Consilience: The Journal of Sustainable Development
Vol. 7, Iss. 1 (2012), Pp. 1–16

Waste Not, Want Not: How Utilities Can Help Consumers Save Energy

Frank Hemmes
Institute for Environmental Studies
Vrije Universiteit Amsterdam, The Netherlands
hemmes.f@gmail.com

Elissaios Papyrakis
1. Institute for Environmental Studies,
Vrije Universiteit Amsterdam, The Netherlands
2. School of International Development,
University of East Anglia, Norwich, UK
elissaios.papyrakis@ivm.vu.nl

Pieter van Beukering
Institute for Environmental Studies
Vrije Universiteit Amsterdam, The Netherlands
pieter.van.beukering@ivm.vu.nl

Academic Abstract

Residential energy use constitutes a large part of global energy demand and consequent greenhouse gas emissions. Much research in many different fields, including behavioral sciences, economics and sociology, has been carried out to understand and possibly influence domestic energy consumption patterns. In this paper we conduct a field experiment of an online application, jointly developed with Dutch energy utility Greenchoice. During one month, a sample of customers was requested to record and submit the readouts of their electricity meter. These readouts were then converted to easily comprehensible information that was fed back to the customer. Performance was also compared to a control group which did not receive any feedback and served as a baseline. The results suggest that feedback through the web application does indeed increase perceived consumer awareness and reduces electricity consumption. Experimental groups consumed on average 6-7 percentage-points less electricity compared to the control group.

Public Abstract

Energy consumption by households plays an important part in the creation of greenhouse gasses and thus contributes to climate change. Decreasing this consumption can thus help to reduce emissions. In this article, we look at means to assist consumers in controlling their energy use, by giving them customized feedback on their electricity meter readouts. During a one-month test, customers of Dutch energy utility Greenchoice could upload their electricity meter readouts and receive information to monitor their consumption. Feedback on consumption is thought to stimulate consumers to use less energy. The results of the experiment support this theory, as participating customers consumed 6-7 percentage points less electricity compared to non-participants.

Authors' Note

Frank Hemmes holds an MSc in Environmental and Resource Management at the Institute for Environmental Studies at the Vrije Universiteit Amsterdam in the Netherlands. Elissaios Papyrakis is a Senior Researcher in

environmental economics at the Institute for Environmental Studies at the VU University, Amsterdam in the Netherlands and an Assistant Professor in economics at the School of International Development at the University of East Anglia in the UK. Pieter van Beukering is an Associate Professor in environmental economics at the Institute for Environmental Studies at the VU University, Amsterdam in the Netherlands. We wish to thank Jasper Gremmen and Ron Huizer, as well as Greenchoice more broadly, for providing support and hosting the experiment.

Keywords: Residential Energy Consumption, Consumer Behavior, Online Feedback

1. Introduction

Reducing residential energy consumption has been on policy agendas since the late 1970s (Geller et al. 2006; Socolow 1978). Consumers exert substantial influence on global energy consumption through daily behavior and consumption patterns (Abrahamse et al. 2007), and evidence shows households are responsible for a large percentage of energy consumption (Levine et al. 2007). Changes in consumer behavior can thus have an impact on the entire production chain, making them an ideal starting point for energy reduction initiatives. This also justifies continued research into means of influencing consumer behavior toward increased energy efficiency.

This paper falls into the field of research examining potential stimulants of energy efficient behavior, placing an emphasis on potential synergies between scientific research and commercial development. Jointly with Greenchoice – a 100% 'green' Dutch energy utility with about 300,000 customers – the authors developed an online application that monitors daily residential electricity consumption. A sample of customers was asked to monitor their electricity use for one month, with the implicit aim of reducing their consumption. The purpose of this exercise was to investigate whether the developed online application helped customers to save energy, as well as to evaluate how individuals valued this new addition to the online services Greenchoice already offered before the experiment. To assess whether an online feedback tool could assist Greenchoice customers in saving energy, four subquestions were posed:

1. Does feedback encourage customers to reduce energy use?
2. Can weekly reminders stimulate customers to participate more actively in the program?
3. Do practical suggestions help consumers translate their insight into consumption reduction?
4. Does the form and presentation of a savings tool influence its effectiveness?

In this paper, we contribute to this strand of the literature in a novel way, not only by evaluating whether such online feedback applications stimulate energy-saving behavior, but also by investigating whether the user-friendliness of such applications plays a role. Furthermore, this is the first time that such an experiment with self-reporting customers on energy consumption has been conducted in the Netherlands. Finally, our findings suggest that such online feedback tools can have a direct application in a commercial context, taking the implications of our research beyond the academic realm.

Section 2 provides an overview of the literature and discusses current models that explain environmentally friendly consumer behavior. Section 3 describes the design and methodology of our experiment. Section 4 discusses the key findings and Section 5 outlines our conclusion.

2. Review of the Literature

Since the oil shocks of the 1970s, residential energy consumption has been the target of myriad efforts aiming to control and reduce energy use. Beginning in the 1980s, concerns about the adverse environmental effects of energy production have also become an increasingly important driver (Poortinga et al. 2003). Global residential energy consumption accounts for roughly 7% of greenhouse gas emissions directly and 13% indirectly through electricity generation in power stations (Levine et al. 2007a). For example, in 2007 global residential and commercial buildings emissions amounted to over 8Gt of CO2eq (Levine et al. 2007a). Dutch domestic energy consumption composes 17% of total national consumption, divided evenly between direct and indirect consumption (Abrahamse et al. 2007, Reinders et al. 2003). Looking forward, the Dutch government has formulated ambitious targets for energy reductions through efficiency-promoting schemes, with savings in commercial and residential sectors constituting about 40% of prospective emission reductions by 2020 (MinBZK 2011; Harmelink et al. 2010).

Energy consumption can be reduced by either changing behavior or replacing inefficient devices (Görts & Jonkers 2000; Poortinga et al. 2003). Investments in technical replacements tend to result in relatively high energy and monetary savings, but are inhibited by high upfront costs and confusing payback times (Tietenberg 2009; Faiers et al. 2007), and are often affected by a rebound effect (i.e. energy/monetary savings in one area can be offset by additional energy use elsewhere, see Berkhout et al. 2007). Therefore, some technical measures are often not adopted even though they are economically rational (Jaffe & Stavins 1994).

Encouraging environmentally responsible behavior (Abrahamse et al. 2007; De Young 2000) is another energy-saving strategy – and one less susceptible to the rebound effect – but often with smaller gains than technical solutions (Abrahamse et al. 2007; Matthies 2005; De Young 2000). A change to environmentally responsible behavior often needs to be triggered by some external intervention. Consumers often have to be encouraged to re-evaluate their behavior such that they will adopt new behavioral norms that require further motivation, capacity, and information (Fischer 2008; Matthies 2005; De Young 2000).

The extent of behavioral adjustment depends on whether behavior is conscious or habitual. Most environmentally relevant behavior is often habitual and so minimizes the time and effort required for constant conscious decision-making, see Stern 2000, Matthies 2005). This is especially true for energy consumption, which is rarely consciously evaluated because of the omnipresent and homogeneous character of electricity. Since electricity is not used directly as a resource, but only through use of appliances, it remains largely invisible to the consumer (Fischer 2008; Kempton & Layne 1994). There is no observable diminishing stock, nor are there many easy methods to directly attribute energy consumption to different types of electricity use (Kempton & Layne 1994). Except for a non-itemized and infrequent bill, most consumers are not exposed to more detailed or disaggregated information that encourages and helps them to save energy (Van Raaij & Verhallen 1983).

Information is necessary to make consumers aware of their current use, link their behavior and consumption, and reduce electricity usage (Matthies 2005; Van Raaij & Verhallen 1983). More frequent feedback on electricity use is one way of increasing awareness and presenting consumers with the option of adapting their behavior (Fischer 2008). Customers can recognize that their current behavior is causally connected to the suboptimal situation of high energy use (Matthies 2005; Stern 2000), following which reasonable, alternative consumption choices that produce better results should be presented (Steg 2008; Lindenberg & Steg 2007; Matthies 2005). Feedback can inform consumers as to whether an alteration in behavior has yielded the expected results, creating a sense of control and ownership over the problem (Darby 2001).

Several models have been advanced to explain the interplay between feedback and behavior, some focusing on (economic) stimuli and others on social context, pro-environmental attitudes, or norms (Lindenberg & Steg 2007; Parnell & Popovic Larsen 2005; De Young 2000). Matthies (2005) has combined many of these factors into a heuristic model of norm activation, shown in Figure 1. Norm activation models acknowledge that in order to sustain pro-environmental behavior, consumers need to be motivated by normative reasons instead of incentives (Lindenberg & Steg 2007; Matthies 2005) to prevent reversal to the original behavior upon removal of the latter (De Young 2000). Norms are considered essential in sustaining new pro-environmental behavior until this becomes routine (Lindenberg & Steg 2007).

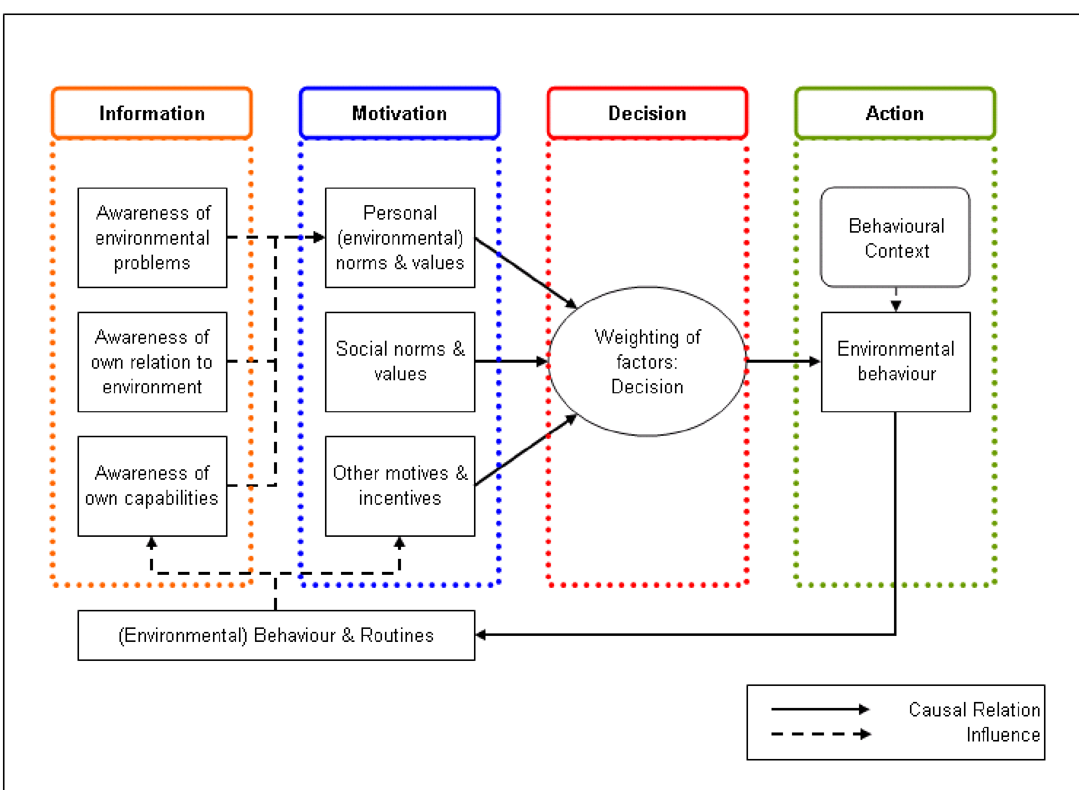

Figure 1: Matthies' model of norm activation. Authors' interpretation.

3. Experiment Methodology

Central to the experiment was the joint development of a new web application with the Dutch energy utility Greenchoice, which converted users' readings of their electricity meters into daily consumption values. Customers provided their meter readings between May 31st and June 30th 2011. Voluntary daily reporting was encouraged, and for longer intervals the consumption was averaged for the intermediate period. The results were displayed in a histogram showing bars with kWh/day values. An example display is shown in Figure 2. "Actual" consumption was compared against "expected" consumption, which was the daily average over the previous year, and "target" consumption, which was 90% of expected consumption. This target was established to show that goal setting can stimulate additional savings, provided the target is neither too ambitious nor too trivial (Wood & Newborough 2007; McCallen & Midden 2002; Houwelingen & Van Raaij 1989; Becker 1978).

3.1 Design

The sample was randomly divided into three groups, depending on the type of information they received (see Table 1). Experiment Group 1 ("Basic") received only **feedback** on electricity consumption. Experiment Group 2 ("Motivated") received both **feedback** and **reminders**. Experiment Group 3 ("Assisted") was exposed to all three types of information: **feedback**, **reminders,** and **suggestions**. Suggestions on energy savings were categorized into four themes, one for each week of the trial: i.e. *general knowledge*, *large appliances*, *small appliances* and *standby/silent consumption* – the sequence corresponding with the 'folk logic' that larger appliances are larger consumers of energy (Schuitema & Steg 2005). A fourth group was established as a control, creating a baseline based on two measurements at the beginning and end of the trial period. Differences in performance across the various groups were used to measure the effect of the different types of information (feedback, reminders, suggestions).

	Group 1: Basic	**Group 2: Motivated**	**Group 3: Assisted**
Feedback	✓	✓	✓
Reminders		✓	✓
Suggestions			✓

Table 1: Characterization of the three experimental groups

3.2 Sampling

Only customers that met a number of criteria were eligible for participation. First, in order to compute a representative historical reference level, participants should neither have moved residences over the past year or during the trial, nor have had major changes to the number of people in the household. Second, having access to the internet and being present in the residence during the experiment were also required. Third, to ensure sufficient consumption during the experiment, average use in the previous year had to be between 4,000 and 10,000 kWh (less consumption would suffer from inaccuracies due to approximations in the tool, whereas 10k+ consumption is likely to be commercial rather than residential).

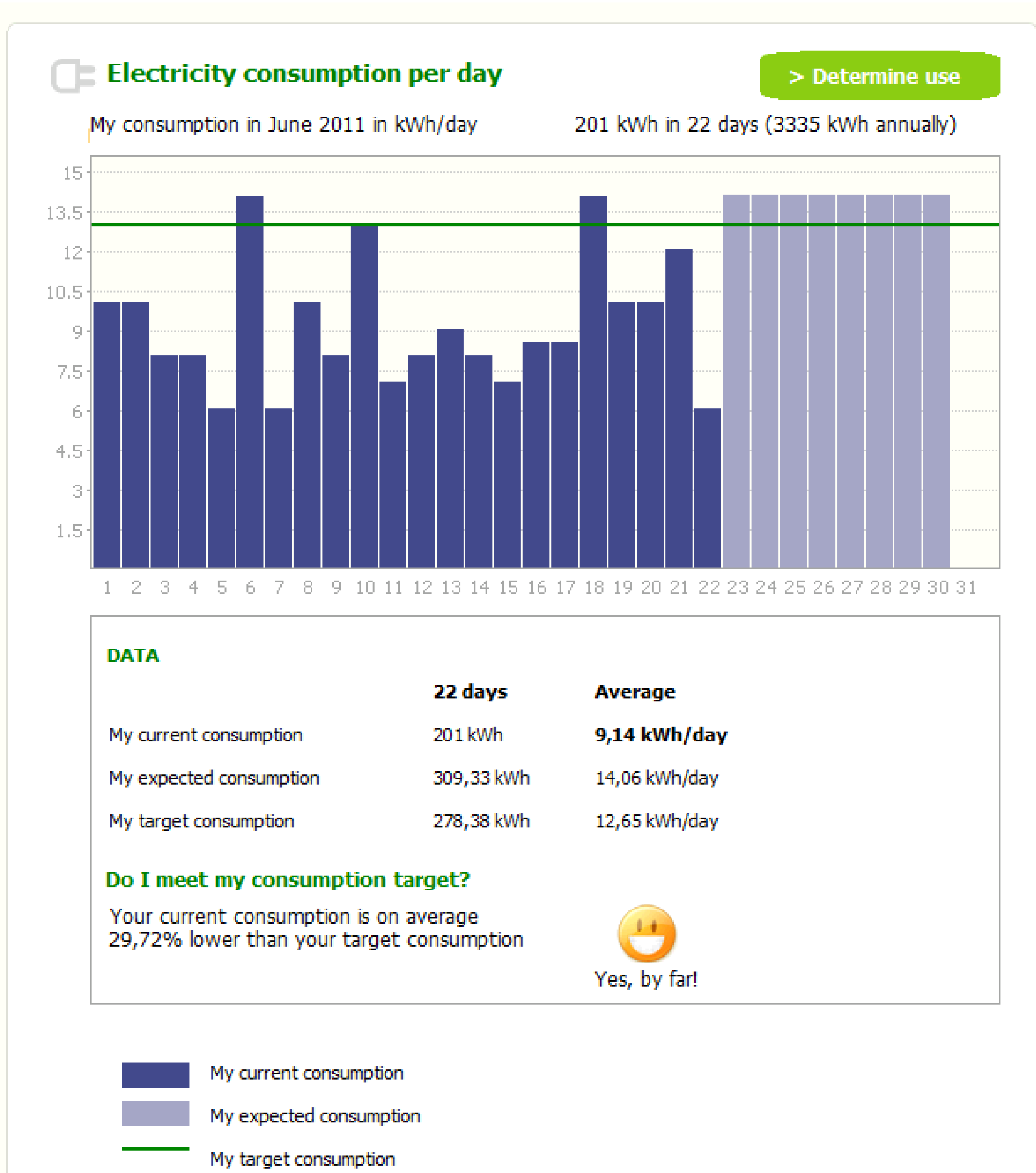

Figure 2: Example of the feedback tool. Dark blue bars indicate measured use. Light blue bars indicate expected use. The green horizontal line represents the saving target. Below the graph, detailed feedback on consumption is provided (translated from Dutch).

Using the above criteria, 4,500 customers out of 40,774 eligible candidates were invited. With a response rate of 8%, this resulted in three groups of approximately 120 participants each, balancing demands for statistical rigor with the resources needed to respond to assistance requests. For the control group, 1,000 different customers received an invitation.

No incentives to participate were offered. Applicants were informed that their feedback would be used to review and improve the new application before deployment. A total of 409 customers signed up for the trial, out of which 320 actually completed the entry survey. This left 104 subjects in Group 1, 107 in Group 2 and 109 in Group 3. For the control group, 143 customers initially signed up, of whom 94 completed the entry survey (see below). The experiment generated three data sources, a copy of the database with meter readouts and responses to two surveys, conducted before and after the trial.

3.3 Entry survey

The entry survey was used to obtain limited background information on the participants, score their attitude towards a number of motivators, and gauge their expectations and willingness to participate. Providing personal information was voluntary for privacy reasons and confined to household net income, education level, house type, and household size. Respondents were also asked to indicate the value they placed on environmental, financial, and energy security concerns. All scoring questions were asked using a 5-point Likert scale, a psychometric scale commonly used in questionnaires (Likert 1932).

3.4 Exit survey

The exit survey was used to collect the evaluations and experiences of all subjects. It tested a range of topics, such as the experienced level of effort of participants, the perceived usefulness of various means of feedback, and the perceived added value of potential features that were not included in the experiment.

4. Data Analysis & Results

Analysis of the data required converting data sources into compatible formats and extracting relevant values. Total consumption and a daily average per customer were computed using the raw meter values. Dividing daily average use by the expected average consumption yielded the variable PERFORMANCE SCORE, with values below 1 corresponding to lower consumption compared to customer's average. The total NUMBER OF ENTRIES and the day of the last entry by a participant (END DAY) were selected as proxies for a customer's participation rate.

Records with fewer than two pairs of meter readings did not allow for computation of performance scores and were removed, resulting in a lower number of *nominal* participants. A more stringent criterion of participation was used to identify *real* participants as those who had engaged for at least 75% of the trial period, since this would allow for feedback to have an effect on energy use. A higher threshold (e.g. 100%) was rejected because active participants that did not necessarily make their final entry on the last day might then be excluded. The numbers of remaining records for each group meeting these criteria can be found in Table 2. Note that *Initial* participants are those who decided to participate in the experiment from the beginning – day 0 – irrespective of whether they completed the entry survey. The loss (attrition) rates were calculated using the following formulas:

$$\text{Attrition}_{(\text{Gross})} = (\text{Initial} - \text{Real}) \;/\; \text{Real}$$
$$\text{Attrition}_{(\text{Net})} = (\text{Nominal} - \text{Real}) \;/\; \text{Nominal}$$

	Initial	Nominal	Real	Gross Loss Rate	Net Loss Rate
Group 1. Basic	132	70	57	57%	19%
Group 2. Motivated	135	84	62	54%	26%
Group 3: Assisted	129	82	64	50%	22%

Table 2: Participation rates for the three experimental groups

The number of participants over the duration of the experiment is shown in Figure 3, with day 0 giving the total number of initial enrollments. Note that the figures do not display the number of entries made on a particular day, but rather the number of participants who had not yet contributed their final entry of meter readings. While only 33% of participants submitted a value on the final day compared to day 1, about 70% adhered to the criterion for *real* participation.

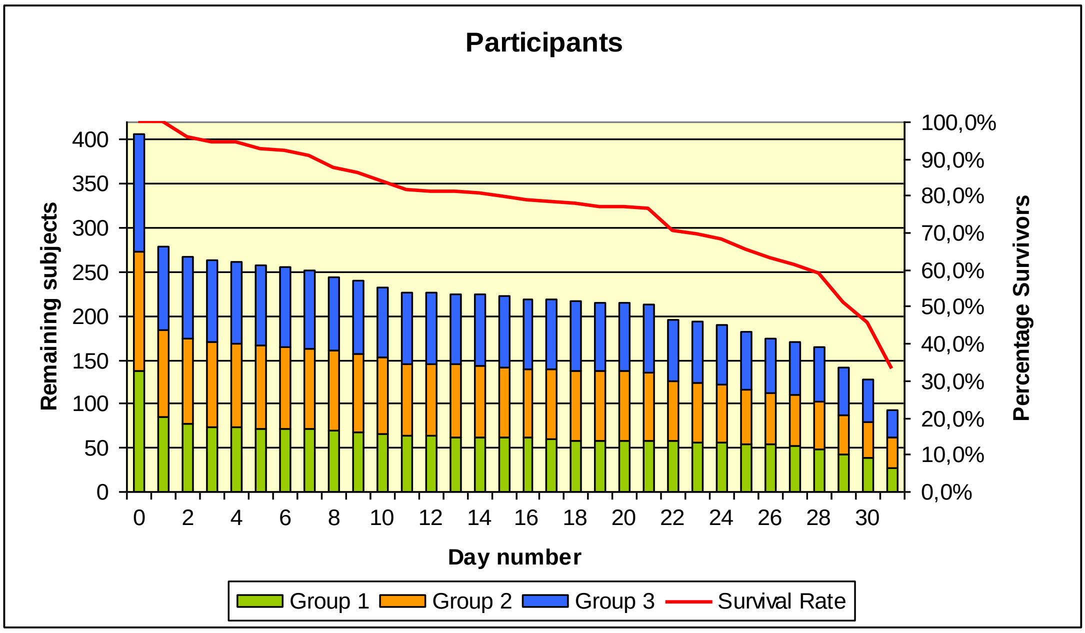

Figure 3. Evolution of the number of remaining participants over time. The different colors correspond to the different groups, whereas the survival rate indicates which percentage of nominal participants still remained.

4.1 Statistical Analysis

Hypothesis 1: Does energy consumption feedback increase awareness and energy-saving behavior?

As shown in Table 3, for statistical tests on PERFORMANCE SCORE, only real participants were considered and suspicious outliers were excluded using SPSS filters. **Filter A** excluded customers with PERFORMANCE SCORES outside a 30% to 250% interval. This interval was chosen because such larger or smaller consumption suggested either changes in the household or self-generation of electricity, which disqualified the record. **Filter B** used the same interval as **A**, but only included *real* participants.

	No Filter	Filter A	Filter B
Means: Experiment; Control	0.731; 0.917	0.778 ; 0.848	0.785 ; 0.848
Difference	0.187	0.070	0.063
T-value	3.542	2.678	2.277
Significance (equal S)	0.000	0.008	0.024
Significance (unequal S)	0.010	0.039	0.063

Table 3: Results of an independent sample T-test for Filters A & B and without filter. Values assume equal variances.

Independent sample T-tests using both filters were performed to check whether the performance scores of the experimental groups differed significantly from the control group. The difference was of a magnitude of 7 and 6.3% points when applying Filters A and B respectively. Results are displayed in Table 3, with higher T-values denoting more significant results. Levene's test was included as a standard to determine whether the variances of both samples (the combined experimental groups and the control group) were equal or unequal, as different distribution of values around the two means diminishes the power of a T-test. With both Filters, the variances proved unequal at a level of 0.01 and 0.05 significance for Filter A and B respectively. However, even with unequal variances, the results in both cases are still significant, as can be seen from Table 3. This suggests that the experimental groups used on average 6-7% less energy than the control group.

To measure a change of 'awareness', customer satisfaction with regard to learning effects of participation was used as a proxy. About 60% of participants reported to be satisfied with what they had learned from participating. Only 14% was dissatisfied. This result can also be seen in Figure 4 and emerged despite the fact that more than 50% of participants indicated their energy consumption was as they had expected.

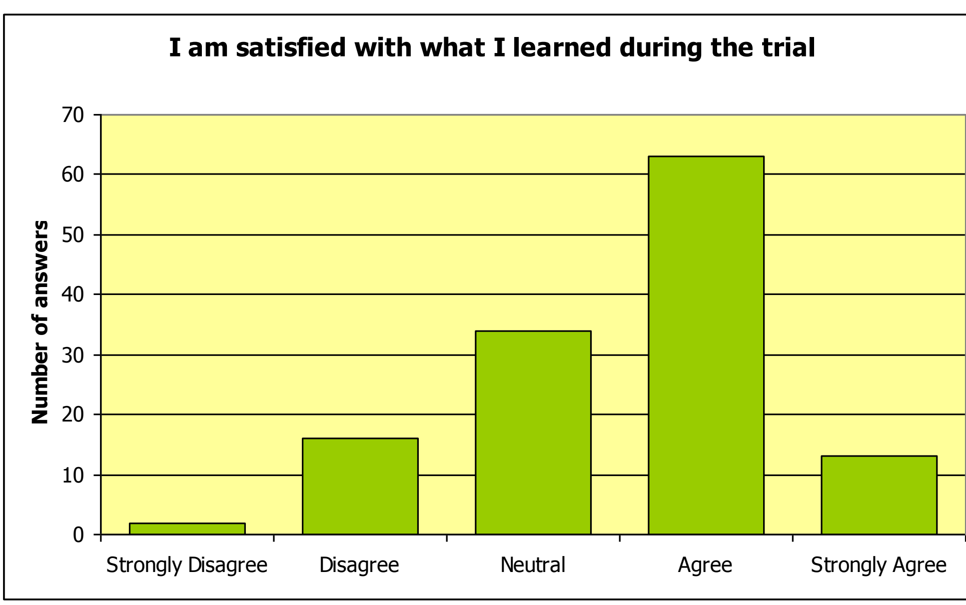

Figure 4: Overview of satisfaction among participants about the knowledge they obtained.

Hypotheses 2 & 3: Can energy-saving behavior be actively encouraged with the use of reminders and suggestions?

No clear differences across the three experimental groups emerged from the data. Applying **Filter B** a one-way ANOVA found no difference across the groups. Means on performance across Groups 1, 2, and 3 were found at 0.766, 0.803, and 0.783, respectively, with Motivated and Assisted Groups actually performing relatively worse compared to the Basic Group. Although the difference was not statistically significant, a possible explanation could be that unmotivated participants lasted longer in the Motivated and Stimulated groups, depressing performance relative to Group 1. This explanation is supported by the participation proxies in Figure 3, which show that Group 1 lost most participants at the start of the trial, whereas the other groups did so towards the end. Qualitative responses from participants themselves support the presumed limited impact of reminders and suggestions: suggestions and reminders did not receive strong approval from the participants. Nevertheless, as can be seen from Figure 5, reminders were associated with increased participation on the days that they were sent.

Hypothesis 4: Does user-friendliness affect performance?

In the exit survey, participants rated the functionality and usability of the web application at a 1-5 Likert scale, while also indicating their possible fatigue with participating. Ratings applied to individual elements and factors of the page and experiment. The results of these individual responses were aggregated into three overall variables: AGGREGATE EFFORT, USABILITY and APPRECIATION. AGGREGATED EFFORT was the main measure of how fatiguing a customer experienced the trial. USABILITY expressed how easy customers found it to navigate the website, submit their results and interpret the resulting feedback. APPRECIATION was an indicator derived from scores customers gave for the utility of specific pieces of information. The effort of recording the meter values, READOUT EFFORT, was also tested individually because it proved to be the most important contributor to the variable AGGREGATE EFFORT. All variables were compared against PERFORMANCE SCORE, NUMBER OF ENTRIES and END DAY using Pearson tests, which measure the extent to which two independent variables are linearly correlated. The results can be found in Table 4.

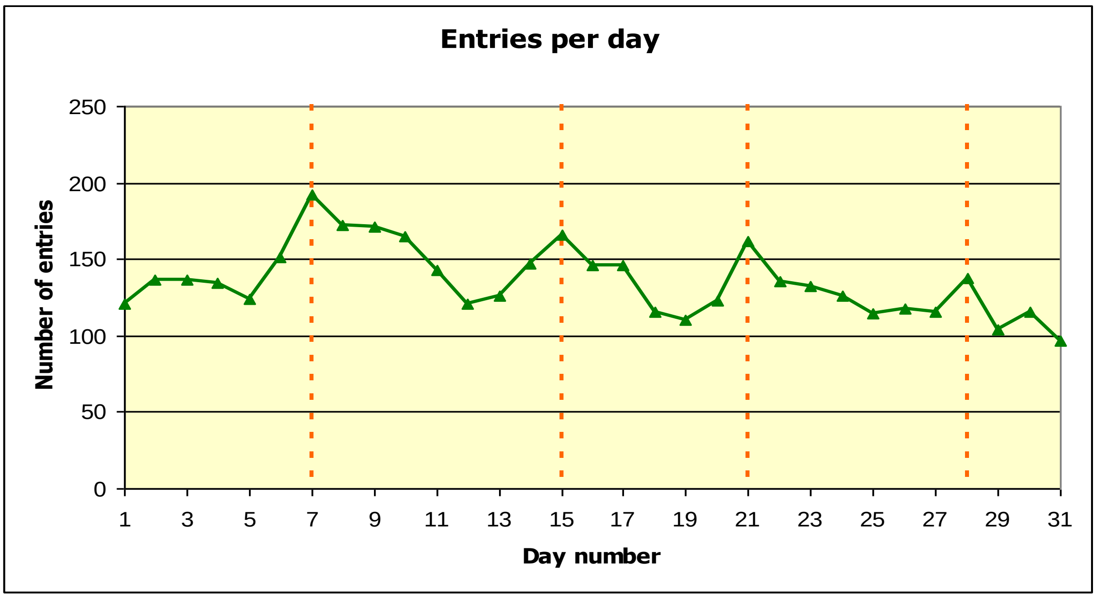

Figure 5: Total number of submitted meter values per day. The orange dashed lines indicate the days on which reminders were sent to Groups 2 & 3.

Table 4 shows that the participation indicators (NUMBER OF ENTRIES and END DAY) are most strongly negatively influenced by the effort experienced by the customer, since both AGGREGATED EFFORT and READOUT EFFORT have correlation coefficients of over 0.6 with the NUMBER OF ENTRIES. The negative sign expresses that for increased effort, the total number of submitted values decreases.

User-friendliness on the other hand positively influenced participation, though less strongly than the negative effect of fatigue. Appreciation of the online application appears to be strongly correlated with the NUMBER OF ENTRIES of participants. None of the variables appear to be correlated with PERFORMANCE SCORE, indicating that user-friendliness contributes to the rate of participation but does not necessarily encourage consumers to save more energy.

	PERFORMANCE SCORE	NUMBER OF ENTRIES	END DAY
AGGREGATED EFFORT	.-0.100	-0.636**	0.263**
READOUT EFFORT	-0.048	-0.621**	-0.228*
USABILITY	0.078	0.271**	0.210**
APPRECIATION	-0.082	0.226*	0.127

Table 4: Correlation coefficients (Pearson) between respondent indicators and performance and participation proxies. ** and * denote significance level at 1% and 5%, respectively.

The conclusion from Table 4 is that the perceived effort required to participate is the main determinant in both the frequency and duration of submitting meter values, with higher perceived effort leading to lower rates of participation. On the other hand, participation is encouraged by a user-friendly website, though this effect is less pronounced than the negative influence of fatigue. The actual level of savings realized by customers seemed to be independent of both the required effort and user-friendliness of the website.

Although these results appear to confirm the hypothesis, they nevertheless need to be interpreted with some caution. Results were based on a smaller number of participants with a possible bias towards more motivated and successful customers. The high correlation between appreciation and performance score may, for example, reflect that some participants appreciated the application more because of their good performance. Second, although participants generally responded that the target (90% less energy compared to previous year) was useful either as a reference level or motivator, future research should experiment with different target levels. Moreover, future research should also pay more attention to the impact of potential seasonal variations in domestic electricity use. Due to the short period of our experiment, seasonal impact could not be considered.

5. Conclusion

The results suggest that feedback through web applications does indeed increase perceived consumer awareness and reduces electricity consumption. Experimental groups scored an average much lower in terms of energy savings compared to the control group. Customers were also satisfied with what they had learned from participating in the experiment, implying that their awareness of electricity consumption had increased.

5.1 Implications for further research

The experiment makes a significant contribution to the understanding of feedback use for energy-saving across Dutch consumers. A similar experiment, requiring self-metering and converting raw data into useful feedback, had not been performed in the Netherlands before. It contributes to the growing literature on preferences and energy consuming behavior of households. The experiment shows that even during a relatively short period, a substantial reduction in energy consumption is feasible. Further experiments could be done over longer periods of time and in other seasons, to determine whether differences in performance become more pronounced.

Finally, the form and presentation of the feedback also exerted an influence on the participation rate of customers. The design of the website, its user-friendliness, and functionality of the different elements of the application all contributed to participants' motivation to continue with the trial. The perceived effort and fatigue of customers strongly influences their motivation. These results suggest that to encourage participation, the presentation and functionality of a tool need to be as carefully chosen as the method itself. Future research may hence try to quantify the extent to which energy saving is attributed to goal-setting and feedback or the way information is presented.

Other recommendations concern the sample size and composition. In this experiment, participants were volunteers, drawn from customers of a sustainable energy utility delivering only electricity from renewable sources. The participants may hence not be representative of the average Dutch household and were probably already more motivated and knowledgeable than the average consumer. The authors plan to run similar experiments with more representative samples in the future, possibly employing smart-meters to avoid self-selecting biases. Furthermore, future research should attempt to increase the sample size, which was kept relatively low in our experiment due to limits in resources and manpower.

5.2 Implications for policy makers and utilities

Two additional concrete conclusions can be drawn from this research. First is that investing in 'smart' technologies is not the only method to reduce energy consumption by households. Second, the user-friendliness of energy saving tools should be given more emphasis.

Recently, there has been a trend by governments and utilities alike to invest in so-called 'smart meters' to assist consumers in reducing their energy consumption. However, it will certainly be a number of years before such meters are widely deployed. It would be a waste to neglect the savings potential that exists among consumers with more traditional metering equipment. This experiment has shown that consumers are willing to invest of time and effort to save energy. The tool used in this experiment was relatively simple and easy to develop. Especially energy companies, but also (local) governments should consider investing in more 'do-it-yourself' methods for energy saving, since the majority of consumers will not be equipped with a smart meter in the near future.

Evidence from our research suggests that the energy feedback tools should also be carefully designed to improve their user-friendliness. Previously, most attention has been on the method for reducing energy, rather than the means of presentation. Though more research might be necessary in this area, organizations developing energy saving tools might consider asking feedback from their customers. During this experiment, customers proved to be highly motivated to give their views on the feedback tool and its efficiency.

Finally, a slightly more conjectural recommendation can be made. That is that in designing energy saving tools, utilities or governments might take into account the sense of ownership of energy consumers over their utilities. While this effect was not explicitly quantified as part of the experiment, it appeared that the active involvement of customers increased their motivation to a certain extent. This related to both the communication between the utility and the participants, as well as participants' effort to collect their own meter readouts. Of course, excessive demands on customers could become fatiguing rather than motivating. However, this trial does suggest that customers might prefer being asked to invest a modicum of time and effort rather than being treated as passive consumers of feedback information. With the trend towards more automated systems, this might be an effect worthy of some consideration.

Bibliography

Abrahamse, W., Steg, L.., Vlek, C. & Rothengatter, T. (2007). *The effect of tailored information, goal setting, tailored feedback on household energy use, energy related behaviors and behavioral antecedents.* Journal of Environmental Psychology 27: 265 – 276.

Becker, J.L. (1978). *Joint Effect of Feedback and Goal Setting on Performance: A Field Study of Residential Energy Conservation.* Journal of Applied Psychology. Vol. 63, no. 4: 428 – 433.

Berkhout, H.G., Muskens, J.C. & Velthuijsen, J.W. (2000). *Defining the rebound effect.* Energy Policy 28:425 – 432.

http://www.cbs.nl/nl-NL/menu/themas/inkomen-bestedingen/cijfers/extra/2009-inkomensverdeling.htmDarby, S. (2001). *Making it obvious: designing feedback into energy consumption*. Proceedings of the 2nd International Conference on Energy.

De Young, R. (2000). *Expanding and Evaluating Motives for Environmentally Responsible behavior.* Journal of Social Issues Vol. 56, No. 3: 509 – 526.

Faiers, A., Cook, M. & Neame, C. (2007). *Towards a contemporary approach for understanding consumer behavior in the context of domestic energy use.* Energy Policy 35: 4381 – 4390.

Fischer, C. (2008). *Feedback on household electricity consumption: a tool for saving energy?* Energy Efficiency 1:79 – 104

Geller, H., Harrington, P., Rosenfeld, A.H., Tanishima, S. & Unander, F. (2006). *Policies for increasing energy efficiency: Thirty years of experience in OECD countries.* Energy Policy 34: 556 – 573.

Görts, C.A. & Jonkers, R. (2000). *Verkenning determinanten energieverbruik en in het bijzonder huishoudelijke apparaten*. ResCon, Research & Consultancy.

Harmelink, M., Graus, W., Marsidi, M., Saygin, D. & Worrell, E. (2010). *Potentieel voor Besparing en Efficiency van Energiegebruik in Nederland (BEEN).* Rapport uitgevoerd door Universiteit Utrecht, Ecofys en Harmelink consulting in opdracht van Energietransitie.

Jaffe, A.B. & Stavins, R.N. (1994). *The energy-efficiency gap: what does it mean?* Energy Policy 22: 804 – 810.

Kempton, W. & Layne, L.L. (1994). *The consumer's energy analysis environment*. Energy Policy Vol. 22, No. 10 p: 857 – 866.

Levine, M., D. Ürge-Vorsatz, K. Blok, L. Geng, D. Harvey, S. Lang, G. Levermore, A. Mongameli Mehlwana, S. Mirasgedis, A. Novikova, J. Rilling, H. Yoshino, (2007). *Residential and commercial buildings. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the*

Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Likert, R. (1932). *A technique for the measurement of attitudes.* Archives of Psychology Vol. 22, No. 140: 1 – 55.

Lindenberg, S. & Steg, L. (2007). *Normative, Gain and Hedonic Goal Frames Guiding Environmental Behavior.* Journal of Social Issues Vol. 63 No. 1 p: 117 – 137.

Matthies, E. (2005). *Wie konnen PsychologInnen ihr Wissen besser an die PraktikerIn bringen? Vorschlag eines neuen integrativen Einflussschemas umweltgerechten Alltagshandels*. Umweltpsychologie Vol 9, No 1 p: 62 – 81.

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (MinBZK) (2011). *Plan van Aanpak Energiebesparing Gebouwde Omgeving*.

Parnell, R. & Popovic-Larsen, O.P. (2005). *Informing the development of domestic energy efficiency initiatives – an everyday householder-centered framework*. Environment and Behavior 37: 787 – 807.

Poortinga, W., Steg, L., Vlek, C. & Wiersma, G. (2003). *Household preferences for energy-saving measures: A conjoint analysis.* Journal of Economic Psychology 24: 49 – 64.

Schuitema, G. & Steg, L. (2005). *Percepties van energieverbruik van huishoudelijke apparaten*. Jaarboek MarktOnderzoek Associatie 2005, hoofdstuk 11, p. 165 – 180.

Socolow, R.H. (1978). *The Twin Rivers Program on Energy Conservation in Housing: Highlights and Conclusions*. Energy and Buildings 1: 207 – 242.

Steg, L. (2008). *Promoting household energy conservation*. Energy Policy 36: 4449 – 4453.

Stern, P.C. (2000). *Toward a Coherent Theory of Environmentally Significant Behavior*. Journal of Social Issues Vol. 56, No. 3, p: 407 – 424.

Tietenberg, T. (2009). *Reflections – Energy Efficiency Policy: Pipe Dream or Pipeline to the Future?* Review of Environmental Economics and Policy. Vol.3, No.2: 304 – 320.

Van Houwelingen, J.H. & Van Raaij, W.F. (1989). *The Effect of Goal-Setting and Daily Electronic Feedback on In-Home Energy Use*. The Journal of Consumer Research. Vol. 16, no. 1: 98 – 105.

Van Raaij, W.F. & Verhallen, Th.M.M. (1983). *A behavioral model of residential energy use.* Journal of Economic Psychology 3: 39 – 63.

Winnet, R.A., Neale, S.M. & Grier, H.C. (1979). *Effects of self-monitoring and feedback on residential electricity consumption.* Journal of Applied Behavior Analysis 12: 173 – 184.

Wood, G. & Newborough, M. (2007). *Energy-use information transfer for intelligent homes: Enabling energy conservation with central and local displays.* Energy and Buildings 39: 495 – 503.