Go for less: the effect of feedback and goal setting on household energy and water consumption

Summary

Introduction

Households tribute significantly to some of the environmental problems western countries are confronted with, for example the emission of carbon dioxide (CO_2), the most important green house gas, caused by burning fossil fuels. To prevent further damage to the environment, governments may promote the use of alternative energy sources like solar and wind energy and implement a variety of measures to reduce energy and water consumption, like subsidizing energy and water saving measures. In addition, governments may also utilize *behavioral* strategies to promote energy and water conservation. In this dissertation it is first investigated what kind of behavioral intervention would make a good chance to get widely accepted by relevant policymakers. Acceptation by relevant policymakers of effective interventions is important for its wide scale implementation, so that it can contribute significantly to the reduction of the CO_2 emission by households. Then this dissertation focuses on the behavioral method that seems to be accepted best: providing feedback about energy and water consumption in relation to goals that are set by households to limit their water, gas and electricity consumption. The effect of feedback, in combination with goal setting, has proved effective in a wide variety of educational, organizational, industrial and laboratory settings (see Locke & Latham, 1990).

The research projects that are reported on in this dissertation have practical as well as theoretical goals. The practical aims of these projects were: (1) to select an intervention that might be implemented on a large scale because it is favorably judged by relevant policymakers and (2) to examine the effectiveness of this selected intervention in saving household water, electricity and gas consumption. The theoretical aims of these projects were to provide more insight into (3) the effects of goal setting and feedback on cognitions and (energy-relevant) behavior and (4) the possible negative effects of repeated negative feedback on cognitions and water and energy saving behaviors. An intervention can only contribute to the solution of environmental problems if it is implemented on a large scale. Therefore, another theoretical aim of this thesis is (5) to shed some light on how responsible policymakers decide to reject or accept an innovative energy conservation intervention.

Chapter 1 provides a general overview of the dissertation. First, the environmental problems this dissertation is concerned with are depicted, and the energy and water consumption of households and the conservation policy of western countries are described. The theoretical background and empirical findings that are relevant to this dissertation follow this. The theoretical ideas behind feedback and goal setting are discussed, and the main empirical findings are summarized, with a focus on the studies that investigated the effect of goal setting and feedback on energy use in households. The diffusion of innovation theory of Rogers (1995) is introduced and an overview is provided of the relevant empirical studies. Thereafter, a brief discussion of the findings of the studies reported in this

dissertation follows. Finally, the most important conclusions and recommendations of our studies are considered.

Chapter two reports a study in which we examined the evaluation of four effective energy conservation interventions by policymakers. These successful energy conservation interventions were selected from a literature review. The selected interventions were: (1) Load management for washing machines, which means that a washing program could only be started during off-peak periods, (2) Electronic feedback on household in-home energy consumption combined with goal-setting (the "electronic indicator"), (3) A community-based communication intervention aimed at stimulating the adoption of insulation and energy saving behavior and (4) Personalized advice on energy saving given to the retail trade by a consultant of the utility companies.

Although these interventions proved to be successful, large-scale implementations failed to occur, because neither consumers, nor responsible policymakers seem to use or adopt successful interventions automatically. In this study we wanted to get more insight in the barriers of adopting an innovation and in the process of judging an innovation on its innovation attributes. This study was based on Rogers' diffusion of innovation theory (Rogers, 1995).

According to Rogers, the decision to adopt an innovation is affected by five innovation attributes: observability, relative advantage, compatibility, trialability and complexity. The first four of these attributes are positively related to adoption rate while complexity is asserted to be inversely related to the adoption rate of an innovation.

In this study we examined which of the four energy conservation interventions might be widely employed because of a positive evaluation by policymakers. Also, the predictive value of advantage, compatibility, trialability and complexity to predict adoption intentions were examined, and a first test was provided of some refinements to Rogers' theory, proposed by Darley & Beniger (1981). Finally, the study examined whether the assessment of innovation attributes is a stepwise process. It was hypothesized that not all innovation attributes are relevant at the same time in the decision process and potential adopters use a non-compensative decision rule to judge an energy conservation intervention on its attributes. Policymakers are expected to be first of all interested in the relative advantage (like the cost-effectiveness) of an energy conservation intervention. When the relative advantage reaches a minimum cut-off value, an energy conservation intervention is in a subsequent step judged on the degree of compatibility.
The study group existed of 41 co-ordinators of the Environmental Action Plan of the energy distribution companies. The judgment of the energy conservation interventions by these co-ordinators is important because of their key position in implementing the energy conservation interventions among households on a wide scale.

The results showed that the electronic indicator had the largest part of positive judgments: 48% of the co-ordinators had a moderate to very positive intention to adopt this intervention. For three of the four energy conservation interventions it was confirmed

that the intention to adopt an energy conservation intervention was positively related to perceived compatibility. Furthermore, for one of the innovations (the electronic indicator) it was found that the intention to adopt was positively correlated with perceived advantage. These results showed that only compatibility was a consistent predictor of the policymaker's intention to adopt the four selected energy conservation interventions. We hypothesized that one of the main reasons for the low predictive value of the other innovation attributes was that an innovation is evaluated one-by-one on the innovation attributes and that not all innovation attributes are relevant to the potential adopter at the same time. For two of four interventions (for the innovation community interventions and for the electronic feedback) the results suggested that an energy conservation intervention is firstly judged on it advantages and in a second step on its compatibility. These findings were also confirmed in the face-to-face interviews with the relevant policymakers. Finally, qualitative findings suggested that the five innovation attributes of Rogers (1995) might become stronger predictors for the intention to adopt energy conservation interventions if they are further specified and extended.

Chapter three described the results of a field experiment, examining the effect of a prepayment meter on household gas consumption. With a prepayment meter, households pay for their gas as they use it and a display on the meter shows the amount of credit left, the emergency credit and the price of the gas per m^3. Additionaly, they could see the cumulative amount of gas used above the display. The prepayment could be charged by means of a smart card that could be recharged at the local super market. The prepayment meter was not originally designed to give feedback on gas consumption and it did not indicate a reference consumption rate. Therefore, half of the participants received a notebook in which they could compare the cost of their gas consumption with the cost of a target consumption. In this way, a gas saving target was set, and the feedback was made more meaningful.

The study aims were to examine (1) whether households were satisfied with the prepayment meter, (2) whether the prepayment meter (with or without goal setting) affected household gas consumption and (3) whether (changes in) self-reported specific gas-saving activities and their determinants were related to (changes in) objective gas consumption.

The participants of this study consisted of 116 heads of households who rented or owned houses at a new housing development in a Dutch village. The design of this study was an experimental pretest-posttest design.

The results showed that households were highly satisfied with the prepayment meter and that the expected disadvantages of the prepayment meter had decreased after the meter had been used for one year. Furthermore it was found that the prepayment meter reduced the gas consumption of households by 4.7% compared to the control group. No significant difference was found in gas consumption between the study groups with

and without a saving target. An explanation might be that the procedure of comparing the actual use with the target use was too laborious and too complex. Furthermore we found that attitude change toward gas-saving activities was positively related to changes in objective gas consumption, whereas no significant relation was found between changes in self reported gas consumption reducing activities and changes in objective gas consumption.

Chapter four described the results of the second field experiment, in which households received feedback about their water, gas and electricity consumption on five information pages on channel 37 of their television sets. The information pages informed households about their weekly water, gas and electricity consumption compared to a saving target of 5%, 10% or 15%. The purpose of the study was to examine the reduction effect of feedback and goal setting on household gas, water and electricity consumption. Additionally we examined which conservation activities households specifically changed to reduce their gas, water and electricity consumption.

In this study we combined an experimental design with a quasi-experiment pretest-post-test design. Participants were 62 homeowners living in the same energy-efficient new housing development in a Dutch village who were randomly assigned to an experimental or waiting-list control group. We suspected test effects in the waiting-list control group because they were well informed about the electronic feedback project, and had to answer questions on energy and water saving behavior. Therefore, 22 households were selected random from a comparable district (extra control group) and data of the experimental group were compared with both control groups.

The results revealed that the information pages were effective in reducing household water consumption (a reduction of 15%) and electricity consumption (a reduction of 22%) when the experimental group was compared with the waiting-list control group. For gas we found no reduction when the experimental group was compared with the waiting-list control group, but when the experimental group was compared with the extra control group a reduction of 25% was found. Furthermore, the results gave further insight in what kind of behaviors people changed to reduce their consumption.

Chapter five describes the effect of repeated negative feedback on people's cognitions and reduction of water, electricity and gas consumption after 14 weeks and 26 weeks of feedback. We expected that repeated negative feedback would negatively affect people's self-efficacy, success expectancy, goal commitment and motivation to attain their target. Furthermore we expected that when negative feedback continued, it could also affect people's performances.

For this study we used the data of the experimental group of the field study described in chapter four. From this group we gathered the necessary data and examined the association between the number of times people received negative feedback and

people's cognitive and behavioral reactions.

Results showed that the number of times households received negative feedback negatively affected their self-efficacy and success expectancy after 14 and 26 weeks of feedback (confirmed for water and electricity). Furthermore, analyses revealed that the number of times households received negative feedback negatively affected their goal commitment after 14 weeks (confirmed for water) and after 26 weeks of feedback (confirmed for water and gas). The number of times households received negative feedback did not affect changes in households' consumption levels after 14 weeks of feedback. However, in the long run (after 26 weeks of feedback) the number of times households received negative feedback did negatively affect the reduction in water and gas consumption as expected.

From these results it is concluded that repeated negative feedback may have a negative effect on a cognitive level and in the long run also at a performance level. However, the negative effects we found between repeated negative feedback and people's cognitions and performance might be specific for a non-competitive and non-hierarchical setting.

Main conclusion

This dissertation has clear practical and theoretical implications. In practical terms, its main implication is that TV information system providing households with weekly feedback about their water, electricity and gas consumption (compared to a target consumption level) can reduce household water, electricity and (maybe) gas consumption. Our results look very promising, as reductions from 10 to 25% were found, which may be considered substantial. Given these positive results and given that the most important conditions for wide-scale use seem to be met, electronic feedback and goal setting interventions may considerably contribute to the solution of environmental problems like the greenhouse effect and the shortage of clean drinking water in the near future.

The main theoretical implication of this dissertation is that innovation attributes (e.g., relative advantage, compatibility)) are not evaluated simultaneously, but one-by-one. This contribution to Rogers' (1995) diffusion of innovation theory deserves more research because of its practical as well as theoretical significance.