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Chapter 7

HOW TO PROMOTE ENERGY SAVINGS AMONG HOUSEHOLDS: THEORETICAL AND PRACTICAL APPROACHES*

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ABSTRACT

Households are responsible for a large part of total energy requirements and CO2 emissions. We review the contribution of social and environmental psychology for understanding and promoting household energy conservation. A general framework is proposed, comprising: (1) identification and measurement of the behavior to be changed, (2) examination of the main factors underlying this behavior, (3) design and implementation of interventions to change behavior to reduce household energy use, and (4) evaluation of the effects of interventions. We discuss how psychologists empirically studied these four topics.

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INTRODUCTION

Greenhouse gas emissions have steadily increased by about 1% per year during the last decade (e.g., EPA, 2004; RIVM, 2004). CO_2 is the most important greenhouse gas, responsible for about 84% of the total emissions of greenhouse gases (EPA, 2004). Household energy use significantly contributes to greenhouse gas emissions. For example, households are responsible for approximately 15 to 20% of total energy requirements in OECD countries (OECD, 2001) by using electricity, natural gas and fuels; in the Netherlands, this percentage is 23% (Ministerie van EZ, 1999). Many governments aim to reduce household energy use, and consequently, greenhouse gas emissions. However, despite their efforts, household energy consumption is still increasing. In the Netherlands, electricity and fuel use have increased steadily from 1990, due to increases in possession and use of electric appliances, and increases in car use (Steg, 1999). More effective energy policies seem to be warranted to reduce the emission of greenhouse gases by households.

This chapter discusses factors influencing household energy use, and ways to promote household energy savings. Attempts to promote household energy conservation will be more effective when one (1) selects high impact behaviors, that involve relatively large amounts of energy use and CO_2 emissions, and monitors behavior over longer periods of time, (2) examines which factors are related to those behaviors, (3) implements interventions that change these antecedents and the behavior, and (4) systematically evaluates the effects of these interventions in terms of behavior changes, changes in behavioral antecedents, changes in energy use, environmental quality and human quality of life (Geller, 2002; Steg and Vlek, 2008). This chapter provides a brief overview of how psychologists have addressed these issues.

SELECTING AND ASSESSING ENERGY USE BEHAVIORS

If psychologists aim to significantly contribute to the reduction of energy problems, they should study behaviors associated with high energy consumption. Households use energy in a direct and in an indirect way (e.g. Vringer and Blok, 1995). Direct energy use is the use of electricity, natural gas and other fossil fuels, and indirect energy use refers to the energy used in the production, transportation and disposal of goods and services. In European countries, about half of total household energy use is direct energy use, the

other half is indirect energy use (Kok, Falkena, Benders, Moll, and Noorman, 2003; Reinders, Vringer, and Blok, 2003). Although a substantial part of total household energy use involves indirect energy use, only few studies examined the indirect use of energy (Abrahamse, Steg, Vlek, and Rothengatter, 2007; Gatersleben, Steg, and Vlek, 2002; Poortinga, Steg, Vlek and Wiersma, 2003).

Household activities vary widely in the amount of energy they use. In 2005, in the UK, about 53% of domestic direct energy use related to space heating, 20% to water heating, 16% to the use of household appliances, 6% to lighting and 5% to cooking (Maslin, Austin, Dickson, Murlis, Owen, and Panizzo, 2007). Environmental scientists have developed various tools for assessing direct and indirect energy use, such as life-cycle analysis, or input-output analysis (e.g., Kok, Benders, and Moll, 2006) that are useful for identifying behaviors associated with relatively high levels of energy use. These data can help practitioners decide which type of conservation behavior would be most worthwhile. Besides impact, psychologists should also consider the feasibility of behaviour changes. Of course, the feasibility can be facilitated via various intervention strategies (see Section Interventions to promote energy conservation).

After a specific energy-related behavior is identified, it needs to be measured properly. That is, valid behavioral measures are needed. Based on this, one can decide which (groups of) individuals should be targeted. Moreover, by monitoring (changes in) environmental behavior over time, one can assess whether interventions have been successful.

Most studies on household energy use rely on self-reported data. Some studies revealed that self-reports are adequate indicators of actual behavior (e.g., Fujii, Hennesy, and Mak, 1985; Warriner, McDougall, and Claxton, 1984), but others reported weak correlations between self-reported and observed behavior (e.g., Corral-Verdugo, 1997). Whenever possible, one should try to measure actual behavior; smart meters and GPS devices could yield useful insights in this respect. When the measurement of people's actual behavior is not feasible, it is important to consider how to collect valid and reliable measures of self-reported behavior (see also Vining and Ebreo, 2002), and to check the accuracy of the employed measures.

Psychologists have studied separate energy conservation behaviors, such as reducing car use, or switching off lights, but they have also tried to assess total household energy use. Meter readings reflect how much electricity, gas, fuel or water has been used by a particular household. However, meter readings do not reveal which specific behaviors contributed most to total energy, fuel or water use. From an educational point of view this is

problematic, for people generally do not know which and whose behaviors significantly affect resource use, and people cannot receive specific feedback on the results of their behavioral changes (see also Gatersleben et al., 2002).

Therefore, composite behavioral measures of energy use have been proposed based on a well-defined set of specific behaviors (see Abrahamse et al., 2007; Gatersleben et al., 2002). This approach implies that respondents first indicate which goods they possess (e.g., fridges, cars) and how often they use these. Subsequently, environmental scientists asses the direct as well as indirect 'energy contents' of these behaviors. Next, the energy contents of various behaviors are summed, yielding a measure of total energy use involved in a given household behavior pattern. On the basis of this approach, households can be provided with information on specific ways to reduce their energy use. Also, feedback can be provided about the specific behavior changes that have been most effective in realizing energy savings, and those that have not been effective (see Abrahamse et al., 2007). This is important, as households may gain insight into the relative impact of the various energy-saving options they consider implementing.

FACTORS INFLUENCING HOUSEHOLD ENERGY USE

Behavioral interventions are generally more effective when they target important antecedents of the relevant behavior and remove barriers to change. Therefore, it is important to understand which factors promote or inhibit energy conservation. Various factors influence household energy use and energy savings. Individuals need to be aware of the need for and possible ways to reduce household energy use, they need to be motivated to conserve energy, and they should be able to adopt the relevant behaviors. Each of these factors will be discussed briefly below.

Knowledge

In general, people are well aware of the problems related to household energy use, and are concerned about these problems (Abrahamse, 2007), although there is still confusion about the causal processes involved (e.g. Bord, O'Connor, and Fischer, 2000; Gorsira, Steg, Bolderdijk, and Keizer, in preparation). For example, many people think global warming is caused by the depletion of ozone in the upper atmosphere (which is incorrect), while only a

limited number of people think global warming is caused by heating and cooling homes, which is correct (Bord et al., 2000). In 2008, only 21% of a representative sample of the Dutch population knew that global warming does not result in ozone depletion, and only 35% knew that acid rain is not caused by global warming (Gorsira et al., in preparation). Moreover, people know relatively little about the energy use associated with their daily behaviors. For example, when assessing the energy use of household appliances, people tend to rely on a simple heuristic: the size of appliances. The larger the appliance, the more energy it is believed to use (Baird and Brier, 1981; Schuitema and Steg, 2005). Obviously, this heuristic is not always accurate. Moreover, people have a tendency to underestimate the energy use involved in heating water, which suggests that people are not well aware of the fact that energy sources are needed to do this (Schuitema and Steg, 2005). Assessing indirect energy use is even more complicated, as, typically, no information of the 'embedded' energy use of products and services is provided. People know relatively little about the energy use associated with the production, transportation, and disposal of products (Tobler, Visschers, and Siegrist, 2009). For example, people think the term 'organic' means that these products are more environmentally-friendly than non-organic products, while they do not necessarily consider the energy use involved in transporting organic products to the supermarket (e.g., flown in from overseas).

Motivations

Various studies have examined relationships between motivational factors and energy behaviors. Below, we first discuss relationships between motivations and household energy use, and next relationships between motivational factors and specific energy behaviors.

Household Energy Use

Household energy use is most strongly related to socio demographics, in particular income and household size, while motivational factors do not play an important role (Gatersleben et al., 2002). Not surprisingly, wealthier and larger households use more energy. This is true for direct as well as indirect energy use (Abrahamse, 2007), and for energy use in home as well as for transport (Poortinga, Steg, and Vlek, 2004). This implies that households use more energy as soon as they need to (household size) or when they have the opportunity to do so (income). However, larger households use less energy per

person than smaller households, because they share appliances, space, cars, etc.

In contrast, intention to reduce household energy use is most strongly related to motivational factors, in particular attitudes towards energy conservation and perceived behavioral control, while socio demographics do not play a significant role. This is true for direct as well as indirect energy use (Abrahamse, 2007). Environmental considerations are less strongly related to intention to reduce household energy use. So, even though concern with environmental and energy problems is generally high in Western countries (Abrahamse, 2007; Poortinga, Steg, and Vlek, 2002; Schultz and Zelezny, 1999), people often do not act in line with their concerns. As well as lacking knowledge of the energy use related to various behaviors (see above), many people attach only a low priority to saving energy. Energy use and energy conservation are not only driven by concerns about environmental and energy problems. Many other factors play a role, such as status, comfort and effort (Stern, 2000). People are less likely to reduce their energy use when saving energy involves high behavioral costs in terms of money, effort or convenience. For example, people are far more likely to carry out pro-environment activities such as recycling, which has a low cost in money and effort, than others such as reducing car use which have higher financial and lifestyle costs (see Lindenberg and Steg, 2007, for a review). This does not imply that environmental and normative concerns do not affect high-cost behavior. Some people do reduce their energy use even at the cost of personal disadvantage. Normative and environmental concerns are important in promoting energy conservation, because they provide the most solid basis for it (Lindenberg and Steg, 2007). If people only conserve energy for hedonic or cost reasons, they will stop doing so as soon as the behavior is no longer attractive or cost-effective. When energy conservation results from normative concerns as well, it is more robust against such changes.

Energy Behaviors

Motivational factors proved to be related to specific energy behaviors. Energy behaviors have been studied from different theoretical perspectives. Below, we elaborate on three types of motivations that are the focus of different theoretical perspectives: perceived cost and benefits, affect, and moral and normative concerns. We also indicate how these different perspectives may be integrated into a coherent framework, and elaborate on the role of habits.

Cost-Benefit Considerations

The Theory of Planned Behavior (TPB; Ajzen, 1991) assumes that individuals make reasoned choices and choose alternatives with highest benefits against lowest costs (e.g., in terms of money, effort and/or social approval). The TPB proposes that behavior follows from an individual's intention, which reflects how much effort one is willing to take to engage in a specific behavior. Intentions depend on attitudes towards the behavior (that is, the degree to which engagement in behavior is positively valued), social norms (that is, social pressure from important others to engage in a particular behavior), and perceived behavioral control (that is, beliefs on whether one is capable of performing the behavior). All other factors, such as socio demographics or values, are believed to affect intentions indirectly, via attitudes, social norms and perceived behavioral control. The TPB has proven to be successful in explaining various types of behavior associated with direct or indirect energy use, including travel mode choice (e.g., Bamberg and Schmidt, 2003; Heath and Gifford, 2002), the purchase of energy-saving light bulbs, use of unbleached paper, and meat consumption (Harland, Staats, and Wilke, 1999).

Affect

Various studies demonstrated that affect is related to behavior, in particular energy use related to car use (see Gatersleben, 2007, for a review). Most studies were exploratory and not theory-driven. Dittmar's (1992) theory on the meaning of material possessions provides a promising perspective to study the role of affective and symbolic factors in more detail. This theory proposes that the use of material goods fulfils three functions: instrumental, symbolic, and affective. Interestingly, Steg (2005) showed that commuting car use is most strongly related to symbolic and affective motives, while instrumental motives are less important, indicating that it is important to consider affective and symbolic aspects of energy use.

Moral and Normative Concerns

Many scholars studied the role of moral and normative concerns in relation to energy conservation. This is not surprising, because energy conservation is often costly, e.g., in terms of money, time, or effort. In this case, people probably only conserve energy if they think this helps to benefit the environment, taking the additional behavioral costs for granted. Various theoretical perspectives have been employed to study the role of moral and normative concerns. First, scholars have examined the value-basis of

environmental beliefs and behavior (De Groot and Steg, 2007; 2008b; Nordlund and Garvill, 2002; Stern and Dietz, 1994; Stern, Dietz, Kalof, and Guagnano, 1995). These studies revealed that people are more likely to engage in pro-environmental actions such as energy conservation when they endorse values beyond their immediate own interests, that is, self-transcendent, pro-social, altruistic or biospheric values, while egoistic or self-enhancement values are negatively related to pro-environmental behavior.

Second, scholars have studied the role of environmental concern. The most influential perspective here is the New Environmental Paradigm (NEP), which reflects people's beliefs about humanity's ability to upset the balance of nature, the existence of limits to growth for human societies, and humanity's right to rule over the rest of nature (Dunlap and Van Liere, 1978; Dunlap, Van Liere, Mertig, and Jones, 2000). It appeared that a higher environmental concern is associated with acting more pro-environmentally, although these relationships are generally not strong (e.g., Poortinga, Steg, and Vlek, 2004; Schultz and Zelezny, 1998). A recent study revealed that environmental concern is less predictive of behavior-specific beliefs than are values (Steg, De Groot, Dreijerink, Abrahamse, and Siero, in press), probably because values reflect a wider range of motivations than does NEP.

A third line of research is based on the norm-activation model (NAM; Schwartz, 1977; Schwartz and Howard, 1981) and the value-belief-norm theory of environmentalism (VBN theory; Stern, 2000; Stern, Dietz, Abel, Guagnano, and Kalof, 1999). These theories assume that people conserve energy when they feel a moral obligation to do so, which depends on the extent to which people are aware of the problems caused by their behavior, and feel responsible for these problems and their solution. The VBN-theory further proposes that awareness of the problems is rooted in environmental concern (NEP) and values. The NAM and VBN theory appeared to be successful in explaining low-cost environmental behavior and "good intentions" such as willingness to change behavior (e.g., Nordlund and Garvill, 2003; Stern et al., 1999), political behavior (e.g., Gärling, Fujii, Gärling, and Jakobsson, 2003), environmental citizenship (e.g., Stern et al., 1999), or acceptability of energy policies (e.g., De Groot and Steg, 2008a; Steg, Dreijerink, and Abrahamse, 2005), but their explanatory power is generally low in situations characterized by high behavioral costs or strong constraints on behavior, such as reducing car use (e.g., Bamberg and Schmidt, 2003; Hunecke, Blöbaum, Matthies, and Höger, 2001). In such settings, the TPB appears to be more powerful in explaining behavior (Bamberg and Schmidt,

2003), probably because the TPB considers a wider range of factors, notably non-environmental motivations and perceived behavioral control.

A fourth line of research focuses on the influence of social norms on behavior. The theory of normative conduct (Cialdini, Kallgren, and Reno, 1991; Cialdini, Reno, and Kallgren, 1990) distinguishes two types of social norms. Injunctive norms refer to the extent to which behavior is supposed to be commonly approved or disapproved of. Descriptive norms reflect the extent to which behavior is perceived as common. When injunctive and descriptive norms are in conflict, behavior will be most strongly influenced by the norm that is most salient. This theory has been validated in a series of experimental studies about littering in public places and energy use (Cialdini et al., 1990; 1991). It appeared that people are more likely to violate a particular social norm when they see that others violate that specific norm as well. Recent studies revealed that norm violations spread, that is, when people see that a particular norm is being violated, they are more likely to violate other norms as well, suggesting that people are not merely copying the behavior of others, but that perceptions of norm violations reduce the likelihood of normative behavior in general (Keizer, Lindenberg and Steg, 2008).

Multiple Motivations

Various scholars have integrated concepts and variables from different theoretical frameworks, showing that behavior results from multiple motivations (e.g., Harland et al., 1999; Heath and Gifford, 2002; Stern et al., 1995). Goal-framing theory (Lindenberg, 2006) explicitly acknowledges that behavior results from multiple motivations. This theory postulates that goals govern or "frame" the way people process information and act upon it. Three general goals are distinguished: a hedonic goal-frame "to feel better right now", a gain goal-frame "to guard and improve one's resources", and a normative goal-frame "to act appropriately". In a given situation, one of these goals is focal and influences information processing the most (that is, it is the goal-frame), while other goals are in the background and increase or decrease the strength of the focal goal. The hedonic goal-frame is a priori strongest, while in particular the normative goal-frame needs external social and institutional support in order to become focal. The three goal-frames coincide with the three types of motivational factors discussed above (Lindenberg and Steg, 2007). That is, theories and models on affect focus on hedonic goals, the TPB focuses on gain goals, while theories on norms, values and environmental concern (e.g. the NAM, VBN theory) focus on normative goals. As such, goal-

framing theory provides an integrative framework for understanding pro-environmental behavior.

Habits

The theoretical frameworks discussed above generally imply that individuals make reasoned choices. However, in many cases, behavior is habitual and guided by automated cognitive processes, rather than being preceded by elaborate reasoning. When people frequently act in the same way in a particular situation, that situation will be mentally associated to the relevant goal-directed behavior. The more frequently this occurs, the stronger and more accessible the association becomes, and the more likely it is that an individual acts accordingly. Thus, habitual behavior is triggered by a cognitive structure that is learned, stored, and retrieved from memory when individuals perceive a particular situation. Various studies revealed that environmental behavior, and more particularly car use, is habitual (e.g., Aarts and Dijksterhuis, 2000; Aarts, Verplanken, and Van Knippenberg, 1998; Klöckner, Matthies, and Hunecke, 2003). Fujii and colleagues found that temporarily forcing car drivers to use alternative travel modes induced long-term reductions in car use (Fujii and Gärling, 2003; Fujii, Gärling, and Kitamura, 2001). The impacts of such temporary changes were particularly strong for habitual car drivers. This suggests that habitual drivers have inaccurate and modifiable perceptions of the pros and cons of different transport modes.

Ability to Engage in Energy Conservation

Obviously, human behavior does not depend on motivations alone. Many contextual factors may facilitate or constrain energy conservation and influence individual motivations (Ölander and Thøgersen, 1995; Stern, 1999; Thøgersen, 2005), such as the availability of energy efficient appliances, the quality of public transport, or pricing regimes (e.g., Santos, 2008; Vining and Ebreo, 1992). In some cases, constraints may even be so strong that motivations make little difference in the environmental outcome (see, e.g., Corraliza and Berenguer, 2000). Only few scholars included contextual factors in their studies (Black, Stern, and Elworth, 1985; Hunecke et al., 2001), and surprisingly, contextual factors are not included in theories to explain energy use. The TPB only considers individuals' perceptions of contextual factors, as expressed in perceived behavioral control. It is highly important to understand

how contextual factors influence energy use in order to design intervention strategies that remove important barriers for energy conservation.

INTERVENTIONS TO PROMOTE ENERGY CONSERVATION

The question of how to encourage household energy conservation has been a topic of interest within social and environmental psychological research for a number of decades. Behavioral interventions may be aimed at changing an individual's perceptions, preferences, motivations, and norms via informational strategies. Alternatively, interventions may be aimed at changing the context in which decisions are being made, for instance, through financial rewards, laws, or the provision of energy-efficient equipment. The latter strategy is aimed at changing the pay-off structure, so as to make energy-saving activities relatively more attractive. When energy saving is rather costly or difficult because of external barriers to energy conservation, changes in the circumstances under which behavioral choices are made may be needed so as to increase individual opportunities to conserve energy and to make energy saving behavior choices more attractive (cf. Ölander and Thøgersen, 1995; Stern, 1999; Thøgersen, 2005). The costs and benefits of behavioral alternatives may be changed in various ways. First, the availability and quality of products and services may be altered via changes in physical, technical, and/or organizational systems. Environmentally harmful behavioral options can be made less feasible or even impossible, or new and/or better-quality (energy-saving) behavior options may be provided (e.g., recycling bins, energy efficient technology). Second, legal regulations can be implemented (e.g., prohibiting the use of specific appliances). Legal measures of course require that the relevant laws and regulations are enforced, and that violations are penalized. Third, pricing policies are aimed at decreasing prices of energy saving behavior options and/or increasing prices of less energy-saving alternatives.

Behavioral interventions are typically classified according to the taxonomy for behavior change interventions as proposed by Geller, Berry, Ludwig, Evans, Gilmore and Clark (1990), which distinguishes between antecedent and consequence intervention strategies (see also Lehman and Geller, 2004). Antecedent interventions are assumed to influence one or more determinants *prior* to the performance of energy behaviors. Examples of such interventions are information, commitment, and goal setting. For instance, providing households with information about energy-saving options in the

office may result in energy savings, because people have acquired (more) knowledge. Consequence strategies on the other hand are based on the assumption that positive or negative consequences will influence behavioral choices. To illustrate, pro-environmental behavior will become a more attractive alternative when positive consequences are attached to it, e.g., by the provision of a monetary incentive. Feedback, punishments and rewards are well-known examples of this type of interventions. A browse through the social and environmental psychology literature reveals an abundance of intervention studies with an aim to encourage consumers to conserve energy – with varying degrees of success (for reviews see Abrahamse, Steg, Vlek, and Rothengatter, 2005; Dwyer, Leeming, Cobern, and Porter, 1993; Schultz, Oskamp, and Mainieri, 1995).

Antecedent Strategies

Information is a widely used intervention to encourage household energy savings – its success, however, is rather debatable. This may be general information about energy-related problems, or specific information about possible solutions, such as information about various energy-saving measures households can adopt. Providing information serves to increase households' awareness of energy problems and their knowledge about possibilities to reduce these problems. It appears that information provision about energy conservation or environmental issues does indeed generally lead to an increase in knowledge, or awareness, but it does not necessarily translate into behavior changes (Gardner and Stern, 2002; Geller, 1981; Staats, Wit, and Midden, 1996).

The provision of personalized, tailored, information tends to be more effective. An advantage of this approach is that households receive relevant information only, rather than getting an overload of general information, which may not always apply to their specific situation. Examples of such approaches are home energy audits, which have proven to be quite effective in encourage energy savings among households (e.g. Winett, Love, and Kidd, 1982-1983), or personalized information about energy saving options via the Internet, which proved to be effective as well (Abrahamse, Steg, Vlek, and Rothengatter, 2007).

It has been suggested that, the provision of information may be more effective when it makes salient social norms in favor of energy conservation. One particular study found that towels were re-used more frequently by hotel

guests when they were provided with information that emphasized descriptive social norms in favor of re-use (e.g. 'did you know 75% of our guests help save the environment by reusing their towels') compared to when they were given environmental information only (e.g. 'help save the environment by re-using your towels') (Goldstein, Cialdini, and Griskevicius, 2008). Alternatively, information provision can also be more effective when it is given in a certain social context. Neighborhood interactions may be important in this respect, as this may lead to the diffusion of information, and it may help people to develop and establish social norms (see Weenig and Midden, 1991).

Commitments are potentially powerful and cost-effective interventions. Commitments essentially entail making a promise to try and engage in a certain pro-environmental behavior (e.g. try driving less often), and in doing so, eliciting a moral obligation to stick to the promise made. In terms of large scale implementation, commitments do not necessarily have to cost a lot of money (in contrast to for instance financial incentives), but they may be difficult to implement when they rely on personal contact. Various studies have found commitment to be effective in encouraging energy conservation (e.g. Pallak and Cummings, 1976) and recycling (e.g. DeLeon and Fuqua, 1995; Wang and Katzev, 1990). Especially in view of the long-term effects found in several studies (Katzev and Johnson, 1983; Pallak and Cummings, 1976), commitment may be a successful strategy for reducing household energy use.

Goal setting entails giving households a reference point, for instance to save 5% or 15% energy. A goal can be set by the experimenters, or by the households themselves. A study by Becker (1978) found that a relatively difficult goal (20%) was more effective when it was combined with feedback, as compared to a relatively easy goal (2%). This indicates that in order for a (difficult) goal to work, households need feedback on how they are performing in relation to the goal. Also, eliciting implementation intentions, in which people are not only asked whether they intend to change their behavior, but also to indicate how they plan to do so (i.e. reach that goal), appeared to be effective (e.g., Bamberg, 2002; Jakobsson, Fujii, and Gärling, 2002).

Consequent Strategies

Feedback is often applied to promote energy conservation. Feedback consists of giving households information about their energy consumption, or energy savings. It can influence behavior, because households can associate

certain outcomes (e.g., energy savings) with their behavior. Ideally, feedback is given immediately after the behavior occurs, because households need to understand the relationship between the feedback and their behavior (Geller, 2002). Feedback appears to be an effective strategy for reducing household energy use (e.g., Seligman and Darley, 1977), although some exceptions exist (e.g., Katzev, Cooper, and Fisher, 1980-1981). Results of studies using feedback seem to suggest that the more frequent the feedback is given, the more effective it is. Positive effects have for instance been found for continuous feedback (e.g., McClelland and Cook, 1979-1980). A study by Kantola, Syme and Campbell (1984) showed that high frequency is not necessarily the key to success: by giving feedback one single time, evoking dissonance between people's reported attitudes (i.e. favorable towards energy conservation) and their behavior (i.e. high energy usage), households significantly reduced their energy use.

Feedback about individual performance relative to the performance of others may be helpful in encouraging energy conservation. By providing people with feedback on how they are doing as a group, social norms in favor of a certain pro-environmental behavior may become salient. Similarly, by giving comparative feedback about how a group of individuals is doing relative to other groups may evoke feelings of social comparison, which may be especially effective when important or relevant others are used as a reference group. The results of the use of comparative feedback are mixed, and seem to be dependent on the target group that is studied. In the area of household energy conservation, group feedback is generally no more effective than individual feedback (e.g. Abrahamse et al., 2007; Midden, Meter, Weenig, and Zieverink, 1983). Group feedback has also been implemented to encourage energy conservation in organizational settings, with promising results (e.g. Siero, Bakker, Dekker, and Van den Burg, 1996). Another line of research suggests that the effects of comparative feedback may depend on whether people already behave according to the group norm (see for instance, Schultz, Nolan, Cialdini, Goldstein, and Griskevicius, 2007). In fact, differential effects of feedback have been found for relatively high and low consumers of energy, the latter group (who already behaved in a pro-environmental way) actually increased their energy use as a result of feedback (e.g. Brandon and Lewis, 1999). Apparently, the behavior of others is taken as a reference point to strive for. Interestingly, this boomerang effect was neutralized by adding an injunctive message (in this case a smiley), which probably conveyed social approval (Schultz et al., 2007).

Monetary rewards may serve as an extrinsic motivator to conserve energy. Rewards can either be contingent on the amount of energy saved, or a fixed amount (e.g., when a certain percentage is attained). Overall, rewards seem to have a positive effect on energy savings. Results of several studies (e.g. Slavin, Wodarski, and Blackburn, 1981) do however suggest that the effect of rewards is rather short-lived.

Combining Interventions

Combinations of interventions are generally more effective than single interventions. This makes sense to the extent that different people may have different barriers to change (Gardner and Stern, 2002). A combination of antecedent (e.g., information) and consequence strategies (e.g., feedback) is generally more effective than the individual interventions. Interventions within the realm of social and environmental psychology typically focus on informational strategies, rather than changing contextual factors which may more strongly steer households' behavioral decisions (see Abrahamse et al., 2005; Dwyer et al., 1993; Schultz et al., 1995, for reviews). This is regrettable, because to the extent that contextual factors strongly influence energy use, structural strategies are probably very effective in promoting household energy savings. Moreover, informational and structural strategies could complement one another. For instance, informational strategies may be an important element in the implementation of structural strategies that force individuals to change their behavior (Gärling and Schuitema, 2007). For example, public support for structural strategies may be increased by informing individuals about the need for and the possible consequences of such strategies.

Evaluation of the Effectiveness of Interventions

Studies aimed at evaluating an intervention's effectiveness should follow rigorous experimental research designs that reveal the effectiveness of single as well as combinations of interventions for one or more 'treatment' groups and a comparable control group. In addition, it is important to also study long-term effects as well, as interventions may lose their effectiveness as soon as they are discontinued (e.g. as is often the case with rewards; see Abrahamse et al., 2005). Effect measurements should not only focus on (changes in) energy behaviors. First, it is important to monitor (changes in) determinants of energy

use and energy savings as this enhances our understanding of why intervention programs were successful or not. This allows change agents to adapt interventions in order to increase their effectiveness. For instance, failure of group feedback to encourage pro-environmental behaviors may well be attributable to the fact that social norms did not change as a result of the intervention. Second, it is important to monitor (changes in) total energy use and environmental quality, since this is the ultimate goal of behavioral interventions. Here, collaboration with environmental scientists is needed. Based on this, feedback can be provided to the target population so as to inform them about the effectiveness of their efforts to conserve energy and to reduce energy problems. This may strengthen people's commitment to change their behavior, and to maintain the changes already implemented. Third, one would need to know changes in people's quality of life, which is an important component of the more general notion of sustainable development. Studies revealed that people generally expect that environmental policies will not seriously threaten their quality of life (De Groot and Steg, 2006; see also Steg and Gifford, 2005). As yet, most studies (see Steg and Gifford, 2005, for a review) examined expected changes in quality of life, while actual changes resulting from environmental policies or conditions have hardly been monitored over time. Expected changes may differ from actual changes in perceived quality of life, for example, because people do not fully understand or imagine how interventions will affect their life. Also, they may underestimate the positive consequences of energy policies on, for example, environmental quality.

Next to studying actual effects of interventions, psychologists studied the perceived effectiveness and acceptability of environmental policies before policies have been implemented, particularly in the travel domain (e.g., Bamberg and Rölle, 2003; Eriksson, Garvill, and Nordlund, 2006; 2008; Jakobsson, Fujii, and Gärling, 2000; Schade and Schlag, 2003; Schuitema and Steg, 2008; see Steg and Schuitema, 2007, for a review), but also regarding energy use (Nilsson, Von Borgstede and Biel, 2004; Steg et al., 2005). Most studies examined individual factors related to perceived effectiveness or acceptability judgments. These studies revealed, among other things, that policies are more acceptable when they are believed to be more fair, when they are effective in reducing relevant problems, and when they do not seriously affect individual freedom. Moreover, policies are more acceptable to people who have strong environmental values, who are highly aware of the problem, and who feel a strong moral obligation to reduce the problems (De Groot and Steg, 2007; Steg et al., 2005). Thus, normative and environmental concerns are

important for the acceptability of policies. Acceptability may increase after policies have been implemented. For example, acceptability of the congestion charge in Stockholm increased after the implementation of the charge, probably because the charge had more positive effects on congestion, environmental problems, and parking problems than expected beforehand, while the additional travel costs for households were lower than expected (Schuitema, Steg, and Forward, 2009).

A few studies examined the extent to which perceived effectiveness and acceptability depends on specific policy features, such as rewards versus penalties, or the type of behaviour being targeted (e.g., Poortinga, Steg, Vlek, and Wiersma, 2003; Steg, Dreijerink, and Abrahamse, 2006). It appeared that policies that increase the attractiveness of pro-environmental behavior (that is, energy savings) are evaluated as more effective and acceptable than policies aimed at decreasing the attractiveness of environmentally harmful behavior (that is, not saving energy; Steg et al., 2006). Moreover, people prefer policies aimed at promoting the adoption of energy-efficient equipment above policies aimed at reducing the use of existing equipment (Poortinga et al., 2003; Steg et al., 2006), and energy savings in home above energy savings in transport (Poortinga et al., 2003). Interestingly, people high in environmental concern evaluate governmental regulations and behavioral strategies as more acceptable, while people with a low environmental concern prefer market-oriented and technological strategies (Poortinga, Steg, and Vlek, 2002).

CONCLUSION

Psychologists have an important role to play in promoting energy conservation via behavioral changes. Behavioral interventions are generally more effective when they are systematically planned, implemented and evaluated. Four key issues to be addressed are: (1) identification of the behavior to be changed, (2) examination of the main factors underlying this behavior, (3) application of interventions to change the relevant behaviors and their determinants, and (4) evaluation of intervention effects on the behavior itself, its main determinants, energy use, environmental quality, and human quality of life. Individuals can contribute significantly to achieving long-term environmental sustainability by reducing household energy use. The challenge for psychologists is to understand the individual and structural factors and processes that threaten environmental sustainability, so that energy saving could be facilitated and emerge worldwide.

Studies on household energy conservation typically have a mono-disciplinary focus. However, multidisciplinary approaches can have clear added value. For instance, sociologists can provide valuable insight into the meanings individuals attach to sustainable practices, with regards to existing institutional and contextual arrangements (e.g. Spaargaren, 2003). Also, as has been mentioned earlier, input from environmental scientists can be of valuable importance to further improve intervention studies. Environmental scientists can help translate energy-related behaviors into energy use and environmental impact, e.g., in terms of CO_2 emissions, and help select high-impact behaviors. It is therefore important to consider energy conservation from an interdisciplinary perspective. Equally well, close collaboration between academia and the policy arena is essential in order to develop and evaluate effective interventions to encourage household energy conservation.

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