

The Experiment Has Shown *Set Your Own Goal and save Electricity!*

Jurek Pyrko and Magdalena Ugemark
Department of Energy Sciences, Lund University, Lund, Sweden

Keywords: Electricity Saving, Energy Feedback, Energy Visualization, Smart Energy Use.

Abstract: This study describes the final results from so-called “The Experiment - Swedish largest energy saving experiment” carried out by E.ON Sweden. The purpose of the Experiment was to investigate whether visualization of electricity consumption in real time would lead to a reduced electricity use. Almost 10,000 customers participated in the project and received displays where they could observe their electricity use. Over 50% of the participants made an actual electricity saving; for these customers the mean electricity saving became 8%. At the beginning of the Experiment, participants could set a saving goal and about 22% of the customers managed to achieve the target. This group saved about 15% of electricity. All the participants in total had made a saving of 0.7% compared to a control group that had increased their use by 1.5% during the same period. The impact of different factors on the final result was investigated in four segmentations after space heating type, family composition, level of education and bidding area. Four surveys were sent out to all participants to investigate their opinions and views on the Experiment. The interest for possible changes in the service and the willingness to pay for it was also investigated.

1 INTRODUCTION

Power company E.ON Sweden launched, as they called, “The Experiment - Swedish largest energy saving experiment” where 10,000 customers participated and tried on energy feedback technique called 100Koll. The main question of this experiment was whether the involved households could save electricity by getting their usage visualized and by setting up clear saving goals, which was a new way that has never before been tested in an experiment on the same scale. Furthermore, this experiment covered a full year, which is also rare for this type of investigations.

The Experiment started on February 1st, 2012 and lasted a whole year until January 31st, 2013. 10,000 grid customers of E.ON used home displays retrieving data from smart meters, giving possibility to follow household electricity consumption in real-time. Participants of the Experiment could also log into a website "My Account" and download a mobile application to monitor their daily electricity consumption.

A control group of 2,000 households was randomly chosen by the energy company among all the customers in the country (besides bidding area 1

in Northern Sweden - as for the experiment group), not participating in the Experiment and not being aware that they were included in the control group in order to evaluate their energy consumption change and compare it with the results from households participating in the Experiment.

1.1 Motivation Events

In order to increase participants' motivation to change their habits and achieve reduction of electricity use, five so-called “motivation events” were planned during the Experiment (E.ON, 2013). The aim of these actions was to generate interest in savings, in various ways, and to encourage participants to try to save even more electricity. Some of them were connected to TV-commercials, billboards and advertisements in newspapers all over the country. The results of these campaigns were evaluated in two surveys during the Experiment.

The first period started with the motivation case called "Balance". The participants could download an application to their smart phones to track the electricity usage of the households visualized in Swedish currency instead of kWh, see Figure 1.



Figure 1: Visualization of the Balance.

Second period was called "Neighbour Feud" and was a game between neighbours. 5 families in the neighbourhood could compete with each other to see who was able to save the most of electricity during the game, see Figure 2.



Figure 2: The "Neighbour Feud" on a smart phone display.

Then, the "Carrot" was a period during the Experiment where the households could send in their

saving tips. The best of them were later rewarded with prizes and some saving tips were illustrated in a playful manner by cartoonist Henrik Lange (see Figure 3) and in humorous TV-advertisements.



Figure 3: Example of energy saving tips from the motivation booster Carrot - The Anonymous Energy-holics. (Text: Change your behaviour! "Hej! My name is Gustav and I don't turn the light off when I leave a room.")

After that, during the autumn 2012, the fourth motivation case called "General" started. Through a special app, downloaded from the Experiment's website, daily reminders were sent of things possible to do and with inspiration and challenge to do even more savings - much like a personal "energy coach", see Figure 4.

Finally came the "Bongo", a small creature who appealed to the Experiment participants' empathy being very sad and feeling sick if the family members did not save electricity, see Figure 5.

The boosting period that was most appreciated by the participants was the "Balance". They felt that it helped them the most with their electricity saving efforts.

The overall interest was quite low for all the motivation cases. During the interviews it was revealed that some people felt that motivation cases were a bit bizarre in an otherwise so important and serious subject as energy saving. One participant also pointed out the contradiction in messages in the game "Neighbour Feud". The more the family saved, the greater became the house and at last it could end up with a helipad on the roof of this already very spectacular building.



Figure 4: Motivation booster "The General". (Text on the display says: "Not bad! I've checked your electricity use and it's sinking. Is there something more you can do to lower it further? Think really carefully now!").



Figure 5: "Bongo" on a smart phone display.

2 METHODS OF EVALUATION

The scientific evaluation of the whole Experiment was carried out at the Department of Energy Sciences at the Lund University and reported in three publications (Andersson and Larsson, 2012),

(Taimor and Hols, 2013), (Uggmark, 2013).

Electricity consumption during one calendar year (Feb 1, 2012 - Jan 31, 2013) was compared with equivalent period 2011-2012. Monthly electricity consumption data was collected and analysed for each household showing how the electricity consumption had changed compared to previous year. For electrically heated households the data was corrected for outdoor temperature variations.

A particular methodology was developed by the authors to calculate electricity savings. The percentage of electricity used for space heating was calculated as a difference between electricity use during winter (October -April) and summer (June-August) months. Degree-days values were obtained from the energy company and processed before they were allotted to the households.

Four web-based surveys and an interview study with limited amount of households were conducted during the Experiment in order to examine how the participants experienced different aspects of the Experiment - from technology to engagement. The content and structure of each survey was designed in cooperation with representatives from the energy company. The responses from the questionnaires and the facts about participants of the Experiment were put together to enable the segmentation of different test groups. Statistical tests were then performed to ensure that any differences between groups were significant and not just a coincidence.

Some specific conditions for participation in the Experiment were required:

1. the household should be a customer of E.ON;
2. the participants lived in single-family houses;
3. the electricity use was at least 10,000 kWh per year (which usually means for Swedish conditions that electricity is used both for space heating and household needs).
4. the household should decide an electricity saving target for the coming year (from 1 to 25%).

Totally, over 8.000 households participated actively in the Experiment. Unfortunately, as the analyses showed later, about 800 of them had electricity use below 10,000 kWh per year.

Annual electricity consumption (between February 1, 2012 and January 31, 2013) was compared with equivalent period year before (February 2011 - January 2012).

Because of the weather-related changes in heat demand, the evaluation of electricity savings from one year to another has to consider how the outdoor temperature differ between the two years. The space heating data was corrected for outdoor temperature

variations for all electrically heated households (direct resistive heating, electric furnaces or heat pumps).

In this way, the electricity savings were defined as temperature corrected difference between the year of the Experiment and the year before.

The methodology used for temperature correction was developed by one of the authors and is presented in detail in the final report (Uggmark, 2013).

The method used was based on degree-days for each geographical location and on the assumption that the electricity use during the summer months (June to August) might represent the use of electricity for household purposes and tap hot water preparation. This electricity was assumed as constant over the year. In this way the energy consumption was only adjusted for the part of electricity used for space heating.

Four web-based surveys were conducted during the Experiment with responses according to a 6-grade Likert's scale. The content and structure of each survey was designed in cooperation with the staff from the energy company. The responses from the questionnaires and the facts about households were put together to enable the segmentation of different experiment groups. Each question was evaluated and the level of "belief" or "scepticism" was calculated.

Statistical tests were then performed to ensure that any differences between groups were significant and not just a coincidence. Kruskal-Wallis test and Chi2-test were used to examine the significance of the response results (significance level 0.05).

3 RESULTS

3.1 Electricity Savings

The final result of the Experiment is based on 8,040 participating households. At the beginning of the Experiment, the participants were asked to decide the electricity saving target during the coming year. Of these who actively participated, about 23% achieved or exceeded their stated energy saving targets. This group saved about 15% of electricity.

Of the remaining active households, about 34% saved electricity but stayed below their saving targets. About 43% of the households even raised their consumption, in some cases as much as by 70%.

Somewhat over 50% of the households who participated in the Experiment made some electricity

savings (>0) compared to the year before. Their average savings were of 8%.

The group "Active households" comprises households participating actively in the Experiment by answering surveys (3985 households). This group as a whole saved 1.68% of power. In this group, totally 2,203 households saved 8.40% of the electricity. Those who reached their targets within this "active" group (886 households) saved 14.88%, see Table 1.

The analysis made with the same criteria for the Control group (2,000 households) showed that this group, on average, increased its use of electricity by 1.50% during the same period.

The fairly similar result was identified for those participants of the Experiment who did not put up the saving targets (about 4,000 households) in the beginning of the Experiment. This group had also increased the electricity consumption by 0.2%.

Table 1: The final energy savings in the Experiment (Uggmark, 2013).

| | Total electricity saving (+values = saving) | |
|---|--|---------------|
| | Experiment group | Control group |
| All households | 0.74% | -1.50% |
| 'Active' households | 1.68% | -1.50% |
| 'Active hh' who 'Saved power' | 8.40% | 8.33% |
| 'Active hh' who 'Reached saving target' | 14.88% | NA |

To investigate closer whether different groups among the participants had better (or worse) electricity saving results compared to the others, four segmentations after "space heating type", "family composition", "level of education" and "bidding area" (there are 4 such areas in Sweden) were made.

The most noticeable result from the segmentations was that bidding area 4 (Malmö) in the south of Sweden, usually having higher electricity prices, had the highest saving of 2% and that bidding area 3 (Stockholm) made a significantly lower savings. Households within bidding area 2 (Sundsvall) actually increased their use of electricity with approximately 0.6%.

3.2 The Participants' Experiences

To collect and evaluate participants' opinions on the Experiment, four surveys and an interview study was made. Surveys were sent out to all participants to investigate their own opinions on for example the

motivation cases and to study their views on the Experiment. The interest for possible changes was also investigated to see what could make the service more attractive and so was also the willingness to pay for the service. The survey ended with a question whether the respondents could consider participating in an interview. 18 respondents were later contacted for a short interview so that some questions could be investigated further.

It appeared that many participants were very positive about the Experiment. Most of the households felt that they would benefit from the equipment in the future and would be very disappointed if the service disappeared.

In addition, slightly more than half of the households were willing to pay for the service. Families with children and those who had reached their saving target were in slightly higher extent willing to pay. Not surprisingly - those who reached their electricity saving target probably had a more clear view of the benefits.

However, it was quite noticeable that many households participated in the Experiment not because of a possibility to save electricity and money. Many of them were also very interested in keeping an eye on their own everyday electricity use. For many households it was the most important argument. Another example of the reason to participate in the Experiment was the possibility to be able to see that the electricity bills were correct. Yet another one was, for example, the possibility to remotely watch that everything worked properly in the summerhouse.

The interest in the motivation cases was proved not to be very large however "The Balance" was considered to be the motivation case that had helped most participants to save electricity.

Finally, an inquiry was made to see how Facebook had been used during the Experiment and what kind of saving tips that had been submitted during the motivation case period "Saving tips". Most of all Facebook was used for technical support and other questions but the interest for this platform soon declined.

Technical Measures. The Experiment had influenced many participants to make small changes in their homes like switching lighting to more energy efficient but several families had also made major changes, such as changing heating systems or installing new white goods.

Approximately 66% of the participants answered that they had carried out different technical measures during the Experiment in order to save energy (Taimor and Hols, 2013).

The responses also indicated that performing technical measures was preferred rather than change of the behaviour. Participants also seemed to use the real-time display 100Koll a lot to ensure that the measures they had undertaken really resulted in energy savings.

Behavioural Changes. About 73% of the participants said in the surveys that they had changed their behaviour as a way of achieving energy savings during the Experiment (Taimor & Hols, 2013).

Again, the answers indicated that the participants made bigger steps in behavioural adaptation than they would if they were not involved in the Experiment.

The survey answers indicated also that the behavioural changes in the households did not affect the indoor comfort or family's living standard. Some respondents mentioned however that the most negative impact of the measures was reduction of the indoor temperature.

Respondents also indicated that both their partners and children often changed their energy related behaviour during the Experiment.

Usability of the System. Although one-third of survey respondents strongly agreed with the statement that they only had few problems with the feedback system during the Experiment, many households used the opportunity to submit open answers about the problems they experienced. At least one-third of these comments indicated that the equipment did not work correctly. Sensors reading electricity consumption often lost contact with the display. This means that nearly 20% of the households had this problem. This might also have affected the results of electricity savings shown on the website because the estimation of electricity consumption made by the company was based on these readings.

Many participants stated that their knowledge about household electricity consumption increased due to the visualization and feedback.

Possible Improvements. Some improvements and new options added to the service would, according to the participants, additionally increase the value of the service:

- better contact between devices,
- automatic updating of electricity price,
- more smart plugs for measuring individual outlets,
- possibility of measuring the consumption of fixed appliances e.g. heat pump,

- better information about possible functions,
- comparison with 'normal' values,
- lighting of the display,
- warning system for the temperature level - too high or too low,
- possibility of deciding saving targets
- warning system for if the consumption is too high for the goal to be achieved.

3.3 Future

There is a clear possibility that the participants discovered some "electricity thieves" during the Experiment and have started some major investments to reduce their electricity consumption during the next heating season (2013-2014).

Many households were very interested to keep the equipment after the end of the Experiment, which promises well. Whether the participants will continue to save electricity or will return to their old habits, remains to be seen. A possible follow-up after the winter 2013-2014 might give some indication of the duration of electricity savings for each group.

4 CONCLUSIONS

The following conclusions have been drawn from the study:

- Just over 50% of the participants made electricity savings during the experiment compared with the previous year; this group of customers saved an average of 8% electricity.
- Just over 22% of participants with a set energy saving goal managed to reach the target; this group saved an average of 15% electricity.
- All the participants together made a saving of 0.7%.
- All the customers from the control group increased electricity consumption by 1.5 %.
- 30% of the households believed they had reached their goals, while 55% did not know if they done it or not.
- Most people would benefit from the equipment and the service in the future and would be disappointed if it disappeared.
- Most people were not afraid that it would be a problem of privacy or integrity with company's access to the information about their electricity consumption.

- Slightly more than half of the households would be willing to pay for a similar service in the future.
- Families with children were more willing to pay for the service and more than others used the consumption data to check the situation at home.
- Those who achieved their electricity saving target were willing to pay more for the service than the others.
- Many of the participants interviewed had made some smaller or bigger modifications of the heating systems.
- Many of the participants interviewed had made some small changes at homes like converting light bulbs to more energy efficient.
- Participants used Facebook but focused on technical problems and issues.
- E.ON used Facebook primarily to spread out information about the Experiment and its homepage.
- The number of posts from participants dropped sharply during the Experiment.
- Almost 70% of the saving tips sent by the participants were serious.

ACKNOWLEDGEMENTS

The authors would like to thank the staff of the energy company E.ON Sweden for all their help and support during the Experiment.

REFERENCES

- Andersson, J., Larsson, P., 2012. Energy use and energy feedback - Evaluation of the largest energy-saving experiment at E.ON - Phase 1. Report LUTMDN/TMHP--12/5255--SE, Lund University, Lund. (in Swedish)
- Taimor, A., Hols, D., 2013. Energy use and energy feedback - Evaluation of the largest energy-saving experiment at E.ON - Phase 2. Report LUTMDN/TMHP--13/5267--SE, Lund University, Lund. (in Swedish)
- Uggmark, M., 2013. Scientific evaluation of the largest energy-saving experiment at E.ON - Results. Report LUTMDN/TMHP--13/5278--SE, Lund University, Lund. (in Swedish)
- E.ON, 2013. Website of the Experiment. Available at <http://experimentet.eon.se>, December 15th, 2013.