Energy Efficiency (2015) 8:827–843
DOI 10.1007/s12053-014-9300-8

ORIGINAL ARTICLE

Pioneering customers as change agents for new energy efficiency services—an empirical study in the Finnish electricity markets

Kaisa Matschoss · Nina Kahma · Eva Heiskanen

Received: 21 February 2014 / Accepted: 8 September 2014 / Published online: 23 January 2015

Abstract Energy companies are in dire need of new business models that bring revenues from energy services rather than from increasing energy use. Smart meters and grids offer new opportunities for such services. However, there is a lack of research on what the market potential of such services could be in end-user markets. Certain innovative consumers are more likely to be the first to test new technology-based services and engage in new service co-creation. However, identification of such innovator or lead user customers is difficult especially for electricity end-use efficiency, an invisible and unexciting service for most consumers. This article identifies pioneering customers for novel energy efficiency services offered by electricity providers in terms of psychological factors from an empirical data collected with a consumer survey in spring 2013. We also analyse the similarities and differences between pioneering customers and the mass market with the principal component analysis. We find that certain characteristics of pioneering customers (expertise, ahead-of-the-market needs) could become more widespread in the market due to rising energy prices and improved billing and metering. However, some other aspects contributing to innovativeness (such as experimentalism) are less likely to develop among average consumers, who are more likely to rely on leading companies and seek recommendations from peers before obtaining new services. These differences among consumers need to be taken into account in order to offer consumers usable and useful products and peer group-relevant marketing.

Keywords Energy efficiency · Services · Innovators · Lead users · Market potential

K. Matschoss (✉) · N. Kahma · E. Heiskanen
Consumer Society Research Centre at the University of Helsinki,
P.O. Box 24, 00014 Helsingin yliopisto, Finland
e-mail: kaisa.matschoss@helsinki.fi

N. Kahma
e-mail: nina.kahma@helsinki.fi

E. Heiskanen
e-mail: eva.heiskanen@helsinki.fi

Introduction

This article explores the market potential of energy efficiency services among consumers in Finland, with a focus on services provided by energy companies. European energy suppliers, in particular, are in dire need of new business models considering the requirements in the Energy Efficiency Directive (EED 2012) and the looming future shift to a low-energy and distributed energy system (European Commission 2011). New services, products and product–service packages for improving energy efficiency are enabled by new smart grid technologies. These services are often based on data on customers' real-time consumption, such as monitoring real-time electricity use through displays or remote control of electricity consumption. These services are now emerging in the electricity markets and therefore, there is a great need for research on the size and nature of the potential demand for such services. Since 75 % of GDP in advanced economies today is derived from services (Oliveira and von Hippel 2010), studying service

development in general, and especially in energy markets, has a high priority.

New "smart" (i.e. ICT-enabled) services can promote energy efficiency by offering consumers feedback on their energy consumption, which has been shown to lead to an average reduction of about 7 % in energy consumption in an extensive meta-analysis by Delmas et al. (2013). Automated control devices (e.g. home energy management systems) can make it easier for consumers to turn off appliances and systems when not needed, or in peak electricity consumption periods. However, it is not self-evident that smart services are the most effective way to reduce consumption. Thus, electricity companies might also explore other forms of service delivery, such as personal advice and energy audits, or services providing consumers with energy efficient equipment (e.g. LED lighting or heat pumps) or equipment for on-site electricity generation.

There is a wealth of research on the difficulties of marketing energy efficiency to ordinary consumers. Electricity is an infrastructural service that does not offer direct benefits to customers; benefits arise from using electricity in various appliances or for heating (e.g. Wilhite et al. 2000). Services for energy efficiency improvements are a challenging topic also for other reasons: conventionally, energy efficiency identified with energy conservation, which for many people, automatically means reduced comfort. Few people are interested in buying services that they imagine causing discomfort. Moreover, the average consumer's knowledge about electricity is very limited. Consumers rarely know how much electricity they consume and rarely have a high level of expertise or involvement in electricity (Fischer 2008). Much of this lack of interest attributes to the historical characteristics of the electricity market (van Vliet et al. 2005). As market conditions change, so can consumers' needs. Advanced billing and metering, an overall increase in the provision of energy advice and societal debate on energy, and the rising price of energy are expected to increase consumers' interest in services for energy saving (Darby 2006; Klopfert and Wallenborn 2011). Better feedback enables households to learn about their energy consumption and, therefore, might lead to incremental changes in energy consumption (Fischer 2011).

There is some emerging research suggesting that some consumers might be forerunners of the more engaged energy consumer of the future. Studies of smart metering use suggest that some consumers are more likely to have an interest in energy efficiency services than others (Hargreaves et al. 2013; Wallenborn et al. 2011; Klopfert and Wallenborn 2011; Gangale et al. 2013). Consumers with needs that precede those commonly encountered in the market could hence offer a lead market or serve as lead users for launching and co-developing new services (Heiskanen and Matschoss 2012). In emerging markets with only few consumers, early consumer research, also by necessity, draws on the experiences of pioneering users of novel energy-related services (Caird et al. 2008; Pierre et al. 2011).

However, in the market for smart electricity services, there is still very little research on who could be the pioneering or lead users, and equally importantly, whether experiences gained when working with such pioneering users can readily be transferred to the mass market. Innovation theory suggests two slightly contradictory perspectives. More generally, it has become increasingly common to work with pioneering "lead users" in new product development (von Hippel 2005). However, innovation diffusion theory (Rogers 1995; Moore 1991) suggests that later adopters of an innovation might be qualitatively different from the innovators and early adopters. We build on this framework in our study to examine the structure of the potential energy efficiency service markets, identifying promising pioneers or "lead users" and their similarities and differences with the rest of the market. In an analysis of a nationally representative survey data, we study the factors that explain consumers' level of interest in certain energy efficiency services.

In this article, we first present the theoretical framework of innovation diffusion theory and lead user theory relevant to the empirical analysis. In the evaluation of the business potential of energy efficiency services, our research questions are the following: (a) what characterizes consumers who are particularly interested in novel (smart) energy efficiency services provided by electricity companies (i.e. pioneers), and (b) to what extent and in what respects are these characteristics of pioneers similar to or different from the characteristics of the majority of less interested consumers? We identify seven psychological factors that relate to the respondents' interest in novel energy efficiency services using principal component analysis (PCA). The psychological factors can be compressed into three factor measures representing three orientations in the energy market *leaduserness, following the mass market* and *scepticism*. Finally, we discuss the novelty value of the results and

their implications for service development and for future research.

Theoretical background: the lead user construct and technology diffusion theory

The market for new energy efficiency services does not yet truly exist and this is why it is important to understand the structure of the potential market. We build our analysis on lead user theory by Eric von Hippel (2005) and innovation diffusion theory by Everett M. Rogers (1995) and Geoffrey A. Moore (1991). From a service development and marketing perspective, a key issue is whether lead users are ahead of the market and experience needs that are soon to become prevalent in the market, as von Hippel (2005) claims, and whether they thus offer input to service development and marketing that is helpful for reaching the mass market.

Most of the pioneers who are the first users (and sometimes co-developers) of new products like electric vehicles or sustainable home technologies are similar to the lead users described by von Hippel (2005). The key constructs in lead user theory are: (ahead-of-the market) needs, expertise and experience (e.g. von Hippel 2005) and opinion leadership (Spann et al. 2009). Lead users are, thus, defined as users in a particular market whose needs and expertise are ahead of the market and because of these, they are eager to innovate (Herstatt and von Hippel 1992; von Hippel 2005; von Hippel and Riggs 1996). In the early stage of a novel service market, it is important to find lead users, because they usually are the first to find new services.

Gruner and Homburg (2000) and Lüthje and Herstatt (2004) have shown that integrating lead users in product development, especially in the initial stage, promotes product acceptance and diffusion in the market. They are individuals and groups who are ahead of trends as compared to average users. In addition, they have higher expectations on the potential benefits the services would bring. According to Bloch (1986), lead users can be eager pioneers who enable the spread of products to others in the markets because they often are opinion leaders in their community. They can thus help to identify strong market opportunities and to develop concepts for new products or services (Churchill et al. 2009).

Morrison et al. (2004) have presented evidence for a general concept of leaduserness, in which the lead user status is considered as a continuous variable. This suggests that there are no qualitative differences between the lead users and the mass market, and that diffusion from the lead user community to the mass market is mainly a matter of time. There is empirical evidence that some innovations do actually diffuse from lead users/innovators to the mass market (Woersdorfer and Kaus 2011) but there is also evidence that innovation diffusion stops after the initial stage and that some innovations never manage to break through to the mass market. Rogers (1995) and Moore (1991) have proposed market models that are based on an assumption that there are qualitative differences between the market segments, which partly explain why some innovations never manage to leave the niche status and succeed in mass markets.

Lead user theory acknowledges that the needs of lead users do not resemble the needs in the mass market. However, the experience and the views of lead users are necessary in the initial phase of service development, when the customers are required to be particularly active and interested (Bloch 1986; von Hippel 2005). How the innovations spread from lead users to the mainstream market poses a special challenge for the later phases of service life cycle. Lead user theory does not specify how this is expected to occur.

In Moore's innovation diffusion theory (1991), people can be divided into groups according to their attitudes towards new technology (see also Rogers 1995). The technology adoption curve is assumed to be normally distributed so that the innovators are at one extreme and the laggards at the other. The differences between the groups are based on their typical reaction to innovations based on new technology. Each group has its individual psychographic profile, which makes the people in the group respond to marketing in a different way than other groups. To understand each profile and the relationship between the profiles is a critical part of high-technology market expertise (Moore 1991). The theory was originally developed for business customers or new IT technology products, but it has been applied to consumer products also in the field of energy efficiency (Heimdal and Bjørnstad 2009; Prendergast et al. 2010).

We take Moore's theoretical framework as the starting point for our research on the structure of the potential energy efficiency service market. According to Moore's theory, innovators pursue new technology products determinedly. They sometimes even find them before the official marketing has begun. This is because

these people are very interested in technology regardless of its purpose. They buy new technology simply because they find it fulfilling to study the features of a new device. There are not many innovators in any market segment, but still, it is very useful to get them on board at an early stage of a marketing campaign, because their acceptance ensures others that a product really works.

According to the innovation diffusion theory, early adopters adopt a new product concept in a very early stage of the product's life cycle like the innovators do, but compared to the innovators, they are not technologists. Rather, they are people who find it easy to picture, understand and respect the benefits of the new technology and see how this technology could benefit them. When they find the benefits large enough, the early adopters are prepared to base their purchase decision on it. Early adopters do not trust outside sources while making a purchase decision, but instead, their own intuition and visions. That is why they are in a key position when creating any new high-technology market segment. Mainstream markets are dominated by an early majority, who can be understood as pragmatists, who in turn, tend to be accepted as leaders by the late majority, best thought of as conservatives (Moore 1991, p. 41.) Like the early adopters, the early majority is characterized by the ability to understand technology but the most dominant characteristic is a strong practicality. They want recommendations from reliable sources before they invest money in any product. According to Moore, this market segment forms one third of the entire potential market of the product. Thus, reaching these people and getting them as customers is essential when considering the success of a new product.

The late majority has the same risk aversion and practicality as the early majority but because the people in this market segment do not trust their own ability to use technology, they wait until a technology has become an established practice. Even then, they want a lot of support and are inclined to buy products only from big, well-known enterprises. One third of all customers form also this segment.

According to Moore (1991), in the far end of the technology adoption curve are the laggards. They do not want to have anything to do with new technology. They only purchase a product with new technology when it is sunk so deep within another product that they do not even know that it exists.

In Moore's (1991) theoretical framework, the most critical phase of the product life cycle is the move from early adopters to the early majority. To emphasise the difference between the groups: early adopters differ from the early majority in that early adopters truly search for something new and are eager to revolutionise their old practices. Early adopters are even prepared to endure the necessary flaws and problems that always prevail in innovations that have just entered the market. The early majority, on the other hand, wants to buy better productivity for their already existing practises. They do not long for revolutions.

In this paper, we do not aim to set the two theoretical approaches against, but to employ innovation diffusion theory to investigate potential qualitative differences between pioneering users and the mass market. (see Table 1 for similarities and differences of these theories.) We use the term *pioneer* to describe the most leading edge users, that is the first users of a service or a product. Thus, pioneers include the lead users of the lead user theory as well as the innovators and early adopters of the technology dissemination theory. We acknowledge that pioneers can have important characteristics of lead users and thus are worth engaging in early product launches, but following innovation diffusion theory, we also investigate the proposition that there might be differences between them and the rest of the market, which can be important for companies to recognize.

The key issue in the evaluation of the business potential is to find out (a) who are the pioneers for new technology-based energy efficiency services and (b) in what respects are pioneers relevant role models and representatives of the future mass market, considering the viewpoints presented above. These issues are topical for novel energy-related services. For example, Pierre et al. (2011) explored the experiences of pioneering electric vehicle adopters in order to gain insights for product and service development. Similarly, Caird et al. (2008) explored barriers faced by pioneering adopters of micro-generation technologies. Heiskanen and Matschoss (2012) identified lead users for smart grid-based demand response and energy efficiency solutions for households. Moreover, even though not explicitly mentioned, several smart metering pilots seem to work with innovative, lead user-type users (e.g. Nyborg and Røpke 2013).

Indeed, studying lead users (or innovators, or pioneers) is the only way to gain information on the use of emerging technologies, even though lead users only represent a small segment of the total market. However, in order to understand the applicability and limitations

Table 1 Differences between and common features of lead user theory and innovation diffusion theory

	Lead user theory	Innovation diffusion theory
Similarities	Pioneering users (lead users) experience needs before the rest of the market and innovate to meet these needs	Pioneering users (innovators and early adopters) have a high propensity to adopt innovative products and disrupt their existing practices
Differences	Pioneering users make and modify products and participate in early product development relationship between needs expressed by lead users and the mass market not specified	Pioneering users purchases first market launches of existing products pioneering users (innovators and early adopters) are qualitatively different from the rest of the market, which is characterized by greater pragmatism, search for recommendations and reliance on offerings by market leaders

of such studies, it is highly relevant to explore whether other market segments are qualitatively similar or qualitatively different from the pioneering lead users. This is not only relevant for corporate product development and marketing, but also for policy development and the estimation of the carbon reduction benefits of smart grid-based services (e.g. Darby et al. 2013).

Methodology

The data

The survey "Energy efficiency in Finland" was carried out in the spring of 2013. In order to gain a view of the potential similarities and differences among consumers with different levels of interest and engagement with energy efficiency services, it was important to obtain a representative sample of the total population. The respondents were selected by drawing a random sample of 5000 Finnish citizens, aged 18 to 70, from the Population Register Centre's database. Moreover, the respondents were enticed to participate through the possibility to participate in a raffle of retail gift vouchers. Postal questionnaires were distributed and respondents were offered the possibility to fill in the questionnaire online.

A total of 1240 respondents returned the questionnaire. The response rate (24.8 %) is moderate, which suggests that the topic might be difficult for consumers. Although Web-based surveys are sometimes seen as a means to improve survey response rates, it is known that mail surveys incorporating concurrent Web option have significantly lower response rates than those that do not (Medway and Fulton 2012). The response rate here, may in part, be a result of the length of the survey (20–25 min). However, similar response rates have been gained in similar mail surveys in Finland: in a study about the governance and political consumerism in Finnish energy policy-making (Ruostetsaari 2009), the response rate was 30 % and in a Finnish Science Barometer 2010 (Kiljunen 2010), the response rate was only 21 %. In marketing research, where there are obvious links to some commercial interest, the response rate is often around 25 % in Finland (Simpura et al. 2011; Dillman et al. 2009).

In comparison with the whole population, the data has some small biases, which are most likely connected to the subject matter of the questionnaire, which should be taken into account when interpreting the results (Appendix Table 6). A comparison to the 2013 population census showed that 45–64 year olds, respondents with higher education and respondents in working class occupations were slightly overrepresented in the data. The share of respondents with higher education (university degree) was 14.8 % in the sample, whereas in the entire population, the share was 8.7 %. By contrast, the younger age groups, respondents with a low level of education, and clerical workers were slightly underrepresented.

Slightly more substantial bias can be seen in terms of housing. Those living in detached houses, in households with three or more people, in houses with either oil heating or wood or pellet heating, houses built after 1980 and respondents owning one or more holiday homes, were slightly overrepresented in the data (Appendix Table 6). This bias, as well as the fact that the average size of the home was bigger than in the whole population, suggests that those living in detached houses are more interested or knowledgeable in energy efficiency than those living in other types of households. The fact that 34 % of the respondents reported having changed their electricity provider for other reasons than

moving communicates that we have a slight overrepresentation of active consumers.

Measures

The main challenge for our study was to develop measures that reflect the key constructs of the lead user theory of von Hippel (2005) and Rogers' (1995) and Moore's (1991) technology diffusion theory and adapt them to the case of consumers' energy consumption behaviour and attitudes. The key concepts in technology diffusion theory are the innovativeness of users in developing new solutions, their interests towards new technologies, the need for well-functioning examples and recommendations from previous users of new technologies, as well as reliance on the leading market actors and finally, scepticism.

There are many "smart energy applications", which can be very different from each other, which will appeal to a variety of different groups of people. Previous research (Heiskanen and Matschoss 2012) suggests that leaduserness for smart energy applications cannot be found in a consistent group of people, but might be found in various sub-populations such as early home automation adopters, technology enthusiasts, home electricity generators, heavy electricity users, environmentalists or people who keep a keen eye on their expenses.

A set of questionnaire items was developed based on studies and theoretical literature on characteristics of lead users. These included statements such as "I have been interested in energy already for a long time", "I readily advise my friends about energy issues", "I monitor my energy consumption by keeping records of the electricity consumption in different years (e.g., Excel tables)", "I like to follow technical developments in newspapers and TV", "I have developed some small technical inventions at home or at work", "I have actively looked for home automation to control appliances in my home", "If an electric appliance does not work, I usually know what the problem is" and "I would be interested in participating in the innovation work of my electricity company".

We mapped out interest towards novel energy efficiency services with questionnaire items such as "I like to take part into pilots and experiments because I would like to change the world", "I find it easy to grasp the benefits of new solutions", "I want recommendations from reliable sources before I purchase a new product or service", "I do not like to buy any new solutions if there are no successful examples of real users in my close environment", "I would prefer buying an energy efficiency service only from a market leader" and "I am interested in buying an energy efficiency service only from large reliable companies".

Considering that our focus was on energy efficiency services provided by electricity providers, also items concerning the respondents' views on energy companies were included: "I trust that the services of my electricity provider respect the customer's privacy", "I do not necessarily trust in getting a fair deal from an electricity company", "I am dissatisfied with the possibilities to save energy offered by my electric company" and "the equipment offered by the electricity company is of good quality that does not break down or damage other appliances". A full listing of the items in the study is presented as Appendix Table 7

The respondents' interest in services was mapped out with questions about novel services entering the market including smart displays of real-time electricity consumption and devices for automated control of electricity use. Moreover, some energy companies are offering energy-saving devices (e.g. heat pumps) and solar panels as a service, as well as on-site energy audits as more conventional services. We asked how interested the respondents were in these services assuming the services would pay off as energy saving within 1–5 years, which to some extent, takes into account the economic aspect through willingness to pay for a service. The respondents were asked if they (1) had already purchased the service, (2) were considering purchasing the service, (3) were interested in getting more information about the service, (4) were not interested in the service or (5) were not willing to get the service under any circumstances. In addition, the option "I cannot say" was included.

Statistical methods

The items that were included in the analysis were originally measured with 5-point Likert scale anchored by "totally agree" and "totally disagree". In addition, the response options included the option "I cannot say".

In order to analyse statistical patterns using the set of questionnaire items consisting of, altogether, 30 items, we chose to use principal component analysis (PCA) for explorative purposes. The method reduces the number of observed variables to a smaller number of principal

components, which account for most of the variance of the observed variables.

The items included in the PCA include a range of variables measuring the attitudes towards new technology, interest in energy and electricity issues, social setting and need for assistance in questions concerning energy solutions and participation in different organisations. For the analysis, the items were coded so that low value represents negative and high value a positive stand. The alternative "I cannot say" was coded missing.

PCA has often been used for marketing studies, and it can be used as an explorative method in customer segmentation. Compound variables for psychographic characteristics (consumer motivations and attitudes) were constructed applying principal component analysis (PCA) on questions concerning consumer's energy consumption behaviour and attitudes.

In the first stage of the explorative analysis, we retained all factors with the eigenvalue above 1. The effects between psychological factors and service interest were evaluated by analysis of variance (ANOVA) using the computer software package SPSS 21.0. The method is a conventional means test that is used for performing analyses for factorial designs (cf. Vassileva et al. 2012). Examining the connection between psychological factors and service interest is important if we are to evaluate technology diffusion and to discuss the psychological factors that are connected to leaduserness in the area of energy services.

In the second stage of the analysis, we discuss the psychological factors and their overlapping. Returning to the initial set of variables, we restrict the number of outcome factors and perform a confirmatory principal component analysis, in order to test, if we can build a leaduserness factor based on the psychological factors, and the knowledge we have on their connection to service interest. The first stage of our analysis focuses on underlying psychological factors explaining interest in novel energy services, whereas the second stage builds on the concepts of leaduserness and the characteristics of consumers at various stages of the diffusion curve.

Results

Interest in novel energy services

The distributions of the service interest variables reporting the respondents' interest to the energy efficiency services are shown in Table 2.

We chose these services because we wanted to study not only the pioneers but also the structure of the market in general. We wanted to see whether there are differences in the service interest between different groups in the market. We did not want to focus only in most innovative services because most likely, only pioneers would have purchased these and we would not have any information on the behaviour of other groups in the market. We therefore chose a mixed set of different kinds of services to be able find possible differences in service interest.

The most popular service was the installation and purchase of low-energy technologies: 16 % of respondents reported having purchased some low-energy technologies (not necessarily via an energy company, though) and only 3.3 % said that they would not be interested in the service under any circumstances. Displays for monitoring real-time electricity consumption and equipment to control electricity consumption generated a medium level of interest. Respondents found the services that offer installation and finance services for micro-generation and energy audits least appealing. The reasons for the lack of interest in energy audit might be that people misjudge their own energy efficiency or may not want to hear any bad news that would force them to take action or give them a guilty conscience. People may also associate energy audits with the loss of comfort and therefore reject it. Other explanation for the lack of interest is that some utilities have already offered this service free of charge and consumers are not willing to pay for it, if it is available free of charge. Possibly, respondents are also reluctant to let any strangers into their homes and therefore reject the service. In addition, roughly half of the respondents live in an apartment building where energy audit would make little sense, because people are not able to influence or make decisions about their building.

We examined whether the interest in novel energy services is connected to respondents' use of currently prevalent, informative services offered by energy companies free of charge, such as informative billing and advice. We found positive correlations between the use of current informative (free-of-charge) services and interest in novel, chargeable energy services. For example, even respondents who had already borrowed equipment to monitor their energy consumption still claimed an interest in purchasing displays showing their consumption of electricity in real time. The correlation does not imply causality, but nonetheless suggests that free-of-

Table 2 Distribution of level of interest in novel energy services (percent)

	Has already purchased the service	Considers purchasing the service	Interested in learning more about the service	Not interested in the service	Not willing to have the service under any circumstances	Total
Display to monitor electricity consumption in real time	8.1	17.4	**38.0**	33.1	3.3	100.0
Equipment to control electricity consumption by, e.g. timing to turn appliances off	8.1	16.2	**36.6**	34.9	4.2	100.0
Services for installing low-energy technologies (such as LED, heat pumps)	16.2	22.1	**29.7**	28.8	3.3	100.0
Micro-generation with solar panels or micro-wind power	2.3	19.9	28.5	**39.1**	10.2	100.0
Micro-generation equipment (solar, wind) and installation via electricity provider, payable via electric bill	0.3	7.3	33.9	**45.6**	12.9	100.0
On-site energy audit by expert at reasonable cost	1.4	5.8	29.5	**55.8**	7.5	100.0

In our study, we focused on services that can be offered by the local electricity distribution company or the electricity seller. For example, the European Energy Service Companies (ESCOs) offer important services but they were not in the focus of our study. Moreover, we focus on services offered to private (household) consumers and these are rarely targeted by ESCOs

charge services offered by the utilities may prepare the market and lead to an interest towards more developed and novel energy efficiency services.

Psychological factors behind the service interest

We extracted seven factors with an eigenvalue greater than 1 by principal component analysis. We decided upon the number of factors based on the eigenvalues and factor loadings the criteria for factor loadings to be over 0.5 (see Appendix Table 7). The seven factors that we gained reflect different dimensions of consumer behaviour. Together, the seven factors account for 56.1 % of the variance, which is a reasonable share.

The first psychological factor consists of variables that are linked to expertise, interest and skills related to home electronics. The second factor of variables reflects reliance on big energy companies. The third factor represents the respondent's stand towards seeking recommendations and the fourth factor, dissatisfaction and mistrust in electricity companies. The fifth represents experimentalism when technological solutions are concerned, the sixth represents sense of competence in own abilities and the seventh factor represents service trust. The sense of competence is interpreted as the tendency of the respondent to strive for the highest possible independency from external influences including technical solutions offered by others. Such people are sceptical because they trust their own abilities and reject services from others.

The number of factors with an eigenvalue of >1 is relatively high. This raises the question of how the seven psychological factors are related: it is reasonable to assume, for instance, that from the viewpoint of the leaduserness construct, expertise and experimentalism would be interrelated. Compound variables representing the seven different psychological factors were constructed based on the factor analysis so that the scale of the items with negative factor loading was reversed, the items in each factor were summed up and the sum divided with the number of items. The distributions of these variables are presented in Table 3.

The reliability of the summated variables was estimated on the basis of Cronbach's alpha, which determines the internal consistency or average correlation of items in a survey instrument to evaluate its reliability. The higher the score, the more reliable the summated variable is. Nunnaly (1978) has suggested 0.7 to be an acceptable reliability coefficient, but lower values are sometimes accepted in the literature. Table 3 shows that the metrics for expertise, reliance on big energy companies and seeking recommendations are reliable measures. However, mistrust in electricity companies, experimentalism, sense of competence and trust in services gain lower scores. On the basis of the means and median, we see that the distributions are quite close to being

Table 3 The distributions of summated variables, Cronbach's alpha of compound variables

	Expertise	Reliance in big energy companies	Seeking recommendations	Mistrust in electricity companies	Experimentalism	Sense of competence	Service trust
Means	3.06	3.46	2.69	2.62	3.25	3.03	2.42
Median	3.00	3.33	2.75	2.75	3.25	3.00	2.50
Kurtosis	−0.52	−0.43	−0.15	0.17	−0.39	−0.71	0.23
Skewness	0.08	0.22	0.13	−0.02	−0.06	0.04	0.42
N of items	7	3	4	4	4	3	2
Cronbach's alpha	0.82	0.71	0.69	0.62	0.59	0.51	0.62

normally distributed, although in expertise and sense of competence, we can detect moderate skewness.

The psychological characteristics were examined against the respondents' interest in purchasing novel energy services. Table 4 presents the results of ANOVA for how these characteristics connect to purchases and interest towards novel electricity services.

Generally, consumers who have either purchased or considered purchasing real-time home electricity displays score higher in expertise and experimentalism, than other respondents in the data. Those not wanting the service under any circumstances instead score lower in expertise and experimentalism, and lower also reliance in big energy companies than other respondents.

Purchasing or considering to purchase home electricity control equipment is connected to a higher level of sense of competence. Thus, not wanting to have the service under any circumstances was connected to a lower score in expertise and experimentalism, and a slightly higher level of mistrust in electricity companies.

Similarly, purchasing electricity saving equipment was connected on the average to a slightly higher level of expertise and experimentalism. Not wanting the service, on the contrary, was connected to lower level of expertise, reliance in big electricity companies and experimentalism.

As noted above, micro-production of energy and installation and purchase of services for micro-production of energy are still very rare among the respondents, although a number of respondents would be interested in such services. Micro-generation of electricity was connected to a slightly lower level of reliance in big electricity companies and seeking recommendations, and higher level of expertise and experimentalism. Purchasing and interest in energy audits was connected to slightly higher level of expertise, seeking recommendations and reliance on big electricity companies (but also slightly lower level of experimentalism) and a slightly higher level of service trust and sense of competence.

By examining the correlations between the summated psychological variables, it was detected that expertise and experimentalism have a strong positive relationship (Pearson's r=0.509**). Also sense of competence correlates positively with expertise (r=0.449**). Together the three psychological characteristics can be thought to represent leaduserness. Searching for recommendations and reliance in big electricity companies instead have a weaker correlation (r=0.301*), and mistrust towards electricity companies a moderate negative correlation (r=−0.275**) with trust in services. The latter does not seem relevant from the viewpoint of innovation diffusion theory. In order to examine how the constructs relate to each other, we return to principal component analysis (PCA) using the initial set of variables. We thus use the initial set of variables for both sets of PCA but accept only those over 0.5 for the final analysis.

Constructing factors representing leaduserness, scepticism and following the mass market

Moore's (1991) hypothesis is that there is a chasm between the early adopters and the early majority. In the PCA, we chose to retain three variables representing leaduserness, scepticism and following the mass market. Together, the three factors account for 48.3 % of the variance.

Table 5 presents the three principal components as an outcome of the analysis. The variables represent three different orientations towards energy efficiency services. The three variables are in standard units (mean= 0, standard deviation=1). The factor score derivation

Table 4 Piloted service purchases and interest by psychological characteristics, means (*F*, sig.)

	Purchased	Considering	Interested in more information	Not interested in the service	Not wanting the service under any circumstances	Total	*F*, sig.
Real-time home electricity display							
Expertise	3.4	3.2	3.0	2.8	2.5	3.0	16.273***
Reliance in big electricity companies	2.5	2.5	2.6	2.5	2.1	2.5	3.458**
Seeking recommendations	3.2	3.1	3.4	3.3	3.2	3.3	3.063*
Mistrust in electricity companies	3.3	3.3	3.4	3.4	3.6	3.4	1.725 (ns.)
Experimentalism	3.0	3.1	2.8	2.6	2.1	2.8	21.269***
Sense of competence	3.2	3.0	2.8	3.1	3.5	3.0	6.424***
Service trust	3.8	3.6	3.6	3.6	3.3	3.6	2.058 (ns.)
Home electricity guiding equipment (such as controls)							
Expertise	3.5	3.1	3.0	2.8	2.5	2.9	18.913***
Reliance in big electricity companies	2.5	2.5	2.5	2.5	2.3	2.5	1.157 (ns.)
Seeking recommendations	3.2	3.1	3.3	3.4	3.4	3.3	4.310**
Mistrust in electricity companies	3.5	3.3	3.4	3.4	3.7	3.4	2.779*
Experimentalism	2.9	3.0	2.9	2.5	2.3	2.8	20.679***
Sense of competence	3.4	3.0	2.8	3.1	3.4	3.0	11.094***
Service trust	3.6	3.6	3.6	3.6	3.4	3.6	1.141 (ns.)
Electricity saving equipment							
Expertise	3.3	3.1	3.0	2.7	2.5	3.0	17.703***
Reliance in big electricity companies	2.5	2.5	2.6	2.5	2.1	2.5	2.502*
Seeking recommendations	3.1	3.3	3.3	3.4	3.3	3.3	4.325**
Mistrust in electricity companies	3.4	3.4	3.4	3.4	3.6	3.4	0.900 (ns.)
Experimentalism	3.1	3.0	2.8	2.5	2.2	2.8	21.794***
Sense of competence	3.2	3.0	2.9	3.1	3.6	3.0	6.863***
Service trust	3.6	3.5	3.6	3.6	3.7	3.6	0.550 (ns.)
Micro-production of energy							
Expertise	3.5	3.3	3.1	2.7	2.5	2.9	34.517***
Reliance in big electricity companies	2.4	2.3	2.5	2.6	2.5	2.5	3.797**
Seeking recommendations	3.1	3.1	3.2	3.4	3.4	3.3	4.429**
Mistrust in electricity companies	3.6	3.5	3.3	3.3	3.5	3.4	4.413**
Experimentalism	3.1	3.1	3.0	2.6	2.3	2.8	33.706***
Sense of competence	3.3	3.1	2.9	3.0	2.9	3.0	1.721 (ns.)
Service trust	3.5	3.4	3.6	3.7	3.7	3.6	3.536**
Instalment and purchase services of micro-production of energy							
Expertise	3.4	3.3	3.2	2.8	2.6	2.9	23.355***
Reliance in big electricity companies	1.9	2.4	2.4	2.6	2.4	2.5	2.225 (ns.)
Seeking recommendations	3.5	3.0	3.3	3.3	3.4	3.3	3.192*
Mistrust in electricity companies	2.6	3.4	3.4	3.3	3.6	3.4	5.894***
Experimentalism	3.3	3.1	3.1	2.6	2.3	2.8	29.290***
Sense of competence	2.0	3.1	3.0	3.0	3.2	3.0	1.533 (ns.)
Service trust	3.7	3.5	3.6	3.7	3.4	3.6	2.285 (ns.)
Energy audit							
Expertise	3.2	3.2	3.1	2.9	2.8	3.0	4.679**
Reliance in big electricity companies	2.9	2.5	2.6	2.5	2.3	2.5	2.853*

Table 4 (continued)

	Purchased	Considering	Interested in more information	Not interested in the service	Not wanting the service under any circumstances	Total	*F*, sig.
Seeking recommendations	3.4	3.4	3.4	3.2	3.3	3.3	1.618 (ns.)
Mistrust in electricity companies	3.5	3.3	3.4	3.4	3.6	3.4	1.963 (ns.)
Experimentalism	3.0	2.9	2.9	2.7	2.3	2.8	11.996***
Sense of competence	3.4	2.8	2.8	3.1	3.3	3.0	7.778***
Service trust	3.9	3.8	3.6	3.6	3.5	3.5	1.692 (ns.)

(regression) and the rotation method used (varimax) result in variables not correlated with each other. The range for leaduserness (factor 1) is from −3.07 to 2.62, for scepticism (factor 2) from −2.86 to 3.02 and for following the mass market (factor 3) from −4.39 to 2.99. The three measures are valid, as the Cronbach's alphas score above 0.6 (0.84 for factor 1, 0.66 for factor 2 and 0.66 for factor 3).

First, our results confirm that expertise, experimentalism and sense of competence are associated with each other (factor 1). The term leaduserness is well suited to describe the content of the factor. The second factor consists of mistrust towards electricity companies as well as uncertainty and suspiciousness in the use of technology, in other words, scepticism. The third factor consists of reliance on large electricity companies and

Table 5 Leaduserness, scepticism, and following the market in the data (PCA, rotation method: varimax with Kaiser normalization)

	Component		
	1	2	3
I like to follow the technical developments in newspapers and TV	0.748	−0.041	−0.027
I readily advise my friends about energy issues	0.738	0.006	0.073
I have been already long time interested in energy	0.730	−0.065	0.063
I have made some small technical solutions in my home or work	0.713	0.025	−0.034
I have actively searched home automatics that guide appliances in my home	0.652	−0.001	0.286
If an electric appliance does not work, I usually know what the problem is	0.648	0.236	−0.092
I gladly follow my energy consumption by making notes of the electricity consumption in different years (e.g. Excel tables)	0.609	0.086	0.187
It is easy for me to see the benefits of new solutions	0.538	−0.038	−0.115
I'm fascinated by the idea that consumers could produce electricity into the electricity network	0.531	−0.214	0.180
I am not interested in using a new service until it becomes an established practice	0.013	0.762	0.138
I do not like to buy any new solutions if there are no successful examples of real users in my close environment	−0.009	0.752	0.127
I am skeptical about solutions produced by multiple actors	0.090	0.637	0.003
I don't like experimenting new products or technology	−0.140	0.535	0.263
I buy gladly an energy efficiency service only from a market leader	0.014	0.239	0.762
I am interested in buying an energy efficiency service only from large reliable companies	0.057	0.208	0.656
I am interested in buying an energy efficiency service only if it is offered as a give-away with another service or product	0.040	0.237	0.656
Outside help in saving electricity is welcome in my household	0.095	−0.136	0.616
Eigenvalue	4.084	2.736	1.393
% of variance explained	24.0	16.1	8.2

seeking recommendations, which we named "following the mass market". The results suggest that, according to our initial findings, there is, indeed, some kind of chasm between leaduserness and characteristics defining the mass market.

Discussion

Theoretical implications of the initial findings

In light of these initial findings, we suggest that the seven psychological factors form three attributes that are relevant in the first phases of novel technology diffusion to the market: leaduserness, following the mass market and scepticism. The first attribute, leaduserness, seems the most important because consumers with a leading edge status act as a reference point to others in the market. Moreover, the factors that grouped together under leaduserness are in line with von Hippel's theory of the lead user construct (e.g. Churchill et al. 2009; von Hippel 2005; Schreier et al. 2007). We are also able to specify the general notion of lead users as being "ahead of the market" by showing that pioneering users might have somewhat different needs and appreciate somewhat different characteristics than those following the mass market.

In addition to the pioneers having ahead of the market needs, they also have higher than average experimentalism, which fits in well in Moore's (1991) theory of innovators and early adopters, even though it is not an attribute of lead users in the lead user theory of von Hippel. In electricity markets, expected benefits and opinion leadership describe people with lead user attributes more than a capability to carry out product modification. This is because electricity forms a product–service combination with what a respondent cannot truly innovate. Experimentalism translates into interest in purchasing new technology, because pioneers find it interesting to get to know the features of novel technical solutions purely out of interest. These people would make inventions and modify products if it was possible in the case of electricity. They also find it easy to grasp the benefits from new solutions. They take part into pilots and experiments because they like to change their old practices. (Please see Appendix for the relevant questions.)

People with expertise have already been interested in energy for a long time and they follow their energy consumption by making records of the electricity consumption over several years. They readily advise their friends and neighbours about energy issues. These people like to follow technical developments in newspapers and TV and they are interested in Internet forums and blogs concerning energy. They have made some small technical solutions in their home or work and they readily do some repair works at home. They have searched actively for home automation to control their appliances at home. If their electrical appliance does not work, they usually know what the problem is. They would also be interested in participating in the innovation work of their electric company (see Fig. 1).

In the middle of Moore's technology diffusion curve, there are two large majorities: the early and the late majority. Compared to Moore's framework, in our results, those scoring high on seeking recommendations present qualities that are similar to the early majority. These are people who usually do not like to buy any new applications unless there are successful examples of real users in their own environment. They want recommendations from reliable sources before they get any new product or service. They are also not interested in adopting a new service until it becomes an established practice. If they heard about a new energy solution, they would seek advice from the energy experts in their surroundings before they would decide to purchase it. Moore's late majority has similarities in our data with those who rely mostly on large companies and would buy an energy efficiency service only from a market leader. They are interested in buying a novel energy service only from large reliable companies. They would be interested in buying a novel energy service only if it is offered as a give-away with another service or product.

The theoretical frameworks of Rogers (1995) and Moore (1991) suggest the existence of a group of laggards. They would be people who do not want to have anything to do with any new technology. In our sample, we named this characteristic scepticism. It is formed of two related characteristics: sense of competence and mistrust towards electricity companies. People who are characterized with a high sense of competence trust only their own judgement when making purchase decisions. They do not welcome any outside help in their home for saving electricity. They are very suspicious about the functioning of solutions involving several parties in the production process. Respondents characterized by mistrust toward electricity companies do not trust that the

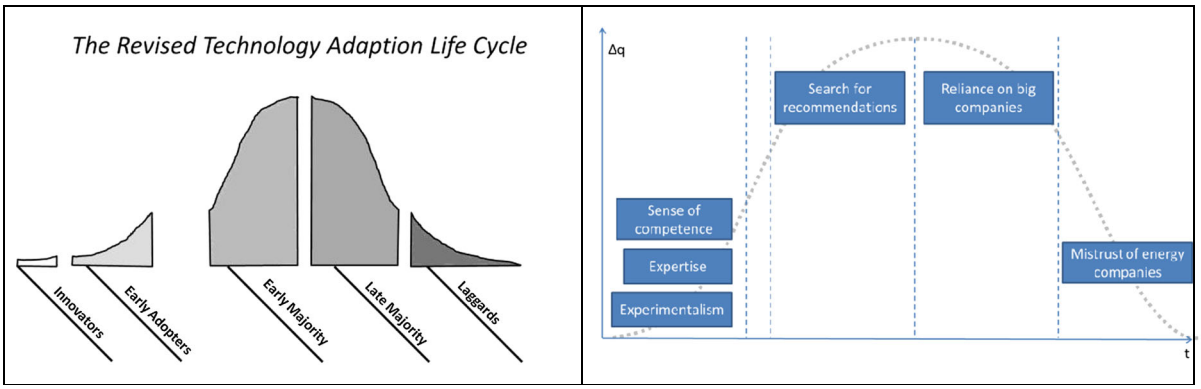

Fig. 1 The revised technology adoption cycle (Moore 1991) vs. findings in the sample

services of an electric company respect the privacy or information security of the customer. They do not trust in getting a fair deal from an electricity company, nor do they trust the quality of the equipment offered by their electricity company. These respondents also state that they are dissatisfied with the possibilities to save energy offered by their electric company. Looking at the distributions of the three variables describing the consumer attitudes, the respondents in our data tend to score higher on leaduserness and following the mass market than scepticism.

Our research presents original empirical evidence suggesting that innovation diffusion theory is relevant for electricity services and that there are specific pioneers of novel energy services. Our research also suggests that psychological factors can be used to identify consumer groups that have different kinds of interests in energy efficiency services in electricity markets.

Limitations of the study and implications for future research needs

Our study has examined the characteristics of innovators/lead users for energy efficiency services, with a focus on services offered by electricity providers, including electricity use displays, control equipment, on-site energy audits and equipment for on-site microgeneration. We have focused on the psychological factors explaining consumers' interest in novel energy services. However, further research should offer a more detailed analysis of the specific sizes of each market segment, as well as of the socio-demographic characteristics of these segments confirming also our initial findings. Nonetheless, our findings indicate that the pioneers, i.e. the first adopters of energy efficiency services are characterized by a high level of expertise, experimentalism and sense of competence. In contrast, the mass market is more likely to be characterized by recommendation seeking and reliance on large companies and market leaders. They are not likely to obtain novel products or services until the benefits are evident and they are recommended by referents in their own peer group.

Our research focused on psychological characteristics of consumers in the markets, which are relevant for their interest in different energy efficiency services. We included the economic aspect of these services only through the willingness to pay—aspect in setting the payback time of the services a maximum of 5 years. The lead user construct does not take into consideration the price but rather the expected benefits from the services. Benefits can include also the monetary cost aspect. The market potential of these services from the economic point of view is a matter of future research.

Our analysis also suggests that there are attributes that are specific to the electricity market that influence especially the rejection of services and consumer scepticism (sense of competence and mistrust in energy companies). The underlying characteristics were statistically significant in explaining the service interest of the respondents. The more expertise and experimentalism the respondents had, the more they were interested in the service. The more sense of competence and mistrust in energy companies they had, the less they were interested in the service.

Advanced billing and metering, an overall increase in the provision of energy advice and societal debate on energy, and the rising price of energy are expected to increase consumers' interest in services for energy saving (Darby 2006; Wallenborn et al. 2011). Considering

the evolution of the market, it is promising that leaduserness is evenly distributed in the population. Certain underlying factors, such as expertise and ahead-of-the market needs could be diffused to a broader segment of the market as needs and technologies evolve. As people gain more experience of how and where energy is used, they are likely to develop more interest. However, the characteristics of experimentalism are less likely to diffuse. Hence, these features need to be taken into account in service development and marketing when targeting the mass market. Services need to be usable and useful for ordinary consumers who are not motivated to explore new technologies just to learn about them.

A further point for closer analysis is to examine the scepticism component. The reasons underlying this kind of scepticism should be analysed closely, as they can be key for whether electricity companies manage to turn into energy efficiency service providers. The component of scepticism also has relevance for how far the market can evolve and how large a share of consumers can become active players in the energy market. In our analysis, the attribute sense of competence is most strongly associated with Moore's concept of laggards, but we suggest that the lack of interest towards energy efficiency services is more complex than merely technology resistance or rejection. Moreover, scepticism also includes the factor mistrust in energy companies, which can set critical limits on the diffusion of energy efficiency services or the possibilities to engage all consumers as active players in the energy market. While our findings in this respect are only provisional, we suggest further exploration of the hypothesis that only a fraction of all consumers can be engaged as active players. If this is indeed the case, it is worth also exploring what this means for those who remain passive in the restructuring of the electricity market and the rollout of smart metering. Will they bear an extra cost? It would also be interesting to study how the constructs of leaduserness, scepticism and following the mass market relate to consumers' environmental attitudes.

Acknowledgments This research project was financed by the Finnish Funding Agency for Technology and Innovation (TEKES), the Electricity Research Pool of the Finnish energy companies as well as the Finnish Energy Industries. The National Consumer Research Centre contributed to the possibility to publish the results. We, as authors, thank these organisations for their financial support.

Appendix

Table 6 Sample data independent variables compared to population average

	In population 2012	In the sample data
Building type		
Apartment building	40.4	31.4
Single house	43.9	48.6
Two-apartment building or a row house	15.7	19.9
Size of household		
1–2 persons	74.6	70.5
3 or more persons	25.4	29.5
Average area of the home	81.5 m^2	107.4 m^2
Source of heat*		
District heat	38.0 %	43.9 %
Electric heating	28.0 %	29.5 %
Oil heating	19.0 %	11.4 %
Ground source heat pump	2.0 %	4.9 %
Wood or pellet heating	12.0 %	10.3 %
Air source heat pump		
No		84.0 %
Yes		16.0 %
Age of the building (building year)		
<1939	7.5 %	6.5 %
1940–1959	12.7 %	12.8 %
1960–1979	33.8 %	28.9 %
1980–1999	31.3 %	34.9 %
2000>	14.7 %	16.9 %
Electrified leisure apartment		
No	80.8 %	69.2 %
Yes, one or more	19.2 %	30.8 %
Gender		
Male	49.1 %	50.6 %
Female	50.9 %	49.4 %
Age		
Younger than 25 years	14.7 %	6.9 %
25–34 years	15.3 %	9.9 %
35–44 years	14.8 %	11.9 %
45–54 years	16.8 %	22.1 %
55–64 years	17.5 %	28.8 %
Older than 64 years	21.0 %	20.4 %
Highest education		
Secondary school	32.3 %	18.8 %
High school, vocational school	49.8 %	35.1 %

Table 6 (continued)

	In population 2012	In the sample data
Lower university degree	9.2 %	31.3 %
Higher university degree	8.7 %	14.8 %
Educational field		
High school	11 %	18.8 %
Technical	30 %	30.5 %
Health and social	14 %	17.0 %
Service	12 %	13.3 %
Educational and teaching, humanities and art	8 %	10.5 %
Natural scientific, agricultural and forestry	7 %	9.8 %
Profession		
Independent entrepreneur, farmer	6.5 %	7.9 %
Employee, worker	18.7 %	24.2 %
Clerical worker	31.8 %	21.1 %
Leading position	4.2 %	6.0 %
Outside of labour force (pensioner, student, unemployed etc.)	38.8 %	40.9 %

*The share of district heat is probably larger than the official statistics indicate

Table 7 Psychographic factors, factor loadings (PCA, rotation method: varimax with Kaiser normalization)

	Component						
	1	2	3	4	5	6	7
I have been already long time interested in energy	0.764	−0.092	0.028	0.044	−0.076	−0.014	0.083
I readily advise my friends about energy issues	0.715	0.053	0.020	0.047	−0.115	0.119	0.068
I have actively searched home automatics that guide appliances in my home	0.696	0.266	0.018	0.025	−0.118	0.032	−0.137
I gladly follow my energy consumption by making notes of the electricity consumption in different years (e.g., Excel tables)	0.667	0.111	0.110	−0.027	0.021	0.063	0.030
I have made some small technical solutions in my home or work	0.652	−0.027	−0.092	0.138	−0.056	0.276	0.045
I like to follow the technical developments in newspapers and TV	0.633	−0.051	0.042	0.028	−0.275	0.245	0.140
I'm fascinated by the ide, that consumers could produce electricity into the electricity network	0.627	−0.076	−0.019	0.168	−0.100	−0.320	−0.017
I buy gladly an energy efficiency service only from a market leader	0.028	0.758	0.143	0.114	0.038	0.015	0.107
I am interested in buying an energy efficiency service only from large reliable companies	0.044	0.682	0.134	0.027	−0.001	0.089	0.177
I am interested in buying an energy efficiency service only if it is offered as a give-away with another service or product	0.061	0.653	0.073	0.250	0.074	−0.032	0.098
I do not like to buy any new solutions if there are no successful examples of real users in my close environment	−0.004	0.104	0.798	0.086	0.173	0.044	−0.027
I am interested in taking a new service in use not until it becomes an established practice	0.011	0.135	0.729	0.064	0.238	0.150	0.056
I want recommendations from reliable sources before I purchase a new product or service	0.120	−0.067	0.691	0.117	−0.170	−0.222	0.122
	0.000	0.298	0.577	0.038	−0.066	0.051	−0.047

Table 7 (continued)

	Component						
	1	2	3	4	5	6	7
I will not purchase any new energy solution, unless some of my neighbours recommends it							
I do not necessarily trust getting a fair deal from an electricity company	0.051	0.055	0.057	0.752	0.048	−0.142	−0.164
I feel that there are no such energy efficiency services in the market that I would desperately need	0.012	0.104	0.105	0.632	0.003	0.165	0.081
I am dissatisfied with the possibilities to save energy offered by the electric company	0.110	0.226	0.066	0.624	−0.102	−0.064	−0.176
New kinds of energy services may cost more than they save	0.131	0.005	0.049	0.604	0.235	0.211	0.117
I buy new technology because I find it interesting to get to know its features	0.222	0.271	0.045	−0.034	−0.652	0.146	−0.036
I don't like experimenting new products or technology	0.015	0.336	0.221	0.085	0.649	0.007	−0.029
I like to take part into pilots and experiments because I would like to change the world	0.333	0.177	−0.042	0.061	−0.555	−0.302	0.018
I am not interested in Internet forums and blogs concerning energy	−0.179	0.240	0.020	0.092	0.555	−0.136	0.011
I do not like to do any repair works at home	−0.077	0.383	0.156	−0.097	0.306	−0.599	−0.060
If an electric appliance does not work, I usually know what the problem is	0.506	0.060	0.046	0.059	−0.056	0.569	0.045
I trust only my own judgement when I make purchase decisions	0.186	0.262	0.121	0.073	0.042	0.538	−0.103
I trust that the services of an electric company respects the privacy or information security of the customer	0.023	0.134	0.072	−0.103	0.009	−0.092	0.821
The equipment of the electricity company is good quality that does not break or break other appliances	0.135	0.196	−0.006	−0.006	−0.007	0.068	0.784
Eigenvalue	4.61	3.43	1.84	1.49	1.46	1.21	1.12
% of variance explained	17.08	12.70	6.80	5.53	5.40	4.47	4.42

References

Bloch, P. H. (1986). The product enthusiast: implications for marketing strategy. *Journal of Consumer Marketing, 3*(3), 51–62.

Caird, S., Roy, R., & Herring, H. (2008). Improving the energy performance of UK households: results from surveys of consumer adoption and use of low- and zero-carbon technologies. *Energy Efficiency, 1*, 149–166.

Churchill, J., von Hippel, E. & Sonnack, M. (2009). Lead user project handbook: a practical guide for lead user project teams. http://web.mit.edu/people/evhippel/Lead%20User%20Project%20Handbook%20%28Full%20Version%29.pdf Accessed 21 February 2014.

Darby, S. (2006). Social learning and public policy: lessons from an energy-conscious village. *Energy Policy, 34*(17), 2929–2940.

Darby, S., Strömbäck, J., & Wilks, M. (2013). Potential carbon impacts of smart grid development in six European countries. *Energy Efficiency, 6*(4), 725–739.

Delmas, M. A., Fischlein, M., & Asensio, O. I. (2013). Information strategies and energy conservation behavior: a meta-analysis of experimental studies from 1975 to 2012. *Energy Policy, 61*, 729–739.

Dillman, D. A., Smyth, J.D., & Christian, L.M. (2009). *Internet, mail and mixed-mode surveys. The tailored design method* (3rd ed.). Hoboken: John Wiley & Sons Inc.

EED (2012). Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, http://eur-lex.europa.eu/JOHtml.do?uri=OJ%3AL%3A2012%3A315%3ASOM%3AEN%3AHTML. Accessed 21 February 2014.

European Commission (2011). Smart grids: from innovation to deployment. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. *European Commission SEC(2011) 463 final*.

Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy? *Energy Efficiency, 1*(1), 79–104.

Fischer, C. (2011). Consumer feedback: a helpful tool for simulating electricity conservation? A review of experience. Chapter 9 in System Innovation for Sustainability 4: Case studies in sustainable consumption and production—energy use and the built environment. In: Saadi Lahlou (Ed.), Greenleaf Publishing.

Gangale, F., Mengolini, A., & Onyeji, I. (2013). Consumer engagement: An insight from smart grid projects in Europe. *Energy Policy, 60*, 621–628.

Gruner, K. E., & Homburg, C. (2000). Does customer interaction enhance new product success? *Journal of Business Research, 49*(1), 1–14.

Hargreaves, T., Nye, M., & Burgess, J. (2013). Keeping energy visible? exploring how householders interact with feedback from smart energy monitors in the longer term. *Energy Policy, 52*, 126–134.

Heimdal, S. I., & Bjørnstad, E. (2009). A policy model for diffusion of electricity saving technologies. *Proceedings of the Eceee Summer Study Act! Innovate! Deliver! Reducing Energy Demand Sustainably*, 441–452.

Heiskanen, E., & Matschoss, K. (2012). Exploring emerging customer needs for smart grid applications. *IEEE PES Innovative Smart Grid Technologies Conference Europe*. doi:10.1109/ISGT Europe.2011.6162655IEEE.

Herstatt, C., & von Hippel, E. (1992). From experience: developing new product concepts via the lead user method: a case study in a "low-tech" field. *The Journal of Product Innovation Management, 9*(3), 213–221.

Kiljunen, P. (2010). Tiedebarometri 2010. *Tutkimus suomalaisten suhtautumisesta tieteeseen ja tieteellis-tekniseen kehitykseen*. Helsinki: Tieteen tiedotus ry

Klopfert, F., & Wallenborn, G. (2011). *Empowering consumers through smart metering. Report for the BEUC, the European Consumer Organisation*. Brussels: BEUC.

Lüthje, C., & Herstatt, C. (2004). The lead user method: an outline of empirical findings and issues for future research. *R & D Management, 34*(5), 553–568.

Medway, R. L., & Fulton, J. (2012). When more gets you less: A meta-analysis of the effect of concurrent web options on mail survey response rates. *Public Opinion Quarterly, 76*(4), 733–746.

Moore, G. (1991). *Crossing the chasm*. New York: HarperBusiness.

Morrison, P. D., Roberts, J. H., & Midgley, D. F. (2004). The nature of lead users and measurement of leading edge status. *Research Policy, 33*(2), 351–362.

Nunnaly, J. (1978). *Psychometric theory*. New York: McGraw-Hill.

Nyborg, S., & Røpke, I. (2013). Constructing users in the smart grid—insights from the Danish eFlex project. *Energy Efficiency, 6*(4), 655–670.

Oliveira, P., & von Hippel, E. (2010). Users as Service innovators: the case of banking services. Massachusetts Institute of Technology (MIT), Sloan School of Management, *Working papers*, 4748–09.

Pierre, M., Jemelin, C., & Louvet, N. (2011). Driving an electric vehicle. A sociological analysis on pioneer users. *Energy Efficiency, 4*(4), 511–522.

Prendergast, E., Mlecnik, E., Haavik, T., Rødsjø, A., & Parker, P. (2010). From demonstration projects to volume market. Market development for advanced housing renovation. International Energy Agency: IEA Task 37. http://members.iea-shc.org/publications/downloads/Advanced_Housing_Renovation.pdf . Accessed 21 February 2014.

Rogers, E. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press.

Ruostetsaari, I. (2009). Governance and political consumerism in Finnish energy policy-making. *Energy Policy, 37*(1), 102–110.

Schreier, M., Oberhauser, S., & Prügl, R. (2007). Lead users and the adoption and diffusion of new products: insights from two extreme sports communities. *Marketing Letters, 18*(1–2), 15–30.

Simpura, J., Härkänen, T., Kaikkonen, R., Koponen, P., & Tolonen, H. (2011). Alenevat vastausprosentit terveys- ja hyvinvointiolojen seurantatietoa tuottavissa haastattelu- ja kyselytutkimuksissa. Methods festival, *University of Tampere*, 31.8.2011 (oral presentation).

Spann, M., Ernst, H., Skiera, B., & Soll, J. H. (2009). Identification of lead users for consumer products via virtual stock markets. *Journal of Product Innovation Management, 26*(3), 322–335.

Van Vliet, B., Chappells, H., & Shove, E. (2005). *Infrastructures of consumption. Environmental innovation in the utility industries*. London: Earthscan.

Vassileva, I , Wallin, F., Dahlquist E. (2012). Understanding energy consumption behavior for future demand response strategy development. *Energy Policy* 46 (1), 94–100.

von Hippel, E. (2005). *Democratizing innovation*. Cambridge: MIT Press.

von Hippel, E., & Riggs, W. (1996). A lead user study of electronic home banking services : lessons from the learning curve. Massachusetts Institute of Technology (MIT), Sloan School of Management, *Working papers*, 3911–96.

Wallenborn, G., Orsini, M., & Vanhaverbeke, J. (2011). Household appropriation of electricity monitors. *International Journal of Consumer Studies, 35*(2), 146–152.

Wilhite, H., Shove, E., Lutzenhiser, L., & Kempton, W. (2000). The legacy of twenty years of energy demand management: we know more about individual behaviour but next to nothing about demand. In E. Jochem et al. (Eds.), *Society, Behaviour, and Climate Change Mitigation* (pp. 109–126). Dordrecht: Kluwer Academic Publishers.

Woersdorfer, J. S., & Kaus, W. (2011). Will nonowners follow pioneer consumers in the adoption of solar thermal systems? Empirical evidence for northwestern Germany. *Ecological Economics, 70*(12), 2282–2291.