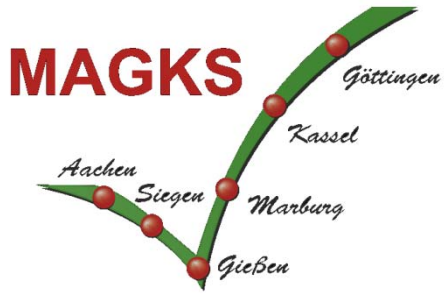

Joint Discussion Paper Series in Economics

by the Universities of

Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen

ISSN 1867-3678

No. 34-2015

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Do not incentivize eco-friendly behavior - Go for a competition to go green!

Christoph Bühren[1] and Maria Daskalakis[2]

Abstract

Which behavior-based interventions are more appropriate to induce energy saving: energy saving goals with or without incentive, energy saving products, environmentally related information, social comparison or competition? We try to answer this question in a comprehensive study. First, we designed energy bills with different behavioral interventions. Second, we evaluated their appropriateness in an empirical survey with 457 participants. Third, we tested behavioral consequences in real effort lab experiments with 550 subjects in 11 treatments and one baseline. Our results indicate that monetary incentives to save energy might foster the intention to invest effort in energy saving but backfire if factual performance is required. Instead, fostering non-incentivized self-set goals and providing social comparison induced substantial effort to protect the environment. Non-incentivized competition to save energy provided the best results. Our study concludes with implications for practical policy design and further need of research.

JEL: D03; D12; C91

Keywords: Environmental behavior; Goals; Incentives; Social Comparison; Competition; Experiment

Research Highlights:

We assessed preferences for electricity bills that should trigger energy saving

We designed and evaluated 11 different behavioral interventions

We conducted a large scale market survey and a large scale real effort experiment

We find that incentives can reduce the motivation to save energy

Goals, social comparison, and especially competition induce eco-friendly effort

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1. Introduction

Policy instruments which are aligned with the insights from behavioral economics – and with corresponding insights from psychology – might actually be more efficient than traditional policy instruments. The nudge approach of Thaler and Sunstein (2009), in particular, has provided a comprehensive fundament. The application examples are manifold and include health policy, pension policy and environmental policy (see ibd.). It has to be noted, however, that the development of practical applications of behavioral instruments is still at an early stage and certainly requires more in-depth analyses.

The present study aims to make a contribution to the development of behavioral instruments. The study is in the area of environmental policy, a field where the discussion about the relevance of behavioral economics for policy making is an ongoing topic (for an overview see Beckenbach 2016 and Daskalakis 2016a). Our study is concerned with a specific area of application, i.e. the question of the extent to which behavior-based elements on energy bills may motivate private households to save energy. This subject is not new as researchers already considered it in the 1970s, albeit in varying intensity. But it was not until recent years that the discussion gained momentum.

The relevant research mostly makes use of field or natural experiments respectively. However, it has to be noted that even if a particular instrument is focused on, for example incentives for energy saving, it is rarely studied on its own. Often, associated information about environmental effects and energy saving tips are provided in the studies, too. This may be ascribed to the very nature of the subject because such field experiments presuppose communication with the consumers. As a result, not the effect of a particular instrument is analyzed, but rather the effect of a mix of instruments. Identifying the effect of particular instruments is hence not possible.

This is the starting point of our study. The advantages of our study are that we cooperated with a local energy provider and that we used different methods in our empirical strategy. To provide a comprehensive basis, we started by developing and sequentially pre-testing different versions and designs of behavior-based energy bill designs and conducted large-scale face-to-face interviews in the city in order to evaluate the resulting designs. The findings were the basis for carrying out an economic lab experiment with 550 participants

and 11 different treatments in which we used the real effort task of Gill and Prowse (2012) in order to simulate the effort to save energy.

The remainder of the paper is structured as follows: After discussing related literature on energy saving and real effort tasks in section 2, we explain the behavioral design of the electricity bills in section 3. Results from the survey that evaluated these bills are given in section 4. Section 5 presents and discusses experimental results related to the behavioral consequences of the different interventions applied in these bills. Finally, we conclude our findings, give policy implications, and options for further research in section 6.

2. Related Literature

2.1. Energy saving behavior

Empirical research concerned with interventions that are appropriate for promoting energy saving behavior of households can be found since the 1970s and was almost certainly stimulated by the oil crisis. The research was initiated by psychologists setting up field experiments in order to evaluate the efficiency of different instruments addressing behavioral effects (for an overview, see Shippee, 1980; Abrahamse et al., 2005, Winnett and Neale, 1979). Most of the research projects were field experiments using various media for communicating the interventions (e.g. posters, door-hangers).

One key area of research was the question whether feedback about the own energy consumption leads to a reduction in energy use. In her review in 1980, Shippee already referred to 20 corresponding field experiments. The reduction observed amounted to between 20 and 40 percent. Another main topic was the question to what extent incentives in form of monetary rewards lead to energy saving behavior, whereby this research mostly examined goal setting scenarios, too. Shippee (1980) distinguished between research concerned with individually attributable incentives and research concerned with group related incentives. Regarding the individually attributable incentives, Shippee reports energy consumption reductions between 3 and 36 percent, depending on the specific treatment design. Hayes and Cone (1977), for example, found that energy saving results are higher the higher the incentives are (see also Shippee, 1980). Group incentives induced reductions between 5 and 25 percent (ibd.). Another topic was the question, whether setting goals for

energy saving improves effort to save energy. Becker (1978), e.g., found that setting a higher goal (20% more than the period before) leads to reductions in energy consumption up to 15.1%, but setting a lower goal (2%) not (see also e.g. Seligmann et al. 1977).

In the 1980s, another type of intervention, social comparison, gained prominence. Social comparison extends the individual feedback in that it encompasses information about the consumption of comparable other households. The idea is that social comparison addresses descriptive social norms and hence fosters the propensity to comply. Midden et al. (1983) were probably the first to study social comparison of energy consumption. They find that it is an effective instrument, which can be reinforced by monetary incentives. Since then, research has developed and there are quite a number of field experiments and natural experiments concerned with the effectiveness of behavior-based interventions related to energy consumption reduction (for an overview, see Abrahamse et al. 2005, Osbaldiston and Schott, 2012, and RAND Europe 2012). Two aspects should be noted, however. *First,* albeit the studies often pointed out certain instruments, they mostly applied several instruments at once (see Daskalakis 2016b and RAND Europe 2012). Hence, often the effects of the treatments cannot be assigned unambiguously and it is not possible to isolate the effect of a single instrument. *Second*, the scientific foundation of these studies varies to a large extent (see also RAND Europe, 2012).

In the following we will refer to nine field experiments which were carefully chosen with regard to the information given about the treatments, all of them either had a control group, or, at least, referred to a baseline scenario. The main findings of these studies are summarized in Table 1. Table 1 provides information about the medium used for displaying the intervention, the main types of interventions used, the number of participants, the type of energy addressed, the duration of the study and the effect on energy saving.

Table 1: Overview of the literature

Author	Medium for communicating the intervention	Core interventions	Number of participants (households/rooms in case of dormitories)	Type of energy	Duration of the study	Achieved reduction
Allcott (2011)	Energy report (written), energy saving tips	Feedback, energy saving tips, social comparison (with emoticon)	60,000	Electricity	23 months	- 2.03% on average over all treatments - Upper 10 percent of the households with the highest overall consumption: 6.3% - least consuming 10 percent of the households: 0.3%
Allcott/ Rogers (2014)	Energy report (written), energy saving tips	Feedback, energy saving tips, social comparison (with emoticon)	234,000	Electricity	Interventions: 2 to 4 years Observations: further 2 to 3 years	- Second year: 3% on average - Increase of reduction 50-60% in the third year if continued - Effect decay after discontinuation of reports 10 to 20% per year
Ayres et al. (2013)	Energy report (written), energy saving tips	Feedback, energy saving tips, social comparison (with emoticon)	84,000 (SMUD), 84,000 (PSE)	Electricity	12 months (SMUD), 7 months (PSE)	Sacramento Municipal Utility District Experiment (SMUD): - 2% on average Puget Sound Energy Experiment (PSE): - 1.2% (energy) and 1.2 to 1.3% (therm usage) on average
Abra-hamse et al. (2007)	Online tool on Web-Page (with energy report)	Individual and group feedback, individual and group goal setting (default goal of 5%), tailored energy saving tips	189	Gas, electricity, fuel	5 months	- 5.1% average treatment effect on direct energy use (gas, electricity and fuel) - Tailored energy saving tips and goal setting: 5.0% - Tailored energy saving tips on energy saving, goal setting and group feedback: 5.3%
Delmas/ Lessem (2014)	Energy report (online)	Individual feedback, public feedback (reputational) competition	66	Electricity	8 months	- Only individual feedback: no significant effect - Individual feedback and reputational competition: 25% reduction of heating energy, 5% reduction of energy for lights in case previous energy consumption was above median
Loock et al. (2013)	Online tool on Web-Page (with energy report)	Feedback, goal setting	1,791	Electricity	4 months	- 2.3% on average over all treatments - No default goal): 4.02% - Default 0%; individually adjustable: 0.76% (not significant) - Default 15%: 4.18% - Default 30%: 0.001% (not significant)

Petersen et al. (2007)	Monitoring system with real time feedback; Energy report (online)	Competition. feedback, social comparison	1,612	Electricity, water	7 weeks	Electricity: - Total reduction of 32% - Treatment a): 55% - Treatment b): 31% (Students in earlier semesters (46%); students of higher semesters (2%) Water: - 3% (both treatments)
Schultz et al. (2007)	Energy report (written)	Feedback, , energy saving tips social comparison (a) with and b) without emoticon)	287	Electricity	5 weeks	Without emoticon: - Households with above-average energy consumption: 1.22 kWh per day - Households of group 1 with below-average energy consumption: **increase** of 0.89 kWh per day With emoticon: - Households with above-average energy consumption: 1.72 kWh per day - Households with below-average energy consumption: no significant effect
Tiefen-beck et al. (2013)	Individualized flyers (written)	Appeal for the relevance of saving the environment feedback, energy saving tips, social comparison	200	Electricity, water	11 weeks	- 4.1% less water use - 5.6% **more** electricity use

As can be seen in Table 1, all of the studies used feedback as a type of intervention, but this was always accompanied by other interventions, especially by providing social comparison, inducing goal setting, or setting up competitions. The latter is a rather new type of intervention, but is, however, already addressed partly by providing social comparison (see Abrahamse 2005). Furthermore, in some of the studies energy saving tips were provided in order to enhance the actual abilities to save energy.

The results show, among others, that interventions including competition by far had the highest effects, leading to reductions of energy consumption of 31% resp. 55% (Petersen et al., 2007) and 25% (Delmas/Lessem, 2014). The results of the studies with goal-setting are mixed: moderate default goals (5% to 15%) induced a significant reduction up to 5.3% (see Abrahamse et al., 2007) whereas a higher default goal (30%) and a default goal of 0%, which could be changed manually, had no significant effects (see Look et al. 2013). Interventions which mainly used a mix of feedback, energy tips, and social comparison resulted in savingup to 3% energy saving per household on average. In two studies, the authors found rebound effects (see Schultz et al. 2007, Tiefenbeck et al. 2013). Energy saving may be realized not only by behavioral changes but also by investments in energy-efficient applications (see Allcott/Rogers 2014). One way to promote such investments is subsidization. However, to or knowledge, there is no field experiment that analyzes the effect of such a subsidy reimbursement. Allcott and Rogers (2014) used data from energy suppliers and found that their subsidization programs were more efficient in case the customers received energy reports. In survey data of customers who purchased air conditioners, Hausman (1979) shows that consumers trade off capital costs for energy efficient products and expected operating costs. Qui et al. (2014) find in an online survey that more risk-averse consumers are less likely to buy energy efficient products like (dish) washers, dryers, fridges, or insulation – they do not obtain this relationship for air conditioners.

The examples in this section show that behavior-based instruments can lead to energy saving. Yet, it has to be noted that albeit the field experiments often pointed out certain instruments, they actually applied several instruments at once. This is probably due to the nature of these field experiments: Compared to lab experiments, energy bills and energy reports in the field imply a more intense communication with the subjects. As a result, however, the effects of the treatments cannot be assigned unambiguously and it is not

possible to isolate the effect of a single instrument. Therefore, in our study, we aim at analyzing the effects of single interventions. We make use of the interventions of the literature presented above, with one exception, the energy saving tips, which we included in the market survey, but not in the laboratory experiment as they could not be operationalized appropriate for the slider task we used.

In contrast to the literature, we used the energy bill as a medium for the interventions. In comparison to the additional energy report used in some of the studies we reviewed, this has the advantage of getting more attention as the bill is of immediate interest for the consumers whereby the energy report might be overlooked (see Ipsos MORI 2011 and Roberts 2004). Furthermore, it might be more cost efficient as it is not necessary to send out additional letters. Some of the studies we reviewed used online-applications, here, from our point of view, the bill is more appropriate as online applications still only reaches those subsamples of households with frequent internet access. As energy bills are sent out regularly and reach nearly every household, at least in the industrialized countries, the effects of such an enhanced bill, even if they might be small at the individual level on average, might sum up to considerable amounts at the national level. In Germany, for example, there are 40.2 million households with an average electricity consumption of 3,516 kWh per year. An average reduction of 2% in one year would lead to a reduction of 169,142 tons of CO_2.

2.2. Real effort tasks

Carlsson et al. (2013) emphasize that real effort tasks are able to enhance the external validity of laboratory experiments. Quite a few real effort tasks have already been implemented in economic experiments: e.g. counting 1s in matrices consisting of 1s and zeros (Abeler et al., 2011), summing up numbers (Corgnet et al., 2014), or filling envelopes (Hennig-Schmidt et al., 2010).

Yet, there are only few lab experiments in which consumption is addressed by behavioral economics. Newell and Silkamäki (2013), e.g., analyze the behavioral effects of different energy labels for electronic devices and Barth and Graf (2011) examine if subjects choose alternative tariffs for mobile telephony in a rationale way.

The laboratory experiment of McCalley et al. (2011) is closer to the topic of our study. McCalley et al. (2011) asked the subjects to set energy saving goals for energy saving before selecting programs of a simulated washing machine. The subjects were free to choose a goal between 0 and 20 percent in steps of 5. The authors also examined whether a prior foot-in-the-door treatment (e.g. a small commitment) increased the effect of goal setting. The results show that goal setting induces energy saving. The foot-in-the-door treatment increases this effect but is not effective on its own. The different goal levels have no influence on the effect of the foot-in-the-door treatment.

Probably the most acknowledged real effort task is the slider task of Gill and Prowse (2012) in which subjects have to put sliders (maximum 48 per round) that are scaled from 0 to 100 to the middle position (50). Heap et al. (2015) introduced reference points via social comparison in the slider task. In a neutral setting, they find that social comparison boosts performance (especially for subjects who perform poorly before the reference point is given). In our experiment, we took the slider task as a basis because the tasks reminds at calibrating energy consuming products and the effort invested in the slider task might be transferrable to the effort of reducing the brightness of screens and switching of lights or stand-by functions etc.

3. The design of our behavioral energy bill

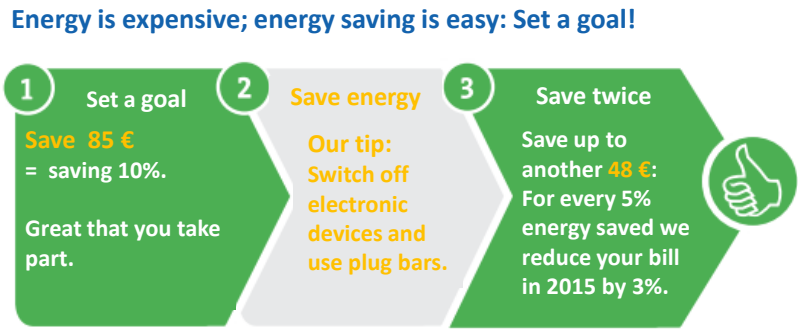
In Europe, like in many states in the US, most of the contents of the energy bill are required by law (Directive 2006/32/EC, European Commission 2006; see for the US Mahone/Haley 2011) and are to be provided by the energy supplier in order "to enable final consumers to make better-informed decision as regards their individual energy consumption…" (Directive 2006/32/EC (29), European Comission 2006). Most of the provisions are concerned with providing the consumers with information related to the understanding of the bill. In one point, however, there is already made use of the insights of behavioral economics as the law requires the energy provider to provide comparative information (social comparison) about the own energy usage and the one of other households (Directive (2006/3/2; §5(a)).

Accordingly, the bill of our project partner provides information on the consumption (expressed in kWh) and on the resulting costs (in Euro), information on the future partial invoice amounts and their debiting on the first page. Three more pages contain all the other

information required by the law. All in all, the energy bill of our industry partner had the typical design of an administrative bill, with few specific formatting or visual highlights.

For the purpose of our research, we focused on designing the first page of the bill. This is because research indicates that energy costumers typically lay attention on the first page when receiving the bill (see Ipsos MORI (2011); Roberts (2004)). Our design approach comprised several steps: First, all contents not directly relevant for payment were removed from the first page. Subsequently, a new design for the payment information was created. The relevant information was expressed in Euro instead of kWh since our pre-test as well as Roberts (2004) and Ipos MORI (2011) showed that energy costumers often do not sufficiently understand those technical parameters. The payment information was integrated in a design element and placed on the bill. Furthermore, the bill provided an energy saving tip and the respective intervention. As an example, Figure 1 shows the intervention of bill no. 2 (translated from German) which comprised goal setting and a monetary incentive as behavioral interventions. We checked and adapted the design and the comprehensibility of the bills in an iterative process during 46 interviews (see section 4.1.).

Figure 1: Behavioral element of bill no. 2[3]



4. Empirical survey

4.1. Procedure

First, we redesigned the energy bills of our industry partner (a German energy supplier with over 150.000 customers) in cooperation with the supplier. For this purpose, we designed different versions of the first page of the bill, each comprising the different kind of

[3] All the original bills can be obtained from the authors. See Appendix for a sample bill.

interventions we analyzed, but with the same layout and text otherwise. We tested and adapted those bills with regard to comprehensibility and layout successively in 46 pre-test interviews that lasted 10 to 15 minutes and took place at the customer center of the supplier. As mentioned above, the resulting energy bills comprised an energy saving tip at the right margin. This was done because the consumers interviewed felt that the energy saving tip added to the seriousness of the (energy saving) bill.

Building on that, we investigated the potential effects of a sample of bill designs in a large scale empirical survey which was embedded in the annual market survey of our partner. This gave us the chance to reach a large number of respondents, restricted us, however, in that we could only evaluate three of the bills. Because of its prominence in the literature, we chose social comparison and goal setting (see Table 2). We choose two goal setting scenarios, both including a default goal and one of them an additional monetary incentive in case the goal was reached after the end of the accounting period. The representative survey was conducted in all city districts of Kassel (Germany) by a market research institute via face to face interviews in May and June 2014.

In order to test the bill designs, we first requested the 457 persons interviewed to imagine that they were at home, had just received their energy bill and were in the process of opening it. This was done to ensure the respondents projected themselves into this hypothetical situation they had probably experienced before in a similar form which in turn should increase the closeness to reality. Subsequently, we presented the behavior-based energy bills successively and explained them thoroughly. After that, the respondents were asked to evaluate each of the bills with regard to what extent it would motivate them to reduce their energy usage. To control for the effect of the energy tipp on the bills, we also asked, whether the inclusion of information on energy saving aspects was seen to be important and whether offering tips for energy saving is a relevant element of the bill or whether it could be omitted. Furthermore, we asked whether the bills should show an additional reference to environmental aspects. This was done with because it gave us a chance to evaluate whether it would be worthwhile to take up this aspect in the experiment.

Table 2: Interventions on the bills presented in the market survey

Bills	
Bill 1	Default saving goal of 15% with energy saving tip
Bill 2	Default saving goal of 10%, a monetary incentive in the form of a 3% reduction of the annual billing amount per 5% saving, and energy saving tip
Bill 3	Social comparison with energy saving tip

4.2. Results

As stated above, in our survey the participants were asked to evaluate each of the three bills (goal, goal with incentive, social comparison) with regard to what extent it would motivate them to reduce their energy usage. The answers were given at a 5-point rating scale (0=not all; 5= very much). All of the bills included the respective behavioral intervention and an (identical) energy saving tip.

Out of the three bills, the bill with the combination of goal and incentive (with energy saving tip) was rated the highest (mean: 3.407, median: 4), followed by the bill with the social comparison (and energy saving tip; mean: 3.046, median: 3) and the bill with the goal (and energy saving tip; mean: 2.661, median: 3). There was relatively high agreement to the question whether the extension of the bill with energy saving aspects is useful (mean: 4.050, median: 4). The energy saving tip and the additional reference to environmental aspects were also considered as relevant elements of the bill (mean: 3.847 respectively 3.571, median: 4 for each). Table 3 shows that there were respondents who did not consider the bills as a motivation to save energy, as, altogether, 11% of the respondents chose the options “Not at all” or “Rather not” for all three bills.

Table 3: Results of the market survey

Item	Median	Average	N	Std. dev.
Bill no. 1 (goal + energy saving tip)	3,00	2,66	457	1,18
Bill no. 2 (goal + incentive + energy saving tip)	4,00	3,41	457	1,24
Bill no. 3 (social comparison + energy saving tip)	3,00	3,05	457	1,37
Energy saving tip	4.00	3.85	457	1.15
Extension with energy saving aspects	4.00	4.05	457	1.01
Additional environmental aspects	4.00	3.57	457	1.23
Total	3.67	3.43	2742	1.20

We controlled for gender and found no difference regarding the three behavioral bills and only one significant difference as women emphasized the relevance of the addition of environmental aspects more strongly (see Appendix).

4.3. Discussion

Our survey was designed to test the potential of behavioral based energy bills in order to induce a reduction of energy usage. 457 respondents were asked to evaluate the possible effects three behavioral interventions with regard to their own energy saving behavior. All in all, the respondents confirmed the appropriateness of the interventions designed. The results show, however, that there are differences regarding the impact of each of the three interventions. Social comparison, which is being prominently discussed at the moment, thereby is evaluated as less efficient than default goal with incentive and the bill with the default saving goal was rated the lowest.

In order to assess the results of the survey, three aspects should be taken into consideration. *First*, the bill default goal with incentive is an extension of the otherwise identical bill default

goal without incentive. Therefore, we cannot exclude the possibility that the evaluation of the three bills was biased in favor of the bill default goal with incentive by an attraction effect (Huber 1982/2014; Ariely, 2008, Chapter 1, calls it decoy effect).

Second, as it is the nature of surveys, the respondents gave their opinion about the possible impact of the bills on their own energy saving behavior. Hence, it is not possible to measure the actual effect of the bills and the might be a gap between the evaluation of the (possible) impact of the bills and the factual behavior. In the literature, such kind of discrepancies are referred to as hypothetical biases (see for an overview Carlsson 2010; Robinson/Hammitt 2011) or intention -behavior- gaps (see for an overview Sheeran 2002; Ajzen/Brown 2004). Up to now, the results of the studies concerning with the question, whether and under which circumstances such bias or gaps are to be observed (and are to be prevented) are mixed (see for an overview Carlsson 2010; Fishbein/Ajzen 2010; Schläpfer/Fischhoff 2011). Our results, however, are in line with current state of research as presented in section 2.1.; thus, even if we are not able to evaluate the real degree of energy saving induced by our bills, an effect can be expected albeit to a different degree according to the different assessment of the three interventions. Still, it would be preferable if the impact on the interventions could be measured directly.

Third, it must be noted, that the market survey was restricted to three interventions. Hence, we could neither evaluate the effects of different versions of the given interventions, especially with regard to the goal based intervention, nor the effects of additional, different interventions.

Fourth, all the three bills included an energy saving tip. Hence, we cannot separate the effect of the energy saving tip from the effect of the interventions. As the tip was the same for all of the three bills, it could be assumed that the tip should not change the order of the valuation of the interventions. The correlation analysis, however, showed, that the energy saving tip is of different importance for the three kind interventions. This empathizes the relevance of analyzing the interventions separately.

Our laboratory experiments, which will be presented in the next section, were especially designed with regard to the three above-motioned aspects. *First*, the design of the treatments allows for analyzing the bills separately. *Second*, even if we are not able to make real world conversations in the laboratory (see for a discussion e.g. Levitt/List (2007);

Camerer (2011)), the specific method we chose, the real task effort, should allow for a closer approximation of real energy saving behavior. *Third*, we set up different versions of the three interventions which were part of the market survey and designed additional interventions, too.

5. Experiment

5.1. Procedure and treatments

As set out above, we designed the economic experiment in a way that enabled us to compare the results to our survey results reported in section 4. We used the identical behavioral bill designs in order to make both empirical investigations as comparable as possible.

Because in the market survey the results concerning the goal setting interventions were ambiguous, we analyze different goal setting interventions. With regard to the literature discussed in section 2.1., we further focus on social comparison, competition, environmental framing and fostering the purchase of energy saving products.

As indicated in section 2.2., in order to simulate the effort of saving energy, we used a real effort task (the slider task of Gill and Prowse 2012).

The instructions started with a cover story in which we tried to introduce an energy saving framing according to the treatments[4]: Therein, we asked subjects to imagine putting effort in energy saving activities like adjusting the temperature of fridges or the brightness of screens, and switching off stand-by functions. In two treatment variants, we actually wasted energy with terrace heaters outside the laboratory and combined the slider task with timers that switched the heaters off earlier the more sliders subjects put in the middle position. Thereby, we could test if our results change if the real effort task is coupled with real (and visible) energy usage.

In order to make sure that subjects understood the task, after having read the instructions, they were asked to fill out a printed sample electricity bill. These bills were designed

[4] All the instructions and energy bills can be obtained from the authors.

according to the corresponding treatment and to the findings gained in the pre-tests introduced in section 4.1.

In Table 4, we describe the procedure of the baseline in detail and explain briefly the deviations from the baseline in our treatments.

Table 4: Description of Treatments

Main Treatments	
Baseline	Subjects received a show up fee of 15 € from which they had to pay electricity bills of 2.40 € in all of the 6 rounds played. They could reduce the bill with the slider task of Gill and Prowse (2012): In every round, they had two minutes time to put up to 48 sliders into the right position. Every correct slider saved 5 Cent of the bill. Thereby, we try to simulate the effort of saving energy. Thus, subjects earn at least 60 Cent (15 € - 6*2.40 €) if they do not save anything and a maximum of 15 € if they put every slider into the right position in all six rounds. The experiment lasted around 45 minutes.
Goal	Before every round in the Goal treatment (except for round 1), subjects had to set a goal for how much more they wanted to save than in the previous round.
Goal + Incentive	In the Goal + Incentive treatment, the achievement of the goal was incentivized with 2 Cent for every slider (in addition to the 5 Cent, see baseline) that the achieved goal was higher than the number of correct sliders in the previous round. Hence, subjects faced a tradeoff between setting low vs. high goals which were easy vs. hard to achieve but having a small vs. considerable impact on payoffs.
Products	In the Products treatment, subjects could buy up to four energy saving products for 20 Cent each in every round. In Addition to the 5 Cent per slider (see baseline), they could save a further $2*\overline{\ }$ Cent (with x=number of products per correct slider); e.g. additionally 2 Cent (4 Cent) if they bought one (four) products. Thus, buying one product makes sense if subjects think that they will achieve at least 10 correct sliders and buying four products (4*20 Cent) is profitable if more than 20 sliders are put into the correct position (20*4 Cent) in that round.
Social Comparison	After every round in the Social Comparison treatment, subjects received feedback on the average number of correct slider in the session.
Competition	In the Competition treatment, subjects were divided into two groups. After every round, we made public which group had saved the most energy and announced the average number of correct sliders per group. Therefore, Competition extends Social comparison by a competitive element.
Treatment variants	
Baseline + Environment	In Baseline + Environment, we extended the baseline by an environment framing, in which we made subjects aware of how much CO_2 is saved by saving energy.
Default **Goal + Incentive**	In Default Goal + Incentive, subjects were asked to put two sliders more into the correct position than in the previous round. The incentive was as high as in Goal +

	incentive (2*2 Cent = 4 Cent) in addition to the 5 Cent per slider (see baseline).
Default **Goal +** High **Incentive**	The procedure of Default Goal + High Incentive was the same as in Default Goal + Incentive, only the incentive was 15 Cent instead of 4 Cent.
Social Comparison + Heater	In order to evaluate the external validity of our energy saving simulation, we combined the results of the slider task with the time in which terrace heaters outside the PC pool (visible through the window) were switched off. The heaters burned for maximum one hour and were switched off 10 seconds earlier for every slider that was, on average, put in the right position in the session.
Competition + Heater	In Competition + Heater, every group had its own terrace heater, which was switched off 10 seconds earlier for every slider that was, on average, put in the right position in the respective group.
Competition + Bonus	In each round of Competition + Bonus, every participant of the winning group (the group which saved the most) got a 15 Cent bonus.

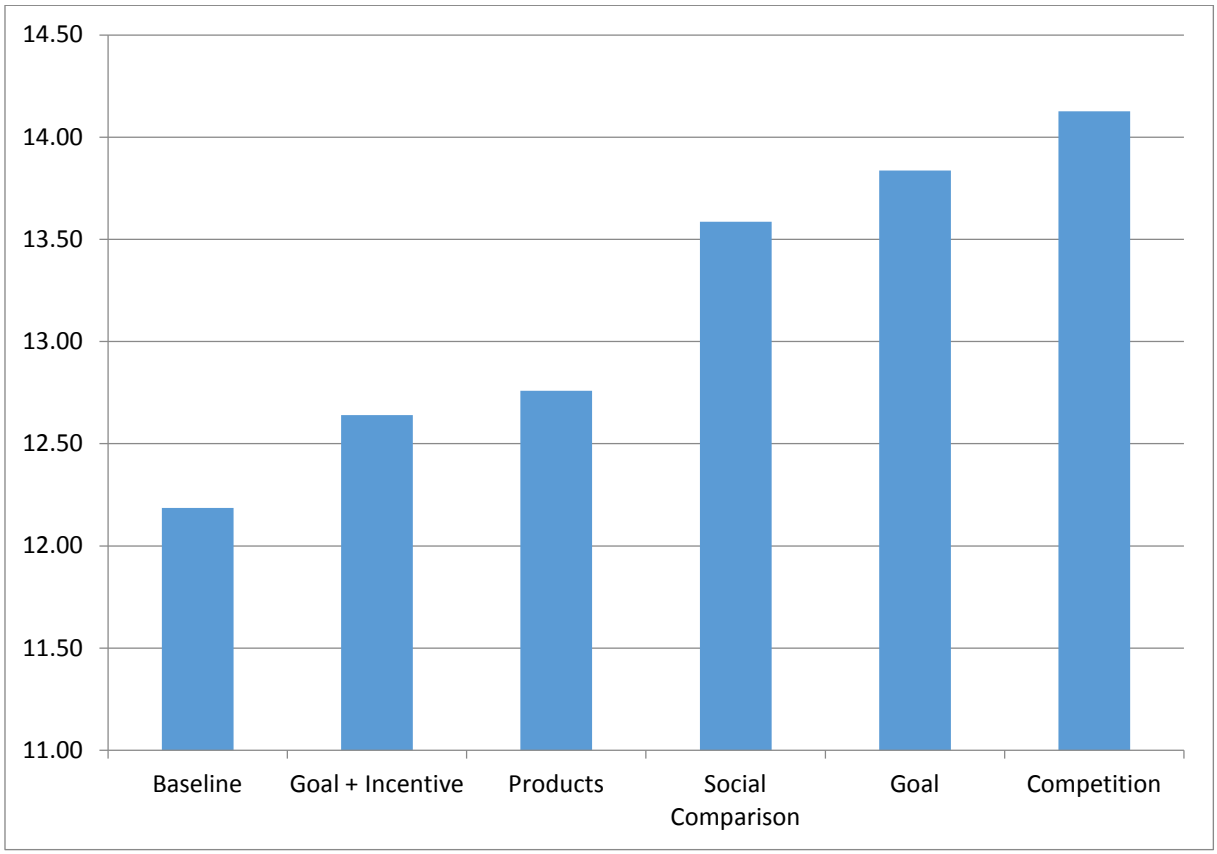
5.2. Results

5.2.1. Descriptive Statistics and nonparametric tests

Figure 2 displays the average amount of energy saved (in terms of correct sliders) by our main treatments. It was highest in Competition, Goal, and Social Comparison. In Competition, subjects on average put about 2 sliders per round more into the right position than in Baseline. That means their electricity bills were on average 60 Cent lower than in the Baseline treatment (6 rounds*2 sliders*5 Cent); in Baseline, subjects saved 3.66 € (6*12.19*5 Cent) and in Competition 4.24 € (6*14.13* 5 Cent) (two-sided Mann Whitney U test[5]: Z=-3.231, p=0.001). In Goal, subjects saved on average approximately 50 Cent more (Z=-2.247, p=0.025) and in Social Comparison 42 Cent more (Z=-2.223, p=0.026) than in Baseline.

[5] If not explicitly mentioned, we use two sided Mann Whitney U tests throughout the paper.

Figure 2: Average amount of energy saved (in terms of correct sliders) by main treatment



Monetary incentives reduced the effort to save energy from 4.15 € saved in Goal (6*13.84*5 Cent) to 3.79 € in Goal + Incentive (6*12.64*5 Cent) (Z=-1.919, p=0.055). A possible explanation for this finding is crowding out of intrinsic motivation (Frey and Oberholzer-Gee, 1997; Gneezy et al. 2011). Similar to Goal + Incentive, the energy saved in the Products treatment was not significantly different to Baseline either (3.83 € vs. 3.66 €).

Table 5: Average amount of energy saved (in terms of correct sliders) by all treatment variants

Treatment	Rank	Average	N	Std. dev.
Competition	1	14.43***	29	2.50
Competition +Heater	3	14.10**	40	3.17
Competition + Bonus	4	13.93*	40	4.68
Goal	5	13.84**	81	5.03
Social Comparison + Heater	6	13.71*	37	3.60
Default Goal + Incentive	7	13.69	24	3.44
Social Comparison	8	13.49*	50	3.83
Products	10	12.76	59	4.16
Goal + Incentive	11	12.49	56	3.21
Baseline + Environment	12	12.31	39	4.16
Baseline	13	12.12	76	3.68
Default Goal + High Incentive	14	11.77	19	3.69
Total		13.18	550	3.99

Notes: *: p<0.1, **p<0.05, ***: p<0.01, two-sided Mann Whitney U tests treatment vs. baseline; Kruskal Wallis test: Chi^2=19.722, p=0.049

Table 5 ranks the energy saved across all treatment variants. The treatment variants did not differ significantly from the specific main treatments: The environment framing did not change the effort compared to Baseline (similar to the result of McCalley et al. 2011); default goals with (high) incentives did not change the bad performance of Goal + Incentive; the bonus did not significantly affect the Competition treatment; and effort was on average the same after including real energy saving in Social Comparison and Competition via terrace heaters.

The pure Competition treatment (without heater or bonus) performed best on average; that means that competition encouraged subjects the most to put effort into the energy saving task. In contrast, in treatments with monetary incentives the effort was low - in Default Goal + High Incentive even slightly (not significantly) lower than in baseline.

5.2.2. Regression results

Table 6: OLS regressions of energy saved on average (1) and energy saved in each round (2)

	(1) **Average number of sliders per round** OLS		**(2)** **Sliders in each round** OLS	
	Coef.	Std. err.	Coef.	Robust std. err.
Social Comparison	1.214**	0.548	1.398***	0.523
Goal	1.504***	0.558	1.497**	0.658
Goal + Incentive	0.419	0.527	0.395	0.486
Products	0.457	0.620	0.440	0.662
Competition	1.656***	0.517	1.950***	0.345
Male	1.765***	0.329	1.504***	0.345
Round			0.982***	0.044
Cons	11.418***	0.386	8.123***	0.427
N	549		3132	
R^2	0.083		0.143	
Adjusted R^2	0.073		0.141	
F, Prob>F	8.15,< 0.01		75.03, <0.01	

Notes: reference category: Baseline; *****: p<0.1, ******: p<0.05, *******: p<0.01; standard errors in (2) are clustered at the individual level; calculating the treatment effects with the nearest neighbor matching estimation (Abadie et al. 2004) yields very similar results.

Table 6 shows OLS regression results of the average amount of energy saved per round (1) and the energy saved in each round (2). Ceteris paribus, subjects in Social Comparison put on average 1.21 more sliders per round into the right position than the baseline group; in Goal, it was 1.50 more sliders and in Competition 1.66 more than in Baseline (specification 1). Furthermore, male subjects performed on average 1.77 sliders better and earned about 53 Cent (6*1.69*5 Cent) more than females.

Specification (2), which includes the data from all rounds, confirms the main results of (1). Moreover, it shows a learning effect in the slider task: On average, subjects managed to put nearly 1 slider more per round into the correct position.

Table 7: OLS regressions of energy saved on average (1) and energy saved in each round (2) in the Goal treatments

	(1) **Average number of sliders per round** OLS		**(2)** **Sliders in each round** OLS	
	Coef.	Std. err.	Coef.	Robust std. err.
Incentive	-1.088*	0.620	0.382	0.557
Male	1.710***	0.617	1.403**	0.689
Round			0.419***	0.103
Goal set			0.331***	0.105
Cons	12.951***	0.560	6.198***	1.289
N	180		685	
R^2	0.061		0.256	
Adjusted R^2	0.050		0.252	
F, Prob>F	5.71,< 0.01		19.90, <0.01	

Notes: reference category: Goal; *: p<0.1, **: p<0.05, ***: p<0.01; standard errors in (2) are clustered at the individual level; calculating the treatment effects with the nearest neighbor matching estimation (Abadie et al. 2004) yields very similar results.

Table 7 analyses the data of treatments that include a goal: the pure Goal treatment that serves as a baseline in this analysis as well as the Goal + Incentive treatment pooled with its two variants (Default Goal + Incentive and Default Goal + High Incentive). Monetary incentives reduced average effort by one slider (specification 1), yet we cannot confirm this result in specification 2.

The set goal positively influences effort – a goal that is 1 slider higher enhances effort by 0.33 sliders (specification 2). According to a two-sided Wilcoxon signed rank test, subjects

set optimistically high goals compared to their effort (Z=-6.910, p<0.01) in the Goal treatment. This effect is not observed when achieved goals are incentivized because subjects only obtained the bonus payment in Goal + Incentive if they actually reached their own set goal Furthermore, subjects seem to strategically underperform in the first rounds of all Goal + Incentive treatment variants in order to reach goals in the following rounds easier: On average, they moved only 8 sliders into the correct position whereas subjects of the Goal treatment managed to achieve about 12 sliders in the first round (two-sided Mann Whitney U test, Z=4.659, p<0.01).

Table 8: OLS regressions of energy saved on average (1) and energy saved in each round (2) in the Social Comparison and Competition treatments

	(1) **Average number of sliders per round** OLS		**(2)** **Sliders in each round** OLS	
	Coef.	Std. err.	Coef.	Robust std. err.
Social Comparison + Heater	0.416	0.772	0.129	0.833
Competition	0.413	0.840	1.772**	1.011
Competition + Heater	0.781	0.755	0.440	0.727
Competition + Bonus	0.553	0.754	0.215	0.931
Male	2.12***	0.526	2.003***	0.574
Round			1.129***	0.074
Cons	12.262***	0.588	8.710***	0.548
N	196		1128	
R^2	0.086		0.180	
Adjusted R^2	0.062		0.175	
F, Prob>F	3.56, p<0.01		43.47, p<0.01	

Notes: reference category: Social Comparison; *: p<0.1, **: p<0.05, ***: p<0.01; standard errors in (2) are clustered at the individual level; calculating the treatment effects with the nearest neighbor matching estimation (Abadie et al. 2004) yields very similar results.

Table 8 shows the regression results for treatments (plus variants) in which there is a social comparison; i.e., for Social Comparison (reference category), Social Comparison + Heater, Competition, Competition + Heater, and Competition + Bonus. The heater and bonus payments did not encourage effort to save energy. In specification (2), in which we analyze all rounds (not the averages of all rounds), pure competition without bonus payments or terrace heaters affected effort positively compared to Social Comparison.

In the Social Comparison treatments (with and without heater), subjects that had performed below average in the previous round increased their effort in the current round to a significantly larger extent than subjects that had performed above average (on average 2.75 sliders vs. 1.06 sliders, $Z=-3.73$, $p<0.01$). Yet this large discrepancy can partly be explained by the fact that below average subjects had more space for improving their bad results. Interestingly, we find the opposite effect in the pooled Competition treatments (with and without heater or bonus): On average, subjects that performed worse than the average even slightly reduced their effort in the next round (-0.13 sliders) whereas subjects that performed better than the average increased their effort by 2.80 sliders ($Z=-8.66$, $p<0.01$). A possible explanation is a free rider effect that could be enforced by the belief of badly performing participants that they cannot really help their team. We cannot replicate this finding if we compare the effort of subjects that had previously won the energy saving contest with their team to those who had lost (on average 1.39 sliders vs. 1.00 slider more after winning vs. losing, $Z=-1.10$, $p=0.271$).

5.3. Discussion

The initiation of competition leads to the highest energy saving in our experiment. Similarly, the trophy winner effect of Bühren and Pleßner (2014) demonstrates the positive influence of competition and social comparison on effort and the positive effect of effort and winning on the evaluation of the won good. Our results show that competition is able to enhance effort invested in energy saving and the evaluation of energy saving throughout the experiment. This is consistent with the findings from the field experiments referred to in section 2.1. Incentivizing the competition, however, impairs the effect of the treatment and the difference to the baseline was only significant on a 10% level in that case. The high standard deviation in Competition + Bonus (see Table 5) can be considered as an indicator that participants were rather heterogeneous regarding the effect of incentives.

In second place after the Competition treatments, the Goal treatment had the highest effect which is in line with the findings of Shippee (1980) and Loock et al. (2013). Here again, the negative effect of the incentivizing becomes evident as the Goal treatment variants with incentives no longer significantly differ from Baseline. It should be noted, however, that in the experiment it was obvious for the participants when they reached their goal. The incentive to proceed with the slider task after reaching the goal is not very high and subjects could strategically underperform after reaching the goal in order to reach future goals easier. In real life, people do not check their energy consumption regularly. Therefore, the motivation to save energy may be higher in reality as people might be unsure if they already reached their goal.

In the market survey, social comparison performed worse than the (incentivized) goal setting. Also in the experiments, the results of this bill were slightly worse than the goal setting and the competition and only differed from the baseline on a 10% level. Allcott and Rogers (2014) as well as Delmas and Lessem (2014) find the distinction between people with a previously low vs. high energy consumption to be an important determinant of the effectiveness of social comparison. Our results indicate that social comparison works better for subjects that have performed below average before (subjects with a higher previous energy usage). However, this does not hold true if we introduce a competition between teams: Then, the encouraging effect of subjects that perform below average seems to be counteracted by a free rider effect.

The Product treatment was not significantly different from the baseline. This is in line with the mixed evidence with regard to purchasing energy efficient products cited in section 2.1. Yet, it has to be noted that we did not check for subjects' risk aversion; Qui et al. (2014) used similar lotteries to those of Holt and Laury (2002) but did not incentivize them in their online survey.

Additional environmental references had no effect in our experiment which is in line with the findings of Petersen et al. (2007).

The market survey shows no relevant gender differences regarding the three energy bills although women had a stronger preference for environmental references on the bill. However, the lab results show that the treatments had an overall stronger effect on male subjects than on female. These findings reflect the inconsistency of corresponding findings:

Karlin et al. (2014), for example found within the framework of a field study that males responded more strongly to behavior-based interventions by showing energy saving behavior than females. Other studies, predominantly surveys, come to the conclusion that females show stronger environmental attitudes (see e.g. Stern et al., 1993; Yue et al., 2013; Botetzagias et al., 2014). Finally, the results of Urban and Ščasný (2012) indicate that gender differences highly depend on the specific energy saving activities.

The combination of the slider task with real energy usage via terrace heaters did not change the results of the specific treatments (Social Comparison and Competition). This serves as a first indication that our results can be external valid.

6. Conclusion, policy implications, and future research

6.1. Conclusion

With our study, we evaluated the effect of particular behavior-based interventions included in energy bills on the effort to reduce energy usage or costs for energy usage. For this, we applied a comprehensive empirical approach. In a first step, the behavior-based bills were designed in cooperation with an energy provider in an iterative process of feedback from consumers. In a second step, selected versions of the bill were presented to 457 respondents in a market survey. The respondents were requested to specify to what extent the bills would motivate them to save energy. The results were the basis for the third step, where we aimed to evaluate the actual effectiveness of the different bill versions in lab experiments with real effort tasks. In the experiment, we compared 11 treatments and one baseline with 550 subjects. The results show that the provision of incentives has a potentially negative influence. The encouragement to buy energy saving products as well as the encouragement to save energy by providing environmentally related information had no effect. Social comparison and the request to set energy saving goals, however, resulted in actions to save energy. Nevertheless, the highest effect was induced by energy saving competitions. The results of our study are not only relevant for the present application but provide a basis for other behavior-based interventions.

6.2. Policy implications

Our results show that behavior-based interventions on the first page of an energy bill are appropriate measures to induce energy saving behavior. Therefore, it is recommended to extend the present regulations concerning the energy bill accordingly. Our results illustrate, however, that the effectiveness of the interventions varies. In the context of political practice, the question arises which of the interventions will work efficiently in terms of cost and benefits. Regarding the benefits, our findings indicate that the initiation of competition generates the best results. However, initiating competition through an energy bill may be relatively complex and expensive. Applying a goal setting intervention as it was also used in our empirical approach seems to be more promising in terms of the simplicity and costs of implementation, although the results might not be as good as with the competition. Regarding social comparison, which is already addressed by the regulations, the results are not clear - its effectiveness may depend on whether the consumers used less or more energy than their comparison group. Against this background, it is recommended that the environmental economic regulation of the energy bill should rather focus on a mix of behavioral interventions than solely on one particular intervention. It should also be ensured that the interventions are placed on the very first page of the energy bill. As the results of the survey show that the provision of energy saving tips is favored by the customers, they should also be included.

6.3. Future research

Our experimental incentive schemes backfired: They seemed to crowd out intrinsic motivation to save energy. Goals that were not incentivized, social comparison and especially competition are more promising according to our results. Nevertheless, future research could try to find monetary incentive schemes that actually have the desired positive effect and may outperform non-incentivized interventions.

The differences between the rating of the bills given by participants of our survey and the behavior of the subjects in our experiments when faced with the same bills might indicate socially desirable answering of the participants: The statement that a behavioral intervention would encourage you to invest effort could very well be completely different to the real behavioral consequences of the same intervention. The discrepancy between the

survey and experimental results suggests three possible extensions of our design: First, it might be worthwhile to extend the survey with additional behavioral interventions, especially competition. Furthermore, in order to avoid possible attraction effects, interventions with and without incentive (but otherwise identical) should be evaluated sperately. Second, to enable a consistent comparison of the survey results and the lab experiments, it could be fruitful to conduct the lab experiments with the surveyed participants or a representative subject pool of electricity customers, respectively. Third, in future experiments more realistic simulations of energy usage or saving could be used instead of the slider task of Gill and Prowse (2012). The simulation of McCalley et al. (2011) in which washing machines have to be programmed may serve as a starting point.

Furthermore, future research could try to find out which interventions are the most appropriate for different subject pools. The next major step would certainly be to transfer our results to real electricity bills and test in a field experiment if they are able to change peoples' every day energy usage.

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Appendix

Sample electricity bill: Bill no. 2

Städtische Werke Aktiengesellschaft

Städtische Werke
Aktiengesellschaft
Königstor 3–13
34117 Kassel

Telefon 0561 782-0
Telefax 0561 782-2121

www.sw-kassel.de
/swkassel

Städtische Werke Aktiengesellschaft | Postfach 10 36 09 | 34112 Kassel

Stefan Schmidt
Strombergstraße 23
34117 Kassel

Ihre Kundennummer	Rechnungdatum	Rechnungsnummer	Ihre Lieferadresse
STWKA-10010000070-9	15.6.2014	STWKA-ARV-2014-26486	(Siehe links oben)

Ihre Stromrechnung

Guten Tag Herr Schmidt,

für die vom 06.06.2013 bis zum 31.05.2014 gelieferte Energie erhalten Sie heute Ihre Rechnung. Zusätzlich geben wir Ihnen Informationen zum Verbrauchsvergleich und wollen Ihnen Stromspartipps vorstellen, mit welchen Sie Strom und Geld sparen können.

Überblick Ihrer Verbräuche und Kosten vom 06.06.2013 bis 31.05.2014

	Abrechnungsmenge	Bruttobetrag
Energiekosten Strom	2.865,85 kWh	847,72 €
Abzüglich geleisteter Abschläge		-805,27 €
Noch zu zahlender Betrag		42,23 €

Abschlagsinfo: **Ihr neuer Abschlag: 70,64 €**
Ihren ausführlichen Abschlagsplan finden Sie auf Seite 2

Die Nachzahlung in Höhe von 42,23Euro werden wir zum 14.07.2014 von Ihrem Konto mit der IBAN DE12 44345 4656 6767 88 bei der Kasseler Sparkasse abbuchen.

Strom ist teuer, Stromsparen ist nicht schwer: Setzen Sie sich ein Ziel!

1 **Ziel setzen**
85 € sparen
=10% sparen. Toll, dass Sie dabei sind.

2 **Strom sparen**
Unser Tipp:
Ihre Elektrogeräte ausstecken und Steckerleisten anbringen.

3 **Doppelt sparen**
Nochmal bis zu 48 € sparen: Pro eingesparte 5 % senken wir Ihre Stromrechnung in 2015 um 3%.

ACHTUNG TIPP!

Standby ist immer noch ein unterschätzter Stromfresser - Stromsparen ist nicht schwer:

Bis zu 115 € Ersparnis
durch konsequentes Ausstecken von Kaffeemaschine, Trockner, Fernseher und DvD-Spieler usw.

Bis 80 € Ersparnis
durch konsequentes Abschalten von Computer, Monitor, Router etc.

Schaltbare Steckdosen reduzieren den Aufwand und rechnen sich schnell.

Mehr Energiespartipps:
www.die-stromsparinitiative.de

Ranks

	v95	H	Mean rank	Rank sum
Bill no. 1	Male	226	221.65	50094.00
	Female	231	236.19	54559.00
	Sum	457		
Bill no. 2	Male	226	221.42	50042.00
	Female	231	236.41	54611.00
	Sum	457		
Bill no. 3	Male	226	235.20	53155.00
	Female	231	222.94	51498.00
	Sum	457		
Extension with energy saving aspects	Male	226	219.03	49501.50
	Female	231	238.75	55151.50
	Sum	457		
Energy saving tip	Male	226	219.70	49652.50
	Female	231	238.10	55000.50
	Sum	457		
Additional environmental aspects	Male	226	212.94	48125.00
	Female	231	244.71	56528.00
	Sum	457		

Test statistics[a]

	v64 Bill no. 1	v65 Bill no. 2	v66 Bill no. 3	v74	v75 Energy	v76
Mann-Whitney-U	24443.000	24391.000	24702.000	23850.500	24001.500	22474.000
Wilcoxon-W	50094.000	50042.000	51498.000	49501.500	49652.500	48125.000
U	-1.213	-1.268	-1.019	-1.715	-1.576	-2.665
Asymp. Sig. (2-	.225	.205	.308	.086	.115	.008

a. Group variable: Gender