Energy saving in Swedish households. The (relative) importance of environmental attitudes

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1. Introduction

The objectives of the 2009 Swedish joint policies for energy and climate are very ambitious. Energy efficiency should increase by 20% up to 2020 to help decoupling economic growth from increased use of energy. Greenhouse gas emissions should be 40% lower by 2020 than they were in 1990. Among other things, this implies a decrease of no less than 20 million tons of CO2 emissions from the sectors not covered by the EU ETS system, e.g., housing and transport. These ambitious goals should be viewed against the background of the already low per capita emissions in Sweden, and the fact that the most important decreases in CO2 emissions have actually occurred in the housing and service sectors and in the production of district heating. Energy consumption for heating and the use of hot water has decreased since 1970 amidst a 1.3 million increase in population and a 40% increase in the number of dwellings (Cabinet Bill, 2008/09:162, pp. 48, 61; Cabinet Bill, 2008/09:163, p. 40; Energimyndigheten, 2009).

What becomes politically crucial is how Swedish households, who obviously already save on energy, react to these far-reaching policy objectives. It is evident from the arguments in the Government Bills that economic measures are expected to do the trick; they should be "directed towards supporting the [energy] effectivisation occurring spontaneously in society and as a consequence of policy measures adapted to market mechanisms" (Cabinet Bill, 2008/09:163, p. 155). Prominent among such measures are increases in and extensions of the carbon dioxide tax, as well as increases in other energy taxes. This is expected to encourage households to change their energy behaviours by way of energy effectivisation and changes in consumption patterns (Cabinet Bill, 2008/09:162, p. 231). Even informational policy measures are motivated in economic terms; such measures should provide households with explicit "economic inducements to act more energy efficient" (Cabinet Bill, 2008/09:163, p. 133).

What is remarkable about these future Swedish energy and climate policies is their strong reliance on market-based measures and economic incentives. This seems to go against growing evidence from studies on household energy behaviour that gains in policy incidence and effectiveness could be made if measures were broadened to address also households’ environmental attitudes and beliefs. True enough, there are some reoccurring patterns that seem firmly linked to socio-economic factors. Household income, housing tenure and location, as well as demographic factors such as age and type of household do influence energy behaviour. Households with less economic resources are more eager to save on energy expenditures. Those living in owner-occupied dwellings tend to save more on energy than those living in apartment blocks, and these tendencies are stronger among older households (Barr et al., 2005).

Age, homeownership and household income are important predictors of energy behaviour also among Swedish households.
A report from 2005 found housing tenure more important than income for heating and hot water usage. The authors conclude that the independent effects of income and housing indicate that people’s economic self-interest affects the degree of energy saving. Although they also find that “green ideology” has an independent significant effect on general energy saving behaviour, they question its importance for energy saving in owner-occupied housing: People “living in houses tend to save on heating costs regardless of whether they have a green or a grey attitude to the environment” (Hedberg and Holmberg, 2005).

There is, however, a growing body of research indicating that household attitudes and beliefs related to the environment do have effects on the propensity to save energy. With stronger and more clearly expressed environmental concern comes a more marked propensity to save energy in the household (Brandon and Lewis, 1999; Abrahamse and Steg, 2009). What is less evident from previous research so far is the relative importance of socio-economic and demographic factors for household energy saving on the one hand, and environmental oriented attitudes and beliefs on the other. This is particularly important to clarify from the point of energy policy, since this lack of evidence does not provide for a well-grounded choice of an effective and precisely targeted energy policy. There is a need for studies that explicitly seek to include the influence on household energy saving from both socio-economic/demographic characteristics and from environmental attitudes, and seek to assess how the importance of environmental attitudes varies depending on these other characteristics. This might enable us to pinpoint different key groups of households with a comparatively large potential for energy savings. Thus, to gain further knowledge on the relative importance of socio-economic versus attitudinal factors and their interaction will improve the possibilities for adequate choice of policy instrument and targeting of relevant groups of households. Therefore, the aim of this study is to add to our knowledge of what more exactly makes which households save or not save energy. We examine the main determinants of household energy saving and the relative importance of various factors by using a large survey data set on Swedish inhabitants and their environmental attitudes and energy-related behaviours. From the results we obtain, we then proceed to discuss the implications for policy and what could be done to target energy saving policy measures for those different groups of the population where the savings potential is comparatively large.

2. Theoretical considerations and previous research

Research on what makes people save energy can be divided along two major lines, each with distinct subthemes (cf. Steg, 2008). On the one hand, there is a string of studies of the influence on energy behaviour of ‘objective’ factors, roughly grouped under the headings of socio-economic and demographic characteristics. On the other, there is a very large body of studies on possibly influential ‘subjective’ motivational factors that could, in turn, be specified in at least four different ways. On a general level, studies seek evidence on how personal norms and values affect energy behaviour. Of particular importance here are studies of the effects of energy savings on attitudes and beliefs related to environment and climate. Furthermore, a number of studies deal with the influence of social norms and social integration on the propensity to save energy. Finally, some studies have focused on political orientation and trust in governmental institutions as potentially influential variables.

The study of socio-economic and demographic factors has yielded some clearly validated patterns. A series of Swedish studies and overviews of current research corroborate and illuminate further these patterns. A report published by the Swedish Energy Agency concludes that “household energy behaviour differ with household size, age, housing tenure and income ... [and] ... can thus reasonably be identified as interesting separate groups” for targeting energy policy measures (Lindén, 2007: 35; cf. Hedberg and Holmberg, 2005). Also gender seems to influence energy use and the propensity to change energy habits, where women are generally found to be slightly more inclined to save energy (Carlsson-Kanyama and Lindén, 2007; Räty and Carlsson-Kanyama, 2010; see also SEPA, 2009). Findings from studies in other countries point in the same direction. The “analysis of individual studies shows that there are a set of core variables which have significant efficacy: homeownership, income (or socio-economic status), family size and age” (Barr et al., 2005: 1426).

Theoretically, these links to income and type of housing could be taken as signs that individuals are utility maximising market actors that react to economic stimuli to make rational choices given their preferences and amount of resources. Psychological research views such individuals as driven by self-centred values (Harsh and Dolderman, 2007). Energy consumption and use can be viewed as a means for individuals and households to realise their preferences for “the good life”, i.e., own comfort, welfare and development. However important as changes of such lifestyles may be in view of, e.g., global climate change (see, e.g., Roy and Tal, 2009) they may still prove very difficult to bring about (Steg and Vlek, 2009: 311; Barr et al., 2005: 1427).

The image of self-centred individuals has been widely challenged. Values and beliefs about moral obligations are held to be important motivations for human behaviour. After testing his Value-Belief-Norm theory, Stern concludes that “personal moral norms are the main basis for individuals’ general predisposition for pro-environmental action” (Stern, 2000: 413). These norms are activated partly by the individual’s views of whether environmental degradation threatens things highly valued by the individual, and partly by how the individual views his or her personal responsibility and ability to launch effective action to help solving the problem (Stern, 2000; Faiers et al., 2007). Based on the activation of altruistic and self-transcendental values (cf. Hirsh and Dolderman, 2007), people “may refrain from individual short-term gains if the society at large is better off in the long term” (Berglund and Matti, 2006: 555).

One should note that Stern does not view individuals’ general predisposition for pro-environmental action as the sole driving force behind significant environmental behaviour. He contextualises individual choice by pointing to how public policy with its arsenal of economic, regulatory and informative measures affects individual behaviour, as do possibilities and hindrances stemming from technological development and physical infrastructure. Stern invokes the concept of personal opportunity structure: i.e., actors’ knowledge, monetary resources and engrained habits as affecting the ‘bite’ of the general (moral) predisposition for pro-environmental action (Stern, 2000; see also Fries et al., 2008). Recent studies of energy behaviour emphasise the importance of the context of household choice. In particular, the existing “socio-technological system” in the energy sector tends to reduce household opportunities to undertake energy conservation measures (Maréchal and Lazaric, 2008). As a consequence, “policy-makers should specifically address the performance context of habits in order to increase the effectiveness measures aimed at reducing domestic energy domestic energy consumption.” (Maréchal, 2010:1112). A broader opportunity structure is linked to a broader perception of behavioural control. A recent Dutch study concludes that “the more respondents thought they were capable of saving energy, the more energy they tended to save” (Abrahamse and Steg, 2009: 717). It is important to note that
energy saving among households is also on the coherence of policy messages. To maximise behavioural change different policy strategies should be both coherent and remain sensitive to context-specific factors (Owens and Driffill, 2008: 4415).

The importance of personal opportunity structures should not be allowed to overshadow the many studies evidencing the importance of environmental attitudes and beliefs for changes in energy behaviour. Although using different conceptualisations of environmental concern, they imply that higher environmental concern is positively related to pro-environmental action (see Steg and Vlek, 2009; do Paço and Varejão, 2010). In a large study undertaken in Devon, UK, Barr et al. identified four clusters of households in terms of environmental values and attitudes, ranging from ‘committed’ and ‘mainstream’ to ‘occasional’ and ‘non’-environmentalists. The first two were almost equal with regard to scope and intensity of their energy saving activities, but differed significantly from the other two clusters whose self-reported energy saving propensities and activities were very low (Barr et al., 2005: 1430). Dutch studies imply that while patterns of energy use are strongly associated with socio-economic variables, household propensity to change present use towards more energy saving is associated with activated norms of environmental concern and altruism (Abrahamse and Steg, 2009; Poortinga et al., 2003).

Earlier research thus makes it reasonable to expect that the more individuals value the environment as a central aspect when assessing alternative courses of action, the more likely it is that also their energy behaviour is influenced by their environmental views, provided of course that they also have some knowledge of the environmental consequences of their energy-related behaviour (for an overview, see Faier et al., 2007: 4384). When households believe that energy use can have negative consequences for the environment, and furthermore feel personally responsible for problems of the environment, they seem more willing to save energy and thus contribute to saving the environment (Abrahamse and Steg, 2009: 172; see also Poortinga et al., 2003: 57). The above mentioned British Devon study also demonstrated that people with stronger environmental convictions and attitudes were – ceteris paribus – more keen on saving energy in the household than those less environmentally concerned (Barr et al., 2005: 1430).

Another line of studying influences on energy behaviour concerns the impact of social norms, i.e., the behavioural patterns expected within a society for a given situation. These normative expectations on individual behaviour may stem from the family, from friends and from broader social norms of behaviour. The Devon study found that individuals who ascribe less importance to obedience and social unity and more significance to personal wealth and social power are much less environmentally active than the “keen energy saver” who puts social unity and obedience above own material wealth and social power.

We thus have reason to expect peoples’ propensity to save energy to be positively related to their beliefs about other peoples’ behaviour, opinions and/or expectations (Ek and Söderholm, 2008, 2010: 1580). To begin with, social trust may play a role; when trusted neighbours show that their energy saving measures “pay off”, this triggers earlier non-saving neighbours into energy-saving activities (Nybørg et al., 2006: 363; Jörgensen, 2009). Furthermore, active engagement in social networks, i.e., a high degree of social integration, also seems positively associated with the acceptance of energy saving behaviour (Barr et al., 2005). Those who often discuss energy saving measures with neighbours and friends are more prepared to save energy (Ek and Söderholm, 2010). It thus seems plausible to expect that the degrees of social trust and social integration, e.g., the degree of participation in social networks, and the frequency of seeing one’s neighbours, may have an independent effect on households’ propensity to save energy (Biel and Thøgersen, 2007; Barr et al., 2005: 1436).

Another research theme concerns whether and how the level of political trust affects individuals’ willingness to accept governmental measures that affect their possibilities to choose what they consider the good life. This points to the relevance of Stern’s typology of environmentally significant behaviour for analysing how households – qua citizens – relate to the opportunity structure, i.e., the structuration of their context of behavioural choice provided by energy policy measures. We are interested in Stern’s category “non-activist behaviours in the public sphere”, which denotes “support or acceptance of public policies” such as regulations or willingness to pay taxes, in this case in the energy policy field (see Stern, 2000, pp. 409, 417).

On a general level, it is found that “low levels of political trust are associated with less support for law compliance within a society. Low trust in political institutions results in less public willingness to defer to decisions taken by those institutions” (Marien and Hooghe, 2010: 16). This should also be highly relevant for the energy policy field. The willingness to change behaviour in line with policy intentions affecting households’ choice of energy behaviour might be higher among households with higher levels of trust in government and its institutions (Diekmann and Preisendörfer, 2003). One recent study finds that “respondents with higher levels of confidence in government are more likely to support government action to address issues such as climate change, ozone depletion, and the protection of biodiversity” (Konisky et al., 2008: 1079).

Such findings lead us to assume that the degree of compliance with policy intentions among targeted groups will be associated with the prevailing levels of citizen trust in politicians and political institutions. Given the character of our data, we are able to analyse whether and how such factors as degree of interest in politics, trust in politicians and in political institutions, and position on the Right-Left ideology spectrum affect the propensity of households to save energy. It should also be noted that our data does not enable us to pursue this lifestyle aspect of energy behaviour further.

We are aware that there might be groups more attuned to Stern's category of “environmental activists” who hold such strong environmental attitudes as to distrust politicians and political institutions. However, patterns from recent comparative studies of political trust make us assume that within the fields of energy and climate policies, individuals with high political trust might be more keen on adapting their energy behaviours than are those with lower degrees of trust (Tjernström and Tietenberg, 2008: 321f; Marien and Hooghe, 2010).

3. Research questions and disposition of the study

Our study will mainly address three questions:

1) What are the main socio-economic and structural factors related to household energy saving?
2) What is the relative importance of these factors compared to environmental attitudes?
3) Among which socio-economic groups are the impact of environmental attitudes on energy saving behaviour stronger/weaker?

The most important contribution of our study lies in examining and comparing the relative importance of attitudes and socio-economic and structural factors, and in analysing more carefully if the impact of environmental attitudes varies between different
socio-economic groups. Such knowledge might allow better adaptation of energy policy measures to the target the population and thus increased impact on household energy saving.

When it comes to the third question, we must limit our study to focussing only on two theoretically particularly interesting sub-groups. In this case, we have also developed more precise expectations. Detached homes, most often with the tenure of owner-occupation, and apartments in multi-family housing with rental or cooperative tenures—provide households with different opportunity structures for energy saving. Given the difference in size of dwellings, people living in detached housing generally have stronger economic incentives to save energy than people living in apartment buildings (see, e.g., Barr et al., 2005: 1426). Moreover, household income may also condition the impact of attitudes. With energy prices continually rising, low-income households have stronger incentives to save energy than households with higher incomes where the economic gain from saving on energy might seem less important.

Thus, we may expect that the economic incentives for households to save energy are less strong for people living in apartment buildings and for higher income groups than they are for other household groups. This implies that environmental attitudes and beliefs may have a relatively stronger impact on the energy saving behaviour of these two groups of households. If so, this could mean that as private economic incentives become less relevant, pro-environmental attitudes become relatively more important since they constitute the major alternative motive for energy saving. Whether this is the case or not is an important question that we address in the last empirical section of this study.

4. Data, measurements and methods

This study is based on data from the annual nationwide representative postal surveys of the SOM institute (Society, Opinion, Media), an academic data collection organisation at the University of Gothenburg. The SOM-surveys contain questions on a large selection of topics such as politics, media consumption, attitudes towards public service and the environment, leisure activities and more. We employ data from the period of 2004–2007, when relevant questions on household energy saving behaviour are consistently included. The SOM-surveys are characterised by high quality fieldwork and representative samples of the Swedish population with relatively high response rates between 70% and 60% (see Nilsson, 2009; for more information on the SOM-surveys, see www.som.gu.se).

The large samples of the SOM-surveys allow us to specifically study interesting sub-groups of the population with reasonable accuracy. Since we are not focusing on variation over time, our strategy is to analyse all four annual surveys together ("pooled analysis"). Before combining the samples of the four years, however, we investigated each year separately to ensure that the aggregate distribution of the central variables do not differ substantially. Even when using several control variables, this yields an effective research sample of almost 4000 respondents.

Although the SOM-surveys lack some of the previously used measurements such as Schwartz value scale, NEP or personal norms, this data provide other unique opportunities to refine our knowledge of the driving forces behind household energy saving in the general population. The combination of large samples, high response rates and samples drawn from the national population register means that this data provides a unique opportunity to estimate correlates of energy household saving and interactions between different determinants among the general population with great accuracy. Further, the fact that the questions we use are included in a general survey that covers a wide range of topics decreases the risk of selections bias where only those environmentally aware or interested in energy saving participate.

Our main dependent variable is household energy saving behaviour. We have chosen two aspects of household energy saving; heating and hot water usage. The reader should note that that what we study is energy saving behaviour reported by individuals, not by households, on energy saving conducted in the household. Thus, the data we use in this study is based on self reported behaviour. When we talk about “energy saving”, we refer to subjectively reported energy saving behaviour, not to actual observed behaviour. Admittedly, this strategy has some drawbacks and limitations. It is, however, commonly used within research on individual behaviour and attitudes across a wide range of disciplines, from political science all the way to psychology and economics (see Whitehead, 2005 for an assessment).

Relying on self-reported behaviour means that we cannot immediately translate our results into conclusions about actual energy saving behaviour. We have to remain aware that our data might to some extent be contaminated by what the respondents wish they were doing, or what they are in principle willing to do. At the same time, one should keep in mind that our interest here is not mainly to estimate absolute levels of energy saving behaviour, but above all to catch and analyse tendencies, group differences and correlates.

The two most important methodological considerations when using self-reported behaviour are that we are likely to over-estimate both (a) energy saving due to social desirability bias, and (b) the correlations between attitudes and (self-reported) behaviour. The effect of attitudes on behaviour might in reality be somewhat weaker than what we find based on self-reported data (see, e.g., Nancarrow et al., 2001). On the other hand, there are also studies that demonstrate high agreement between stated and actual behaviour (Whitehead, 2005).

With this caveat, let us proceed to describe the construction and coding procedures for the most important predictor variables employed here. We mainly rely on an index of General Environmental Attitudes which is intended to reflect respondents’ general degree of pro-environmental attitudes. The index includes two main components; (a) environmental concern, i.e., the extent to which respondents worry about the environmental situation as compared to other societal problems and (b) perceived environmental threat, i.e., respondents’ views on the extent to which the Swedish environment is presently threatened. Thus, the index is built from two different sets of survey items.

The first set of items is related to environmental beliefs and perceived threat and includes seven items concerning “How serious threats to the Swedish environment do you think the following environmental problems are?” The specific problems included in this question are industrial pollution, exhausts from vehicles, coastal oil spills, extinction of plant and animal species, use of chemicals in agriculture, ozone depletion, and management of highly radioactive waste from nuclear energy production. The response scale runs from 1 (“very small threat”) to 10 (“very strong threat”). Theoretically, this is relatively close to the notion of Awareness of Consequences often employed in research on environmental attitudes (see, e.g., Stern et al., 1993).

The second set of items included in the general index relates to the degree of concern for the environment and has a somewhat stronger evaluative element than the question just discussed. A set of items is used which reflects the extent to which respondents worry about the environmental situation as compared to other societal problems. Thus, this set of items resembles, e.g., the use of the notion of Environmental Concern as developed by Schultz and Zelezný (1998). However, we use a slightly different operationalisation. It is based on the survey question “If you look at the situation today, what do you feel is most worrying for the future?”, and includes several items, e.g., high
unemployment, economic crisis, large amounts of refugees, terrorism and religious conflicts. For general environmental concern we use two items measuring the degree of concern for the environment, i.e. “environmental deterioration” and “climate change”. The response scale consists of four categories: “very”, “somewhat”, “not particularly” and “not at all” worrying.

When creating the single index of general environmental attitudes we want to give equal weight to our two components, i.e., environmental concern and perceived threat. Thus, we adjust for (1) the length of the different response scales, (2) the unequal number of items in the two sets of items, and (3) invert the order of the second response scale. The final result is a general index running from 0 to 1, where 1 indicates the strongest, and 0 the weakest pro-environmental attitude. The Cronbach’s alpha reliability coefficient for this index is 0.74, the mean value is 0.76 and the standard deviation is 0.17.

When it comes to household income, we have processed the original data in several steps in order to provide a measure taking into account the number of adults in the respondent’s household. The SOM-survey item asks about the total annual household income and provides a response scale with eight categories. Based on this question we constructed a measure of relative household income with five categories, creating a ranking of five equally large groups (as far as possible based on the eight response options) separately for single person households and households with two adults. These two five-degree separate household income variables were then collapsed into one five-degree scale of relative household income adjusted for household size.

Since we aim at exploring the effects of different explanatory factors for household energy saving behaviour a natural choice of model technique is regression analysis. However, our dependent variable, the self-reported frequency of energy saving behaviour concerning heating and hot water usage, is measured as an ordinal level scale through the five response options “never”, “sometimes”, “often”, “very often” and “always”. This means that ordinary least squares is not an adequate model. Instead, we will use an ordered logit regression model (see e.g., Maddala, 1983, Gujarati, 2003). To make our results interpretable and to link them to our three overarching research questions focusing on the substantive importance of different factors, we will rely on predicted probabilities of energy saving behaviour based on the results of our ordered logit regression models (Scott Long, 1997).

### 5. Socio-economic and demographic factors, and patterns of energy saving

We now turn to an analysis of which socio-economic and structural factors are the most important for energy saving behaviour and an examination of the relative importance of socio-economic factors and environmental attitudes. Table 1 shows the results of a multiple regression model where household energy saving on heating and hot water consumption are regressed on a set of socio-economic predictors as well as on a set of environmental attitudes.

When analysing the results from the two regression models reported in Table 1, we will first address what socio-economic and structural factors are most important. We then proceed by explicitly comparing the importance of these factors with the impact of attitudinal factors, i.e. general environmental attitudes, in this case. Lastly, the question of interaction effects and whether the impact of environmental attitudes is greater among some socio-economic groups than others is examined. All these analyses are based on the results reported in Table 1.

The results reveal some clear patterns. Among the socio-economic factors, three of them stand out as consistently significant at the 99% confidence level, i.e., age, housing type and household income. Other factors, such as marital status and urbanisation, also sometimes exhibit a significant effect on energy saving, but either not consistently or at a lower level of statistical significance.

With some exceptions, the patterns are rather similar for energy saving on heating and hot water consumption. The most important difference is that the coefficient of age for saving on hot water is twice the size of the coefficient of age for heating. Since the relative size of the coefficients for the two models is quite similar, with some exceptions, we will not dwell upon such differences in detail, focusing instead mainly on the results for energy saving on heating.

Although the size and direction of the coefficients indicate the importance of these socio-economic factors, they cannot be readily translated into substantially interpretable effects on the dependent variable. This is because in an ordered logistic regression model the effects are not linear, and unlike in ordinary least square models, the substantial size of an effect is also dependent upon the value of all other explanatory factors in the model.

We will therefore explore the effects of the most important socio-economic factors from Table 1 by computing predicted probabilities of energy saving for a few hypothetical individuals based on the results in Table 1. We cannot do this in a comprehensive manner, since the number of possible comparisons very quickly becomes intractable. Rather, we treat these predicted probabilities partly as (a) an instrument to verify our impression from Table 1 that age, housing type and income are the most important socio-economic and structural factors for explaining the degree of household energy saving and (b) as a necessary step to properly understand the results from the logistic regression models and the interplay between the different main factors.

We do this by graphing different combination of age, housing type and household income for individuals that are clearly “grey” in their attitudes (i.e., exhibiting the minimum value on our General Environmental Attitude scale). The reason for this focus

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Effect of socio-economic factors and environmental attitudes on energy saving behaviour (ordered logistic regression, unstandardised regression coefficients).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Energy saving on heating</td>
</tr>
<tr>
<td>0.61***</td>
<td>0.01</td>
</tr>
<tr>
<td>Married, co-habiting</td>
<td>0.17**</td>
</tr>
<tr>
<td>Children in household</td>
<td>−0.06</td>
</tr>
<tr>
<td>Female</td>
<td>−0.04</td>
</tr>
<tr>
<td>Education (high)</td>
<td>−0.12</td>
</tr>
<tr>
<td>Residence in urban area</td>
<td>−0.30***</td>
</tr>
<tr>
<td>Detached housing</td>
<td>2.12***</td>
</tr>
<tr>
<td>Relative household income</td>
<td>−1.01**</td>
</tr>
<tr>
<td>General environmental attitude</td>
<td>0.90***</td>
</tr>
<tr>
<td>General environmental attitude</td>
<td>−1.31***</td>
</tr>
<tr>
<td>Detached housing</td>
<td>1.50***</td>
</tr>
<tr>
<td>General environmental attitude</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Note: The SOM-surveys from the period of 2004–2007. Numbers in the table are unstandardised coefficients. Estimation by the Stata ‘ologit’ procedure. In addition to the variables shown in Table 1, a large set of other political attitudes and indicators of trust and social integration were also included in the regression model, but not reported here. More information on this is given in Section 8. All independent variables that are not dichotomous (i.e., age and relative household income) in nature have their scale length set to one (min=0 and max=1).

*p < 0.1.

**p < 0.01.

***p < 0.001.

**p < 0.05.
on "grey citizens" is that for other individuals, the interaction effects between environmental attitudes and housing type and income - which will be explored in detail below - would interfere and make it impossible to single out the specific effect of the socio-economic factors. To simplify, other variables in the model behind the predictions are held at their sample means.¹

Fig. 1 makes it strikingly clear that among the three socio-economic factors of housing type, age and income, housing type is by far the most important for determining energy saving on heating. The largest effect of housing type is found among low income people at age 85, where the difference between people in detached housing and people in apartment buildings amounts to as much as 36 percentage points. Income also has a fairly large effect, particularly for people in detached housing. One should note, however, that all three income groups in detached housing displayed in Fig. 1 have a much higher probability of saving energy than any income group in apartment buildings. The substantial importance of age and income is also clearly dependent on housing type. The lines for age are almost flat for people in apartment buildings. The probability of energy saving is just a trifle higher for someone at the age of 85 than for someone at the age of 20, if both individuals are living in apartments.

However, this is a common feature of logistic regression models where the same coefficient means much more as we approach "the tipping point", but might be of little importance when the baseline for that individual is a very low or very high probability. Household income is an example of this feature. The highest income group among our five categories does have a lower probability of energy saving than the lowest income group, but this difference is much larger among people in detached housing. Fig. 1 shows that the difference in saving probability between low and high income households for a person aged 20 in detached housing is larger than 15 percentage points, while the same difference for an equally young person in an apartment building is less than five percentage points. For older people, the size of these differences increases further.

Age also has a rather tangible effect. For average income persons living in a detached house, the change in predicted probability for saving on heating "very often" or "always" changes by +12 percentage points (from 21% to 33%) when we compare someone aged 20 with someone aged 85. When we examine energy saving on hot water, the change in predicted probability is +17 (from 7% to 24%). Both effects are thus substantial, but age has a somewhat larger effect on energy saving on hot water usage, as was previously seen in Table 1.

What then about the effects of other factors presented in Table 1 but not illustrated in Fig. 1? Judging from the coefficients in Table 1, residence in urban areas has a substantial and significant effect, although it still seems minor compared to that of age. When comparing the predicted probability of an elderly person (age 70) belonging to the lowest household income group and living in an apartment in a small town with a similar person living in an apartment in an urban area, we find a difference of only −2 percentage points (9–7%). When we make the same comparison for two such persons living instead in detached housing, the difference is a decrease in probability of 8 percentage points. The conclusion is easily drawn; the effect of area of residence is markedly smaller than that of age.

When it comes to energy saving on hot water consumption, the effect of housing type is less dominant than it is for saving on heating. While the maximum effect of housing type for heating was 36 percentage points (see above), the same figure for energy saving on hot water consumption is 24 percentage points. For age on the other hand, the maximum effect for saving on heating is 14 percentage points, compared to 25 percentage points for saving on hot water. For heating, housing type is clearly the more important factor, but for hot water consumption on the other hand, age seem about equally important.

To sum up, housing type, age and household income stand out as the three most important socio-economic factors influencing household energy saving on heating and hot water consumption, where type of housing is generally the single most important determinant. Though sometimes statistically significant, other socio-economic factors seem to be of less substantial importance.

6. Socio-economic factors versus general attitudes

We now turn to the effect of environmental attitudes. Judging from the results presented in Table 1, environmental attitudes also seem to have a clearly significant effect on energy saving.
behaviour. But the question remains: How strong is the impact of attitudes compared to that of socio-economic factors?

We seek the answer to this question by examining the maximum effect of varying socio-economic conditions compared to the maximum effect of varying general environmental attitudes. Let us therefore now explore the effects of socio-economic factors and environmental attitudes in terms of predicted probabilities of energy saving for a set of hypothetical individuals with varying socio-economic attributes and environmental attitudes.

We expect to find the lowest amount of energy saving among persons with “grey” attitudes that are living in apartment buildings and are young, high income persons. The largest amount of saving among people with “grey” attitudes we expect to find among older, low income persons living in detached housing. And indeed, the predicted probability of saving energy on heating “always” or “very often” for the “rich young grey” in an apartment is only 2%. For the “poor old grey” in a detached house, the same probability is as high as 45%, i.e., a difference of 43 percentage points. The same predictions for saving on hot water yield a difference of 37 percentage points.

The interaction effects included in the models reported in Table 1 make it hard to find a single way to estimate the substantial size of the effect of environmental attitudes. Our strategy here is to simply estimate the maximum attitudinal effect and to compare this with the maximum socio-economic effect. The computation of the maximum attitudinal effect starts from an old high-income person living in an apartment. For such an individual, the move from the minimum to the maximum value on the general environmental attitudes scale results in an upward shift of 26 percentage points (from about 3% to almost 30%) in predicted probability of energy saving on heating. For energy saving on hot water on the other hand, the maximum effect is as large as 40 percentage points (4% compared to 44%) and thus outperforms the maximum effect of socio-economic factors (37 percentage points). However, we must be wary that this large attitude effect is highly conditional upon other factors. In a minimum estimate – based on a young, low income person living in detached housing – the effect only amounts to just under 4 percentage points (a probability of roughly 12% compared to 16%).

For energy saving on heating it seems clear that socio-economic and structural factors are more important than general environmental attitudes. One should remember, however, that if we were to use a more specific measure of attitudes tied to specific energy saving beliefs and behaviours, the effect of such attitudes would of course be much stronger. For hot water consumption on the other hand, the case is less clear and highlights the importance of considering the conditionality of attitudinal effects. The next section will examine this issue in more detail and analyse how the impact of environmental attitudes varies depending on other characteristics.

7. The relative importance of environmental attitudes

We are now ready to address our third main question in detail: Is the impact of environmental attitudes stronger among some groups than others? We particularly focus on two such groups where the attitudinal impact might be more pronounced, i.e., high income groups and people living in apartment buildings. As explained above (Section 2), we build this expectation on the assumption that the economic incentives for household energy saving are weaker in those two groups, and that this increases the relative importance of environmental attitudes.

Table 1 above indicates that both of the aforementioned interaction effects are indeed statistically significant. In addition to the positive effect of general environmental attitudes on energy saving, the interaction term between housing type (detached housing = 1, apartments etc. = 0) and general environmental attitudes is significant and negative. This means that the effect is stronger among people living in apartment buildings than among people in detached housing. The interaction term between relative household income (five categories, lowest income group = 0, highest income group = 1) and environmental attitudes was also found to be statistically significant and positive. This indicates that the effect of general environmental attitudes is stronger the higher the household income.

Let us now examine the importance of these interactions more closely. Since an understanding of interactions is sometimes quite complicated, our examination once again includes graphical means to illustrate and understand how the interactions work but also what they mean in practise. We focus on predicted probabilities of energy saving on heating rather than on consistently analysing both heating and hot water consumption. However, we have checked the results for hot water as well, and despite some differences in their details, the general patterns and conclusions remain the same for the two behaviours we study.

Fig. 2 indicates a linear effect of environmental attitudes for people living in detached housing, with the probability of energy saving increasing approximately 10 percentage points when gradually increasing the extent of “green” attitudes from the bottom to the top. For people living in apartment buildings we observe a curvilinear pattern with gradually increasing effects of pro-environmental attitudes, where the increased probability that results from a 0.1 increase in pro-environmental attitudes gets somewhat larger as we approach the right end of the scale in Fig. 2. The difference in predicted probability between a completely “grey” and completely “green” person living in an apartment is 15 percentage points.

Fig. 3 reveals an interesting pattern of clearly conditional importance of attitudes for energy saving on heating, depending on household income. As we hypothesised, the impact of attitudes is larger among high income groups than among low income groups. For people in the highest income category the difference in predicted probability of saving energy “very often” or “always” for someone with completely “grey” attitudes (= 0) and someone with completely “green” attitudes (= 1) is 21 percentage points, while the difference for someone in the lowest income category is just above 9 percentage points. In fact, the effect is fairly linear for low income people, while the effect of attitudes clearly increases more and more the closer to the “green end” of the scale we get for the middle and highest income groups depicted in Fig. 3.

Generally speaking, people with higher incomes tend to save less on energy since they do not have equally strong economic incentives to do so. As seen in the left part of Fig. 3, where relatively “grey” attitudes prevail, low income households also have higher energy saving probabilities than high income households. Our findings indicate, however, that the interaction effect between environmental attitudes and income is sufficiently strong to reverse this pattern for people with clearly green attitudes. This results in switched positions for different income groups among environmentally concerned people where households with higher income have a higher probability of saving than low income households. The connection between environmental attitudes and energy saving behaviour is quite complex and thus difficult to grasp in general terms.

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This is in part a simplification, however, since we are setting all other variables not mentioned here to the sample mean. If we would take all variables included in our regression model into account and manipulate them correspondingly in order to estimate a complete maximum SES effect, this would be somewhat larger.
What does seem clear is that there are indeed important interactions between attitudes and socio-economic and structural factors that previous research has not considered sufficiently. For both the two factors we have examined in this part of the study – household income and housing type – we find considerable and important interaction effects, though perhaps somewhat more so for income.

8. Other factors at work?

In addition to the three main research questions pursued here, we have also briefly examined whether indicators of political trust and the degree of social integration have important effects on energy saving behaviour and whether they change the effects of attitudes or socio-economic and structural factors discussed in the previous section.

Our data provide some possibilities to control for the influence of social integration and political trust. We choose to include a set of indicators such as general interpersonal trust, an index of social activities and membership in voluntary organisations. Trust in politicians and in political institutions as well as left-right ideology was also included in the estimation of the regression model presented in Table 1 above, although the full results not reported.3

This control for social integration and political trust enables us to be even more confident in our previous results. The effects of environmental attitudes and beliefs are still standing after control for a set of indicators of social integration and political trust. The relationship between the most important socio-economic and structural variables and energy saving as well as between environmental attitudes and energy saving remain almost untouched when these extended controls are included.

Our results indicate that social integration and political trust are not of any greater importance for household energy saving. Political trust, interpersonal trust, interest in politics and left-right ideology all seem inconsequential for household propensity

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3 Full results can be obtained from the authors upon request.
to save energy. We do receive one indication that social integration might have a slightly positive effect. Those who socialise more often than others with their neighbours have a higher probability of saving energy. However, it is unclear what this result reflects since many other factors might be related to this kind of social activity or this response pattern. We therefore refrain from drawing any conclusions from this; suffice it to note that local social integration might have a significantly positive, although comparatively weak, effect on energy saving.

9. Implications for energy policy

We started out by pointing to the very ambitious objectives of the 2009 Swedish joint policies for energy and climate and wondering whether and how Swedish households, who obviously already are keen on saving energy, react to these far-reaching policy objectives. In particular, the strong reliance on market-based measures and economic incentives seems to go against scientific evidence that gains in policy incidence and effectiveness could be made if measures are broadened to also address households’ environmental attitudes and beliefs.

To that end, we have used a large survey data set on Swedish inhabitants and their environmental attitudes and energy-related behaviours to examine the main determinants of household energy saving and the relative importance of socio-economic factors and environmental attitudes. Our results can be used to help improve the targeting and selection of policy measures intended to increase household energy saving.

First of all, we have found significantly weaker effects of environmental-related attitudes on saving behaviour among households in (owner-occupied) detached housing. This implies that energy policy measures built on efforts to utilise environmental attitudes should first and foremost be targeted on households in detached housing and the ensuing clear economic incentives. This, in sum, leads us to suggest that policy measures should be carefully tailored to fit the propensities and preferences of households in different income strata and in different housing forms. Finally, we think that the interaction analyses carried out here point to intricate and powerful interaction effects among socio-economic, structural and attitudinal factors that previous research has not considered sufficiently. This is a line of research on energy, policy and behaviour that should be carried further to help increasing the incidence and effectiveness of energy policies.

Acknowledgment

The research presented in this paper was made possible by a grant from the Expert Group for Environmental Studies at the Swedish Ministry of Finance.

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