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A Multi-Method Evaluation of the Potential for Using the Electricity Bill to Encourage Energy Savings in Norwegian Households

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Abstract

This study explores whether the electricity bill can be used as a medium to deliver information that encourages energy conservation in Norwegian households. Two main categories of information were tested: social comparative feedback and information about the monetary savings that can be made through specific energy-saving measures. The study combines four methods. First, a focus group study gathered advice on the categories and design of information that could influence energy consumption, and addressed general issues on energy consumption. Second, a field experiment monitored actual electricity use in 1000 households over a period of 10 months. In addition, through a survey and a series of in-depth interviews, the experience of the participating households was investigated. The experiment showed no effect on actual consumption. One main barrier was that only half the sample noticed the information. This suggests that the potential for encouraging energy conservation through adding new information to the bill in Norway is limited. The bill is already quite informative and is becoming less relevant as an increasing share of consumers switch to electronic bills and direct debit, which decreases the attention they pay to their bills.

Keywords: information, energy savings, electricity bill

1. Introduction

The question of how to motivate energy conservation in households has been a topic of considerable interest since the 1970s, as the answer is believed to hold great potential for reducing energy consumption and its associated environmental impacts at a small or negative economic cost. Tapping into this potential, however, has proven difficult. By now it is well established that technical and physical improvements in housing are not enough to guarantee reduced energy consumption (Darby, 2006). Consumption in identical homes, even those designed to low-energy standards, can often differ by a factor of two or more depending on the behavior of the inhabitants (Curtis, 1992; Keesee, 2005; Sonderegger, 1978). Further, economic incentives to reduce energy consumption appear to be muted, as there is evidence that foregone energy investment opportunities with a short payback time are ubiquitous (Stern, 2007).

It has been argued that it is difficult to realize the potential for energy conservation because energy use in modern systems is largely an invisible good, which means that it tends to escape human consciousness and reflexivity (Lindén, Carlsson-Kanyama, & Eriksson, 2006; Pedersen, 2000; Winther, 2008). This makes it challenging for users to get a clear idea of how their use changes over time, how it relates to meaningful benchmarks, how it is distributed between different end-uses, and how it would be affected by various energy-saving measures.

This study assesses the potential for using the electricity bill to increase the visibility of the good and thereby motivate electricity conservation. A field experiment is conducted in which different messages seeking to motivate electricity conservation are added to the bills of a sample of electricity consumers, and the level of consumption is measured relative to a control group. The field experiment is supplemented by a focus group study, a survey, and in-depth interviews to broaden the understanding of electricity consumption and of what motivates conservation.

Existing studies on the effect of information on household energy consumption have tested various types of information delivered through a variety of media. The various messages tested in the literature can be divided

into antecedent information and feedback. This division is based on a categorization of a broader set of measures by Abrahamse, Steg, Vlek, and Rothengatter (2005). Antecedent information is aimed at influencing determinants prior to the performance of behavior, such as knowledge or attitude. Examples of this would be energy-saving tips and messages underlining the environmental or national energy security importance of conserving energy. Feedback is a way of making the consequences of behavior more salient. Direct feedback is near real-time information (e.g. given in a display), while indirect feedback has been processed in some way before reaching the energy user.

The empirical effectiveness of the different types of messages varies greatly – both within and across categories. Based on a review of existing studies, Abrahamse et al. (2005) conclude that, in general, antecedent information is not very effective on its own. Mass media campaigns about energy problems appear to be successful at increasing knowledge, but little is known about their effects on energy use. The evidence for the effectiveness of feedback is more robust. A review by Fischer (2008) shows that savings generally fall in the range from 1.1% to over 20%, with typical savings in the range between 5% and 12%. However, there are also instances in which no savings are found. Furthermore, the studies finding smaller effects appear more reliable than those indicating large effects, and most studies only look at the short-term effect of information. On aggregate, indirect feedback seems to be somewhat less efficient than direct feedback, with savings in the range of 0-10% (Darby, 2006). At a more disaggregated level, Darby argues that indirect feedback is usually more suitable than direct feedback for demonstrating the effect of changes in space heating, household composition and capital, but less effective for understanding how most appliances use electricity.

A study by Schultz, Nolan, Cialdini, Goldstein, and Griskevicius (2007) on the effectiveness of social comparative feedback has received much attention – such as in the book *Nudge* (Thaler & Sunstein, 2008) – due to the effect obtained from using social comparative feedback. Earlier studies of normative feedback have yielded unexciting results: Out of twelve such studies reviewed by Fischer (2008), none finds a statistically significant difference between the effect of this treatment and other types of information (Note 1). In some of the studies, a boomerang effect is evident. The boomerang effect is defined as a situation where customers whose initial energy use is below the average in the reference group increase their consumption in response to social comparative feedback. What the study by Schultz et al. (2007) suggests is that this effect can be eliminated by adding a message of social approval or disapproval (injunctive normative information). Half of their sample received only social comparisons. The other half also received injunctive normative information: ☺ or ☹, depending on whether they were below or above the average. In both groups, those who initially consumed more than the average reduced their consumption in response to the feedback. However, in the first group, which received only social comparisons, the boomerang effect was evident. In the second group, which also received injunctive normative information, this effect was eliminated; there was no longer a significant increase in the consumption of those who were initially below the average. A problem regarding this result is that the analysis does not control for regression to the mean. A study of social comparative feedback on water consumption (Ferraro & Price, 2011) found no boomerang effect even though no injunctive message was included. Another shortcoming is the small sample (290), and a medium that is difficult to scale up (research assistants leaving messages at participants' doors). Today, however, home energy reports inspired by Schultz et al.'s study are sent to one million households in the USA by the company Opower. Large scale studies have confirmed the effect, with a reduction of about 2% relative to control groups (Allcott, 2011; Ayres, Raseman, Shih, & Research, 2009). These reports include – in addition to neighborhood comparisons - personal historic comparison, targeted energy advice, and injunctive normative feedback, so the studies do not isolate the effect of each piece of information. The present study attempts to do so for the types of information investigated. The study also differs from the Opower studies by including the information with the bill rather than distributing it in a separate report.

Focusing specifically on the electricity bill as a medium for communication, a rigorous quantitative study was carried out by Wilhite and Ling (1995) among households in Oslo in the early 1990s. At the time, Norwegian customers only received information about their actual electricity use once a year. Every three months, they paid one-fourth of the estimated annual consumption based on the previous year. Hence, there was no relationship between the invoiced cost for a given three-month period and actual electricity consumption in that period. One treatment group received the bill for actual use at a greater frequency. This resulted in an 8% reduction in electricity use relative to the control group. Another group received – in addition to more frequent bills – a graph of their current and previous year's consumption. Electricity savings in this group was 12%. However, the difference between this group and the group that only received more frequent billing was not significant, which indicates that the main stimulant was the increased billing frequency. Since 1999, it has been mandatory for Norwegian utility companies to supply quarterly billing based on actual consumption including graphical historical comparative information.

Other studies have investigated the preferences of consumers concerning energy bills. In a study of Swedish households, roughly 75% wanted a graphic presentation of the actual consumption compared with the same month the previous year, about 65% wanted energy-conservation tips incorporated into the bill, and almost 50% wanted comparative statistical information from a comparable household (Sernhed, Pyrko, & Abaravicius, 2003). In a test of social comparative feedback, Wilhite, Hoivik, and Olsen (1999) found that three-quarters of consumers stated that they would be motivated to reduce consumption if they were informed that it was higher than the average. Another study from Sweden (Henryson, Håkansson, & Pyrko, 2000) found that the electricity bill serves two purposes from the perspective of the household: firstly as an invoice, and secondly as a control tool. The latter is achieved through a comparison with previous bills and with those of friends and neighbors. The majority of the households felt that social comparative information would be useful. Consistent findings across studies are that consumers strongly prefer billing for actual use, and that graphic information is easier to process than written information.

The current study contributes to the literature by testing electricity bills systematically as a medium for providing information to customers, both by quantitatively investigating the effects on electricity consumption in a field experiment and by combining this experiment with other methods to understand the effects obtained. Below, the context for the present study is given, explaining why Norway is a particularly relevant case and providing the background for the billing and reporting routines used for the consumers who were part of the study. This is followed by an explanation of the study design and methods used, and a presentation of the results obtained in the field experiment, the follow-up survey, in-depth interviews, and focus group study. Finally, the findings are summarized.

2. Context for the Experiment

In some respects, the Norwegian electricity market is rather atypical. For one thing, 96% of the country's electricity production comes from hydropower (Norwegian Water Resources and Energy Directorat, 2009). The large supply of hydropower has resulted in electricity prices that historically have been low compared to the rest of Europe. However, two aspects make Norway a particularly relevant case. Firstly, Norway has come relatively far in implementing requirements on information that must appear on the electricity bill, which is gradually becoming legally required in other European countries due to EU directives. Secondly, the Norwegian power market has been liberalized, a process several other European countries have also gone through recently, or will be going through. Below, the arguments for these two points are further explained.

The Wilhite and Ling study (1995 – see above) among households in Oslo in the early 1990s, had implications for the billing procedures and the type of information included in the electricity bill Norwegian customers. More frequent billing based on actual consumption as well as historical comparative feedback are now mandatory for the energy suppliers in Norway to provide (Hille, Simonsen, & Aal, 2011). Hence, Norway had already introduced some of the requirements from the EU directive on energy end-use efficiency and energy service when the directive came into force in 2006. This directive introduced strict new requirements for the contents of energy bills, see box 1. Historically comparative feedback is required "where appropriate" while social comparative feedback is required "wherever possible and useful." The proposal for a new directive on energy efficiency goes further, suggesting that these be made unconditional requirements (Commission, 2011).

EU directive on energy end-use efficiency and energy services (Commission, 2006)

Article 13

2. Member states shall ensure that, where appropriate, billing […] is based on actual energy consumption, and is presented in clear and understandable terms. […] Billing on the basis of actual use shall be performed frequently enough to enable customers to regulate their own energy consumption.

3. Member states shall ensure that, where appropriate, the following information is made available to final customers in clear and understandable terms […] in or with their bills […]:

(a) Current actual prices and actual consumption of energy;

(b) Comparisons of the final customer's current energy consumption with consumption for the same period in the previous year, preferably in graphic form;

(c) Wherever possible and useful, comparisons with an average normalized or benchmarked user of energy in the same user category.

However, Norwegian energy retailers are not required to provide social comparative feedback. (Note 2) Given that the bill is already utilized to deliver feedback on actual consumption, prices, and historical comparisons, is it "useful" to include further information, such as social comparisons? This is one of the elements tested in the field experiment of the present study. Information is considered useful in a strict sense if it leads to observed reductions in energy consumption in this study. However, its usefulness in a looser sense is also judged based on the views of the recipients.

The Norwegian power market was liberalized in 1991, and consumers can choose their power supplier in a competitive market for electricity where access to the network system is given on a transparent and nondiscriminatory basis (see e.g. Bye & Hope, 2005). The power grid is a natural monopoly where the prices in this market are regulated, but owners of the grid have an obligation to deliver electricity to consumers irrespective of which power supplier the consumer chooses. Network companies are required by law to bill household customers at least quarterly (Note 3). For those countries that have also liberalized their electricity markets or are in the process of doing so, knowing more about how information intended to motivate energy savings in a liberalized setting, would be of interest.

2.1 Background for the Field Experiment

The field experiment was conducted in collaboration with the network division of Hafslund. Hafslund is one of the largest utility companies in the Nordic countries. Its network division owns and manages the power grid in Oslo and parts of the adjoining counties of Akershus and Østfold. It services about 550 000 customers, making it the largest network company in Norway. Network customers of Hafslund can choose to receive the bill either by mail or electronically. They can also choose whether they want to pay manually, or through direct debit. Electronic bills are sent directly to the customer's online bank, from which the customer can access the bill by clicking on a link. Payment must be activated by the customer, unless the customer combines electronic billing with direct debit, in which case the amount is automatically deducted. Those who have direct debit without electronic billing receive the bill by mail for their information even though the amount is deducted automatically. When the field experiment was conducted, Hafslund was billing its customers bimonthly, but they planned to change their billing routines to monthly billing (Note 4). This was introduced after the field experiment finished.

All households are requested to report their consumption manually. They are reminded to do so on the first day of every odd month, but can in principle report their meter reading whenever they choose. Meter readings can be submitted by post, phone, sms, or online. If households fail to self-report, their consumption is stipulated by the utility.

3. Method

As the study employs a diverse mix of methods, each will be presented in turn.

3.1 The Focus Group Study

A series of focus group sessions were arranged in Oslo in November and December 2009 to explore consumer preferences for possible designs and content of the information to be tested in the field experiment.

The messages were presented to the focus group participants as examples of ordinary bills from the electricity supplier (Hafslund). The information was either included on the bill or presented as attachments to the bill. The messages discussed in the focus groups included:

- Comparative feedback with information about the electricity consumption in similar homes in their neighborhood. This information was presented as bar graphs comparing the household's electricity consumption to that of the reference group. In addition, one version in which the information was presented as text was included for discussion.
- Comparative feedback with information about the electricity consumption in similar homes in their neighborhood plus an injunctive normative message in the form of a smiley face if the household's consumption was below that of the neighborhood or a grumpy face if the household's consumption was above that of the neighborhood.
- Information on what measures the majority of Norwegian households have already taken to save electricity based on a previous survey (CICERO & Synovate, 2008) and presented as text (Note 5).

In addition to discussing the messages above, the focus group participants were also asked questions about the reasoning behind their energy use. They were asked about which energy savings measures they had already implemented or planned to implement, why they saved energy (if they did), who inspired them in their energy saving decisions, and their views on how a good life was connected to energy use. These questions where

included to obtain data for the interpretations of the results from the field experiment. Knowing for instance the arguments for saving electricity, more information that is useful could be found regarding how people reason when it comes to energy savings.

Four focus group sessions in Oslo were arranged, each with eight participants. The recruitment of participants was handled by Synovate (Note 6), via telephone using the phone book or by contacting people who had volunteered to participate in focus groups (Note 7). The participants were divided into age- and gender-specific groups; men aged 30-45, men aged 50-65, women aged 30-45, and women aged 50-65 (Note 8). The focus groups were led by a moderator from Synovate who used the focus group guide developed by the researchers to facilitate the sessions. The focus group sessions and the focus group guide were semi-structured, allowing flexibility in the discussion. The proceedings of the focus groups were documented by professional transcribers. The team of researchers also observed the discussions in real-time through a one-way mirror. The data collected during the focus group sessions were analyzed using the software program NVIVO. This program allows for the organizing and classifying of qualitative data.

3.2 The Field Experiment

3.2.1 Treatments in the Field Experiment

The focus group discussions gave an indication of how to formulate the messages and what messages to include in the field experiment. The following changes in the messages were made based on the focus group discussions:

- The comparative normative feedback messages were only presented as graphs. It was evident from the focus group discussions that a graphical presentation was preferred to receiving the information only as text. Other studies show the same results – graphical presentations are often preferred to plain text (see e.g. Wilhite, 2007; Teisl, Halverson, & Holt, 1997).
- The grumpy face for those consuming electricity above that of their neighborhood was excluded. As one of the focus group participants stated: "You really feel monitored, and that I reject" (Note 9). This sentiment was shared by the majority focus group participants. Based on the negative evaluation of this message as well as the electricity supplier's unwillingness to give negative feedback on their customer's behavior, this type of message was excluded from the field experiment.
- Information on what other consumers did to save electricity was excluded. The participants in the focus groups did not find this information interesting: "I think it's nice to get some concrete advice, but we've heard it all before, as you say. And, what most Norwegians do is probably not the most interesting thing. I would rather know what is most effective, because that's not necessarily what most Norwegians do" (Note 10). Instead, when focus group participants were asked what kind of information they would like to see included in their bills, the most frequent response was information about how much money they could save by carrying out specific measures. "How about giving information like if you turn down the heat two degrees in the whole house, you will save this much money annually. You can cook potatoes on residual heat by turning off the stove when they're almost done and letting them continue to cook for five minutes, lots of things like that, and if people saw that they could save so much money by doing that, then it would stick better" (Note 11).

Furthermore, the focus group discussions clearly indicated that the information must be presented where it is easily noticed. Attachment to the bill was rarely read which led to a preference of including the information treatments on the actual bill. However, because the front page of the bill is already fully covered by required information, the only option was to use page 2 or 3 of the bill. This could potentially lead to lesser awareness of the information provided, but also made it possible to test the treatments in a realistic setting since this is where the energy supplier would present the information.

The final treatments used in the field experiments were the following:

Treatment 1: Descriptive normative information

This group received a bar graph comparing their own consumption with the median for their postal code. It was accompanied by the following text:

> **New information: Compare your consumption with other detached houses in [postal code]**
>
> Most detached houses in this area normally use less than [median consumption of detached houses within postal code (rounded up to nearest 100 kWh)] in [month 1] and [month 2].*
>
> Your household used x kWh in this period this year.

The difference is y%

How to save electricity: see www.enova.no/hjemme

* Based on the average for 2007-2009.

Treatment 2: Additional injunctive normative information

Following Schultz et al. (2007), an injunctive normative message was added to the second treatment in the form of a smiley face (☺) to households who consumed less than the median.

Treatment 3: Energy-saving tips – gain frame

The monetary savings from 12 commonly mentioned measures were estimated, including both investments and curtailments. On each bill, three measures appeared, chosen for their relevance to the season in which they were distributed. This treatment was introduced in response to the many calls for this type of information by focus group participants (Note 12).

Treatment 4: Energy-saving tips – loss frame

A consistent observation in experimental economics is that people systematically attach greater importance to losses than to gains of similar magnitude (Tversky & Kahneman, 1991). Therefore, variations of the same pieces of information used in treatment 3 were created with a loss framing instead of a gain framing. The monetary figures used were identical, but they were now expressed as the additional expense one would incur through electricity-wasting behavior or by failing to take electricity-saving measures.

3.2.2 Sampling of Households

It was not feasible to obtain a fully random sample of all Norwegian households for this type of study, and some concessions had to be made for practical reasons. Therefore, the results cannot be directly generalized outside the study. However, the collaboration with Norway's largest utility company provided an excellent opportunity to investigate the effect of information in a very realistic and scalable manner.

In order to facilitate social comparisons to be used in treatments 1 and 2, a sample in which the housing stock was relatively homogenous in terms of size, type, and construction year was sought. Several focus group participants stated clearly that it would be meaningless to compare the consumption in a detached house with that in an apartment. The municipality of Asker was chosen. This municipality is dominated by detached houses, and electricity is the dominant source of space and water heating, providing 90% of residential energy use (Statistics-Norway, 2009). Asker has a population of about 55 000, and is located between 15 km and 30 km from the center of Oslo. It has a relatively affluent, well educated, and politically conservative population, while the age structure resembles that of the country as a whole. A central level of analysis in this study is the postal code, since two treatments receive information about their consumption relative to others within the same postal code. There are 14 different postal codes in Asker.

Households were filtered based on a number of criteria. First, the most affluent areas (1390/1391 Vollen and 1397 Nesøya) were excluded in order to somewhat mitigate the issue that the average income in Asker is well above the national average. Next, two postal codes were left out because their low concentration of detached houses made it cost-inefficient to include them (1387 Asker and 1394 Nesbru). Detached houses in the remaining areas were then isolated based on information from the Norwegian Mapping Authority, using Geographical Information System software. Finally, households with a history of not reporting their meter readings were left out due to a lack of reliable data.

A simple random assignment of households to group would have led to high administrative costs, as the reference level consumption for treatments 1 and 2 differ for each postal code. A two-stage cluster sampling was therefore employed. First, three postal codes were randomly drawn. These were 1383 Asker, 1385 Asker, and 1388 Borgen, which are referred to as subsample A. The households in subsample A were randomly assigned to three groups: Group 1, which received the social comparative feedback, Group 2, which received the social comparative feedback plus injunctive normative feedback, and Control Group 1. The remaining households (with postal codes 1384, 1386, 1389, 1392, 1393, 1395, 1396) – which is referred to as subsample B – were randomly assigned to Group 3 which received energy-saving tips with a gain frame, Group 4 which received energy-saving tips with a loss frame, and Control Group 2. Two control groups were chosen in order to ensure that each treatment group was compared with a control group drawn from exactly the same pool, while limiting the number of postal codes implicated by the social comparative information. Hence, Groups 1 and 2 were compared with Control Group 1, while Groups 3 and 4 were compared with Control Group 2. The sample size was chosen based on a standard power analysis. In order to be able to detect a 2.5% reduction in the treatment

group relative to the control group, it was estimated that between 65 and 250 households were needed (Note 13). The range of the estimate is quite large, since the sampling had to be done before the all pre-treatment data was collected, and hence based on assumptions. In the treatments where the information was not personalized, a few more households were included as the cost of doing so was relatively small. The number of households in each group is reported in Table 1. Once all pre-treatment data were ready, the means and standard deviations of pre-treatment consumption within the groups were calculated, and the results are also reported in Table 1. An analysis of variance shows no difference between the groups (F=0.14). As will be explained below, the number of households with valid pre-treatment data is smaller than the original sample size reported in the table.

Table 1. Numbers of households in different groups

Group	N	Pre-treatment mean daily consumption (kWh)	Pre-treatment st.d. of daily consumption
1	268	64.50	21.86
2	287	65.20	22.76
3	375	65.11	20.01
4	373	65.78	20.65
Control 1	250	65,77	22.56
Control 2	339	65.97	23.21
Total	1892	100	

3.2.3 Calculation of Postal Code Benchmark Consumption

For each of the three postal codes in subsample A, and for each of the six annual billing periods, the median consumption based on the three years preceding the experiment was calculated. The postal code benchmark consumption levels were used in treatments 1 and 2 to provide comparative feedback.

3.2.4 Running and Analyzing the Experiment

The information was distributed with five consecutive bills, from March to November 2010 and was printed on page 2 or 3 of the bill. The consumption from receipt of the first such bill until the first reading after receipt of the last bill, i.e. January 2011, was recorded.

The dependent variable in the analysis is the change in consumption from the pre-treatment period (March 1st 2009 – January 1st 2010) to the treatment period (March 1st 2010 – January 1st 2011). Only the households that had self-reported the meter readings that were needed to calculate these consumption levels were included, since stipulated meter readings would be a source of noise in the data set. The readings recorded within a time span of 5 days before and 15 days after the date at which they were requested to report were included (Note 14). This implied that 447 households were excluded due to lack of pre-treatment data, and another 367 due to lack of post-treatment data (Note 15). An additional 85 households reporting an annualized consumption below 8000 kWh were excluded, because these were most likely from rental apartments in the basements of buildings registered as detached houses, and because the network company was not required to bill such households bimonthly. Two households were excluded because their consumption from pre-treatment to treatment was either doubled or cut in half, which most likely indicates that the house was only occupied in one of the two periods. Hence, there were 991 usable observations. The attrition rate in the sample of 57% was larger than expected and reduces the statistical power of the analysis relative to what had been planned (Note 16).

3.3 Follow-up Survey and Interviews

After the experiment was completed, the participating households were followed up with a survey as well as in-depth interviews. The purpose was to gain a better understanding of the results obtained in the field experiment. An invitation to participate in the electronic survey was distributed two weeks after the date of the last meter reading to be included in the analysis. To induce participation, respondents were offered the chance to win one out of five "universal" gift cards valued at NOK 1000 (app. €125). A response rate of 17% was obtained. The survey included questions about how they perceived the information that they had received, what measures they had taken to save electricity, whether any of these measures were initiated during the treatment period and because of the information they had received. In addition, respondents were asked which types of information they believed were most effective among those used in the field experiment.

After the survey was completed, a selection of participants in the experiment was contacted by phone and asked to participate in an interview. Each participant was rewarded with a NOK 1000 gift card. Interviewees were recruited with the aim of obtaining a balanced sample in terms of gender, age, and treatment group. Nine interviews were conducted in the period between six and eight weeks after the date of the last meter reading relevant for the experiment. An interview guide developed for the study focused on how the customers perceived the information they received and compared this to the other treatments used in the field experiment. Boards showing examples of the different information designs used were presented to the interviewees. These qualitative data were analyzed using the software tool NVIVO.

4. Results

4.1 The Field Experiment

Figure 1 shows the development over time of electricity consumption in the different groups. There was no apparent systematic difference between the groups during the treatment period. The effect of the treatments is investigated further in Table 2, which reports the mean percentage change in electricity consumption from the pre-treatment period to the treatment period for the different groups. The universal increase in consumption can be ascribed to colder winter temperatures in the treatment period. The variable of interest is the change in consumption from the pre-treatment period to the treatment period. An Analysis of Variance (ANOVA) finds that there are no significant differences between the groups for this variable ($F=0.45$, $t=0.85$). Pairwise t-tests between each treatment group and the relevant control group also fail to identify significant differences at the 5% level. Finally, the same non-result is obtained by regressing consumption during the treatment period on pre-treatment consumption, treatment group, and billing form (the latter is included as a control variable) (Note 17): there is no significant effect of belonging to any of the treatment groups (Note 18). Hence, one cannot conclude that there were any non-random differences in the development of electricity use between those who received information and those who did not. Therefore, it cannot be concluded that the information tested was useful in a strict sense by leading to a reduction in electricity consumption. It is also worth noting that the signs of the effects are not as expected based on Schultz et al. (2007), as both groups that received comparative feedback increased their consumption relative to the control group, and this was greater in the injunctive norm group than in the group that received only the social comparison.

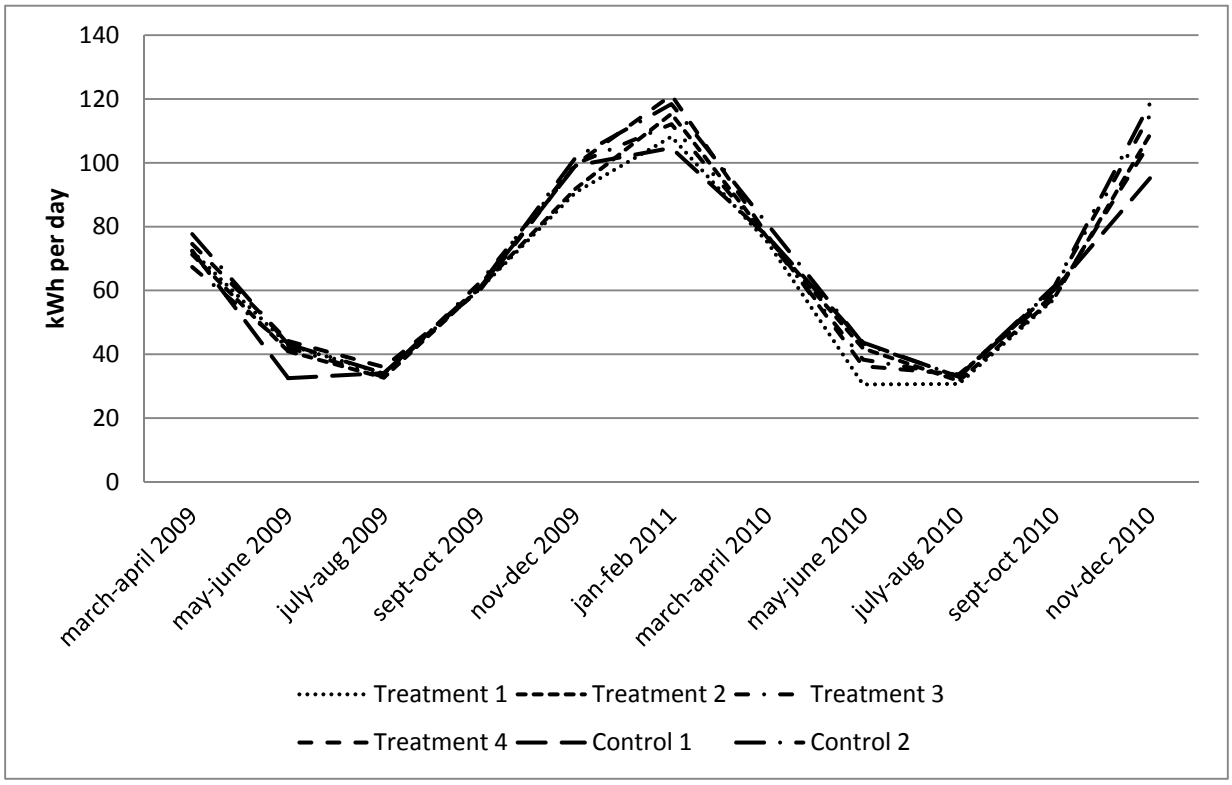

Figure 1. Electricity consumption over time by group

Table 2. Change in consumption during treatment (% of previous year)

Group	Mean	Std. Err.	95% Conf. Interval		No. of usable observations
1	4.47	0.96	2.58	6.35	146
2	6.79	0.96	4.91	8.67	168
3	6.45	0.64	5.19	7.71	219
4	4.21	0.69	2.86	5.57	215
Control 1	4.32	1.00	2.36	6.29	100
Control 2	5.72	0.99	3.78	7.66	143
Total					991

To investigate whether the boomerang effect reported by, amongst others, Schultz et al. (2007) and Ayres et al. (2009) was present in the groups that received social comparative feedback, Table 3 tabulates the mean change in consumption depending on whether the household's consumption in the pre-treatment period was above or below the median. Low-use consumers increased their consumption more than high-use consumers did, but this phenomenon was present in all the groups, not only in Groups 1 and 2, so it appears simply to be a case of regression to the mean.

Table 3. Mean change in electricity consumption (%) by level of pre-treatment consumption

Group	Over median	Under median
1	3.49	5.17
2	4.96	8.54
3	5.49	7.43
4	3.35	5.18
Control 1	3.33	5.15
Control 2	3.36	7.44

4.2 The Survey and the Qualitative Material

The results from the follow-up survey showed that a large proportion of the sample had not noticed the information they were sent, and this proportion varied significantly between the different billing methods, as well as between graphical and written information, as will be explored below (Note 19). Out of those who responded to the survey, 54% stated that they had noticed receiving new information on the bill (Note 20).

However, even among those that had noticed the information, the majority (81%) stated that the information had not induced them to take measures to save electricity. This indicates that the information used did not have the potential for motivating saving of electricity for most people. Hence, the results indicate firstly, that one reason for the lack of effect is that the information failed to reach a large portion of the intended recipients. Secondly, that when noticing the information only a small portion of the respondents became motivated to save electricity. The qualitative material gives us a deeper insight into why this would occur.

First, the qualitative material indicates that people are not careful readers of the information they achieve from their energy suppliers; what they notice is primarily or even exclusively what they are going to pay. After noticing the amount to be paid, some of the respondents said that they might look at the historical comparison. If so, the historical comparison was often used to indicate the reasons for variation in consumption: "Before receiving this information [historical comparison], I compared year-by-year, but now I get it ready-made. It is very useful. For instance, I can see 'This is when our daughter moved out.' But over time, the changes are not so large" (Note 21).

Second, if people are going to notice the information they are achieving, it has to be given to them at the right time. As one informant emphasizes, the information could be valuable for him in a situation when he is about make changes: "For people who move or build a new home. I'm in a situation now where it's expensive to

change anything. But if I were to inherit the house of my mother, in such a situation, it would be great to get this kind of information" (Note 22).

Third, how the information – in this case the bill – is distributed to customers also seems to have an important influence on the extent to which its message is transmitted. The survey indicates that those who received the bill electronically or paid by direct debit were the hardest to reach. Whereas 75% of those that received the bill by post had noticed the information, this figure dropped to 57% for those using direct debit (who also received the bill per post, but who may be less likely to pay attention to it since it was debited automatically) and 40% for those who received the bill electronically. The challenge of getting attention to information given in the bill when using electronic billing is also confirmed by one of the focus group participants: "Since I receive the bill electronically, I don't always read it. I have combined electronic billing and direct debit, so it is automatic. I don't even have to approve it. The information that is included here probably escapes me" (Note 23).

One should note, however, that the causal direction between billing form and attention paid to the bill is not unambiguous. The correlation may partly be due to a selection effect, in which those who are most attentive to their electricity consumption choose postal billing. That way, they have the information in an accessible format, which can also be shown to the rest of the household. Hence, the households that received the electronic bills or paid by direct debit may have been less likely than others to see the information even if they had received the bill by post. Nevertheless, the results indicate that the rising number of customers opting for direct debit and electronic billing is not facilitating feedback regarding the customer's consumption for utilities (/utility companies).

On the issue of layout, the focus groups and interviews revealed that graphical information was perceived as easier to understand and increased the likelihood of attention. It was described as being more eye-catching than written information: "It is more eye-catching, the graphs are easier to recall" (Note 24), or as one of the focus group participants stated: "It gives the same information, but visual information is absorbed much quicker and is better retained. Looking at two different numbers requires more brain capacity to deduce and to remember. When you have seen a picture, it gives more information" (Note 25). The analyses of the survey results also found that graphical information was more easily noticed. A distinct difference between those who received graphical and those who received written information in terms of noticing the information was identified (Table 4). An ANOVA shows that there are significant differences between the four groups at a confidence level <1% (F=4.49).

Table 4. Proportion in treatment groups that had noticed the information

Group	Mean	Std. Err.	95% Conf. Interval	
1	0.62	0.07	0.48	0.76
2	0.69	0.06	0.57	0.80
3	0.47	0.06	0.34	0.59
4	0.42	0.06	0.30	0.53

Nevertheless, even if the information is delivered at the ideal time, in the ideal way and with the ideal layout, it may fail to motivate some consumers. The qualitative material indicates that several of the respondents are either not very motivated to save energy or have already done what they perceive as reasonable for them to do in terms of energy saving. When asked how their energy use is connected to the possibility to live a good life, some of the respondents point to this being essential for them: "I think it's the shower. I work out a lot, so if someone had told me that you cannot shower until tomorrow morning - that you have to wait to shower – that would not be negotiable" (Note 26).

Or as another respondent says, she is not motivated to save energy, since she has been involved in savings all her life, now she wants to do what she likes: I've lived with a large family, and we have always had to save. I think that now that we are only two persons, I want to do as I please. If I want 25 degrees, I can. That's how I think today. Of course, I want to protect the environment and such, but I want to do as I please, that's my thinking, because I have been saving all my life" (Note 27).

Others have already done a lot of energy saving measures, and even if they find the information interesting, it is not something that would motivate them to do more.

Interviewer: "Did you take any measures to save energy in 2010 that you have not taken earlier?"

Interviewee: "It was in 2007 that I took major measures. So I was already there. But the example calculation [the information given to Treatment 3] is interesting, I have a fairly small house, but I guess it [the example] is pretty representative. So it shows that you save a fair amount. So, that's very good. I remember well receiving it. I have read it several times to check that it's correct" (Note 28).

This indicates that aside from the problem of reaching people with the information given in the bill, some would not be motivated to implement electricity saving measures regardless of what type of information they received because they do not prioritize saving electricity, they have already done a lot, or the information is not provided at a time where they would be motivated to implement electricity saving measures. On the other hand, the material also indicates that information could play a role in increasing awareness and interest in energy savings, which in the longer term could play a role in changing attitudes towards energy consumption. Out of nine customers interviewed, seven of them stated that they found the information they had received to be interesting. As one of the interviewees said when asked if he thought the information he had received was interesting: "Yes, it was. I would like to be more aware" (Note 29).

Advice from the respondents on how different categories of information could be combined to create more awareness and action was achieved. Several of the interviewees mentioned that they would have liked to get a combination of comparative social feedback and energy-saving tips. The social comparative feedback would motivate households that use more electricity than their neighbors to save and the energy-saving tips would indicate how they could do it and what the most beneficial measures are: "Graphical (in this case social comparative feedback; authors comment) is more interesting as a first message. Then the pieces of advice are useful as message number two" (Note 30, Note 31).

There is also a monetary cost of providing the information. With possibly no effects from information on electricity consumption – only on interest and awareness concerning electricity use – there might be other and more efficient ways to create interest for energy consumption and behavioral change. Some of the results indicate that considerations of energy savings are greatly influenced by external factors. The focus group discussions indicate that consumers' efforts to save on electricity are highly influenced by external motivations such as cost, and that internal motivation for saving electricity are less relevant. As one of the focus group participants observed: "When we arrived here today, the intention was to talk about environmentally friendly solutions, but I keep hearing all the time, myself included, that we are talking about the power of money, money is what we are talking about. We are supposed to save the environment and not use too much electricity, but the issue of money keeps coming up… that is what we care about" (Note 32). This point is also supported by (Sælen, Westskog, & Strumse, 2012) who show that, in Norway, energy is a consumption domain where the correlation between behaviour and internal factors (values and environmental attitudes) is weaker than in other consumption domains such as food and waste reduction. P. C. Stern, Dietz, Abel, Guagnano, and Kalof (1999) argue that information measures work best when internal factors are most important for behaviour, and that incentives are better suited for areas where external factors dominate. Thus, information provision appears to have a smaller potential for leading to behavioural changes within the area of energy than other consumption areas, at least in the case of Norway, which may support an argument for using taxes or other incentive mechanisms to initiate energy savings rather than information.

Furthermore, there is an opportunity cost to providing information, in the sense that if it does not have the desired effect, it may make it more difficult to succeed with future attempts. There is some evidence that information provision may lead to entrenchment of current levels of consumption. In a study on smart energy monitors, Hargreaves, Nye, and Burgess (2013) found that after a relatively short time, such devices are used primarily to control households' discretionary energy use, whilst leaving "normal" usage unquestioned. Hence, providing feedback to households may, as Hargreaves et al. (2013) indicate, result in an increased engagement in energy use, but at the same time this might result in people to a greater extent perceiving their energy use as "normal", and (therefore) not engaging in reducing their energy. It may lead them to be more defensive of their "normal" consumption in the face of future information campaigns. Smart energy monitors might, hence, lead to non-intended effects as Hargreaves (2013) points out. As smart meters and electronic displays are new technologies that are about to be rolled out in several countries (for instance the UK), it is important to understand if and how these adverse effects might be overcome by specific information designs or in combination with other policy instruments. This is a task for further research.

5. Concluding Remarks

In this study, the potential of the electricity bill to provide information that encourages energy conservation to Norwegian customers has been analyzed. A field experiment was used to test the effects on electricity consumption of different types of information provided on the electricity bill. The information used was based on previous studies that had shown promising results and a focus group study on the types of information preferred by customers. The field experiment was followed by a survey and in-depth interviews of customers who had received the information in the field experiment. The field experiment showed no significant effects of the information tested on the level of electricity consumption compared to that of the control groups. The follow-up survey indicated that the information failed to reach about half the customers. It may be that much of the potential for using the bill as a medium to promote electricity conservation has already been realized through the feedback provided in terms of kWh, cost, and historical comparison. The qualitative material supports this finding, by pointing to the difficulties in reaching and motivating people through use of information in the bill. To affect behavior, the information needs to be given to the households at the right time, to be delivered in the right way, and to have the right layout. However, not even optimal information provision is likely to impact all customers, as some informants expressed that they are not interested at all in saving electricity and thus would always find the information irrelevant when it comes to motivating electricity saving. This draws a rather pessimistic picture of the potential of encouraging energy conservation through information on the electricity bills in Norway, at least in the short run. Studies from other countries (Allcott, 2011; Ayres et al., 2009; Darby, 2006), have found that using the right type of information might lead to saving of energy. The present study indicates that this might be overly optimistic in the Norwegian setting due to barriers such as interest in electricity savings, what people already have done, and the difficulty of reaching people with the right type of information when they are about to make changes.

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Notes

Note 1. One reason for the lack of effect historically might be that pre-smart meters and pre-GIS, neighborhood comparisons may not have seemed very credible to customers.

Note 2. The mandatory inclusion of historical comparative feedback on the electricity bill in Norway was a result of inter alia the research done byWilhite and Ling (1995) in the 1990ies. See discussion above.

Note 3. This applies to households with an annual electricity consumption above 8 000 kWh.

Note 4. The stated motivation for introducing monthly payment is to let the customers spread the payments out more evenly. With bimonthly billing the electricity bills could be very high, specifically in periods with high electricity prices.

Note 5. This message was inspired by the study by (Goldstein, Griskevicius, & Cialdini, 2007) on effective messages for improving hotels' linen reuse programs. They showed that by applying a descriptive norm for pro-environmental behaviour, participation by guests in one hotel linen reuse program was improved. Referring to what previous guests did led to that increase. These effects can be explained by Leo Festinger's (1954) theories on social comparisons, which propose that when making decisions under uncertainty, individuals tend to follow the norms of others who seem similar to them.

Note 6. Synovate is a global company specializing in market research. In the present study the authors collaborated with the Norwegian branch of the company.

Note 7. To be eligible to participate in a new focus group, volunteers must not have taken part in a previous focus group in the past six months.

Note 8. Synovate uses these categories as a standard for their recruitment of people to focus groups.

Note 9. Female focus group participant no. 6, Oslo, November 2009, Transcript 88322 Cicero Group 2.

Note 10. Female focus group participant no. 3, Oslo, November 2009, Transcript 88322 Cicero, Group 1.

Note 11. Male focus group participant no. 2, Oslo, December 2009, Transcript 88322 Cicero, Group 4.

Note 12. The calculations were based on a detached home of 120 m^2, four inhabitant, and electricity as the heating source. Assumed annual consumption is 25 000 kWh and the electricity price was set at 0.80 NOK. These assumptions were listed along with the tips.

Note 13. Based on a significance level of 5%, a statistical power of 80%, and standard deviations between 5% and 10 %.

Note 14. If a customer reported multiple readings within this time window, the average value was used.

Note 15. The households who were dropped due to failure to self-report during the experiment did not differ significantly from the rest of the sample in terms of pre-treatment consumption ($t = 1.8$). Hence, this does not seem to have led to a bias in the sample. It is not possible to do the same test for those who had to be dropped because of missing pre-treatment data, since no reliable data on their consumption were available.

Note 16. In addition, the standard deviations of consumption were at the upper limit of what was expected.

Note 17. This is equivalent to an Analysis of Covariance (ANCOVA).

Note 18. The same non-result holds both for a pooled regression where all treatment groups are included and the two control groups merged, as well as for separate regressions for each of the two cluster described in the sampling procedure

Note 19. It is also worth noting that 74% of the respondents were men. This could be taken as an indication that the electricity bill is often addressed to the male member of the household.

Note 20. This probably represents the upper limit of the percentage of all households that were sent the information. People who read their bill carefully may also be more attentive to other information sent by Hafslund, including the invitation to take part in the survey.

Note 21. Male interviewee no. 8, in-depth interviews, Asker, February 2011.

Note 22. Male interviewee no. 3, in-depth interviews, Asker, February 2011.

Note 23. Female focus group participant no. 6, Kirkenes, December 2009, Transcript 88322 CICERO, Group 6.

Note 24. Female focus group participant no. 6, Oslo, November 2009, Transcript 88322 CICERO, Group 2.

Note 25. Male focus group participant no. 3 Oslo, December 2009, Transcript 88322 CICERO, Group 3.

Note 26. Female focus group participant no.1 Oslo, November 2009, Transcript 88322, CICERO, Group 1.

Note 27. Female focus group participant no. 5, Kirkenes, December 2009, Transcript 88322 CICERO, Group 5.

Note 28. Male interviewee no. 6, in-depth interviews, Asker, February 2011.

Note 29. Female interviewee no. 7, in-depth interviews, Asker, February 2011.

Note 30. Female interviewee no. 7, in-depth interviews, Asker, February 2011.

Note 31. The suggestions were noted by a representative of the utility, who took part in the interviews. The authors also presented them when summarizing the results of the study at a seminar with Hafslund. The utility has not yet implemented social comparative feedback or energy saving tips in the format tested in the present study.

Note 32. Male focus group participant no.2, Oslo, December 2009, Transcript 88322 Cicero Group 4.