective for mainstream consumers, but less so for pioneers.

Conclusion on customer preferences for micropower systems

Some of our key findings of focus groups so far can be summarized as follows:

- Average Swiss customers are relatively uninformed about aspects of heating supply of their homes, and are even less informed about aspects of electricity supply. The connection between heating and electricity is rarely made, which may constitute a strong barrier to diffusion of micro CHP systems.
- Buying decision processes and criteria for heating systems differ between two typical situations, namely an emergency replacement of the existing boiler, and a more planned search for a new system (mainly in the case of new buildings, but to some extent also in the refurbishment market). In emergency replacements, which account for a large percentage of buying decisions, customers tend to be conservative and often choose the same system as before. The new building market is a more promising route for innovative micropower systems.
- Architects and installers play a key role in influencing buying decisions, and many homeowners expressed their preference for getting independent advice in their decision process (e.g. by regional energy agencies).
- Among different micropower systems, heat pumps and solar thermal collectors are relatively popular in Switzerland, while micro-CHP technologies are less present in customers' minds and their value proposition is not immediately clear to many of them.

3.2. Business models for solar heating

Up to now, micropower only accounts for an insignificant share of the market and is hardly noticed as an alternative for residential energy provision at all. This lack of interest may, at least in part, stem from the facts that current value propositions do not appeal to consumers and that businesses still have to struggle seriously to generate substantial profits. If micropower technologies are to make a significant contribution to a shift towards more sustainable energy supply systems, it is essential to develop proper business models that work. This holds especially for businesses that deal with final consumers or their advisers as failure in market penetration can be attributed to a lack in consumer demand for micropower products. If consumers increased their demand for residential generation, this would be passed on along the value chain. With a questionnaire-based survey, this part of the paper intends to provide empirical insights into existing business practice and draw conclusions regarding potential success factors for business models in the market for solar heating systems. Among all micropower businesses, those in the solar heating industry are probably the ones best suited for a more quantitative analysis. In comparison to other micropower technologies, solar heating systems are quite well developed, and companies have been actively marketing them on a larger scale for a number of years now so that there is sufficient experience in the market for a quantitative overview. Furthermore, solar heating is used almost entirely for small scale applications, ie residential or small commercial buildings.

Data for the survey was collected by sending out questionnaires via e-mail to the executives of 311 different companies identified by internet research as being active in the German, Swiss and Austrian solar heating markets. For the most part, these companies comprise manufacturers, wholesalers, retailers, planners and installers. The questionnaire-based research used in this survey enables to cover a broad range of companies in the market under consideration. Furthermore, the questionnaire represents a well-structured high level approach to business model

analysis and thus ensures good comparability of the results. It also sets a strict focus on the solar heating businesses of the addressed companies. In this way, it is possible to draw quite reliable conclusions about business model components and common constellations in the solar heating market. Altogether, 60 companies responded to the survey. Of these, 23 explicitly refused to fill in the questionnaire. So, 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 (cf. for example Porter and Whitcomb 2003). The final sample for the analysis consists of 22 German, 13 Swiss and 2 Austrian businesses. 25 % of the sample companies are strongly diversified firms with solar heating being only one small part of their activities. In contrast, 19 % concentrate exclusively on the solar heating market. The sample 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. On average, the solar heating businesses generated an annual turnover of around EUR 3 million in 2005 and employed 26 persons by the end of the same year.² For the years between 2001 and 2010, the average expected annual growth of revenues is in the order of 26 %.³

The analytic framework for investigating the survey's results is the business model concept which, in recent years, has become increasingly popular in management theory and practice as a tool for examining commercial structures and processes (Magretta 2002, Osterwalder et al 2005, Shafer et al 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/Kalling 2003, Osterwalder et al 2005, Stähler 2001). The market components of a business model define how a firm delivers value and include the *value proposition* to customers and final consumers (Mahadevan 2000, Stähler 2002), the business *strategy* (Bieger et al 2002, Morris et al 2005), the targeted *customers* (Hedman/Kalling 2003, Stähler 2002) and the *revenue model* (Alt/Zimmerman 2001, Timmers 1998). The configuration components of a business model describe how a firm creates the value it derives its revenues from and include *value partners* (Bieger et al 2002, Osterwalder et al 2005), the *value creation architecture* (Alt/Zimmermann 2001, Hedman/Kalling 2003) as well as *strategic resources* (Hamel 2000, Hedman/Kalling 2003). The analysis of the survey in the paragraphs below attempts to capture the most important aspects of all the business model building blocks mentioned above.

The **value proposition** of a business is of utmost importance. It is the key to revenue generation as it gives consumers a reason to opt for solar heating systems and become micropower users. As a consequence, it is vital for solar heating businesses to design their offering in accordance with consumer preferences. In the first part of this paper, preferences were investigated from the consumer point of view using a focus group approach. This part takes the business perspective and shows how managers perceive different consumer groups. In the survey, three groups were distinguished: consumers that actively seek environmentally beneficial products ('eco-active'), consumers that view environmental aspects and cost-related aspects as equally important ('eco-balanced') and consumers that do not consider environmental aspects to be particularly relevant ('eco-passive'). For each of these groups, survey participants were asked to estimate the importance of different aspects on a five-point scale ranging from 'highly important' (1) to 'unimportant' (5). An aspect that seems to be very important to all three groups alike is that solar heating systems facilitate independent heat supply (with average values of 1.7-2.1). Furthermore, advising and planning services (2.3-2.6) as well as installation and maintenance services (2.4) are perceived to be equally important for all three consumer segments. This holds also for another aspect, the positive image associated with owning a solar heating system (2.3-2.7). Not surprisingly, suppliers perceived 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 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, and in accordance with the finding by Pehnt et al. (2006) reported above, eco-active consumers are the only ones who are considered to view operating costs (3.0) as being more important than upfront costs. 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. 85 % of the survey participants consider the group of eco-actives to accept payback periods in excess of 10 years. 33 % think that eco-balanced consumers as well accept at least ten years, and 15 % even expect eco-passive consumers to do so. All in all, eco-active consumers seem to perceive all criteria as more important than the other two groups – with the exception of costs and visual aspects. This leads to the conclusion that they generally show greater care in their purchasing decisions. The preference profiles of the three different consumer groups as perceived by survey participants are illustrated in the figure below. 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. If businesses find a way to offer environmentally beneficial solar heating systems with low initial capital and set-up costs, they stand a good chance of being able to recruit customers from all three consumer groups.

² Only 25 businesses provided turnover figures. Numbers of employees were revealed by 30 firms.

³ 31 firms provided growth figures. For the 25 companies that disclosed their revenues, the weighted average growth rate in this period is 25 %.

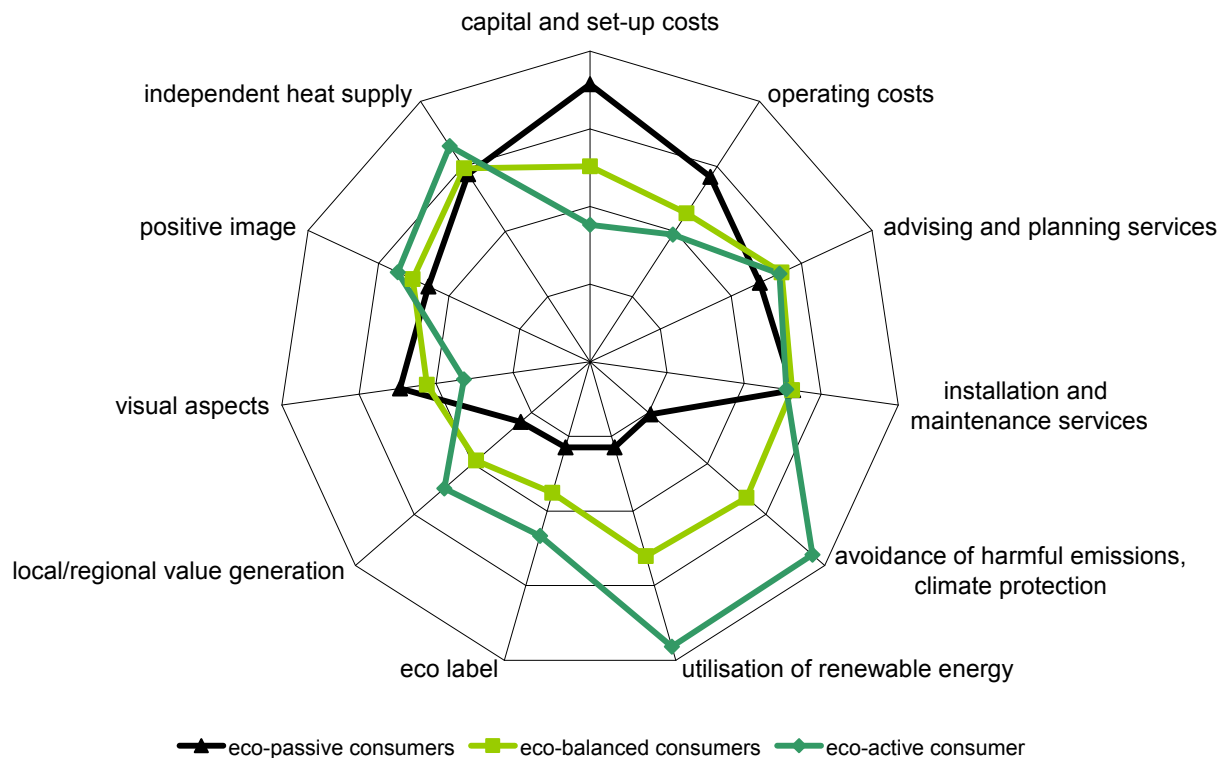


Figure 4: Importance of different aspects for three consumer segments (as perceived by suppliers)

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). While 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). 71 % of the respondents rated quality as highly important (1) or important (2) in their communication activities whereas, for costs, just 34 % did so. Only one of the sample companies puts more emphasis on costs than on quality in its communication.⁴ In general, companies tend to view quality aspects as considerably more promising with regard to an appealing value proposition. This is also confirmed by a comparison of growth figures.⁵ Businesses that regard quality aspects as important in their communication expect an average growth rate of 21 % between 2001 and 2010. Businesses that regard costs as important in this respect expect an average growth rate of 15 % between 2001 and 2010. As verified by the table below, there seems to be an obvious trade-off between quality and costs. Businesses that concentrate on quality exclusively outperform those who concentrate on costs as well as those who treat both, quality and costs, as equally important.

Average growth rates as a function of communication priorities		Cost			
		important (1; 2)	n	less important (3; 4; 5)	n
Quality	important (1; 2)	15.4 %	10	26.2 %	11
	less important (3; 4; 5)	n/a	0	16.6 %	9

Table 2: Average growth rates (2001-2010) for businesses with different communication priorities

Closely connected to a business's value proposition are **strategy** issues. It is essential that the chosen strategic direction helps to fulfil the proposition made to consumers. Inconsistencies may become major obstacles to revenue

⁴ This is backed by another observation: when asked about the selling proposition of their business, 24 respondents mentioned service-related aspects, 12 respondents mentioned product-related aspects, and only 2 respondents mentioned cost-related aspects.

⁵ One company with extreme growth expectations is excluded from all further considerations related to revenue growth in order to enhance coherence.

generation. While above, the importance of quality and costs in communication was investigated, this paragraph takes a closer look at the actual importance of these aspects in strategic planning and daily operations. Both, quality as well as costs, appear to be more important in the business's actual activities than in its communication. With an average importance of 1.5, quality dominates costs (2.1) in this case as well. The share of companies that perceive quality as highly important (1) or important (2) for their business conduct amounts to 83 %. For costs, the respective share still is 60 %. 46 % of the sample companies place a higher emphasis on quality than on costs, 43 % treat the two equally and only 12 % focus on costs. These results are consistent with the findings above in that quality issues are obviously more important to solar heating businesses than costs. Businesses that regard quality aspects as important for strategy formulation have an estimated average growth rate of 21 % between 2001 and 2010. Businesses that regard costs as important in this respect expect an average growth rate of 19 % between 2001 and 2010. The table below shows that a strict focus on quality is perceived as the most promising option regarding the formulation of the business strategy, too.

Average growth rates as a function of strategy priorities		Cost			
		important (1; 2)	n	less important (3; 4; 5)	n
Quality	important (1; 2)	19.5 %	16	22.6 %	8
	less important (3; 4; 5)	(14.8 %)	1	16.9 %	5

Table 3: Average growth rates (2001-2010) for businesses with different strategy priorities

Businesses in the sample can also be investigated with respect to the question whether value proposition and strategy are consistent in terms of the relative importance of quality and costs. 71 % of the respondents show consistent priorities in communication and strategy. The average revenue growth rate of these businesses between 2001 and 2010 is 21.5 % (weighted growth rate: 26.0 %). In contrast, the businesses showing inconsistencies only reach an average growth rate of 13.9 % (weighted growth rate: 21.5 %). This is a sign that consistency is an important factor which should be duly considered in business model design.

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. Not a single business exclusively focuses on eco-active consumers. 32 % of the respondents target the group of eco-rational consumers while the remaining 68 % address the eco-passive mass market. In terms of geography, 41 % of the sample companies generated 100 % of their turnover in the year 2005 in their respective home countries. However, some firms plan to internationalise their commercial activities in the near future so that, for the year 2010, this figure can be expected to decrease to 35 %. The weighted average geographical distribution of revenues in the sample for the years 2005 and 2010 is shown in the figure below. In 2005, the lion's share of the sample's revenues was generated in Germany (51 %). Austria and Switzerland only accounted for 13 % and 12 %, respectively.⁶ In the years to come, other markets in Europe seem to be more attractive as can be seen from the expected shift in market shares. The decreasing share of sales to Austria indicates that this market may be nearing saturation. In fact, installed solar thermal capacity in Austria is about 1.960 MW_{th}, which is about three times as much as in Switzerland.

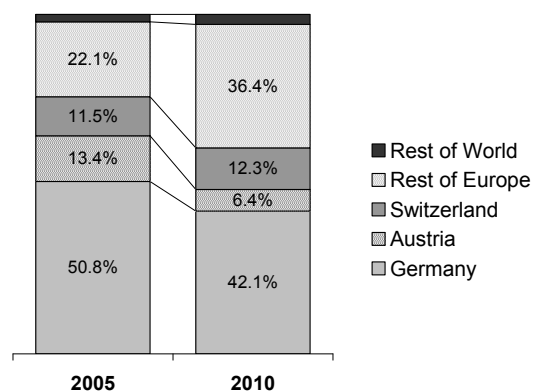


Figure 5: Solar thermal companies expect increasing internationalisation of sales by 2010 (percent of revenues by country, weighted average)

⁶ As our sample included 13 Swiss but only 2 Austrian companies, and assuming that a large part of current sales is in domestic markets, this points to the relatively smaller market share of solar thermal energy in Switzerland.

The **revenue model** has to be considered one of the crucial components of a business model as it describes how the value delivered to the market is translated into sales revenues and, ultimately, profits. It therefore secures the economic bottom line of a business. As can be seen from Figure 6 below, 89 % of the sample businesses generate at least part of their turnover simply by selling solar heating systems. A mere 6 % derive income from offering financing solutions to their customers. Only little more popular, heat contracting is another source of income, tapped by 9 % of the respondents. More common ways to generate revenues in the solar heating market are installation and maintenance as well as planning services, which are performed by 43 % and 54 %, respectively. As this overview shows, very few businesses exploit the opportunity to reduce initial costs for the final consumer – a major barrier to a wider diffusion of solar heating systems. Instead, the traditional ways of revenue generation in the heating market dominate among the sample businesses.

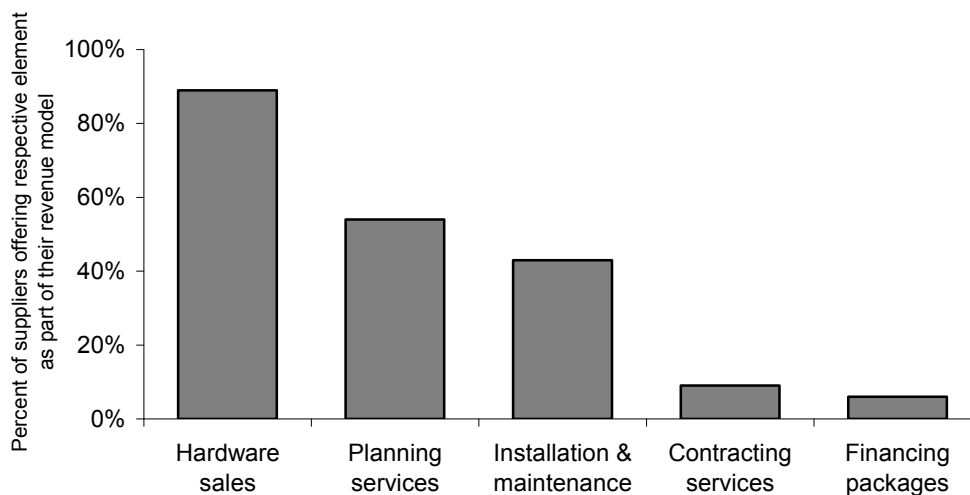


Figure 6: Revenue models are dominated by hardware sales, financing solutions rarely offered

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 solar heating, 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 sample businesses already cooperate with financial institutions, and an additional 26 % are planning to do so in the future. Together, these companies expect an average growth rate of 14 % between 2001 and 2010 whereas the remaining 60 % of the sample expect to grow by 24 % in the same period. This, too, is a sign that innovative services are not yet a key factor for successful commercial activities in the solar heating market.

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 value steps or integrates larger parts of its value chain. In the sample, 33 % of the companies are specialised and perform only one or a few value steps while 19% of the businesses show a high degree of integration. A comparison of average revenue growth rates shows that specialised and integrated businesses achieve similar levels of success with growth rates between 19 and 20 %. In designing the value creation architecture, solar heating businesses have to decide on how to deliver their product or service to the final consumer. In 2005, the sample businesses favoured two main delivery configurations. On average, they generated 33 % of their revenues via the traditional boiler delivery chain, where manufacturers sell their products to wholesalers who supply installers who set up the systems at consumer sites. Another 33 % of the revenues in 2005 were generated via a shorter version of this configuration that excludes wholesalers, which means that manufacturers directly supply installers. For the year 2010, it can be expected that the two configurations slightly decrease in importance as direct sales to consumers or sales via wholesalers/intermediaries may increase, indicating that traditional installers might be circumvented, which opens a door for a 'do-it-yourself' model of distributing solar thermal collectors. For 2005 and 2010, the actual and expected shares of the most important delivery configurations are shown in the table below.

delivery configurations	1. manufacturer ▼ 2. wholesaler ▼ 3. installer ▼ 4. consumer	1. manufacturer ▼ 2. intermediary ▼ 3. installer ▼ 4. consumer	1. manufacturer ▼ 2. installer ▼ 3. consumer	1. manufacturer ▼ 2. wholesaler/ intermediary ▼ 3. consumer	1. manufacturer ▼ 2. consumer
share in 2005	32.8 %	13.5 %	32.6 %	9.2 %	7.2 %
share in 2010	31.1 %	13.5 %	29.4 %	11.3 %	8.9 %

Table 4: Installers are currently key gatekeepers in the distribution channel, but their importance may decrease

Strategic resources are unique sources of value that cannot easily be copied by others. A business's core competences play a major role in this respect. Therefore, survey participants were asked to name their key strengths. 69 % of the respondents highlighted exceptionally friendly and competent service as a special quality of their business. 34 % noted that extraordinarily well-designed products set them apart from competitors. Only two companies in the sample listed competences that effect a reduction of costs for the final consumer. Apparently, superior service quality seems to be a prerequisite for commercial activities in the solar heating market.

The results of the survey discussed in this part of the paper reveal some interesting insights. As regards the value proposition for eco-passive consumers, who basically constitute the mass market, survey participants view low initial costs as the most important attribute, closely followed by the prospects of an independent heat supply and low operating costs. More ecologically oriented consumer groups regard other criteria like environmental benefits as more important. The fact that costs are not the only determinant for consumers is reflected in marketing communication, where the more successful businesses lay emphasis on quality rather than on costs.⁷ Similarly, companies that consequently focus on quality aspects in their strategic decision-making tend to outperform those with other priorities. Consistency between value proposition and business strategy also seems to be a key success factor. With respect to customers, most companies in the sample target the mass market, ie they recruit their customers from all consumer groups and do not specifically concentrate on the eco-niche of the market. In terms of geography, most businesses only serve their respective home markets in Germany, Switzerland or Austria. However, this is expected to change in the future with other European markets becoming more relevant. The companies in the survey mainly rely on traditional ways to generate revenues as innovative revenue models based on financing or contracting services do not yet seem to pay off. Likewise, very few businesses engage in value partnerships with banks or other financial institutions in order to offer their customers concepts to reduce initial set-up costs. The value creation architectures of the sample businesses are also rather traditionally shaped: the majority of systems are marketed via the conventional boiler delivery chain. As far as strategic core competences are concerned, the most cited key strength by far is superior service quality. To round it up, Figure 7 shows what survey participants themselves consider to be key success factors for business models in the solar heating industry. 24 respondents view product quality as the most important prerequisite for success in the market. A fair price was named by 17 respondents. Only one respondent referred to the availability of financing services, sharing the lower end of the ranking with providing consumers with performance measurement systems. Comparing this with other industries, we would not be surprised to see the importance of such value-added services increase significantly over time as the solar thermal industry matures.

⁷ This must, in part, also be attributed to the fact that solar heating systems generally have high upfront costs in comparison to conventional heating technologies so that competing with a low cost strategy beyond the market for solar heating is difficult.



Figure 7: Success factors for business models in the solar heating market as perceived by suppliers

The research presented in this part of the paper suffers from several technical and practical **limitations**. The former mainly result from the high level approach of the questionnaire-based analysis. Oftentimes, differences between business models can only be detected by taking a close look at crucial details (Linder/Cantrell 2000). Those, however, cannot be fully captured by a standardised questionnaire. Likewise, the value partner component of a business model and the highly individualistic design of associated interfaces escape the questionnaire's scope. Another technical shortcoming is that growth and revenues may not be sufficient measures to quantify success. After all, the definition of success depends also on the observer. Practical limitations of the research are mostly related to the sample investigated. First of all, the survey suffers from a survivorship bias: questionnaires can only be filled in by businesses that are successful to a certain degree; failed business models are therefore missed out. A deterioration of the results could also be caused by a sample that is not representative for the whole industry. Finally, although being rather mature in comparison to other micropower markets, the solar heating industry is still young in absolute terms, which makes it difficult to evaluate successfulness over the long term. In the end, this may also lead to neglect of the true potential of innovative business model configurations.

4. Conclusions

This paper has reported on intermediate results of our research project on micropower in residential buildings, which aims at providing fresh insights by adopting a marketing perspective to this area of research. On the demand-side, our results from focus groups help to add the voice of "the ordinary customer" to a debate that has traditionally been dominated by technical experts. This demonstrates that technologies that are well-established in expert circles, such as micro-CHP, fail to meet the expectations of mainstream customer segments, who perceive electricity and heating as two separate issues. This may partly explain why micropower technologies that produce either heat (such as wood pellets, solar thermal or heat pumps) or electricity (such as photovoltaics) have more successfully penetrated the market than CHP. Also, our results indicate that upfront cost is what many homeowners are mainly concerned about, and that systems with higher upfront cost but lower operating cost are often refused by customers. Finally, we could give some first hints for market segmentations, indicating that the various micropower technologies might appeal to different groups of customers.

On the supply-side of the micropower market, based on a survey of companies in the solar thermal energy sector, we found confirmation for the idea that different market segments value different product attributes, once again highlighting the need for proper segmentation strategies. We could also demonstrate that suppliers differ with regard to their positioning in the price and quality dimensions and also give evidence for their plans to increasingly internationalize their business. In terms of innovative revenue models, the solar industry seems to be in a very early stage, where the dominant paradigm is to generate revenues from selling hardware (i.e. solar collectors). New solutions, such as financing packages or contracting services, are only offered by 6% and 9% of firms, respectively, which is puzzling given the importance of lowering upfront cost as shown by our consumer research. Another aspect that deserves further scrutiny is the shift from the traditional installer-centered distribution model towards direct sales, which was expected by some of the respondents. How this move towards solar collectors as do-it-yourself-type equipment can be matched with consumer preferences for convenience is an interesting question for our further research on the demand-side of the market. Also, a technology-by-technology approach seems to be fruitful, given the strong differences in technological features, segment-specific appeal and market structures across different micropower technologies.

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