How to Motivate Energy Efficiency Online

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For energy conservation purposes it is not sufficient to rely on energy efficient technology, energy savings also require changes of behavior and daily routines. However, ICT can play an important role in supporting behavior change. A first step to behavior change is to actively deal with one's energy consumption. We present an interactive online application called aWattgarde which provides customers of an Austrian utility company with insights about their electricity consumption and with suggestions on how to reduce it. Customers are incentivized for reading their electricity meters and entering the readings online on a weekly basis. In this paper, we use aWattgarde as a tool to evaluate the effects of various motivational elements on usage. The evaluation bases on usage data of almost 7'000 customers who have been using the website for six months. In our evaluation we focused on different incentive systems as well as commitment- and infotainment strategies. We found that online applications that aim at motivating energy conservation should incorporate bonus points to reward desirable action immediately, commitment features to get people into a routine and using the application regularly and in the end should provide information in a playful and interactive way.

Keywords: ICT, energy conservation, consumer behavior, rewards, commitment, infotainment

ICT Can Help to Induce Behavior Change

Worldwide energy consumption increases steadily. Today, private households account for 37% of the energy consumed in the U.S. and for 29% in the European Union.[1] The amount of energy consumed by similar households can easily vary by a factor greater than two (Parker et al. 2007). In order to reduce energy consumption and promote energy conservation, it is not sufficient to purely rely on energy efficient technology (Dimitropoulos, 2007). Furthermore, energy conservation requires us to change our behavior and daily routines (Verhallen and van Raaij, 1981). To promote efficiency behaviors (e.g. invest in thermal insulation), many utility companies send their energy efficiency experts to the customer homes to make energy audits. Besides, many utility companies carry out campaigns to promote a specific behavior (e.g. reduce standby consumption). However, energy audits have a limited effect as they are time consuming, require trained experts and therefore reach only a small group of customers. Besides, these customers often need to actively ask for such a service which raises the barrier for actually doing so.

ICT can help to overcome these problems and support behavior change (Mattern, Staake and Weiss, 2010): First, ICT can be used to measure and display energy consumption on device level which is important as consumers often lack knowledge how much they consume and which of their appliances in the house consumes most energy. For example, "Yello", a utility company in Germany, offer their customers a mobile phone application that communicates with a Smart Meter and gives feedback on device level. Whereas such a mobile phone application is rather the exception than the rule, most utility companies offer in-home displays to give feedback on the actual overall consumption as well as historic consumption. Second, the high penetration rate of ICT (especially the internet) allows for addressing a large number of people at low cost compared to personal energy audits or dedicated hardware such as in-home displays energy efficiency interventions which are delivered via web (e.g. a web portal to give feedback on energy consumption and give saving tips). Third, ICT allows for combining informational support with ways of fostering motivation which is important as providing consumption data and giving energy saving tips alone is not adequate for motivating a large group of people to conserve energy (Mattern et al., 2010). Therefore, feedback on energy consumption needs to be facilitated with motivational elements such as bonus points or commitment strategies.

In this paper, we present an online energy efficiency application that promotes energy efficient behavior in private households, called aWattgarde. The online application served as a basis for an Austrian utility company's energy saving campaign. Customers are incentivized for going down to their basements, read their electricity meters, and enter it online on a weekly basis. We provide insights on which motivational concepts should be applied to motivate usage of a website aiming at improving energy efficiency. This might be interesting not only

[1] See www.eea.europa.eu/data-and-maps/figures/final-electricity- consumption-by-sector-eu-27-1 and www.eia.doe.gov/aer/

for developers of "green" online applications, but also for project managers who aim at setting up an online campaign to promote behavior change in various areas. In the following, we describe the development and real-life test of aWattgarde. The website heavily relies on concepts from psychology which have proven to be effective in motivating participation and energy savings. The evaluation of aWattgarde bases on usage data patterns of 6.919 customers who have been using the website for six months. In our evaluation we focused on incentive systems as well as on commitment- and infotainment strategies.

The paper is structured as follows: First, we present different web applications from research and practice which promote energy efficient behavior and specify the most important features with regard to motivating usage. Thereafter, we describe the system design and features of aWattgarde which motivate people to use that system. In the result section, we report which customers use aWattgarde and which features they use most. Finally, we discuss our findings and provide guidelines for the development of online energy efficiency applications.

Web Applications Promoting Energy Efficiency

With regard to web applications promoting energy efficiency, basically three streams can be differentiated. The first stream refers to commercial solutions of utility companies that are often very technical in nature. With smart electricity meters being widely deployed (they are becoming mandatory for virtually all households in the European Union), in-home displays as well as web portals have been developed by utility companies to provide accurate and transparent feedback on each household's electricity consumption. For example, Yello's customer portal allows for monitoring the (near-) real-time feedback and zooming in to the aggregate electricity consumption for a designated period of time. As a consequence of this sophisticated approach typically only a small segment of customers is interested in these solutions. The second stream refers to scientific approaches. The role of (web) applications in promoting energy efficient behavior is a relatively new topic of research (Froehlich, 2009). Most approaches are restricted to the development of concepts, describing the architecture and features that are planned to be implemented in future, and are - if at all - tested in laboratory settings or short-term field studies with small sample sizes. One example is EcoIsland (Shiraishi et al. 2009). It is "a game-like application intended to be used as a background activity by an ecologically minded family in the course of their normal daily activities" (p. 3). A display presents a virtual island and each family member is represented on the island by an avatar. The family sets a target CO2 emissions level and the system tracks their approximate current emissions using self-reported data by altering the water level around the island. After a period of four weeks the families reported an increase in pro-environmental behavior such as reusing shopping bags. Another research project is UbiGreen (Froehlich, 2009), a mobile application prototype that semi-automatically senses and reveals information about transportation behavior. The authors tested how two designs (a tree and an icebear) to visualize eco-feedback were perceived by 14 participants. Participants liked the designs but indicated that their interest faded after some days. The authors didn't examine the effect of the feedback on transportation behavior. The third stream refers to approaches that aim at addressing a large audience. One example is stepgreen.org which is a web application developed by (Grevet, Mankoff and Anderson, 2010) that encourages users to take green

actions. Users are presented with a list of actions with positive environmental consequences (e.g. "Turn off the lights when you exit the house in the morning for the day"). Each action is associated with cost savings and reduction in CO2 emissions. StepGreen calculates the amount of money & CO2 saved, missed pounds of CO2 saved, and provides a historical graph of values. Users can track their progress on a reporting page.

To our knowledge there are very few evaluations available that give insight on which motivational elements work to get a large number of people to use web applications that aim at supporting sustainable behavior. Sample sizes are typically either small or the possibilities to vary experimental conditions within the same rollout are very limited. Thus, it is necessary to investigate the quantitative impact of web applications motivating energy efficient behavior (Allcott and Mullainathan, 2009) with regard to a large sample and long-term consequences.

To get first evidences on which psychological elements are effective to motivate initial and continued participation of users in online applications (Graml, Loock, Staake and Fleisch, 2010) conducted semi-structured interviews with experts (e.g. project leaders) of nine online web applications that featured various persuasion techniques to motivate people to live more sustainable. The experts qualitatively compared the different concepts with regard to their effectiveness. All online applications under study had a large user base, were in place for several months, but did not investigate the effects of psychological concepts systematically (e.g. by altering graphic rendition).

- *Rewards:* In general, rewards can be monetary (cash incentives, tax credits etc.) or non-monetary (bonus points that are used to qualify user activity). Rewards serve as extrinsic motivation and the removal of them may terminate behavior change (De Young, 1993). Nevertheless, rewards are suitable to arouse attention and foster initial participation which is particularly important because energy conservation is a low interest topic for most households due to low prices (Froehlich, 2009). According to the experts, rewards worked for both initial and continued participation regardless whether they were monetary or not. If they are non-monetary, the effectiveness can be enhanced by providing ranks of the top scorer. By doing so, people can get social recognition which can also be seen as a kind of social benefit.
- *Action:* Providing simple one-click-actions was also an important driver for initial participation according to the experts. Websites like www.lovepeace.ch or www.asimpleswitch.com offer to take part in so-called missions, for example signing petitions or buying saving light bulbs. These missions work very well in motivating participation as people can immediately take action or get insights in an entertaining way. Most energy consuming actions are performed outside the Internet (Wilson and Dowlatabadi, 2007). Therefore, providing one-click-actions are just one approach to induce behavior change. The platform must go beyond and try to stimulate awareness concerning daily routines.
- *Social comparisons:* Comparative Feedback is described as feedback about individual performance relative to the performance of others (Mack, 2007). It uses social norms which tell us what kind of behavior is performed by others (descriptive norms) as well as what behavior is appreciated by others (injunctive norms) (Schultz, 2007). The expert interviews revealed that social comparisons seem to raise curiosity and are also

appreciated to track one's progress. Besides, they are often combined with cooperation, competition or both (see www.carbonrally.com).

- *Information:* To behave in a pro-environmental manner it is important to know what kind of behavior is good for the environment. In the context of household energy consumption general information is not very effective (Abrahamse et al., 2005). It leads to higher knowledge levels, but does not induce behavioral change. Even more personalized information in the form of home energy audits often fail because the information provided is either irrelevant or annoying to users (Abrahamse et al., 2005). The expert interviews showed that information like energy saving tips is only useful for motivating usage if it is conveyed as a game or quiz because people like to challenge themselves and learn something without having to read too much. However, information cannot stand alone as games are only played up to three times and therefore get boring.

To conclude, theory and practice clearly pointed to the need of an approach that allows investigating the quantitative impact of web applications motivating energy efficient behavior (Allcott and Mullainathan, 2009) with regard to a large sample and long-term consequences. Based on the insights of the expert interviews and on findings of the scientific community regarding motivational concepts in the area of energy efficiency (for a comprehensive review see Abrahamse et al., 2005) we developed an online energy efficiency application (aWattgarde) that allows us to quantify both short- and long-term effects of different motivational elements with a large number of households. In the following section we describe the system design of aWattgarde. Thereafter, we present the implemented psychological concepts.

System Design

In order to investigate the effectiveness of different motivational elements on site usage and energy consumption some prerequisites need to be fulfilled. First, it is necessary to monitor site usage and electricity consumption of households as well as over a longer period of time. Second, it must be possible to alter experimental conditions in a controlled setting. Third, extensive information on demographics, household characteristics and environmental attitudes need to be gathered but without making users feel that they are part of a study (Adair, 1984). In the following paragraphs we explain the approach we took to reach these goals.

Measuring consumption and behavior changes

Measuring the electricity consumption of households is essential to investigate the effects of different motivational elements. With a Smart Meter (Marvin, Chappells and Guy, 1999) installation in place, this could be done automatically, but most Smart Meter installations in central Europe are still in the pilot stage. Thus, they are either not covering enough households or it is too difficult to adapt the deployed feedback technologies to test different

motivational elements since the utilities do not want to experiment with the user interface as long as the hardware is still under test. Therefore, we chose the approach to motivate users to read their electricity meters manually and to enter these readings on a weekly basis on our online application (Fig. 1).

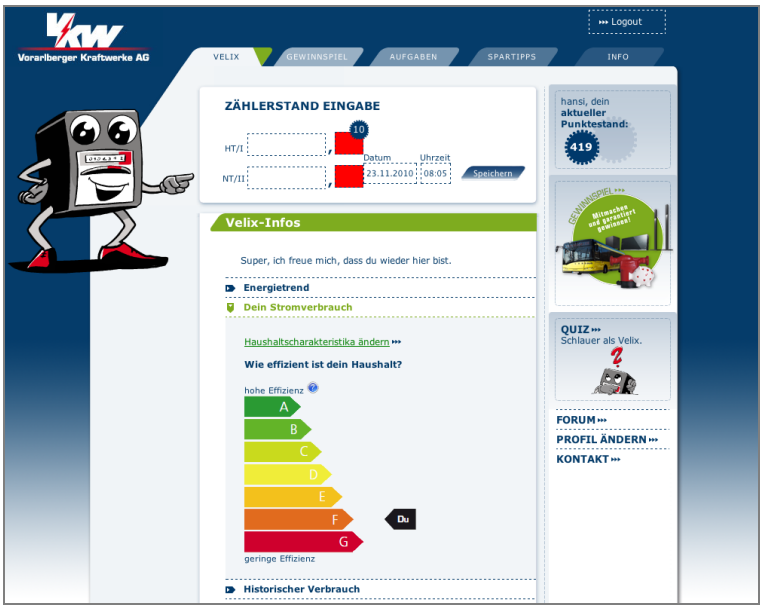

Figure 1: The user enters the meter reading in Velix. Velix calculates the energy consumption and provides the user with feedback in order to stimulate energy conservation.

To retrieve the baseline consumption for each user, the first meter readings did not lead to any consumption feedback. If the user has entered enough readings so that baseline consumption can be calculated, feedback and other motivational elements (interventions) are provided (see Fig. 2 above). Additionally, the web application allows gathering information from the users directly, for example through surveys and indirectly by specific site usage characteristics like the amount of collected bonus points, completed energy saving tasks and time spent on different pages. This usage data allow conclusions about the effectiveness of the implemented concepts motivating usage of aWattgarde.

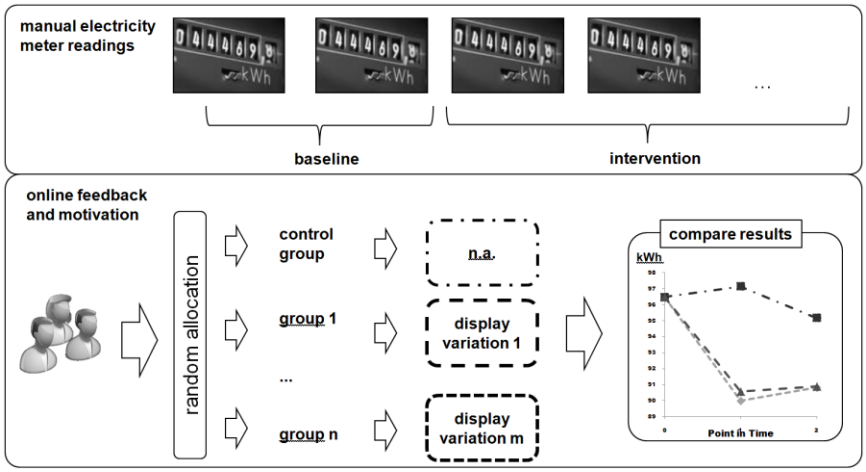

Figure 2: Manual meter readings and display variants allow deriving insights on the effectiveness of the feedback and motivational elements.

Implementation

We implemented the interactive online application on the basis of the open source CMS Silverstripe (Silverstripe, 2010). The CMS provides a modular page layout through widgets and has extensive user management capabilities. We developed a variety of widgets to provide data entry possibilities, for example meter readings or surveys, to display information, for example news or feedback on the consumption, and to provide tasks, that help to save energy. For the user the application is a playful way to explore his or her electricity usage and to do personal energy accounting. To make the entry of readings as convenient as possible for the user, a mobile phone application was developed. Besides, email and SMS reminders help users to regularly visit the application. External data sources like the aggregated yearly consumption per street and per region provide the basis for comparative feedback in aWattgarde.

To test the effectiveness of different motivational elements, we extended the widgets to be able to alter graphic rendition. These display variants can be configured to be shown for different user groups. To conduct experiments, new users are assigned randomly to an experiment group at registration. Users in each group see a slightly different web application, with different motivational elements (see Fig. 2 below). Systematic differences in consumption allow conclusions about the effectiveness of the manipulated motivational elements. The aWattgarde-statistics-module provides basic online analysis of overall user characteristics, like user demographics, or usage of different site features. To do in-depth analysis, export capabilities to excel and SPSS exist.

To add and update content such as saving tips and new lottery prices, we extended the backend system of the CMS. We also added some CRM capabilities to give the customer service hotline the opportunity to deal with possible customers complaints.

Elements to Stimulate Energy Conservation Online

Having a flexible experimental online framework is just the first step. A major challenge is to initially motivate user to try out the application and then to use it for a longer period of time. In order to achieve this, we teamed up with an Austrian utility company and a strong local media partner. For our utility partner, it was important to deploy a useful tool that motivates their customers to change their energy consumption behavior and to gain additional insights into the customer behavior in online saving campaigns. Together with a marketing agency we customized the look and feel of the online application and used different communication channels such as billboards, print media and trade fairs to promote aWattgarde to utility customers. By doing so, 6.919 users have joined within six months and have entered over 100.547 meter readings, meaning that each customer has entered 14 readings on average.

In the following section we describe the feedback and motivational concepts we integrated and evaluated in the platform to stimulate energy conservation: Rewards, social norms, projections, commitment and reminders and infotainment.

Rewards

To not only address those who are already into the topic of energy conservation but a broader range of people, we decided to set up three different kinds of rewards. These different systems differ in their time focus ranging from motivating participation on the short-term to long-term. To attract attention, a lottery was designed with attractive prices for every user that entered at least one electricity meter reading. The lottery with energy efficient products at a value of up to 4.000 Euro takes place once a month. Users can preselect their preference so that they take part in the lottery for their preferred gift. To motivate users to input further readings and support building the weekly meter reading as a habit, participants receive a guaranteed welcome gift after inputting three meter readings. The lottery prices and the welcome gifts are chosen in such a way that a broad range of user interests is addressed. In fact, the user decision on the gift tells a lot about his mindset. Users that pick a donation for the rain forest for example differ from the ones who chose an iTunes coupon. Another reward form employed in aWattgarde is a bonus point system. For entering meter readings, revealing information about themselves in surveys and for doing tasks to get to know their energy consumption better customers get bonus points that can be redeemed as soon as the online-shop of the utility company is built.

Rewards serve as extrinsic motivation and can either be contingent on the amount of energy saved, or a fixed amount (Abrahamse 2005). We decided to give rewards for participation instead of energy savings as the overall goal was to attract a large user base and make them think about their consumption instead of motivating large savings. But it can be assumed that people will save more energy the more they deal with their consumption. Research has shown that rewards should be given immediately after the desirable behavior has been shown otherwise the reward will not be connected to the desirable event. Therefore, the user gets the bonus points immediately after having performed a certain action.

Commitment and reminders

Users can also make a private commitment by choosing a routine. They can choose from a set of different possibilities when they want to read their meter (e.g. every time they go down to the basement) or set their own routine. To make the commitment even more effective we integrated the possibility to set an email or SMS reminder. These reminders or prompts remind people to carry out an action and are thus an effective means to induce behavioral change. As the effectiveness can be increased when the commitment is made in public (McCalley and Midden, 2002) we apply both public and private commitment. On the log-in page testimonials recommend the campaign. Testimonials change regularly so that the chance to see the own statement is fairly high.

Infotainment

Information becomes important as soon as people are motivated to change their behavior and want to know how they can for example improve their efficiency. Therefore, it is necessary to guide next steps by providing easy accessible and action guiding information. We tried to convey information in an entertaining way. Within aWattgarde a whole section is dedicated supporting users to understand their energy behavior better and to support them in becoming more energy efficient. This section consists out of tasks and actions that users can either do directly online or offline. The completion of these tasks is then rewarded with points. An example for such a task is meter sleep. It instructs users to try to turn off all electric devices in their household and to see if they can manage to put their meter to rest. By doing so, they are enabled to find previously unknown energy guzzlers. To guide action in a more specific way we provide saving tips. These tips are personalized in such a way that tenants will not get advice concerning infrastructure (e.g. replace heating pump).

Results

In this section we present the results of the evaluation of the commitment- and infotainment-strategies as well as of the various kinds of incentives that we implemented in aWattgarde. This evaluation is based on usage data from the first six months as aWattgarde is in place since the beginning of April 2010. Additionally, the demographics of the customers of the Austrian utility company using the website are reported.

Sample

Out of the 6.919 registered users, 3.194 (46.2%) participated in a survey that was developed to assess demographics, attitudes and motivation to participate. As data input is not mandatory, demographics reported refer to the 3.194 participants instead of the whole user base. Due to the large sample size, we assume that the users who fulfilled the survey are representative for the whole user base. The questionnaire is integrated into the platform. As soon as a user

chooses an answer, he/she will see, how the other users have responded. Only aggregated answers are shown, individual answers are not visible to the public. Therefore, we assume that users respond sincerely. 76.8% of the users are male. The age ranges from under 20 years (1.2%) to over 70 years (1.6%) with 15.2% being between 41 and 50 years old. 12.9% are between 20 and 30 years, 24.9% between 31 and 40 years, 9.1% between 51 and 60 years and 11.4% between 61 and 70 years. 71.3% of the users live in houses compared to 28.7% who live in apartments. Most people live in a household with two people (31.0%) followed by households with four people (29.7%).

Most of the users are strongly or very strongly interested in sustainability (81.1%). Less than 1% are not at all and 18.3% are slightly interested. This result corresponds to the indicated reasons why people participate. Most of them (47.8%) use aWattgarde because they want to know how much energy they are consuming. 14.9% are curious how well they are doing compared to others. Another 16.9% are convinced that aWattgarde will support them to save money. 11.7% primarily want to do something good for the environment. Prizes, fun and other family members or friends participating are just minor reasons to participate.

Popular features

In this section we describe which features were popular among the user base and thus effective in motivating usage of aWattgarde within the user base meaning often used (see Tab. 1). The results are structured according to the description of the features above.

Rewards

Although the three incentive systems lottery, welcome gift, and bonus points are set per default, we can evaluate the popularity of these concepts. For both the lottery and the guaranteed welcome gift users could indicate their preference in order to win the preferred prize or get the preferred welcome gift. 50.1% chose a lottery prize (56% MacBook Pro 15”, 28.0% electrical bike, and 16.0% coffee dispenser) and 56.6% chose a welcome gift (18.2% voucher for service partner, 25.6% voucher for tourism activities, 13.8% voucher for iTunes and 39.6% donation for a child protection agency). These results indicate that the welcome gift is more popular than the lottery although the welcome gifts have a value of 10 € each which is around 0.25% of the lottery prizes. Bonus points range between 0 and 750 with an average of 143.85 points (Fig. 3). In sum, 997.707 points have been earned. Contrary to findings in previous studies on rewards, we could not confirm the detrimental effect of rewards on motivation: Only 8% of all participants stopped using aWattgarde once they had received their welcome gift.

Commitment and reminders

As described above, we integrated private and public commitment in aWattgarde. Users cannot choose actively whether they want to be a testimonial on the front page. Candidates are chosen by the utility company from the backend system. Instead, they can commit to a routine, when they want to read their meter. 41.4% set a routine. Even more (51.8%) decided to be reminded via email or SMS, making the reminder a very popular feature.

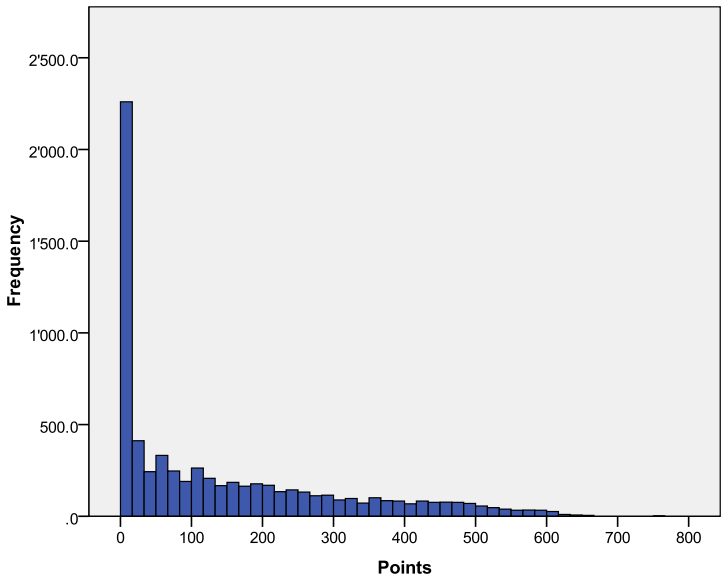

Figure 3: User collect between 0 and 750 bonus points.

Infotainment

To support and guide behavior tasks that trigger insight, saving tips and daily quizzes are provided. 32.1% tried to give their meter a rest overnight by switching all devices off. Almost each of these customers made use of the annotation functionality and shared their insights (e.g. “I figured out, that my TV was still consuming power although I switched it off”). Regarding energy saving tips, customers can tag each one (“already done”, “promise” and “hide” if not interesting). As we provide a bunch of saving tips and add continuously new ones, the number of customers who evaluate a saving tip differs from 0 to 1’893. The top three performed saving tips are the following: 1) Reduce standby consumption of your coffee machine (11.9%) 2) Eliminate standby at your working desk. (11.3%) 3) Put a cover on your cooking pot (10.0%). Energy quizzes were provided daily. 55.4% did at least one quiz. The average is 33.9 quizzes per user. In sum, regarding the infotainment category, the tasks (here meter sleep) seem to be most popular.

Table 1: Overview on popularity of aWattgarde features

Category	Feature	% of users
Rewards	Lottery	50.1
	Welcome gift	56.6
	Bonus points	73.5
Commitment	Routine	41.4
	Reminder	51.8
Infotainment	Tasks	32.1
	Saving tips	<= 11.9
	Quizzes	55.4

Discussion and Conclusion

In this paper we described the development and real-life test of an interactive online application called aWattgarde that was developed in cooperation with an Austrian utility company to give feedback on electricity consumption. With the help of this application we evaluated the effectiveness of various types of rewards as well as commitment- and infotainment-features in motivating usage and thus in the end in stimulating household energy conservation. The evaluation bases on usage data of 6.919 customers who have been using the website for six months.

We applied rewards to motivate a large customer base to sign up and enter electricity meter readings on a regular base. Bonus points seem to work best. Interestingly, users collect points although the value of these points is still not clearly defined by the utility company. Wilson and Dowlatabadi (2007) assume that people prefer incentives that are given immediately after having performed a certain action in contrast to incentives that are higher in value but more distant in time. The timing of the incentive may be the reason why the welcome gift despite being as certain as the bonus points is not as popular as the bonus points. To improve the validity of our findings, it would be necessary to divide participants into three groups with each group getting just one kind of incentive. This would allow us to test the influence of each type of reward on the intensity of meter readings as well as energy consumption. Unfortunately, this was not possible as our study was conducted with “real” customers, making it impossible to risk customer complaints. Interestingly, rewards don’t seem to corrupt intrinsic motivation: Only 8% stopped participating after they had received their welcome gifts. We attribute this to the manifold benefits the website offers.

Concerning commitment strategies, setting a routine and a reminder are appreciated. A similar number of users set a routine and a reminder. This indicates that these strategies are regarded as extra supportive in combination which corresponds to previous findings in literature (Mack, 2007). Additionally, people seem to know that these strategies are useful to support their intention to read their meter regularly. For the future, the use of commitment strategies needs to be linked to actual site usage as well as the number of entered counter readings.

Regarding informational features, people seem to prefer features which require high involvement and offer a real life experience. The "meter sleep" task allowed people to learn more about their standby consumption and to detect energy guzzlers. It was performed by 32.1% of all users. This indicates that people are really motivated to gain insights in an interactive and playful way. The playfulness may also be the reason why quizzes are done quite often and are more popular than common energy saving tips. The latter seem to be "a must have": Although almost each website in the area of sustainability offers saving tips, still a large number of users are interested in reading and using these tips.

To conclude, online applications that aim at motivating energy conservation should incorporate bonus points to reward desirable action immediately, commitment features to get people into a routine and using the application regularly and in the end should provide information in a playful and interactive way.

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