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Energy conservation through behavioral change

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Chapter 6
General Discussion

Many behaviors in our everyday lives require the use of energy. Taken together, these energy-related behaviors steadily lead to adverse environmental effects. Households contribute to these energy-related problems and constitute an important target group for energy conservation. It is therefore important to examine how to effectively encourage household energy conservation and to examine which factors underlie household energy use and conservation. Energy conservation can be accomplished by changing existing behavioral patterns, thereby reducing households' impact on the environment.

The research presented in this dissertation was guided by two themes. First, it examined the effectiveness of intervention strategies aimed at reducing household energy use, and second, an attempt was made at mapping the factors that underlie household energy use, households' intention to reduce energy use and their actual energy savings. This closing chapter integrates and discusses the main findings presented in this thesis, with a focus on their implications for theory, research and policy-making.

Effective intervention planning

An important issue emerging from this thesis is that the effectiveness of intervention studies aimed at household energy conservation should ideally be examined in relation to changes in energy use, changes in energy-related behaviors and changes in behavioral determinants (Chapter 2). By and large, intervention studies focus solely on the effects of an intervention on changes in energy consumption. However, the monitoring of behavioral changes and behavioral antecedents can provide additional insight into reasons why an intervention did or did not encourage households to reduce their energy use. The provision of information about energy-saving measures may not have resulted in energy savings, because knowledge levels did not increase in the first place. In addition, a focus on energy-related behaviors is necessary to examine which behaviors have the highest impact on total energy use (and savings). Thus, in order to enhance our understanding of the effectiveness of interventions aimed to encourage households to reduce their energy use, it is essential to examine changes in energy use, energy-related behaviors and behavioral antecedents.

The multidisciplinary study described in Chapter 3 evaluated the effectiveness of a combination of interventions (tailored information, goal setting and feedback) in terms of changes in energy use, changes in energy-related behaviors and changes in knowledge about energy conservation. Based on current possession and use of appliances and equipment, households received tailor-made advice via the Internet about how they could reduce their energy use. In addition, they received tailored feedback about the savings they accomplished for each energy-saving option (in relation to a 5% goal, set beforehand). Over the course of the five-month intervention period, households exposed to the interventions reduced their energy use and attained the goal of 5% savings, whilst households not exposed to the intervention used more energy. This difference in total energy savings between groups was not statistically significant. Households exposed to the interventions significantly reduced direct energy use (gas, electricity and fuel), compared to households in the control group, who increased their direct energy use slightly. Households in the experimental groups reduced their indirect energy requirements (i.e. food consumption, holidays), while households in the control group increased their indirect energy requirements. However, the difference between the experimental and control group was not statistically significant. A possible explanation for this is the high variability in energy savings. Indeed, when the main source of high variability (viz., energy savings for holidays) was not included in the analyses, group differences in total energy savings over time were statistically significant, with households who received the combination of interventions saving significantly

more energy than households not exposed to the interventions. Overall, the results suggest that the interventions had the strongest impact on direct energy use. In view of the fact that annual energy savings of 1.3% are necessary to meet the Kyoto criterion, these results (of a 5% reduction) are certainly relevant from a practical and policy point of view.

There is some indication of the intervention resulting in changes in energy-related behaviors as well. During the course of the study, households who received tailored information, goal setting and tailored feedback had adopted various energy-saving behaviors, whereas households in the control group did so to a lesser extent (see Chapter 3). Behavioral changes were most marked for relatively low-cost behaviors, such as lowering thermostat settings, whereas relatively high-cost behaviors, such as reducing car use for short trips did not change over time. The combination of interventions mainly resulted in various low-cost behavioral changes.

The results further reveal that households exposed to the interventions had significantly higher knowledge levels than households in the control group had. Thus, the provision of information about energy use and conservation encouraged households to acquire more knowledge of energy conservation. Taken together, these results highlight the importance of examining an intervention's effectiveness in terms of changes in energy use, changes in energy-related behaviors and changes in determinants.

The field study presented in this dissertation targeted indirect energy use specifically (see Chapters 3 and 5). In contrast to gas and electricity use (direct energy use), indirect energy use is embedded in the production, transportation, and disposal of goods and services (Vringer & Blok, 1995). Results of our study suggest that, as a result of the combination of interventions, households have become more aware of the relative impact of indirect energy use, as evidenced by a reduction in their indirect energy requirements. Households in the control group increased indirect energy use, which can be explained by the fact that they were not made aware of indirect energy use. In view of the relatively large share of indirect energy use on total household energy requirements, it should become a focal point for interventions aimed at energy conservation.

A finding that clearly stands out is the relative success of tailored or custom-made interventions. Households were provided with tailored information and tailored feedback. Such a personalized approach has the advantage of being able to provide individual households with information about energy conservation measures applicable to their specific household situation and given them personalized feedback on their energy-saving efforts. This is in sharp contrast to the more general approach used in mass media campaigns (recall the example of

Dutch advertisement campaigns in the Introductory Chapter), which, as our review showed (see Chapter 2) are generally not very effective. The multidisciplinary field study reported in Chapter 3 provided custom-made information and feedback to individual households. It did so in a novel way: by means of an Internet-based tool, households received tailored information and tailored feedback about energy use and conservation. Initial evidence was obtained for positive effects of this 'digital energy advisor', because it resulted in increased knowledge levels about energy conservation, behavioral changes and energy savings.

Factors related to energy use and energy savings

This thesis also examined factors underlying energy consumption and energy savings of households under the assumption that interventions aimed at energy conservation will be more effective if they target these behavioral antecedents. It is thus important to make an inventory of the antecedents of household energy use, intentions to reduce energy use and actual energy savings, as well as subsequently designing and implementing interventions that target these determinants. To date, relatively little attention has been devoted to theoretically examining the underpinnings of energy use and energy savings. In this dissertation, against the backdrop of the theory of planned behavior, norm activation model, and value-belief-norm theory, we focused on the relative importance of socio-demographic variables and psychological variables in relation to (direct and indirect) energy use, intention to reduce it, and (direct and indirect) savings.

As a first remark, the work presented in this thesis suggests clearly that household energy consumption itself is related to different (sets of) variables than (intended) energy savings are. Household energy use was most strongly related to socio-demographic variables: higher incomes and larger household size were associated with higher energy consumption (Chapter 4). This finding was replicated in the second field study, reported in Chapter 5, in which case energy use was related most strongly to socio-demographics as well such as income and household size. This is in line with previous studies (e.g. Brandon & Lewis, 1993; Gatersleben, Steg, & Vlek, 2002). The finding that households with higher incomes use more energy may be self-evident. However, these households also have relatively more financial means to adopt (costly) energy-saving measures, such as the installation of double glazing, or the purchase of products with lower energy intensities. In conclusion, energy use appears to be most strongly related to factors that provide the opportunities and constraints for energy-related consumption patterns.

Households' intentions to reduce energy use and their actual energy savings were

most strongly related to psychological variables, and not to socio-demographics. Perceived behavioral control especially appeared to be a key factor. Intention to reduce energy use was mainly associated with households' perceived possibilities for reducing energy use and to their attitudes toward energy conservation (Chapter 4). The more households felt capable of saving energy and the more positively they evaluated energy conservation, the stronger their intentions to reduce energy use. Energy savings were most strongly explained by perceived behavioral control and feelings of responsibility for energy-related problems (Chapter 5). More specifically, higher levels of perceived behavioral control and lower levels of responsibility were associated with greater energy savings. Psychological variables appear to be most strongly related to intentions to change existing energy-related consumption patterns and actual energy savings.

The results also indicate that different types of energy use and energy savings are related to different (sets of) variables (Chapter 5). Direct energy use was related to household size, and indirect energy use was related to income and household size. Direct energy savings could not be explained by either socio-demographic or psychological variables, an intriguing finding that warrants further research. Indirect energy savings (which were mainly comprised of behaviors related to food consumption and holidays), were explained by perceived behavioral control and ascription of responsibility. In all, these findings indicate that direct and indirect energy use and savings are related to different behavioral antecedents. Again, the relative importance of perceived behavioral control in relation to behavioral change was shown.

Taken together, the results clearly indicate that energy consumption is mainly determined by socio-demographic variables, whereas (intended) changes in energy use are mainly determined by psychological factors. Contextual variables appear to shape households' opportunities for energy consumption, whereas changes in energy use tend to require a certain amount of conscious effort (e.g. to break the habit).

A multidisciplinary approach to household energy conservation

Since household energy use and conservation are multidimensional in nature, it is important for intervention studies aimed to encourage household energy conservation to take a multidisciplinary approach (see also Gardner & Stern, 2002). The field studies presented here brought together the expertise of social scientists (with a focus on behavioral change and behavioral determinants), expertise of environmental scientists (with a focus on (measurement of) energy use associated with various

behaviors), and expertise of computer engineers (with a focus on developing a user-friendly Internet-based tool). The design, successful implementation and evaluation of the combination of interventions hinged upon the combined input of these three disciplines, that is, each strand required input from the others at various stages in the process. The social psychologists focused on the development and implementation of the interventions and on selecting behaviors that would be acceptable and feasible to adopt. The environmental scientists provided more insight into the energy use associated with certain behaviors, which enabled us to target those behaviors that would significantly reduce energy use (if adopted by households). They developed a tool for calculating energy requirements of a broad range of energy-related behaviors, covering direct and indirect energy use. The computer engineers were responsible for the development of a user-friendly website, which conveyed the combination of interventions to households and they constructed the database, which was subsequently used by the environmental and social scientists. This way, the energy-saving options were viable, effective (if adopted), and readily accessible (through the website) for each individual household. It enabled households to get more insight into which specific energy-related behaviors would contribute the most to energy conservation, which would motivate them to adopt these energy-saving measures.

As a drawback, the multidisciplinary approach also entailed that trade-offs needed to be made. Certain energy-related behaviors that were important for the social scientists to incorporate in the study were not feasible from an environmental scientist's point of view, or vice-versa. For instance, the suggestion was put forward to include information about the difference in energy use between seasonal vegetables and vegetables transported from abroad. However, since this required a considerable extension of the questionnaire so as to enable the environmental scientists to measure accurately such energy requirements, this suggestion was waved aside. Multidisciplinary collaboration also proved more time-consuming than mono-disciplinary research, as more frequent and elaborate consultation was needed to reach mutual agreement. Moreover, the collaboration sometimes led to conflicts of interest, which required a mutual understanding of each other's different views on the issue, and some skills in conflict resolution.

Despite these limitations, in our view, the approach including environmental scientists, social scientists, and computer engineers has provided a more comprehensive insight into the psychological factors influencing (un)sustainable behavior patterns, into possible ways to change these behavioral patterns, into which behaviors have the highest impact on energy use and emission reductions, and into how to implement strategies for behavioral change in a user-friendly manner.

Generalizations of the present research

The data presented in this study were collected from samples of households who participated in two separate field studies. Several issues need to be taken into account when interpreting the results. First of all, households voluntarily registered for participation. It is a well-documented fact that it can be quite difficult for intervention studies aimed at energy conservation to find willing participants (see also Chapter 2). In our case, 'quite difficult' is actually putting it mildly, considering the fact that well over 7,000 recruitment letters eventually resulted in a little over 300 participating households. A possible explanation is that we employed a number of strict selection criteria to ensure that energy savings could be calculated accurately. As participation was voluntary, it is likely that participants were already interested in energy conservation in the first place. Both samples were not representative with respect to socio-demographic background. This was not supposed to pose too much of a problem, since our analyses revealed that socio-demographics were not significantly related to intention to reduce energy use and actual energy savings. Nonetheless, caution in generalizing the results to the wider population is warranted.

Second, the samples can be characterized as selective for another reason. The field studies were longitudinal in nature, requiring time and effort, as participants had to fill out lengthy questionnaires on the Internet at several fixed points in time. This was necessary in order to thoroughly evaluate the effectiveness of the Internet-based tool. Despite the fact that considerable effort was put into encouraging households to continue participation, a substantial number of participating households dropped out during the course of the study. Analyses showed, however, that households who continued participation did not significantly differ from those who dropped out, on socio-demographics, energy use or psychological antecedents, suggesting that dropout was not selective.

Third, households in the control group may have unintentionally been 'triggered' about their energy use. To be able to compare energy use of households exposed to the interventions to those in the control group, households in the latter group filled out similar questionnaires about their energy use. This may have led to unwanted effects, as households in the control group may have been triggered about their energy-related behaviors. As a case in point, filling out questions about temperature settings may have increased awareness of the possibility of lowering thermostat settings – and may have prompted them to adopt this energy saving measure.

Fourth, in this study, the psychological variables were measured on an individual level (i.e. the household member who filled out the questionnaires), whereas energy use was measured on a household level. This was done out of practical reasons,

as it was not deemed feasible to have each individual household member filling out the full-length questionnaire. An additional issue with this is how to measure psychological variables on a household level? Equally well, it was impossible to examine the energy use of each individual household member separately – household energy use cannot simply be divided by the number of people in a household because it is not clear what the individual share of each household member is. This does pose a limitation to the study. However, a 'second best' option was chosen, i.e. the household member who filled out the questionnaire was assumed to represent the entire household with respect to the psychological variables. Due to the setup of this study, it was not possible to examine these psychological variables for each household member separately, or to look at the dynamics within a household. Future – qualitative - studies could shed more light on this issue.

Theoretical implications

The results of the present thesis clearly show that household energy use and energy savings are related to different sets of variables. Energy use was most strongly related to socio-demographic variables, that is, factors shaping the context in which energy consumption patterns take place, such as income and household size, whilst psychological variables were not influential. Intentions to reduce energy use and changes in energy use on the other hand were most strongly related to psychological variables (especially perceived behavioral control and attitudes), and not to socio-demographics. Current behavior patterns thus appear to be related to different variables than willingness to change behavior and actual behavioral change. This is not in line with the assumption of Ajzen's theory, as it assumes that prevalent attitudes, social norms and perceived behavioral control are related to behavioral intentions and behavior. The results of this study indicate that this assumption does not hold, to the extent that household energy use and energy conservation appear to be conceptually different behaviors. A similar point has been made in transportation research, where observing and exceeding the speed limit were found to be conceptually different (Letirand & Delhomme, 2005).

Second, the variables from the theory of planned behavior were (most) successful in explaining intention to reduce energy use and actual energy savings. Especially perceived behavioral control (i.e. referring to individual abilities for energy conservation) and attitudes (i.e. referring to individual evaluations of energy conservation) were influential. Variables from the norm activation model (Schwartz, 1977), and the value-belief-norm theory (Stern, 2000) were less influential. This indicates that a framework with a focus on individual considerations in relation to

intentions and behavior change (TPB) may be more suitable for examining household energy conservation than frameworks with a focus on collective or environmental considerations. In the literature (see for instance Lindenberg & Steg, 2007; Thøgersen, 1999), it is indicated that the TPB is more suitable for explaining relatively high-cost environmental behaviors, i.e. characterized by considerable constraints in terms of time, effort, and inconvenience, such as (changes in) travel mode choice (Bamberg & Schmidt, 2003; Heath & Gifford, 2002). NAM and VBN are believed to be more suitable for explaining relatively low-cost environmental behaviors, such as recycling (e.g. Hopper & Nielsen, 1990), or support of environmental movements (see Stern et al., 1999). Thus, contrary to popular belief, pro-environmental intentions and behavior are not always best explained by frameworks that include environmental considerations.

To continue this analogy on a behavioral level, a third implication is that different types of environmentally-relevant behaviors may be related to different behavioral antecedents. We found some indication for this, as different types of energy use and savings were related to different sets of variables. For instance, direct energy savings were related to attitudes, whereas indirect energy savings were not. The issue of pro-environmental behaviors being related to different types of behavioral determinants has been raised elsewhere (e.g. Axelrod & Lehman, 1993; McKenzie-Mohr et al., 1995). Possibly, relatively low-cost behaviors are related to environmental considerations (such as responsibility for energy-related problems), whereas relatively high-cost behaviors are related to individual considerations (such as attitudes). More detailed and systematic research is needed to shed more light on the issue of which behavioral antecedents are related to which environmentally-relevant behaviors.

Policy implications

How can these findings be translated into governmental energy policies? First, our literature review strongly suggests that tailored interventions can be a viable option for promoting household energy conservation. Energy audits are examples of current governmental policies taking a tailored approach, and provide households with custom-made energy-saving advice. An important drawback of these audits is that they tend to focus on efficiency behaviors (such as double glazing) and not so much on curtailment behaviors. As our field study indicates, energy conservation can also be effectively achieved through curtailment behaviors. The Internet-based tool presented in this dissertation has the advantage of aiming at both efficiency as well as curtailment behaviors, and it is relatively cost-effective in case of large-scale implementation, making it a promising avenue for promoting behavioral

change. To be able to properly evaluate the effectiveness of the website, the present study was relatively demanding in the sense that participants had to fill out the questionnaires at fixed time intervals. In case of large-scale implementation, this will no longer be necessary. This will probably increase participation rates, and will enable households to consult the digital energy advisor at any given moment for information and feedback about their energy use. Especially in view of the fact that it offers possibilities for large-scale implementation at relatively low costs, this approach may prove to be highly effective in reducing residential energy use.

Further, governmental energy policies should not only be targeted at households (i.e. the demand side), but they may also want to target the supply side. The industry should be encouraged to make the energy requirements of their products visible to consumers (e.g. via energy labels, indicating the energy use and CO_2 emissions associated with each product). This may be done by reward or penalty schemes. To illustrate, product information should contain information about country of origin and the emissions involved in its transportation (e.g. so-called food miles). Travel agents should be encouraged to publish the CO_2 emissions involved in air travel compared to its alternatives, alongside the price listings. This way, consumers can make (better) informed choices – by making the more aware of the energy implications of the choices they make on a day-to-day basis.

Equally well, governmental policies may want to encourage the development and implementation of technological innovations (structural variables) as well as subsequent use of this equipment (individual variables), which may reduce energy requirements. For instance, governmental subsidies can stimulate the production of energy-efficient equipment, and in conjunction, introduce a rebate scheme aimed to encourage the purchase of such equipment. In view of the influence of structural and individual-level variables in relation to energy use and energy savings, these variables should become an intricate part of governmental energy policy planning.

As a final observation, energy policies may be more effective to the extent that they target behavioral determinants, by taking individual perceptions, knowledge, attitudes, norms and values into account. Initial evidence was presented in this thesis in support of this claim. For example, energy policies should be targeted at increasing knowledge about energy conservation. In our study, knowledge levels of energy conservation increased as a result of the combination of interventions. We have reason to believe that it is important for policies to target the extent to which households perceive they have opportunities to conserve energy, and to emphasize the advantages of energy conservation, as these variables turned out to be related to intention to reduce energy use and to actual energy savings.

Final remarks

Issues related to sustainability are, and will remain, a topic of interest for decades to come. In view of the fact that the Kyoto targets for emission reductions are still to be met and that these emissions continue to increase, the call for energy conservation actions will be increasingly pressing. This dissertation has made a contribution to a better understanding of household energy use and conservation, by (theoretically) examining socio-demographic and psychological variables in relation to direct and indirect household energy use, energy conservation and by examining the effectiveness of interventions aimed at behavioral change.

It was shown that a tailor-made intervention was successful in bringing about changes in energy use, in encouraging the adoption of energy-saving measures, and in increasing knowledge of energy use and conservation. Also, this dissertation puts the multifaceted nature of energy use and conservation in the limelight: household energy use was more strongly related to socio-demographic variables, whilst intention to reduce energy use and actual energy savings were strongly related to psychological factors. Mainly variables related to individual considerations (viz., perceived behavioral control and attitudes) appeared to be influential in case of household energy conservation. In this respect, the advertisement campaigns mentioned at the beginning of this thesis were not too far off. If the aim is to encourage more sustainable behavior patterns, intervention studies aimed at household energy conservation should ideally focus on actual savings, behavioral changes, and behavioral antecedents. In addition, the focus should be on behaviors that have significant environmental impacts and behaviors related to indirect energy use. A multidisciplinary approach is thereby necessary, in order to fully encompass the multifaceted nature of energy-related behaviors and determinants, and to encourage consumers to adopt more sustainable lifestyles.