Customer response on price incentives

Pål C. Næsje
Corresponding/lead/presenting author
SINTEF Technology and Society
NO-7465 Trondheim
NORWAY
pal.nasje@sintef.no

Thale K. Andersen
SINTEF Technology and Society

Hanne Sæle
SINTEF Energy Research

Keywords

Automatic meter reading (AMR), Remote load control (RLC), socio-economic consumer analysis, attitudes, behaviour, energy consumption.

Abstract

This paper analyses the relation between end-users energy attitudes and their corresponding energy behaviour. It presents empirical findings from analyses of the effects of two-way communication between consumers and power companies. Two-way communication has made available high quality data on energy consumption. In the build-up to the analysis in this paper the a number of aspects thought to influence energy consumption has been looked at; including standard of housing, number and age of residents, as well as socio-economic factors, behaviour and preferences. Here we choose to focus specifically on attitudes and behaviour. These aspects are controlled for price incentives.

The combination of very tight peak power balance in the Nordic power system and few investments in extension of power networks has turned the focus towards manual or automatic demand-response which requires hourly metering for documentation. The data are two-fold: Hourly recordings of meter-data of electric consumption of 10 894 customers (nearly half of these had installed technology for remote load control) in two different network areas and survey-data from a questionnaire distributed to consumers that resulted in nearly 550 answers. During the winter 2003/2004 these customers were offered different price incentives. The analyses showed a net reduction in electricity consumption of 1,0 kWh/h at the most in peak load hours.

The paper is based on two connected studies, "End-user flexibility by efficient use of ICT" and "Improving end-user knowledge for managing energy loads end consumption" conducted in Norway by the SINTEF group.

Definitions

ACTORS IN THE NORWEGIAN POWER MARKET

In Norway the sale of electricity to the customers is divided in a monopolistic (distribution) and a market based (sale) part. The **network operator** is responsible for the transmission of the electricity to the customers and the customers pay a network tariff for this service. The **power supplier** sells the electricity to the customers who pay a power price for this product.

Introduction

The aim of this paper is to take a second look into the relation between of users' attitudes and their energy behaviour. It has been argued in a number of studies the last decades that energy consumption among end-users is of a deep-rooted, where energy-use has been learnt from young age, rooted in modernization (cf. Hughes 1983, Nye 1998, Lutzenhiser 1992) and, accordingly, is extremely hard to change. On the other hand, it is argued that energy use in households shows an extreme price-elasticity ((Parti and Parti 1980)(Maddala 1997, Larsen and Nesbakken 2004), and, accordingly, if energy prices were high enough, behaviour would change.

In our study, a number of end-users have accepted very high energy prices in parts of the day, with the overarching aim to reduce peak demand. We have access to precise meter data, gathered every hour. And we have conducted a survey among these consumers. This combination makes it possible to point-point quit precisely the relation between attitudes and energy consumption.

Background

The paper is based on research conducted in the project "Improving end-user knowledge for managing energy loads and consumption". The main objective of the project is to increase systematic knowledge about electricity end-users behaviour, behaviour that limits an efficient implementation of actions for solution of peaking power problem. The project uses self-reports as well as meter data from residential and commercial customers to map and report on end-users' interests, wishes and preferences. The main focus has been on agreements between end-users and electric utilities, reducing the peak load in transmission network via remotely managed temporal shutdowns of end-users' loads through dynamic price-signals.

In the household segment there are some indications that consumers are willing to change behaviour when offered new tariffs, but we know little about the actual reception and use of the technology offered. In Norsk Gallup's survey on management of energy consumption, conducted in the 2000, a cautious approach among Norwegian households can be noted:

"Today, 28% of our households are positive to local network operators and utilities manage and shutdown boilers and floor-heating when nobody is home. But in the end of 1998, there was a much larger positive response to this. At that point, 36% answered that they were positive to such a measure".[1]

An earlier project focusing on a small sample of household where such management was installed showed that consumers were willing to let network operators control certain appliances in "critical peak load" periods, provided that this would not reduce customers' comfort. Consumers felt that they were doing network operators "a favour" and expected something in return, i.e. lowered network transmission tariffs (Jamison and Rohracher 2002)

Large scale development of technology for two-way communication was done in the project "End-user flexibility by efficient use of ICT". In this project the customers were offered a time-of-use Energy network tariff with a high price in predefined peak-load periods and a power contract with the spot price on an hourly basis. The goal was that the customer should react to the time differentiated price signals and adapt the electricity consumption according to these. Technology for direct communication was installed in more than 10 000 private households.

End user perspective – theory

There have been numerous attempts at explaining energy consumption and a variety of theoretical and empirical models of consumer behaviour. Common to most of them are that they seem incomplete as they only claim to explain certain aspects of energy consumption. We will in this section show a model of energy consumption taking into consideration and integrates four models emphasizing different aspects of energy consumption. Here we will specifically explore the relationship between end user attitudes and patterns of consumption and, we will thus take a closer look upon attitudes in general in order to establish an understanding of this complex phenomenon as well as how they are formed and how they may change.

Model of energy consumption

The theoretical point of departure for this study is based on a model developed by (Aune 1998). The model is a synthesis of a wide selection of different research results representing not opposite but complementary perspectives. In order to obtain a picture of energy consumption as complete as possible, Aune's model is based on four different models or perspectives.

The attitudinal perspective developed by Fishbein and Ajzen (Fishbein and Ajzen 1975) holds that attitudes mediate between beliefs about an object or a situation and intentions to take action towards it. It is therefore likely that attitudes influence energy consumption. Attempts to assess highly general attitudes has shown that this approach mostly generate vague results difficult to interpret. In order to measure the effect of attitudes on energy behaviour it is therefore important to address and assess specific attitudes.

The second perspective used by Aune is the evaluation model. This perspective parted from the understanding that we have to make an effort in order to reduce the domestic consumption of energy. The evaluation model includes different forms of public and private measures undertaken to achieve this goal. A mean traditionally considered important are price incentives – al though it seems that moderate increases of costs have little or no effect on energy consumption (Lövstedt, 1993). A problem, as underlined by Aune, is that the average consumer have no means for controlling his or hers consumption in real time, and that energy as a good is invisible. This model also includes public measures such as economic support for improvement of technical standards and campaigns aiming at increased knowledge about energy resources.

Amelioration of technical housing standards is known to have certain effects on energy saving. This represents the third perspective, called the material model, focusing on the technical standard of your home as well as technical installations helping to regulate energy consumption. The problem is when the housing standard is very elevated. It is then difficult to separate what matters most – technical standards or the activities performed inside the house.

Finally, it is also necessary to include socio-demographic variables. Many of the findings show opposing results and are thus inconclusive. Nevertheless, attempts to identify different life style-groups tied to energy consumption may provide us with a better understanding of the interplay between attitudes, behaviour and energy consumption.

1. Gallups Energibarometer for 1. kvartal 2000

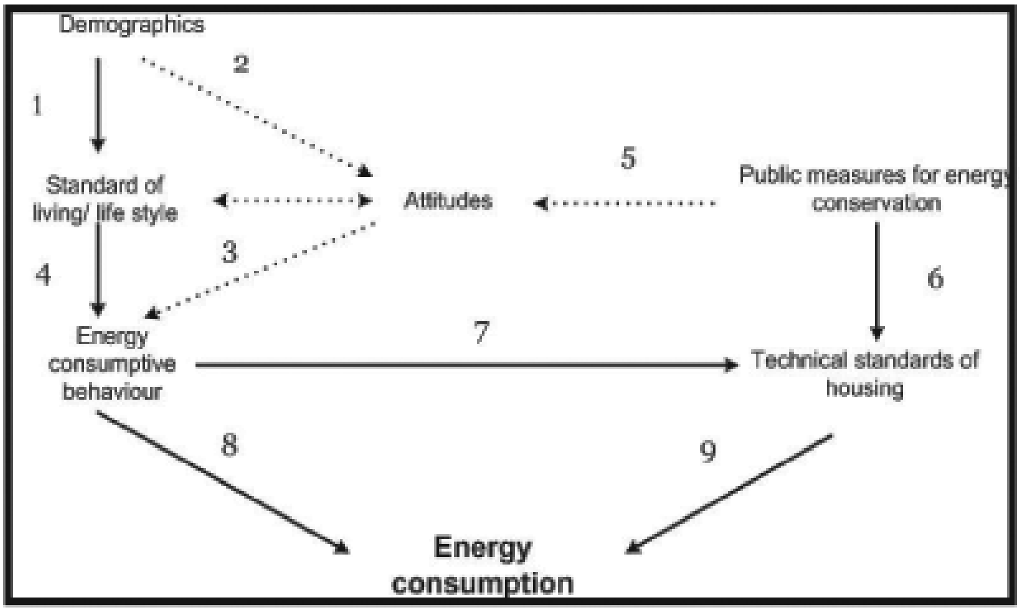

Figure 1. *Model of energy consumption. Based on (Aune 1998).*

The continuous lines represent relationships that have been more or less confirmed empirically, while the stapled lines indicate relationships that are assumed but not proven as such.

Aune's (1997) model includes and relates five main dimensions defining energy related behaviour and energy consumption. Traditional research has focused on the development of new technologies and not behavioural change. An issue perhaps partly responsible is the fuzzy nature of attitudes, which hardens the task of operationalization, measurement and analyzing. Over the past fifteen years attitudes have however been granted increased attention and are believed to exert substantial influence on energy consumptive behaviour – only it has showed itself very difficult to prove. "*The amount of energy saved in a given house over a certain time frame would be near impossible to link to any set of behaviours specifically. Indeed, observations of individuals would also be problematic. Given the habitual nature of many of the actions being examined, it could be argued that the close observation required would produce artificial behavioural conditions, which themselves may alter behaviour*" (Barr, Gilg et al. 2005:1428).We will, nevertheless, make an attempt at strengthen the theoretical foundation of the relationship between attitudes and energy consumption.

In the following section we will give a brief presentation of the concept of attitudes based on psychological theories, as well as their functions and resistance to change. We will further take a look at some other aspects related to energy use; technology, environment as well as the impact of costs, information and socio-demographic variables, linking attitudes and energy-related behaviour.

The concept of attitudes

"*…an attitude is a mental or neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related*" (Allport in Murchison, 1935, 810).

An attitude is generally not perceived as behaviour, but as a *dynamic factor in the motivation and inducement of* behaviour. Attitudes have traditionally been seen as composed of an affective, a cognitive and a behavioural component. Value-based attitudes have shown to be quite persistent, revealing a high degree of stability (Thistlethwaite, 1974; Kelly, 1955). More recently, focus has been upon the evaluative aspect of attitudes, understanding them as a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object (Fishbein & Ajzen, 1975).

According to Katz (1960), attitudes serve four main purposes: understanding the world, need satisfaction, ego defence and value expression. In order to activate a particular attitude we have to feel a particular psychological need or experience a relevant environmental cue. The internal or external cue needed to activate a particular attitude is dependent of the function this attitude serves.

Attitudes have proven to be highly resistant to change. Learning approaches emphasise the importance of learning processes for attitude change. They are based on the principles of association of temporal contiguity and reinforcement, and stress the link between stimulus and response as well as learning through persuasive communication by accentuating the necessary attention and comprehension (Scott, 1959; Insko, 1965; Fazio, 1986; Bem, 1967; Hovland, Janis & Kelley, 1953).

Technology

"*Traditionally, public policies have been aimed rather than at changes in consumer behaviours, at technological developments concerning energy saving thus ignoring the potential of the former*" (Barr, Gilg & Ford, 2005, 1426). A reason for this is that technology has proven to have the greatest impact on household energy saving. Although financial situation may function as a bottleneck concerning the acquisition and installation of new technology, group membership may be equally important as it reflects social status as well as political correct attitudes and values. What is more, the purchase, installation and use of such technology need also be simple enough for the average energy consumer to consider it worthwhile. We can separate direct (driving a car or wash clothes) and indirect (supporting energy saving policies) energy consumption. Adopting technological new-comings is often perceived as an improvement of standard of living, while reducing energy consumption is seen as a sacrifice (Stern, 2000).

A common distinction is between habitual or routine actions, and purchase-related behaviour. Habitual action is defined as "*…everyday reductions in energy use that require either no or minimal structural adjustment*" (Barr et al., 2005) and among others described as direct saving choices (Stern, 1992). Examples of such behaviours are use of thermostats, full load washing machine, low temperature in unused rooms, no tumble dry and so on. Purchase-related behaviour has been described among others as technology choices (Stern, 1992), contributing to the conservation of energy. These actions alter the structure of the home and examples may be insulations, double-glazed windows and the purchase of energy saving products.

Environment

There is substantial reason to believe that pro-environmental households are more concerned about their energy use than more passive-oriented households. Stern (2000) makes a distinction between impact-related and intent-related behaviour. The first aims at identifying behaviours that may significantly and positively affect the environment, while the second emphasises values, beliefs and attitudes. Stern further distinguishes four types of environmental behaviours; environmental activism, non activist behaviours in the public sphere, private-sphere environmentalism and other environmentally significant behaviours. These groups display significantly different environmentally behaviours, and are characterised by a decreasing awareness of environmental protection.

Stern (1994) found, parting from a factor analysis of 17 items measuring self-reported behaviours and behavioural intentions, three factors affecting energy consumption: consumer behaviours, environmental citizenship and policy support. These behaviours are mediated through values, attitudes and beliefs. Stern (2000) proposes a model where relevant values/attitudes are "biospheric", "altruistic" and "egoistic". Also the tendency of having an ecological worldview, to protect "valued objects" and to take on (personal) responsibility is assumed to impact the degree of environmental-friendly behaviours. Personal norms of responsibility towards the environment are seen as important intervening variables between values and environmentalism. According to Stern (2000) this model may contribute to the understanding of attitude formation; important elements are values, beliefs, personal norms, and behaviour. There are different categories of pro-environmental actions, ranging from habits and routines to highly conscious behaviour. The ABC-theory postulates that "*…behaviour (B) is an interactive product of personal-sphere attitudinal variables (A) and contextual factors (C)*" (Stern, 2000, 415). Contextual factors involve important quantitative issues such as cost and amount of effort needed to effectuate the pro-environmental actions. Social-psychological variables were found to have the most effect in cases where costs and necessary effort were low. Individual degrees of personal commitment as well as socio-demographic variables are also influential determinants; "*Specific environmental behaviours cannot be seen in isolation and a more fruitful approach for encouraging environmental action may be found in examining the structural bases of environmental behaviour holistically and attempting to tease out behavioural characteristics that span all activities*" (Barr, 2005, 1426 based on Corraliza and Berenger, 2000, and Oskamp, 2000).

Intervening variables in the relationship between attitudes and energy use: costs, information and socio-demographic factors

"*Through human history, environmental impact has largely been a by-product of human desires for physical comfort, mobility, relief from labour, enjoyment, power status, personal security, maintenance of tradition and family, and so forth, and of the organizations and technologies humanity has created to meet these desires*" (Stern, 2000, 408). The comfort orientation is highly prevalent in today's society, and function as an obstacle as far as energy conservation is concerned. The householder is assumed to be irrational, unpredictable and pleasure-seeking, and generally seems to be misinformed – "*Householders systematically misjudge the amount of energy used in various home activities, and these errors are resistant to ordinary information campaigns*" (Stern, 1992, 1227). The impacts of costs and communication of information have been the traditional persuasive means studied in behavioural research concerning changing energy related behaviour. A problem in this respect is that they have been considered one-dimensional with quantity as the sole valid operationalisation. Research show that information is likely to yield behavioural change the more specific and personalised it is, specifically in combination with a credible and trustworthy source. Local and well-known mediators and communicators are more likely to attract attention and obtain behavioural changes of households energy use through well-adapted programs, as opposed to general information and distant policies. Moreover, householders are more sensitive to preventive measures – for example technology preventing the loss of money – rather than cost-saving measures.

There are also important intervening factors that are non-financial. Stern (1992) lists four non-financial motives affecting energy use: consumer preferences, motives like problem avoidance, group membership, and personal values and attitudes. Low-cost actions to save energy are more influenced by attitudes and values than behavioural changes requiring high levels of material and non-material investments, displaying a contextual dependence of the relationship between attitudes and energy consumption.

Previous research has argued that altruistic and socially open-minded individuals with ecocentric environmental values are more environmentally active in general. Barr et al. (2005, 1440) suggest "*Accordingly, from the perspective of policy, there may be scope for developing alternative promotional techniques that focus attention on different aspects of personal lifestyles, such as consumer behaviour and everyday activities in the home*". The argumentation is that we need to consider lifestyles and demographic composition of the groups as well as their attitudes regarding energy saving.

A multi-factorial and multi-dimensional perspective

Policies have often failed, caused by problems of implementation, low motivation and poor information strategies; "*Policies based on careful technical and economical analysis have often been psychologically naïve or political unrealistic*" (Stern, 1992, 1224). Stern further states that such analysis have as underlying assumption that only the consumer realizes the benefit of a technological purchase he will undertake the action necessary. Psychologists see this as an oversimplification and have emphasized the importance of local/social networks and source credibility saying that the designers of policies and programs for energy saving overlooks the impact of social processes. What psychological researchers really need to understand is the functioning of energy systems (Stern, 1992).

Statistics indicate that households stand for approximately one third of the energy consumption both in the UK and in the US. Energy related behaviour and attitudes are each complex phenomena that cannot be understood through simple and straightforward relationships. Regarding the perceived difficulty tied to attitudinal and behavioural change, Stern (2000, 419) states that "*Interventions do little or nothing until one of them removes an important barrier to change*".

We have in this section tried to provide a way of understanding attitudes and to construct an understanding of various aspects influencing energy consumption. We are well aware of the fact that households is the least influential grouping, but not as an aggregated group, which is why energy conservation programs need to be adapted to specific social groups. Motivation and knowledge are equally important factors. How programs are promoted is thus crucial. Combination of psychological knowledge concerning the impact of demographic and socio-economic factors, attitudes, values as well as interpersonal relationships and social processes, and economic and technological expertise together with policy studies seem to be critical in order to influence the energy consumption of households.

Method and Data

TIME-OF-USE TARIFFS

The household customers were offered a Time-of-use Energy tariff on an hourly basis, where the energy part was only activated in hours defined as peak load hours. The network tariff was based on the fundamental principle that the costs for using the distribution network should be considerable higher in peak load periods. The extra cost in the peak load hours was 0,15 Euro per kWh.

The elements in the ToU tariffs were:

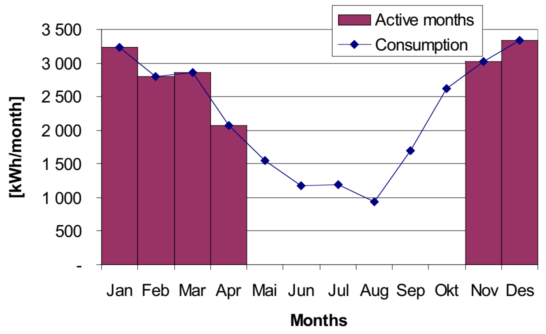

Figure 2. *Months defined as peak load.*

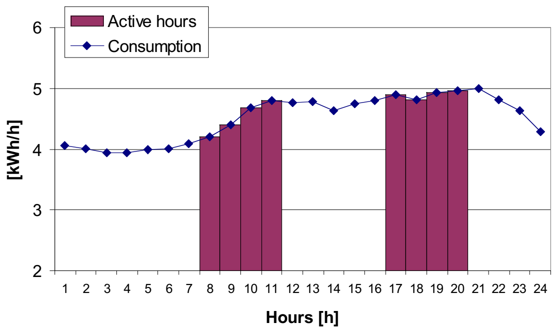

Figure 3. *Hours defined as peak load.*

The time variable energy part was activated in periods from November to March, on workdays in the hours 8-11 and 17-20 (0700-1100 and 1600-2000). This is illustrated in Figure 2 and Figure 3.

In the test project power suppliers offered a power contract with spot price on an hourly basis. The idea behind the hourly power contract was that the customers should be able to reduce their costs by load reduction in peak hours.

Network operators included also a non-intrusive option for load control for some of its customers. In practical terms, the network operator would be able to disconnect a non-vital appliance (in most case hot-water boiler) for no more than two hour if the load situation called for it. This would be effectuated by remote control. In the project period, only test runs have been made, data when such runs have been made is not used in this paper.

A small group of the customers participated both in testing of the time-of-use energy tariff and a power contract on an hourly basis. Among these, a substantial reduction in the consumption in the predefined peak load periods, and an in-

$$\text{ToU Energy tariff}_{\text{households}} = \text{Fixed part} + \text{Network losses part} + \text{Variable Energy part}$$

crease in the consumption in the off-peak periods can be found. The maximum reduction in the consumption is 1 200 W during the morning and 1 000 W during the afternoon. The average change is respectively 960 W and 800 W.

METER DATA

The meter data collection has been ongoing from 1st of august 2003 and onwards. Data is collected on hourly basis. Specifics of data used stated together with analyses. To maintain data integrity, expected consumption was calculated based on the registered consumption. This is necessary as singular missing data would ruin whole data series.[2] In the calculations the meter data are temperature corrected. The hourly meter data is analysed with use of the software USELOAD, developed at SINTEF.

THE SURVEY

In collaboration between Buskerud Kraftnett and researchers from SINTEF Technology and Society a questionnaire was developed. Thematically the questionnaire was mainly based on Aune's model "Nøktern eller nytende – Energy consumption and everyday life in Norwegian households" (1997) as well as (Ljones 1992)and the National Census from 2001 (StatisticsNorway 2004). Specifics of the survey can be found in (Andersen, Sæle et al. 2004). The total N in our data was 544 households.

The population is all customers located in the concession area of Buskerud Kraftnett,. All customers have technology installed for automatic registration of their consumption (two-way communication). All customers had installed technology for automatic meter reading (AMR), and for most of the customers the electricity consumption was metered on an hourly basis. About 50% had installed technology for remote load control (RLC), mainly electrical water heaters. It is the DSO that would active the remote load control. In the project the customers were offered different incentives for reducing energy and peak power consumption trough the following products: Time-of-use tariffs, power contract with spot price on an hourly basis and remote load control. The customers participated in the testing of the different products on voluntary basis.

Findings

DESCRIPTIVE DATA FROM THE SURVEY

The average respondent is a male between 30 and 59 years old, have attended college or university, and lives in a single-family house which he is the owner of. It is nevertheless important to point out that this population is not representative for the Norwegian population. The typical house was built between 15 and 45 years ago with an average size of 140-159 m^2, containing several bedrooms, living rooms and rooms with bath and/or shower. Most households use electricity and wood as the primary energy sources, and electrical heating represent, in self reported data, between 10 and 50 percent of the total heating of the house.

One of three respondents considers having an accurate level of comfort is more important than energy economics. More than half of the population admits that their own economy is imperative over consideration for the environment and energy economics. Four out of five respondents range themselves as positive to the effectuation of simple measures for energy economics in their own house, but the population is less concerned by general and global measures of energy saving, for example in order to take care of the environment. Most respondents judge their heating system as sufficiently environmental-friendly, and there are relatively few that take advantage of public measures for energy saving.

Most respondents report effectuating everyday measures, for example turning of the lights in non-used rooms, while fewer have performed more lasting measures such as isolating their windows in order to save energy.

ENERGY PROFILES

In order to extract energy profiles, it was important to find the underlying attitudes in the population. To achieve this, it was decided to use responses on attitudes, excluding any self-reported behaviour (e.g. turning off lights). The number of questions selected was 16. The questions used were related to energy consumption, energy prices, regulations and public governance, as well as opinions on dwellings. All questions shared the same response structure ("fully agree – fully disagree"). Answers on the question sets were analysed for internal coherence and they matched up fairly well. Then, to identify underlying structures in the material, a standard factor analysis were conducted. Kaisers' criteria were used and, accordingly, all dimensions with an eigenvalue over 1 was selected. This resulted in 5 dimensions (cf. Kim and Mueller 1978). Specifics of the analysis can be found in Appendix A.

As mentioned above, the results of the factor analysis gave five dimensions. The first dimension captures the attitude to comfort, where the extremes indicate an affinity for "the good life" versus the acceptance of some hardships. Positive contributions come here from statements such as comfortable temperatures and simple operation, while negative contributions come from temperature reduction, at night and in corridors. The second dimension captures a economic dimension, where the extremes juxtaposes profit versus environment. Positive contribution come from reducing costs and cost as motivating factor for choosing heating solution, while the negative contributions come from statements where the environment is a priority. The third dimension captures a certain austerity or thriftiness, where saving as such is a principle. Here, the positive contributions come from statements on simple energy saving actions, while negative contributions come from avoiding such actions. The fourth dimension captures attitudes towards societal regulation, with the opposition between public regulation and individual freedom, but also if energy prices as such are too high. The last dimension shows attitudes towards own dwelling, where the extremes are a very relaxed homeowner versus an idealistic home-improver. These dimensions are

2. A weekly collection of data would consist of 168 items. On the average, 1 or 2 of the items would be corrupt.

Table 1. The attitude dimensions of energy consumption.

	DIMENSION	
"Comfortable life"	Comfort	"Allow some hardships"
Profit	Economy	Environment
Indulge	Save	Sober
Individual freedom	Regulations	State
Relaxed, Not important	Home	Home Improver

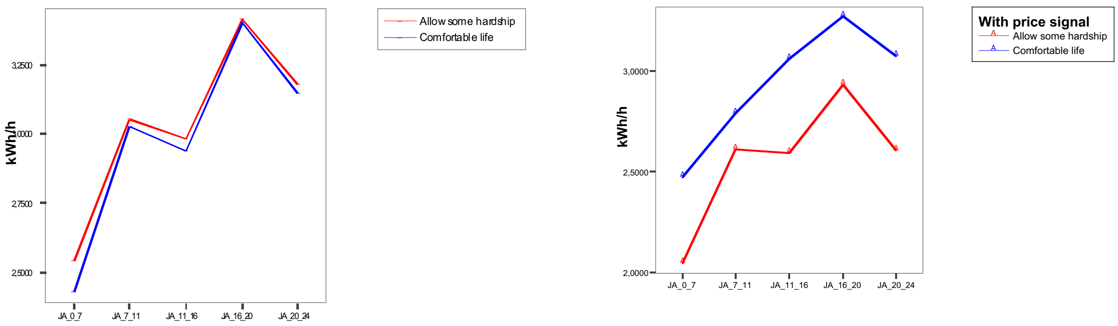

Figure 4. *Attitude dimension "The good life above all vs. allow some hardship". Left: All respondents. Differences are not significant. (one-way ANOVA, df=2, p<0,05). Right: Respondents with price signals. Differences are significant (one-way ANOVA, df=2, p<0,05).*

summed up in Table 1. Due to the nature of factor analysis, dimensions are statistically independent.

Let us then move on to the energy-profiles deducted from these attitudes. As we have hourly meter data, we can follow these dimensions during the day. Collection of meter data has been described earlier. We will use absolute figures (kWh/h) as unit of analysis. To secure statistical significance a standard analysis of variance has been conducted, with level of significance set to p=0,05. All dimensions were spilt into three groups. The middle group will used as a group of reference. The two remaining groups will be used to show the contrast in the dimension, and representing the opposing positions shown in Table 1. First, if we take the comfort dimension, the day profile for the two contrasting groups looks as follows:

As can be seen, there are very small differences between the two groups. They are not significant. Analytically this indicates that this dimension is not related to actions. One could say that whether or not one is inclined to "comfort", this will only be a state of mind, not a state of things. This is maybe somewhat surprising. But other data strengthen such an interpretation. We can see that a majority of households report that they reduce temperature in rooms not used, turn of light etc. Thus, even if one reports to value "the good life", in actual actions one would still reduce temperature. This is strengthened when looking at the question "Yesterday, did you reduce temperature between 11 am and 4 pm?". The differences between the two groups used here is less than 10 percent in reported actions.

The effect, however, of this value dimension can be seen directly in among those who are subject to the price signal

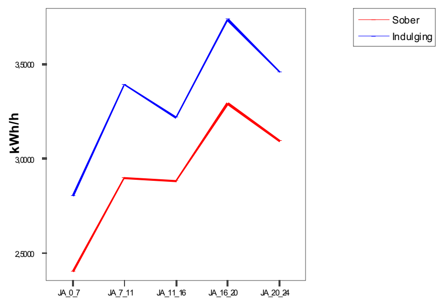

Figure 5. *Attitude dimension "To indulge or to save". Differences are significant in the morning (00-11) (one-way ANOVA, df=2, p<0,05).*

discussed earlier. Here we can see a significant difference between the two groups, in that those who are inclined to "allow some hardship" also avoid a high peaking in the afternoon. The other groups does not reduce their peak in absolute terms.

Then we have the economic dimension. Here we compare those who value the environment with those who value prioritize the economy. Differences between groups are significant and large (hovering around 10% difference in each timeslot). Moreover, the energy profiles show that those who value the environment reduce energy consumption in the afternoon even further, while those who value profit does increases its energy consumption during the day. It is interesting that in absolute figures, those who value profits are unable to reach the levels of those who value the environ-

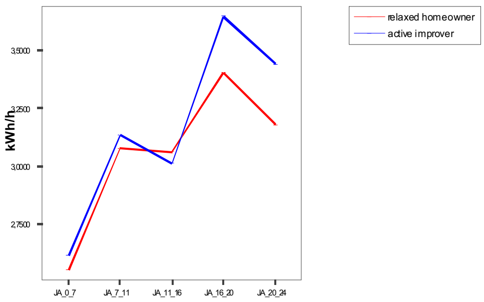

Figure 6. *Attitude dimension "Relaxed homeowner vs active improver". Differences are not significant. (one-way ANOVA, df=2, p<0,05)*

ment highest. To be at profit seeker does not have an direct impact on energy use.

The third dimension is then "to save". This dimension can be understood as representing a type of "protestant ethic" (cf. (Weber and Giddens 1976)), where thrift and hard work has an importance in itself. The results are shown in Figure 6.

Again, the differences between the two groups are large (exceeding 10% between 7 and 11 in the morning). The pattern shows some resemblance with the profit-environment dimension. Energy consumption shows a flatter curve over the day for the sober consumer, with less distinct peaks. This could mean that in such a household, fewer appliances are used in peak hours and the remaining consumption is of a base-load type. The "indulger" shows a diametrical opposite picture, where consumption is peaking significantly both in the morning and the afternoon. Such peaking indicates use of a energy intensive appliances in those periods.

The fourth dimension relates to attitudes on regulation and social governance. The contrasting groups are the liberal minded, "laissez-faire" position as compared to a more direct involvement from state and public. The profile is similar to the profile shown in Figure 5, but differences are not significant on the level set. As an indication, however, the laizzes-faire group has the highest consumption, while the regulations have lower. More important then, is that among those who are subjected to the price signal, the differences between these two groups are statistically significant. Those who are in favour of regulations and state involvement are also significantly less inclined to reduce consumption at any point during the day. The liberal minded has lover consumption in absolute figures and show a more active consumption profile, with day-time and night reduction of consumption.

The last dimension show respondents' attitude towards home and dwelling (Figure 6). The groups compared are those who use and value their home as a prime aspect of life (the home-improver) and those who are rather indifferent to housing. As seen in the figure, the most there are a (weak) difference between groups in the afternoon. This would indicate that the relaxed homeowner is also less active using their home in this period

Discussion

First of all, of all the dimensions, the value dimension between profit and the environment has significant differences between groups for the whole day. The last dimension discussed "home" is the one with the most distinct differences over the day. Here, end-users show energy behaviour in the evening different from the rest of the day. For the other dimensions differences are bigger between groups as such and smaller over the day. The most important value dimension – the comfort dimension – is only effective when mediated through the price signal. The same is true for the dimension on regulations. This indicates that the price incentive is partially effective, but more so through the right value set.

What can be argued is that groups have their distinct energy use pattern and the effect of the price signal is mediated through it. Accordingly, in some dimensions we see a more active energy saving behaviour for the high-load periods (07-11 and 16-20), such as the "allow some hardship"-group, while others does not change behaviour at all. For example, the comfort seeker and the relaxed homeowner show signs of not reducing energy consumption during night time or in the middle of the day, when residents are likely to be asleep or at work. One could argue that the relaxed homeowner takes no measures to reduce energy consumption, thus the profile is relatively flat over the day.

On a more general note, the groups "sober" energy user and the group that prioritize the environment over the economy show significant reduced energy consumption, as much as 10 percent below baseline for each of them. These groups are active in terms of reducing energy consumption as such. Moreover, even end-users who state that "the economy" is important, show no signs of a more advanced type of economical rationality, as the price signal have little impact on actual consumption.

The group that is in favour of information and individuals' choice are also more inclined to use more energy overall. One could argue, then, that individual freedom here indicates freedom to consume.

As we showed in the attitude-section, the relationship between attitudes and behaviour is highly ambiguous, which also is the case for the prediction of energy consumption based on attitudes to costs, environment and life style. Besides, with regards to theory it would perhaps be more accurate to state that attitudes mediate the relation between various incentives aimed both at energy saving and reduction of consumption in general as well as reduction of consumption in high load periods.

The model of energy consumption presented in the beginning of this paper displayed the relationship between attitudes only has highly likely but by no means certain. Understanding attitudes may be hard enough, not to mention their interaction with behaviour. We are relatively sure that an attitude is composed of affective, cognitive and behavioural elements, and that it does indeed exert significant influence on behaviour. If the goal is to change a person's or a group's behaviour by changing hers, his or their attitudes, wouldn't a logic thought be that we need to find measures that stimulate and affect one, two or all three components? This deduction illustrate why it is so important to focus on specific attitudes and specific behaviours in order to succeed with measures aimed at reducing energy consumption either altogether or in defined periods.

Moreover, it is crucial to obtain an understanding of the meaning and value people attach to their use of energy in addition to how they evaluate their own needs, in order to be able to through improvement incentives to manipulate the function their attitudes to energy consumption serve. This means that for those permitting energy going to waste because they can afford it, we need to find a true reason not do to this that gives meaning to them and their view of use. We also should focus on technical solutions adapted to different patterns of consumption which also are highly dependent of socio-demographic factors. Measures should be flexible and specific and communicated through expertise in a credible and trustworthy manner in order to have sufficient persuasive effect and thereby change attitudes to energy consumption.

We see that price signals generate effects, and that these effects are filtered through several different attitude dimensions. However, we have also discovered that the attempt to regulate patterns of energy consumption through price directives prove to have little impact – elsewhere we have found that an increase of the price by 100 percent only resulted in 5 percent reduction of energy consumption. This fact pushes us to deduct that energy consumption is socially robust.

Conclusion

As a temporary conclusion one may state, parting from the fact that attitudes seem to consist of both affective, cognitive and behavioural components and knowing that they act as mediators stimuli and responses, patterns of energy consumption may be altered through affective cues, various experiences, persuasive communication focusing on attention and understanding, as well as through individuals' or groups of individuals striving for socially acceptable attitudes and as a result feel the need for adapting their behaviours to these attitudes. We suggest that measures aimed at energy saving developed and adapted to specific population groups displaying particular patterns of consumption, can manage to strike the "right" attitudes and thus give rise to considerably change of behavioural patterns and a reduction of energy consumption

In the public policy domain, end-users are often interpreted as a "difficult" actor. While not denying that changing behaviour among (any) actors is hard, our study gives some cues to the how behaviour and energy consumption relates to values and attitudes. In our material we can see significant relationships between attitudes and consumption. How one value profit over environment, or how one value moderation and thrift, have consequences for energy consumption. We have also seen that some attitudes does change behaviour indirectly (comfort and regulation), they are mediated through direct incentives. When adding these effects up, we can both argue that some incentives are necessary to unlock the savings potential of some attitudes, while also arguing that some incentives are wasted on groups with attitudes that do not match. Correspondingly; heavy-handed incentives used on though values are counterproductive, while tailored measures fitting the right attitudes should make it possible with substantial, further savings.

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Appendix A

Rotated Component Matrix(a)

	Component				
	1	2	3	4	5
To reduce energy consumption, I think it is better with information campaigns than higher fees on consumption	0,036	0,002	0,169	0,671	-0,006
When choosing heating solution I will place more emphasis on cost than on saving the environment	0,129	0,800	0,086	0,131	0,080
Our Households' part of the total energy consumption is so small, that if we save, it will not change the overall situation	0,386	0,260	0,059	0,059	0,511
If we develop more hydropower now, we will ruin nature for future generations	0,266	-0,191	0,350	-0,262	-0,459
I do not want to use time and effort on my own dwelling	0,080	-0,030	-0,068	-0,159	0,711
I think that electricity cost takes a to big part of the household finances	-0,052	0,100	-0,177	0,746	-0,030
When saving energy in my house I will put more emphasis on reducing cost than on protecting the environment	0,022	0,816	-0,040	0,126	0,179
In the choice between a refrigerator with energy label "A" that cost 150 Euro more than a comparable fridge but with label "B", I would choose the more expensive	0,225	-0,518	0,095	0,150	0,108
We are accustomed to a unlimited supply of heating, light, hot water and energy for cooking. Energy savings should not go so far that this is taken away from us	0,457	0,391	-0,057	0,416	-0,097
To me it is important that the house is heated when getting up in the morning	0,644	0,067	-0,399	0,182	0,085
In our home, we are willing to pay the cost for holding an even, comfortable temperature in the whole house	0,753	0,012	-0,256	-0,008	-0,001
When choosing heating solution I will place more emphasis on simple operation than reducing costs	0,646	-0,159	-0,030	-0,096	0,255
In our home, we use a heating solution that is sufficient environmentally friendly	0,198	-0,003	0,177	0,380	0,398
I find that it can be cooler in corridors and staircases than in the living room	-0,208	0,162	0,625	-0,185	-0,137
I would often reduce temperature in living rooms for the night	-0,188	-0,071	0,726	0,019	0,017
I would be careful to turn of the lights when leaving a room	-0,055	-0,071	0,586	0,255	0,053

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 10 iterations.