Social Norms and Spill-Over Effects on Pro-Environmental Domains

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Abstract:

Social norms have been shown to be effective in changing people's behaviour. This thesis provides insights into the effect of social norms on electricity use and the subsequent spill-over effect on water use of 472 students in Tilburg. A field experiment was conducted in which a randomized subset of students was sent letters that included feedback regarding electricity use. The reference group for the feedback was either strong or weak. Results indicate that feedback seems to be effective only on people who have been using more electricity than the median. This group decreased their electricity use as well as their water use more than those who did not receive feedback on electricity use. Boomerang effects prevail on people who were using less electricity than the median. This group started using relatively more electricity use after receiving feedback. Stronger identification to the reference group seems to lead to more beneficial results.

Contents

1. Introduction

Ever since Robert Cialdini started studying the effects of social norms on human behaviour, there has been a great deal of interest in changing behaviour without necessarily changing the underlying economic incentives. Social norms are considered to be the rules of behaviour that are considered acceptable in a group or society. The social norms approach involves making people aware of these acceptable rules of behaviour. According to the previous literature, this approach has been proven successful in altering behaviour. The environment is one especially interesting field in which the social norms approach has been proven successful. Preserving the environment will allow us to achieve sustainable societies in the future. Previous studies have mainly focused on the effect of social norms on one component of environmental awareness, be it recycling, towel re-use, residual waste, or electricity use (see e.g. Allcott, 2011; Biel & Thøgersen, 2007; Cialdini *et al.*, 2008; Costa & Kahn, 2013; Burchell *et al.*, 2013; Steg & Vlek, 2009).

This thesis will examine the effect of social norms on electricity use and the subsequent spill-over effects on water use. Such a spill-over effect prevails when people decrease their water use after being shown a descriptive social normative message regarding their electricity use. A positive spill-over effect might make it easier in the future to improve pro-environmental behaviour. Positive spill-over effects would imply that it is sufficient to receive feedback on one environmental component in order to change behaviour towards other pro-environmental behaviour. However, negative spill-over effects could prevail as well. A reason could be that people want to compensate favourable behaviour on one domain with unfavourable behaviour on another domain.

In order to study possible spill-over effects, a field experiment in an apartment building for students in Tilburg, the Netherlands has been run. Electricity- and water use by 472 students has been analysed over a time span of 64 days. The experiment consisted of three periods. Period 1 (22 days) was the baseline period. Period 2 (22 days) was the first period after some students were given feedback on their electricity use. Period 3 (20 days) is the second period after the feedback was given.

Students were split into three groups: (A) students who did not receive feedback, (B) students who received feedback on their electricity use compared to a strong reference group, (C) students who received feedback on their electricity use compared to a weak reference group.

Results derived from the Wilcoxon Rank-Sum Tests show that students who used more electricity in the baseline period than the median and received feedback on their electricity use subsequently decreased their electricity use more than students who did not receive feedback. The decrease in electricity use appears to be larger the closer one can identify to the comparison group as indicated in the feedback. However, students who were already using less electricity than the median subsequently increased their electricity use after receiving feedback. This is called the boomerang effect.

The results also indicate a positive spill-over effect towards water use. Students who received feedback on their electricity use and used more electricity than the median, used less water after the feedback moment than those who did not receive feedback.

The results from this experiment give way for policy makers to focus on profiling people who do not yet engage in a given pro-environmental behaviour. Providing especially these people with feedback on a specific behaviour, will lead to increased engagement in this behaviour. Furthermore, since spill-over effects seem to occur, it becomes easier for policy makers to help people conserve the environment. The feedback on one pro-environmental behaviour seems to lead to more favourable behaviour in other pro-environmental domains.

This thesis proceeds with section 2, which reviews the previous literature. Section 3 covers the data and method used. Section 4 contains the results. Section 5 discusses these results and covers the policy recommendation. Section 6 concludes the thesis. Section 7 includes the reference list.

2. Literature Review

In this section, literature regarding social norms will first be reviewed with the focus then shifting to the application to pro-environmental behaviour and subsequent spill-over effects.

2.1 Social Norms

Until recently, policy makers based their policy on the assumption that people maximize utility in line with the neoclassical economic theory. It has however become clear that this assumption does not always hold. There seems to be a discrepancy between how Homo Economicus should act, and how Homo Sapiens act. One of these discrepancies is the attitude towards descriptive social norms. The definition of descriptive social norms is: “norms that characterize the perception of what most people do with reference to a given social group” (Cialdini *et al.*, 1991, p.203).

Social norms are shown to be effective in shifting behaviour towards more beneficial domains, without necessarily changing the underlying economic incentives. One widely studied behaviour is excessive alcohol use by students (Lewis & Neighbors, 2006; Litt & Stock, 2011; Fossos *et al.*, 2007).

Research showed that students overestimate alcohol consumption by other students. This overestimation has led students to drink more in order to behave in line with their reference group. Borsari and Carey (2000) showed that alcohol consumption can be lowered by using social norms. In this study done in New York, students were asked how much alcohol they had consumed in the past 30 days. The students who belonged to the treatment group were then asked to participate in an interview. Students in the control group were not interviewed at all. The interviewer confronted the students with their own alcohol consumption. Their consumption was then compared to that of other students either on campus or in the United States. Students were also given information during the interview on why alcohol is harmful and how consumption can be reduced. Students were then assessed again six weeks later to determine whether behaviour has changed. The primary outcome measures of this study are the amount of drinks consumed per week, the number of times alcohol has been consumed in the past month, the frequency of binge drinking in the past month, and RAPI scores. This last measure is the Rutgers Alcohol Problem index, which assesses adolescent problem drinking. Results showed no clear difference in RAPI scores changes between groups, possibly because the participants were followed for a short time span of only six weeks. However, students in the treatment group did score significantly lower on the first three measures of interest. This indicates that providing students with social norms can reduce alcohol consumption.

Social norms can also be used to encourage pro-environmental behaviour. Cialdini *et al.* (2008) examined whether towel re-use by hotel guests can be increased by providing them information about other people's behaviour. Part I of the experiment tested the effect of sending a descriptive social norms message compared to sending a standard message on subsequent towel re-use. The standard message asked people to help save the environment, which could be done by re-using towels. The social norms message was identical, but also included an indication of how many people already changed their behaviour by re-using towels more than once during their stay. Results show that participants that were shown the social norms message re-used their towels 25% more often than participants did who were shown the standard message. Part II of the experiment investigates whether the type of the reference group that is used in the message affects behaviour. The reference groups in the messages were 'guest', 'same room', 'citizen' and 'gender'. The reference group 'guest' is also the group used in the message in part I of the experiment. Results from part II show that participants re-use their towels significantly more often when the reference group is 'same room'. This is the group with which the participants have the strongest identification. Participants that were shown any of the four reference groups were all more likely to re-use their towels compared to those who only received the standard message. The main implications of this experiment are that social norms are effective in encouraging pro-environmental behaviour, and that it matters which reference group is conveyed in the social norm. The stronger the identification with the reference group, the stronger the effect appears to be.

Energy conservation is another pro-environmental behaviour that can be targeted through the use of social norms. Allcott (2011) examined the effect of feedback on electricity use on subsequent energy conservation of 80,000 households in Minnesota. Participants in the treatment group were sent home energy reports either quarterly or monthly. These reports stated energy conservation information and social comparisons. Participants in the control group did not receive any home energy reports. The social comparisons in the report labelled one's electricity consumption as either "below average", "good" or "great". Participants were also told how much their electricity use deviates from the usage that would place them in the other categories. The analysis of this study examined the ITT, the intention to treat, as it is hard to verify which participants actually opened the letters. Results show that being sent home energy reports decreases average electricity use by around 2% compared to not receiving these reports. Another interesting aspect of this study is the difference between the group that receives the reports monthly, and the other that receives reports quarterly. The results indicate that participants who received the reports on a monthly basis decreased their electricity use more than did participants who received the reports on a quarterly basis. It seems to be the case that not only should people be confronted with a social norm, but also be remembered of the social norm on a frequent basis. Another learning point to be taken from this study is that policy makers should be aware of boomerang effects. These effects prevail when participants use more electricity after they are told they are currently using less than the social norm describes. However, this study pointed out that the effect can be countered by using injunctive norms. Adding a message in which the person is thanked for his pro-environmental behaviour is shown to reduce the increased electricity consumption following the feedback.

Social norms have been shown to only have a positive effect on behaviour so far. In contrast, Beshears *et al.* (2015) found that the effects can also be negative. A field experiment was conducted regarding retirement saving decisions. A randomized subset of employees of a large manufacturing firm were sent letters that included information about enrolment figures in specific saving plans. The letters were only sent to those employees who were not yet enrolled in these plans. The employees could choose to enrol in these plans by handing in a simple reply form. Three groups were created in order to test for the effect of social norms. One group received letters that contained information about enrolment figures of co-workers in the recipient's five-year age bracket. Another group received letters that indicated the enrolment figures of co-workers in the recipient's ten-year age bracket. The third group did not receive information about enrolment figures. Results from this paper showed that an oppositional reaction prevailed. Receiving information indicating that other people are behaving in a more favourable manner than one currently is, can lead to less engagement in this favourable behaviour. Those who received the letters that included social norms decreased their savings rates relative to those who were not made aware of the social norms. This effect is mainly driven by people who have a low economic status. For them, receiving information that others are saving more than they currently are themselves, makes their low economic status more salient. The subsequent reaction seems to be that they become discouraged to increase their savings rates.

All in all, social norms seem to lead to positive effects when used correctly. One needs to take into account the possibility of the boomerang effect occurring. This can be countered by adding an injunctive normative message. It is also of importance to use a comparison group in the feedback to which the recipient closely relates to. Social norms can have negative effects when recipients feel discouraged by the behaviour of others.

2.2 Spill-over effects

Now that it has been shown that social norms can be used to change engagement in several domains of behaviour, it is interesting to investigate whether spill-over effects prevail. Positive spill-overs prevail when engagement in a certain behaviour is increased after receiving feedback on engagement in a different behaviour. Negative spill-overs occur when the opposite is the case.

Bloodhart and Swim (2013) examined the effect of receiving feedback regarding taking the stairs or the elevator, and the subsequent spill-over effect on turning off the lights and their computer monitors. At the beginning of the experiment, participants were asked to go the basement of a psychology department building. Their behaviour regarding the use of stairs or elevator to go downstairs was monitored, without participants being aware of it. Some participants were included in the treatment group and were provided feedback. The feedback would be positive if they had taken the stairs, and negative if they had used the elevator. Participants in the control group were not given feedback at all. All participants were then monitored as they had to go upstairs to leave the building when the experiment finished. Those who received feedback at the beginning of the experiment took the stairs up more than did participants in the control group (95% as compared to 36%). Behavioural spill-over effects were analysed as the experimenters monitored whether participants turned off the lights and monitors as they left the room. The main result from the experiment is that those who received any kind of feedback regarding taking the stairs or elevator were more likely to subsequently turn off the lights and monitors when leaving the room than did subjects who did not receive any feedback at the beginning of the experiment. This implies that providing people with any kind of feedback regarding a certain environmental behaviour, can improve their environmental behaviour in other domains as well.

Positive spill-over effects might also prevail in consumption patterns. Olander and Thøgersen (2003) investigated correlations between buying organic food, recycling and the use of more environmental friendly transport. Participants were randomly selected for three telephone interviews, each being separated with one year. In order to find behavioural spill-over effects, cross-lagged effects were assessed in a three-wave panel analysis. The most striking result from this analysis is the positive spill-over effect from recycling to other environmental friendly behaviour. Heavy recyclers at the time of the first interview, increased their purchase of organic food more than the average. Heavy recyclers also decreased the use of public transportation and bicycles less in the years after the interview. The effects on both the use of public transportation and bicycles are significant. However, there also seems to be a negative spill-over effect in consumption patterns. Heavy users of organic food increased their recycling less than average. An explanation for this negative spill-over effect might be the ceiling effect. People who are already behaving in a pro-environmental manner have less room to engage in more pro-environmental behaviour than those who are not yet behaving in a pro-environmental manner.

Given the literature, it thus seems to be the case that social norms can be used in order to promote pro-environmental behaviour and that spill-over effects might occur to other pro-environmental behaviour. These spill-over effects can be positive as well as negative. Positive spill-overs could prevail as a result of increased awareness on various domains. Negative spill-overs could be the result of compensation: favourable behaviour on one domain is compensated with unfavourable behaviour on another domain.

3. Method and Data

The electricity and water use by 472 students in Tilburg, The Netherlands, has been analysed during a time span of 64 days. The experiment consisted of three periods. Period 1 (22 days) is the baseline period. Period 2 (22 days) is the first period after a randomized subset of students were given feedback on their electricity use. Period 3 (20 days) is the second period after the feedback was given. All students in the experiment lived in the same apartment building: Talent Square.[1]

The two environmental components that will be analysed in this thesis are electricity use and water use. These are the only energy-related connections in the apartment building. There is no gas connection.[2]

Students pay for electricity and water in advance. When less electricity and water are used than paid for in advance, students are reimbursed the excess payment. An important aspect is that reimbursement only occurs when the overall electricity use or water use in the apartment building is lower than paid for. There are no reimbursements to specific individuals. This gives way for the free-riding problem as students can take advantage of the collective goods (electricity and water) without paying their fair share for it.

Data regarding electricity use and water use was acquired by manually reading the meter boxes, with permission of the owner of the apartment building (SSH Student Housing). Appendix 1

[1] People can only apply for apartments in Talent Square if they are enrolled as a student at an educational institution. It can therefore be assumed that all inhabitants are students.
[2] Apartments and water are heated using electricity.

shows what a meter box looks like in this apartment building, and also includes examples of meter box readings for electricity use and water use. The meter boxes are positioned outside the apartments. As it was possible to retrieve data from the meter boxes without entering the apartments, students were not aware that they were being observed during the baseline period of the experiment. This is crucial, as awareness of being in an experiment might lead students to use electricity and water in a manner in which they would not naturally behave. The results of the experiment would then be less representative.

Electricity use and water use are positively correlated as shown in figure 1. This positive correlation implies that those who use large amounts of electricity, also use large amounts of water. Activities that require both electricity and water include showering and doing the dishes. Increased engagement in these activities leads to more electricity use as well as to more water use. Using social norms to decrease electricity use might affect water use as they seem to be related.

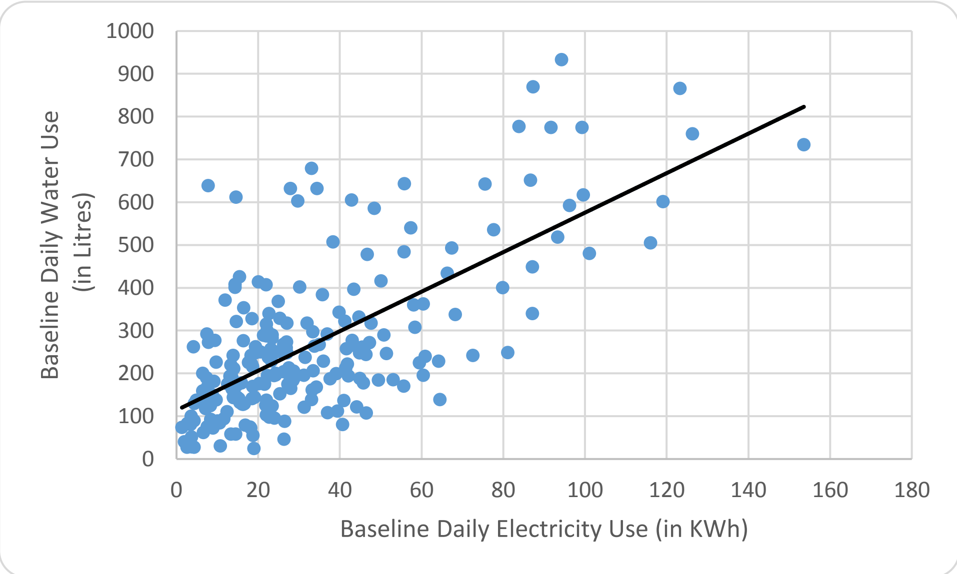

Figure 1 - Correlation: Daily Electricity Use and Daily Water Use in period 1 (r=0.6849)

Subjects in this experiment will be referred to as being the meter boxes that are courtesy of the students. The reason is that some meter boxes are shared by multiple students. In fact, there are three types of meter boxes in the apartment building: private meter boxes (type 1), meter boxes shared by two students (type 2), and meter boxes shared by a total of five students (type 5).[3]

For this experiment, three groups were created in order to test for the effect of feedback regarding electricity use on subsequent electricity and water use. Group A is the control group. This

[3] Students with either a type 1 or type 2 meter box, live in an apartment for one person. A type 2 meter box is shared by two students, who live in two different apartments. Each student has his own kitchen and bathroom. Students with a type 5 meter box live in an apartment for five people and do not share their meter box with another apartment. Students have their own bathroom, but have to share a kitchen with the others in the apartment.

group did not receive any feedback regarding their electricity use in the baseline period. Group B received feedback regarding their electricity use in the baseline period. The feedback given indicated whether the subject used more or less electricity compared to the apartment building median. Group C also received feedback, but their electricity use was compared to the median of comparable households in the Netherlands. The use of two different comparison groups enables the testing of whether stronger identification with a certain comparison group leads to increased engagement in pro-environmental behaviour.

Electricity use of subjects was compared to the median electricity use within the meter box type. It is important to note that for this experiment, the median of comparable households in the Netherlands as used in the letters was equal to the median of the apartment building for each meter box type. The feedback was not deceptive as the term "comparable households in the Netherlands" was used in the letters. The most comparable households in the Netherlands are located in the apartment building.

The median subjects were not given feedback as it is impossible to indicate whether the subject is using more or less electricity than the median without deception. These median subjects were thus added to group A.

Subjects were allocated into the three distinct groups using the matched-pairs randomization technique. Subjects were first separated by meter box type. Within each meter box type, the subjects were ranked based on baseline electricity use. Then, pairs consisting of three subjects each were created. Within each pair, subjects were randomly allocated to either group A, B or C. The use of this technique is optimal for this experiment given the importance of decreasing the probability that there are too many low or heavy electricity users in either one of the groups.

However, the randomization was not perfect due to the attrition of subjects after the groups were created. This attrition occurred as some of the students moved out. Another reason was that the meter box reading was unreadable sometimes as personal items were placed in front of the meter box. Moving these items will lead to awareness of being observed.[4] The randomization was affected as relatively many subjects in group B with meter box type 5 had to be excluded. The result was that group A and group C contained more subjects with meter box type 5, and that the electricity use per subject in the baseline period in these groups was much higher than the average in group B. A similar problem arose with the type 1, where randomization was not perfect as group B contained more heavy electricity users than groups A and C.

[4] This could lead to problematic situations in which people change their behaviour as a result of the awareness of being observed.

In contrast, the electricity use of meter boxes with type 2 was similar across all groups in the baseline period. The randomization problem was thus solved by only using meter boxes of type 2 in the analyses. Figure 2 shows the average baseline electricity usage for each group. The bars indicate the 95%-confidence intervals.

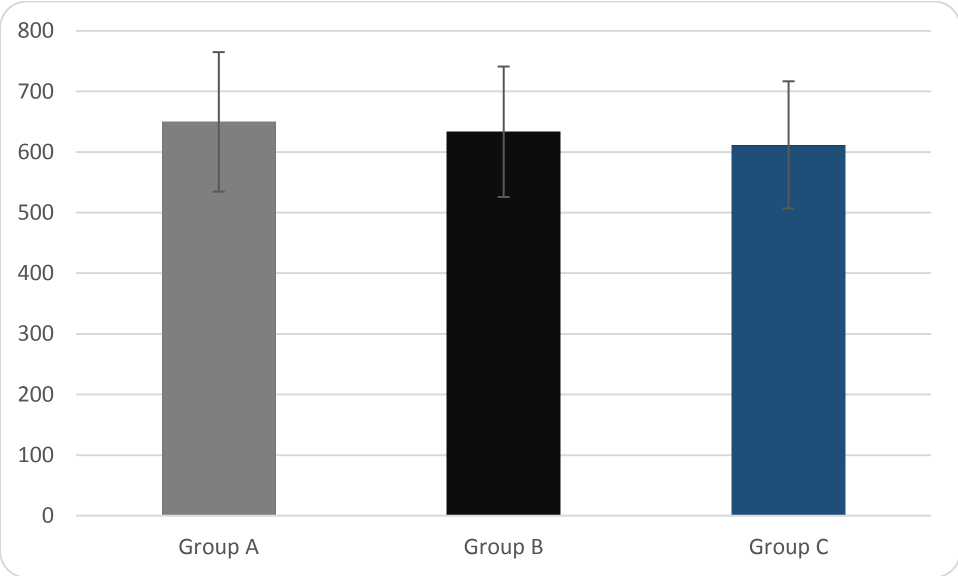

Figure 2 - Baseline Average Electricity Use (in KWh) for Type 2 Meter Boxes

Besides allocating subjects to three distinct groups, the subjects were also divided into subgroups in order to test for heterogeneous treatment effects. The subgroups are called “heavy users” and “low users”. When a subject uses more electricity in the baseline period than the median, the subject is allocated to the “heavy users” subgroup. The “low users” subgroup include those who used less electricity than the median in the baseline period. These subgroups were created irrespective of water use. The reason for this is that students received feedback on electricity use only. The field of interest is the specific feedback given to students regarding their electricity use on subsequent electricity use and water use.

Creating the two subgroups allows for more insight into whether feedback is more effective if it is given to all users, only the heavy users, or only the low users. This insight might prove to be useful for policy makers.

Feedback on electricity use was included in letters which were sent to subjects in group B and C on the first day of period 2. Letters to the heavy users included a message asking them to help protecting the environment by diminishing their electricity use. For low users, an injunctive social norms message was included instead, which thanked the person for the effort in helping to save the environment. The injunctive social norms message is used in order to combat a possible boomerang effect. This effect prevails when people start using more electricity after they are being told they currently using less than the social norms describes.

The feedback only indicated whether the subject was using less or more electricity than the median in the baseline period. No indication was given on exactly how much less (more) electricity the subject was using compared to the median. Furthermore, an e-mail address was included in the letter, allowing participants to opt out from the measurements by sending an e-mail. None of the participants expressed the desire to opt out from the measurements. In order to make it more salient that the feedback is given on a pro-environmental behaviour, a green logo of the apartment building was added. The letters that were sent can be found in Appendix 2. An overview of the timeline for each of the groups is provided in figure 3 below.

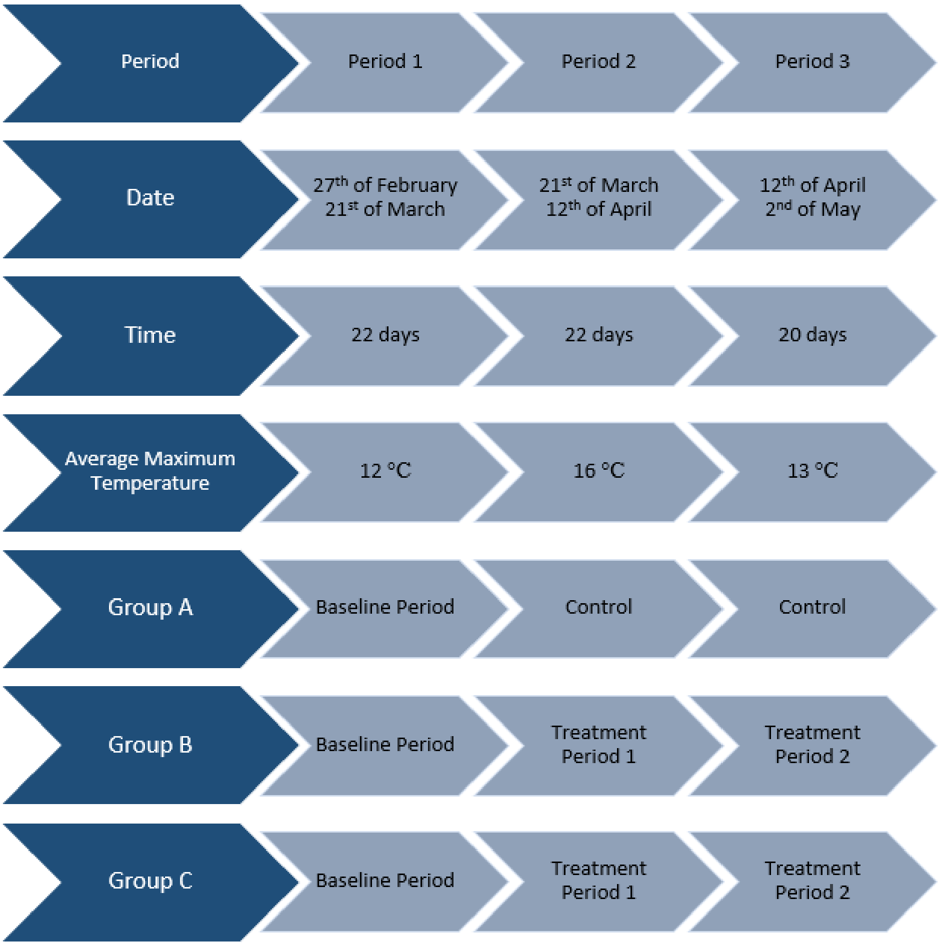

Figure 3 - Timeline of the Experiment

The statistical test that is used to test for the effect of feedback regarding electricity use on subsequent electricity and water use, is the Wilcoxon Rank-Sum Test. A total of 96 tests are run in order to test for differences in population means for both electricity and water use between all groups, and between all periods. The population mean in this context is the relative change in daily electricity use and daily water use. Table 1 provides an overview of the tests that will be run for both electricity use and water use.

Periods	Groups	Heterogeneous Treatment Effect
Period 2 vs Period 1	Group A vs Group B Group A vs Group C Group A vs Group B+C Group B vs Group C	All Users vs All Users Heavy Users vs Heavy Users Low Users vs Low Users
Period 3 vs Period 1	Group A vs Group B Group A vs Group C Group A vs Group B+C Group B vs Group C	All Users vs All Users Heavy Users vs Heavy Users Low Users vs Low Users
Period 2+3 vs Period 1	Group A vs Group B Group A vs Group C Group A vs Group B+C Group B vs Group C	All Users vs All Users Heavy Users vs Heavy Users Low Users vs Low Users
Period 3 vs Period 2	Group A vs Group B Group A vs Group C Group A vs Group B+C Group B vs Group C	All Users vs All Users Heavy Users vs Heavy Users Low Users vs Low Users

Table 1 - Overview of the Statistical Tests

Relative changes are used in order to correct for the higher ability of heavy users in the first period to decrease their electricity and water use more substantially in absolute terms in the following periods. Due to the low amount of independent observations, the real electricity usage in a given period cannot be used in the analysis. Furthermore, as it is difficult to measure who actually opened the letters, the treatment effect to be measured is the effect of being sent a letter on the subsequent relative change in daily electricity and water use.

Table 2 includes the formulas for the calculations of the relative change in electricity use and water use. An overview of the descriptive statistics can be found in Appendix 3.

Periods	Formula
Period 2 vs Period 1	$\frac{\text{Daily use in period 2} - \text{Daily use in period 1}}{\text{Daily use in period 1}} * 100\%$
Period 3 vs Period 1	$\frac{\text{Daily use in period 3} - \text{Daily use in period 1}}{\text{Daily use in period 1}} * 100\%$
Period 2+3 vs Period 1	$\frac{\text{Daily use in period 2 and period 3} - \text{Daily use in period 1}}{\text{Daily use in period 1}} * 100\%$
Period 3 vs Period 2	$\frac{\text{Daily use in period 3} - \text{Daily use in period 2}}{\text{Daily use in period 2}} * 100\%$

Table 2 - Formulas for the Relative Change in Electricity Use and Water Use

4. Results

This section presents the results of the field experiment. The analysis covers both the relative change in daily electricity use and the relative change in daily water use by each of the groups across all periods. Moreover, each of the subgroups (heavy users and low users) will also be analysed separately. This is done in order to test for heterogeneous treatment effects. Subjects of type 1 and type 5 are excluded from the main analysis due to earlier discussed randomization problems. The results regarding these meter boxes will be briefly discussed in section 4.3.

The figures in sections 4.1 and 4.2 show the average relative change in daily electricity and water use between different periods. Bars indicating 95%-confidence intervals are included. In addition to the figures, the results from the Wilcoxon Rank-Sum Tests will be discussed as well. Appendix 4 gives an overview of all the results of the Wilcoxon Rank-Sum Tests.

The generalised hypotheses for the Wilcoxon Rank-Sum Tests on electricity use are as follows:
$H_0: relative\ change\ in\ daily\ electricity\ use\ in\ group\ X = relative\ change\ in\ daily\ electricity\ use\ in\ group\ Y$
$H_1: relative\ change\ in\ daily\ electricity\ use\ in\ group\ X \neq relative\ change\ in\ daily\ electricity\ use\ in\ group\ Y$

The generalised hypotheses for the Wilcoxon Rank-Sum Tests on water use are as follows:
$H_0: relative\ change\ in\ daily\ water\ use\ in\ group\ X = relative\ change\ in\ daily\ water\ use\ in\ group\ Y$
$H_1: relative\ change\ in\ daily\ water\ use\ in\ group\ X \neq relative\ change\ in\ daily\ water\ use\ in\ group\ Y$

4.1 Electricity Use

Figure 4 offers an overview of the real daily electricity use by each of the groups. Remarkable is that all groups decreased their electricity use after period 1.[5] The decreases could be due to the changes in the weather. The average temperature in Tilburg was 12 degrees Celsius in period 1, and 16 degrees Celsius in period 2.[6] Less electricity is used when the temperature is higher as there is less need to heat the apartments. Temperatures decreased to 13 degrees in period 3, causing all groups' electricity use to increase again. The daily electricity use in this period still remained below the electricity use in period 1 for all groups.

The sections below discuss the relative changes in daily electricity use. Relative changes are used in order to account for the higher ability of subjects who are currently using much electricity to

[5] "After period 1" refers to the relative change in daily electricity use in period 2 and 3 combined relative to the daily electricity use in period 1. These results can be found in Appendix 4.1.
[6] Weather data was retrieved from (24-06-2016): www.accuweather.com/nl/nl/tilburg/249209/february-weather/249209.

decrease their electricity use. Heavy and low users will also be analysed separately in order to test for heterogeneous treatment effects.

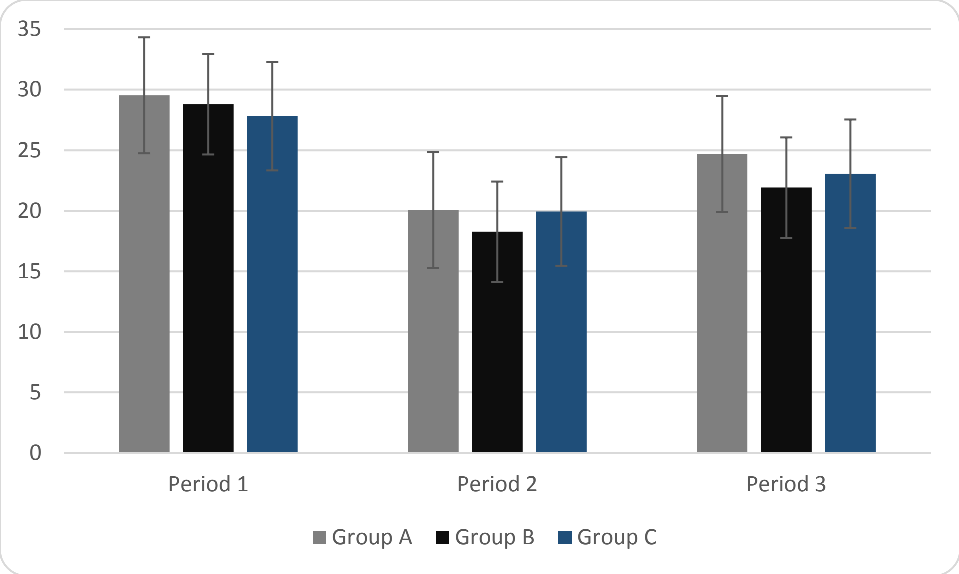

Figure 4 – Average Daily Electricity Use (in KWh) for All Users

4.1.1 All Users

The figure below shows that all groups decreased their electricity use after period 1. The largest decrease is found in group A (24.93%), followed by group B (22.17%). Between period 2 and period 3, all groups increased their electricity use. The smallest increases are found in both treatment groups B and C. *None of the differences between the groups are significant.*

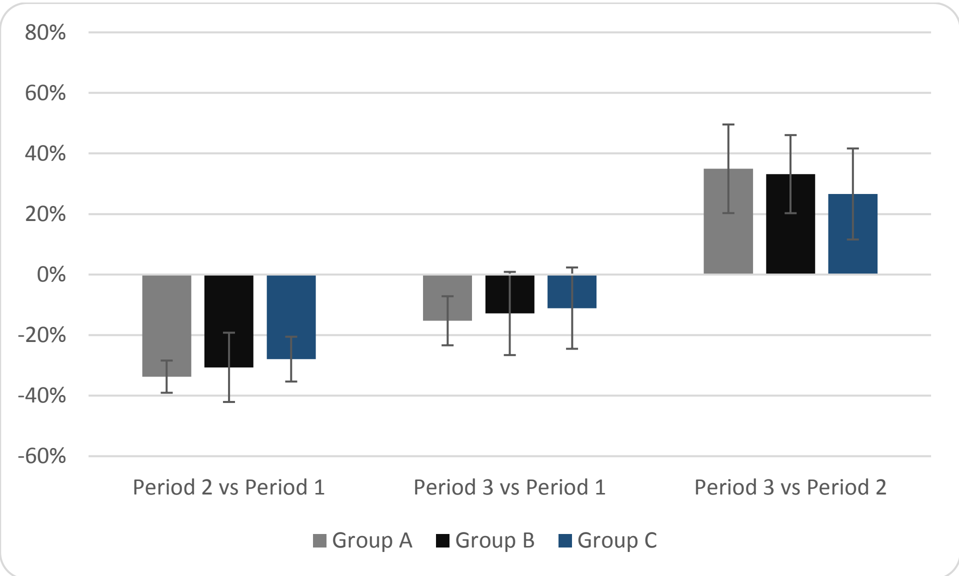

Figure 5 - Average Relative Change in Daily Electricity Use for All Users

4.1.2 Heavy Users

As for the heavy users, the decrease in electricity use after period 1 was largest for group B (34.04%). Group A decreased their electricity use by 24.35%, whereas group C decreased their electricity use by 24.93%. Heavy users in group B increased their electricity use the most after period 2.

Results from the Wilcoxon Rank-Sum Tests confirm that heavy users in group B used significantly less electricity than group A in period 2 and period 3 combined relative to period 1 ($p=0.0716$). Furthermore, the results indicate that heavy users in group B decreased their electricity use more than group C did in period 2 relative to period 1 ($p=0.0950$).

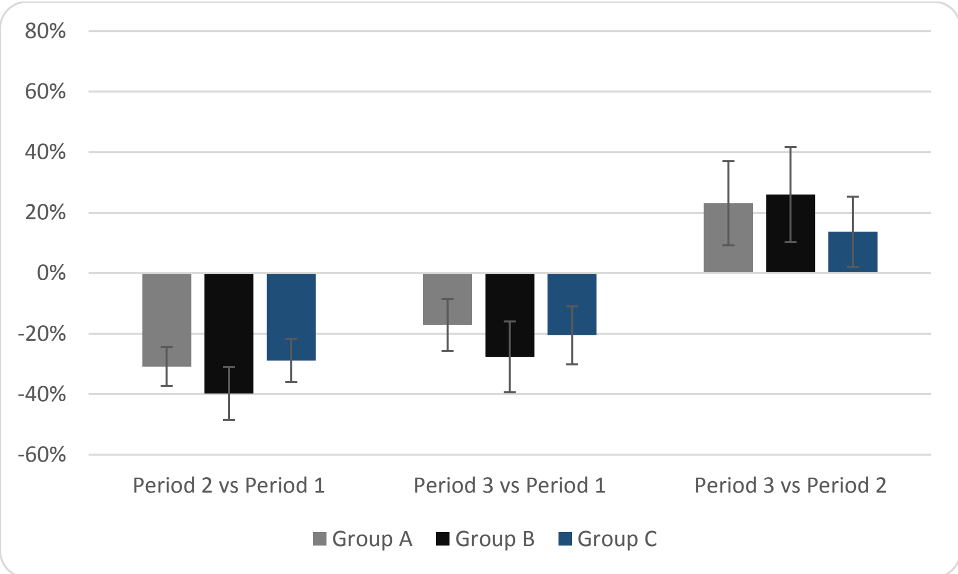

Figure 6 - Average Relative Change in Daily Electricity Use for Heavy Users

4.1.3 Low Users

Figure 7 illustrates that low users in group A decreased their electricity use the most after period 1 (25.14%). Group B decreased their electricity use the least (9.35%). Group C decreased their electricity use by 14.89%. Remarkable is that group B used more electricity in period 3 relative to period 1. It is the only group to do so. The increase in electricity use after period 2 was similar for groups B and C. The increase was the largest in group A. *None of the differences between the groups are significant.*

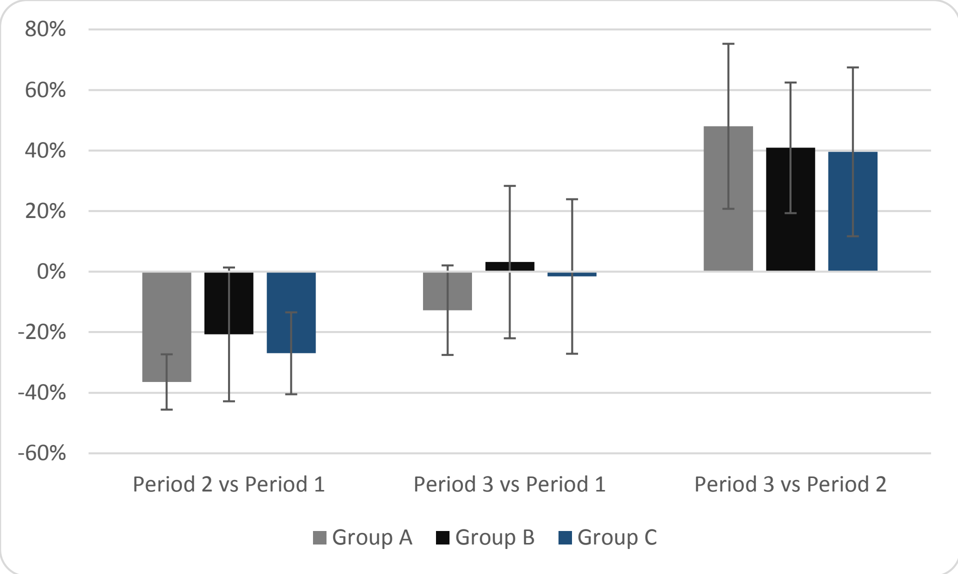

Figure 7 - Average Relative Change in Daily Electricity Use for Low Users

4.2 Water Use

Figure 8 illustrates the real daily water use for each of the groups over all the periods. Unlike the impact the weather has on electricity use, it does not seem to have an impact on water use. Electricity use is more likely to be affected as there is an increased need to heat apartments when temperatures drop. Water use, on the other hand, appears to be more static. Behaviour regarding taking a shower or doing the dishes is not heavily related to the weather, whereas heating the apartments is.

The sections below discuss the relative changes in water use, and will also pay attention to heterogeneous treatment effects by analysing heavy electricity users and low electricity users separately.

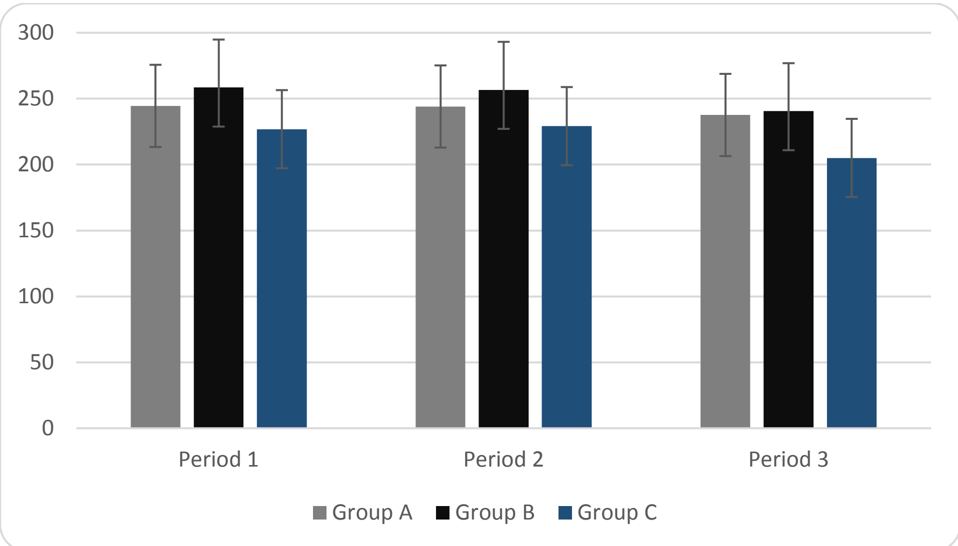

Figure 8 – Average Daily Water Use (in Litres) for All Users

4.2.1 All Users

The figure indicates that all groups increased their water use in period 2 relative to period 1. Groups B and C decreased their water use in period 3. Group C was the only group to decrease their water use after period 1 (1.75%).[7] Both group B (1.13%) and group A (3.12%) increased their water use after period 1. All groups decreased their water use after period 2. *None of the differences between the groups are significant.*

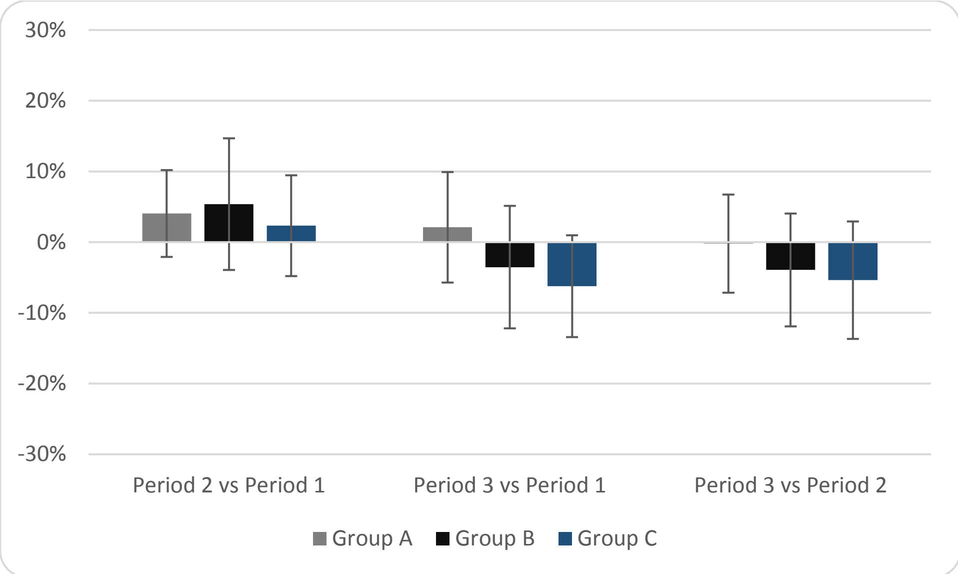

Figure 9 - Average Relative Change in Daily Water Use for All Users

4.2.2 Heavy Users

Heavy electricity users in all groups increased their water use in period 2, as shown in figure 10. As for the comparison between period 1 and period 3, both groups B and C decreased their water use. Group A is the only group to have increased their water use after period 1 (3.28%). Both group B (2.64%) and group C (5.01%) decreased their water use. Comparing period 2 to period 3 yields the result that heavy users in all groups decreased their water use after period 2.

The Wilcoxon Rank-Sum Tests indicate that heavy users in group B used significantly less water than group A in period 2 relative to period 1 ($p=0.0990$). The same result is found when comparing the daily water use in both periods 2 and 3 combined to the daily water use in period 1 ($p=0.0956$). Heavy users in group C also used significantly less water per day than those in group A in periods 2 and 3 relative to period 1 ($p=0.0640$).

[7] "After period 1" refers to the relative change in daily water use in period 2 and 3 combined relative to the daily water use in period 1. These results can be found in Appendix 4.2.

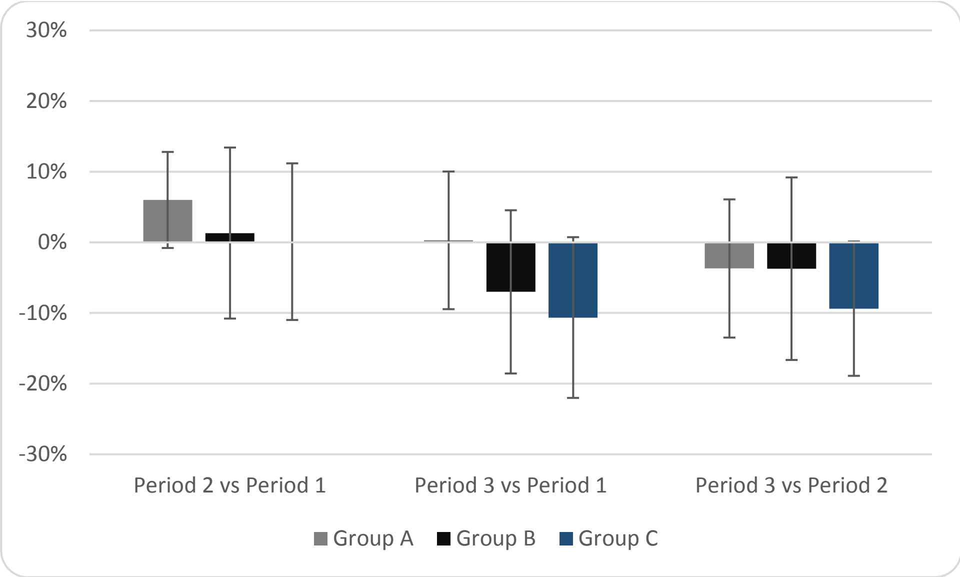

Figure 10 - Average Relative Change in Daily Water Use for Heavy Users

4.2.3 Low Users

The figure indicates that low electricity users in all groups increased their water use in period 2. Low users group B increased their water use the most. As for the comparison between period 1 and period 3, the figure shows that group C is the only group to decrease their water use. Low users in group B increased their water use the most after period 1 (5.21%), followed by low users in group A (3.67%) and low users in group C (1.52%). Group A increased their water use after period 2, whereas groups B and C decreased their water use. *None of the differences between the groups are significant.*

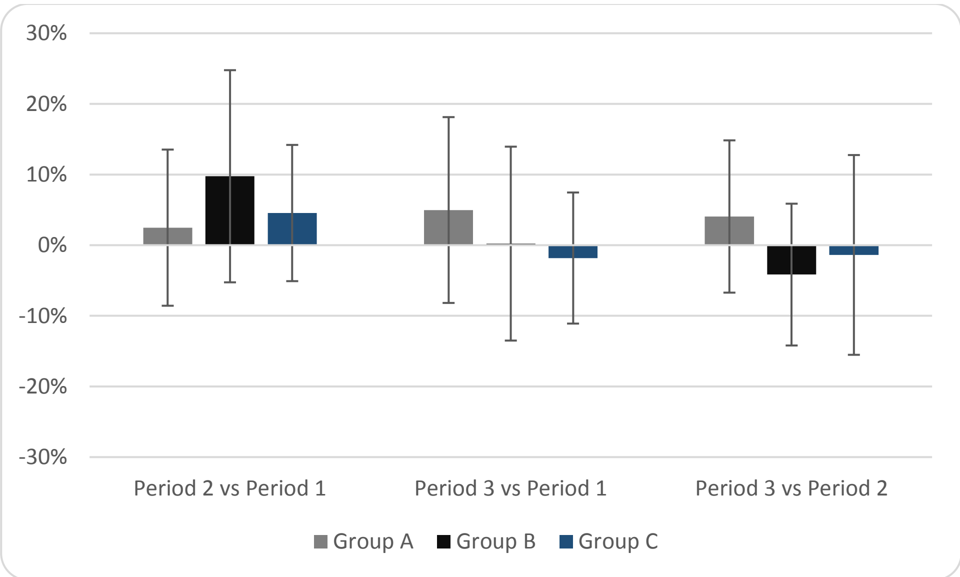

Figure 11 - Average Relative Change in Daily Water Use for Low Users

4.3 Excluded Meter Boxes

This section will discuss the results of the meter boxes of type 1 and 5.[8] These meter boxes were excluded from the main analysis due to the earlier discussed randomization problems. However, it is still worthwhile to look at the results.

4.3.1 Type 1

Students who have a type 1 meter box do not share the meter box with other students. Neither do these students share the apartment with anyone else. For this meter box type, the results on the domain of electricity are very similar to the results for the type 2 meter boxes. Feedback on heavy electricity users is beneficial, although this positive effect is cancelled out by the boomerang effect on low electricity users. Noteworthy is that the effect of feedback appears to be less beneficial when the identification to the comparison group is stronger. Given that there are more heavy electricity users in group B than in group C, this is rather unexpected.

In contrast to the domain of electricity use, the results on the domain of water use are different to the results found for type 2 meter boxes. Receiving feedback on electricity use does not lead to less water use in group B. Even when analysing only the heavy electricity users, the effect of feedback on electricity use does not lead to less water use. Results in group C are similar to those with meter box type 2, however. Having "comparable households" as the comparison group does lead to a decreased water use for heavy electricity users.

4.3.2 Type 5

This type of meter box is shared by 5 students who live in the same apartment. Results show that for this meter box type, the electricity use was decreased more in group B than in group A. Electricity use in group C was decreased less than in group A. Striking is that there is no longer a boomerang effect in group B: low electricity users in this group decreased their electricity use more than low users in group A did. The boomerang effect was still present in group C. Receiving feedback with a comparison group with which one can stronger identify seems to lead to a sharper decrease in electricity use.

Stronger identification also leads to a sharper decrease on the domain of water use. Group C increased their water use, whereas groups A and B used less water after period 1. The sharpest

[8] This section will only analyze the total decrease in electricity use and water use: the combined daily use in period 2 and 3 will be compared to the daily use in period 1.

decrease in water use is found in group B. The boomerang effect is found for low electricity users in group C. This effect was not present when only the meter boxes of type 2 were analysed.

5. Discussion and Policy Recommendation

This thesis examined the effect that social norms have on electricity use and the subsequent spill-over effects on water use. Especially the spill-over effects have not been widely studied yet. Previous studies have mainly been studying these spill-over effects in terms of intentions to engage in behaviour rather than actual engagement in behaviour.

5.1 Electricity Use

The results of the field experiment demonstrated that the use of social norms in order to diminish electricity use can be effective when specific people are targeted. It appeared that students who were sent a message which included feedback indicating that they were using more than the social norms describes, are more likely to change their behaviour in a favourable manner. The total decrease in electricity use for heavy users who did receive feedback was 5 percentage points higher than for heavy users who did not receive any kind of feedback.

The results also suggest that a boomerang effect prevails. This boomerang effect has the implication that people who are told they have been using less electricity than the social norm describes, start using more electricity. Low users who did receive feedback decreased their electricity use by almost 13 percentage points less than those who did not receive feedback. The total effect of the social norms messages is thus ambiguous on a population which consists of both people who use more and who use less than the social norm describes. This is because the diminished electricity use by initially heavy users is cancelled out by the boomerang effect of low users. Allcott (2011) also found that the boomerang effect prevails.

Remarkable is that the effect of social norms on the electricity use by heavy electricity users is stronger in the third period rather than in the second period. This result was also found in Allcott (2011). The letters that included feedback on electricity use were sent on the first day of the second period. It might have been the case that not everyone opened the letter immediately. Recipients could then not alter their behaviour right from the day on which the letter sent. Another reason for this finding could be that the students need some time to interpret the information. Only when they are able to interpret the information, they can actively alter their behaviour.

Another outcome of interest was whether a stronger identification to a comparison group would lead to an increased engagement in the favourable behaviour. Cialdini *et al.* (2008) found evidence for this on the domain of towel re-use. Similar results are found in this thesis. Students who were shown feedback compared to the average in the apartment building reduced their electricity use with more than 2 percentage points more than did students whose electricity use was compared to the average in comparable households in the Netherlands.

5.2 Water Use

In this experiment, spill-over effects prevail when students change their behaviour regarding water use after being informed only about their electricity use. The spill-over effect is positive when subsequent water use is reduced. The results of the field experiment provide an indication of the occurrence of the positive spill-over effect. This effect is only significant for the heavy users, which are the students who used more electricity in the baseline period than the median. Heavy users who received feedback on their electricity use (either with a strong or weak reference group), decreased their water use by 3%. In contrast, heavy users who did not receive feedback actually increased their water use by 3%.

The results are in line with the findings of Bloodhart and Swim (2013). They found that giving feedback on one domain (taking the stairs) leads to more favourable behaviour both on the targeted domain and on other domains (turning off the lights and monitors).

Again similar to Bloodhart and Swim (2013), there does not seem to be a clear boomerang effect towards other domains. Low users who received feedback about their electricity use increased their water use in period 2 more than low users without any kind of feedback did. However, those who received feedback reduced their water use in period 3. The opposite holds for those who did not receive any feedback. When combining the two periods, the negative effect of feedback in period 2 is cancelled out by the positive effect of feedback in period 3.

Noteworthy is that the positive spill-over effect is most substantial for subjects in group C. Students who were allocated to this group were given feedback regarding their electricity use compared to the average in comparable households in the Netherlands. This group decreased their water use after receiving feedback regarding their electricity use. Groups A and B increased their water use. This effect is remarkable as stronger identification to the comparison group leads to an increased treatment effect in the domain of electricity use. Cialdini *et al.* (2008) also found that stronger identification to the reference group leads to increased engagement in pro-environmental behaviour, being towel re-use. In contrast, the spill-over effects on water use do not seem to be positively affected by stronger identification to the reference group. The decrease in water use is not significantly higher than in treatment group B, however. It can therefore not be concluded weaker identification leads to a significantly higher spill-over effect.

5.3 Policy Recommendation

This experiment shows indications of the effect of social norms messages on diminishing electricity use and the subsequent spill-over effect to diminishing water use. Given the results, policy makers would be better off profiling and targeting only those people who are not yet engaging in pro-environmental behaviour.

If targeting is not done, the boomerang effect on people who already behave in a pro-environmental manner could cancel out the positive effect of feedback on people who are currently not behaving in a pro-environmental manner. An indication of this boomerang effect is found for electricity use. In contrast, the boomerang effect is not clear for water use. Unfortunately, profiling is not perceived to be ethically justified. An institution cannot only send letters to those who are not yet behaving in a pro-environmental manner. Therefore, one needs to focus on ways to combat boomerang effects. Adding a more salient injunctive message in the letters would be a good start. This could be done by including a smiley emoticon in the feedback, as suggested by Cialdini *et al*. (2007). People would then be more proud of their favourable behaviour and feel like their behaviour is being appreciated. They could then be less likely to increase their electricity use after receiving feedback. Consequently, the positive effect that feedback has on heavy electricity users will no longer be cancelled out by the negative effect it has on low electricity users.

5.4 Limitations

Due to the relatively small scale of the experiment over only a limited time span, it is troublesome to draw solid conclusions. Subjects were only given feedback once regarding their electricity use. Effects might have been stronger had they been informed more frequently. This was not possible during this experiment given the limited time.

Furthermore, the analysis of the experiment only includes meter boxes that are shared by two students. It might be the case that different results are found when using private meter boxes in the experiment. Given that there are only a small amount of private meter boxes in the apartment building, it is not possible to draw representative conclusions regarding these meter boxes.

Another aspect that has to be taken into account is that the experiment took place during winter. This is a season in which electricity use is the highest. The impact of feedback might be lower when it is done in a different season.

Moreover, the experimental setting was unique as the free-rider problem might prevail in the apartment building. Students have to pay for electricity and water in advance. Reimbursements only take place when the overall electricity use or water use in the apartment building is below the amount they paid for in advance. There are no reimbursements to specific individuals. Students can thus take advantage of the collective goods (electricity and water) without paying their fair share for it. Different results might arise when such a free-rider problem does not prevail.

The results of the experiment only allow for speculation as it offers only few significant results. Given that 96 statistical tests were run in order to test for the effects of social norms, one needs to be cautious when interpreting the results that are significant. Significance levels were not corrected by using the Bonferroni correction.

More research on a larger scale and a longer time frame is needed in order to confirm the indicatory effects as found in this experiment.

6. Conclusion

This thesis has shown that the use of social norms can be effective when environmental behaviour is targeted and that positive spill-over effects occur to other environmental behaviour.

People seem to be willing to behave in a manner that is considered acceptable in a group or society. Awareness of what is considered acceptable by a group or society can be created by showing people message that includes social norms. Effects of these messages appear to be positive when people are targeted who are not yet behaving in a pro-environmental manner. However, the effects seem to be negative when people are targeted who are already behaving conform to the norms. The negative effect can be countered by adding a more salient injunctive message when giving feedback regarding one's behaviour. People might then feel more proud of their behaviour, and will be less likely to change their behaviour in a favourable manner.

The effect of messages that contain social norms reaches further than solely the domain that is explicitly targeted. Findings from the experiment suggest that positive spill-over effects prevail to other domains. Feedback on one specific behavioural domain seems to increase engagement in other, non-targeted behavioural domains. This increased engagement allows for less effort in changing people's behaviour in a favourable manner.

More research on a larger scale and a longer time frame is needed in order to determine to which domains the spill-over effects spread and how much impact these effects have in various domains.

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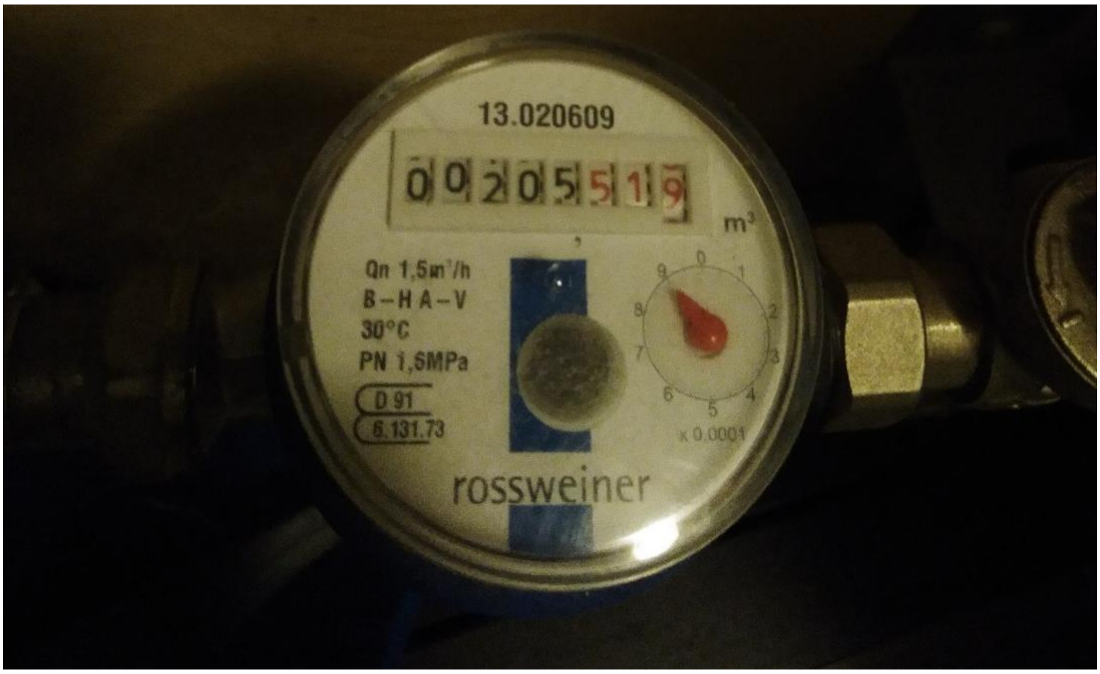
A. Appendix

A.1 Meter Boxes

A.1.1 Example of a meter box in Talent Square.

A.1.2 Example of a meter box reading for electricity use in Talent Square.

A.1.3 Example of a meter box reading for water use in Talent Square.



A.2 Letters

2.1 Letter sent to subjects in group B, who used less than the median in Talent Square.

Dear Talent Square tenant(s),

In the past three weeks, the electricity use by Talent Square tenants has been measured in collaboration with SSH Student Housing, which is the provider of studios and rooms in Talent Square.

The result is as follows:

Your electricity use has been found to be **below the Talent Square average.**

Thank you for helping to protect the environment by using less electricity!

If you have any questions or wish to opt out of the measurements please send an e-mail to electricityuse2017tilburg@gmail.com

---

2.2 Letter sent to subjects in group B, who used more than the median in Talent Square.

Dear Talent Square tenant(s),

In the past three weeks, the electricity use by Talent Square tenants has been measured in collaboration with SSH Student Housing, which is the provider of studios and rooms in Talent Square.

The result is as follows:

Your electricity use has been found to be **above the Talent Square average.**

Please help to protect the environment by diminishing your electricity use!

If you have any questions or wish to opt out of the measurements please send an e-mail to electricityuse2017tilburg@gmail.com

TALENT SQUARE

2.3 Letter sent to subjects in group C, who used less than the median in comparable households in the Netherlands.

Dear Talent Square tenant(s),

In the past three weeks, the electricity use by Talent Square tenants has been measured in collaboration with SSH Student Housing, which is the provider of studios and rooms in Talent Square.

The result is as follows:

> Your electricity use has been found to be **below the average of comparable households in the Netherlands.**

Thank you for helping to protect the environment by using less electricity!

If you have any questions or wish to opt out of the measurements please send an e-mail to electricityuse2017tilburg@gmail.com

TALENT SQUARE

2.4 Letter sent to subjects in group C, who used more than the median in comparable households in the Netherlands.

Dear Talent Square tenant(s),

In the past three weeks, the electricity use by Talent Square tenants has been measured in collaboration with SSH Student Housing, which is the provider of studios and rooms in Talent Square.

The result is as follows:

> Your electricity use has been found to be above **the average of comparable households in the Netherlands.**

Please help to protect the environment by diminishing your electricity use!

If you have any questions or wish to opt out of the measurements please send an e-mail to electricityuse2017tilburg@gmail.com

TALENT
SQUARE

A.3 Descriptive Statistics

3.1 Overview of the type of meter boxes per group.

	Group A			Group B			Group C		
	Total	**Above median**	**Below median**	**Total**	**Above median**	**Below median**	**Total**	**Above median**	**Below median**
Type 1	12	4	7	10	7	3	11	6	5
Type 2	56	28	27	52	27	25	54	27	27
Type 5	10	4	5	7	3	4	6	4	2

3.2 Electricity use

3.2.1 Overview of real daily electricity use (in KWh) per group and per meter box type (total).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 1									
Mean	13.03	29.53	82.39	17.60	28.79	92.25	16.59	27.81	99.26
St. dev	12.04	19.53	15.25	12.65	17.57	38.33	13.72	17.47	18.51
Period 2									
Mean	9.00	20.05	63.55	10.14	18.27	64.96	10.85	19.94	72.89
St. dev	9.32	16.24	15.21	8.26	13.29	23.85	10.79	15.65	8.69
Period 3									
Mean	8.40	24.67	74.55	15.16	21.91	79.57	12.09	23.06	91.13
St. dev	8.00	17.86	18.37	11.98	13.79	24.27	12.02	16.09	17.18
Period 2+3									
Mean	8.72	22.25	68.79	12.53	20.01	71.91	11.44	21.43	81.58
St. dev	8.03	16.59	16.55	9.84	13.00	23.92	11.22	15.48	10.73

3.2.2 Overview of real daily electricity use (in KWh) per group and per meter box type (heavy users).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 1									
Mean	27.57	43.34	96.42	23.57	41.83	126.38	26.21	40.98	108.23
St. dev	9.35	18.64	4.61	9.98	14.44	27.15	11.25	15.17	15.07
Period 2									
Mean	19.88	30.56	70.53	13.10	25.66	85.56	17.22	30.01	76.24
St. dev	8.46	17.01	15.63	8.15	14.41	11.04	10.92	16.21	8.55
Period 3									
Mean	17.03	36.43	79.32	20.22	29.54	99.01	18.72	32.75	94.11
St. dev	7.35	17.87	17.36	10.68	14.48	7.63	12.82	16.13	21.34
Period 2+3									
Mean	18.52	33.36	74.71	16.49	27.51	91.96	17.93	31.32	84.75
St. dev	5.19	16.73	16.44	9.08	13.68	9.26	11.66	15.69	12.27

3.2.3 Overview of real daily electricity use (in KWh) per group and per meter box type (low users).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 1									
Mean	5.08	15.44	70.19	3.68	14.71	66.66	5.05	14.64	81.33
St. dev	2.55	5.72	10.87	2.40	5.67	20.22	2.64	5.62	8.23
Period 2									
Mean	3.68	9.35	55.17	3.24	10.29	49.51	3.21	9.87	66.19
St. dev	2.23	4.25	12.34	2.44	4.78	17.71	2.83	5.11	4.84
Period 3									
Mean	4.18	12.79	65.12	3.34	13.68	64.99	4.14	13.37	85.17
St. dev	3.96	6.71	14.22	2.15	6.38	21.87	3.33	8.51	1.65
Period 2+3									
Mean	3.92	10.99	59.91	3.28	11.90	56.88	3.65	11.54	75.23
St. dev	2.90	5.00	13.14	2.30	4.96	19.61	2.44	6.25	1.75

3.2.4 Overview of relative change in daily electricity use per group and per meter box type (total).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 2 vs 1									
Mean	-0.32	-0.34	-0.23	-0.39	-0.31	-0.29	-0.40	-0.28	-0.25
St. dev	0.23	0.20	0.11	0.22	0.41	0.07	0.19	0.27	0.13
Period 3 vs 1									
Mean	-0.32	-0.15	-0.09	-0.14	-0.13	-0.10	-0.27	-0.11	-0.06
St. dev	0.33	0.30	0.16	0.16	0.49	0.12	0.34	0.49	0.20
Period 2+3 vs 1									
Mean	-0.32	-0.25	-0.16	-0.27	-0.22	-0.20	-0.34	-0.20	-0.16
St. dev	0.24	0.21	0.13	0.16	0.43	0.08	0.19	0.34	0.15
Period 3 vs 2									
Mean	0.07	0.35	0.17	0.61	0.33	0.26	0.34	0.27	0.26
St. dev	0.48	0.55	0.07	0.83	0.46	0.14	0.90	0.55	0.21

3.2.5 Overview of relative change in daily electricity use per group and per meter box type (heavy users).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 2 vs 1									
Mean	-0.28	-0.31	-0.27	-0.48	-0.40	-0.31	-0.38	-0.29	-0.28
St. dev	0.19	0.17	0.16	0.18	0.22	0.07	0.15	0.18	0.16
Period 3 vs 1									
Mean	-0.31	-0.17	-0.18	-0.16	-0.28	-0.20	-0.31	-0.21	-0.12
St. dev	0.37	0.22	0.18	0.18	0.30	0.11	0.32	0.24	0.22
Period 2+3 vs 1									
Mean	-0.29	-0.24	-0.22	-0.33	-0.34	-0.26	-0.35	-0.25	-0.20
St. dev	0.24	0.16	0.17	0.15	0.24	0.09	0.22	0.19	0.16
Period 3 vs 2									
Mean	-0.03	0.23	0.13	0.84	0.26	0.16	0.06	0.14	0.24
St. dev	0.44	0.36	0.02	0.92	0.40	0.08	0.38	0.29	0.26

3.2.6 Overview of relative change in daily electricity use per group and per meter box type (low users).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 2 vs 1									
Mean	-0.29	-0.36	-0.22	-0.16	-0.21	-0.27	-0.42	-0.27	-0.18
St. dev	0.23	0.23	0.06	0.10	0.54	0.06	0.25	0.34	0.02
Period 3 vs 1									
Mean	-0.28	-0.13	-0.08	-0.09	0.03	-0.03	-0.21	-0.02	0.05
St. dev	0.33	0.37	0.09	0.11	0.61	0.05	0.39	0.65	0.13
Period 2+3 vs 1									
Mean	-0.28	-0.25	-0.15	-0.13	-0.09	-0.16	-0.32	-0.15	-0.07
St. dev	0.22	0.25	0.07	0.09	0.55	0.05	0.16	0.44	0.07
Period 3 vs 2									
Mean	0.11	0.48	0.18	0.08	0.41	0.33	0.68	0.40	0.29
St. dev	0.56	0.69	0.06	0.13	0.52	0.13	1.26	0.70	0.12

3.3 Water use

3.3.1 Overview of real daily water use (in litres) per group and per meter box type (total).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 1									
Mean	107.47	244.51	614.37	111.75	258.45	638.02	160.56	226.85	680.75
St. dev	54.18	117.69	148.53	61.20	135.59	135.49	187.13	109.81	182.92
Period 2									
Mean	100.85	244.05	596.67	130.55	256.72	598.66	145.74	229.18	691.54
St. dev	53.25	109.77	144.71	74.66	125.69	119.79	150.41	118.89	92.56
Period 3									
Mean	91.13	237.63	586.95	113.56	240.54	586.03	129.07	205.07	694.07
St. dev	54.17	121.83	125.91	70.98	130.79	172.60	133.33	96.95	111.92
Period 2+3									
Mean	96.22	240.99	592.04	122.46	249.01	592.64	137.81	217.70	692.74
St. dev	50.47	127.64	127.64	70.43	122.91	122.25	141.17	104.62	94.41

3.3.2 Overview of real daily water use (in litres) per group and per meter box type (heavy users).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 1									
Mean	101.15	260.29	597.63	119.20	301.98	756.41	245.38	258.58	748.25
St. dev	63.98	100.78	131.24	64.78	141.19	20.46	225.18	110.36	176.82
Period 2									
Mean	105.74	271.77	608.17	141.36	297.52	694.32	212.13	257.84	735.93
St. dev	49.98	101.10	122.72	65.47	146.23	58.68	180.36	129.57	71.34
Period 3									
Mean	81.26	261.69	579.65	128.51	277.74	579.52	199.33	222.92	722.76
St. dev	74.53	128.58	107.74	69.52	151.96	134.40	148.82	98.94	95.10
Period 2+3									
Mean	94.08	266.97	594.59	135.24	288.10	639.65	206.03	241.21	729.66
St. dev	56.97	107.17	108.10	64.76	142.80	64.17	164.51	110.34	73.77

3.3.3 Overview of real daily water use (in litres) per group and per meter box type (low users).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 1									
Mean	114.34	226.47	576.70	94.35	211.43	549.23	58.78	195.12	545.75
St. dev	56.27	134.41	135.54	60.12	114.18	109.13	20.54	101.55	137.21
Period 2									
Mean	100.22	214.50	609.42	105.32	212.66	526.91	66.08	200.52	602.75
St. dev	62.41	114.55	180.20	104.20	80.68	101.94	36.76	101.60	62.64
Period 3									
Mean	95.66	213.40	606.46	78.65	200.35	590.91	44.77	187.21	636.68
St. dev	50.03	113.93	158.95	74.58	89.96	217.87	21.65	93.32	160.05
Period 2+3									
Mean	98.05	213.98	608.01	92.62	206.80	557.39	55.93	194.18	618.90
St. dev	55.11	110.64	159.81	88.51	80.23	152.58	25.10	94.80	109.03

3.3.4 Overview of relative change in daily water use per group and per meter box type (total).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 2 vs 1	0.05	0.04	-0.01	0.15	0.05	-0.06	-0.01	0.02	0.06
Mean	0.50	0.23	0.20	0.38	0.33	0.07	0.34	0.26	0.24
St. dev									
Period 3 vs 1	-0.11	0.02	-0.02	-0.01	-0.04	-0.07	-0.13	-0.06	0.07
Mean	0.33	0.29	0.22	0.51	0.31	0.23	0.31	0.26	0.29
St. dev									
Period 2+3 vs 1	-0.03	0.03	-0.01	0.08	0.01	-0.06	-0.07	-0.02	0.07
Mean	0.37	0.22	0.19	0.41	0.27	0.12	0.27	0.22	0.26
St. dev									
Period 3 vs 2	0.09	-0.002	0.002	-0.17	-0.04	-0.01	-0.05	-0.05	0.005
Mean	0.86	0.26	0.17	0.37	0.29	0.26	0.35	0.30	0.12

3.3.5 Overview of relative change in daily water use per group and per meter box type (heavy users).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 2 vs 1									
Mean	0.18	0.06	0.03	0.24	0.01	-0.08	-0.05	0.001	0.03
St. dev	0.29	0.18	0.20	0.36	0.31	0.10	0.27	0.28	0.28
Period 3 vs 1									
Mean	-0.20	0.003	-0.02	0.13	-0.07	-0.23	-0.06	-0.11	0.03
St. dev	0.37	0.25	0.07	0.46	0.29	0.17	0.25	0.29	0.36
Period 2+3 vs 1									
Mean	0.0004	0.03	0.006	0.19	-0.03	-0.15	-0.05	-0.05	0.03
St. dev	0.23	0.16	0.14	0.37	0.25	0.09	0.25	0.26	0.32
Period 3 vs 2									
Mean	-0.27	-0.04	-0.04	-0.09	-0.04	-0.16	0.008	-0.09	-0.02
St. dev	0.43	0.25	0.12	0.24	0.33	0.23	0.21	0.24	0.11

3.3.6 Overview of relative change in daily water use per group and per meter box type (low users).

	Group A			Group B			Group C		
	Type 1	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**	**Type 1**	**Type 2**	**Type 5**
Period 2 vs 1									
Mean	-0.01	-0.02	0.05	-0.06	0.10	-0.04	0.04	0.05	0.13
St. dev	0.63	0.28	0.10	0.41	0.36	0.04	0.43	0.24	0.17
Period 3 vs 1									
Mean	-0.10	0.05	0.07	-0.34	0.002	0.05	-0.22	-0.02	0.17
St. dev	0.34	0.33	0.24	0.56	0.33	0.21	0.38	0.23	0.00003
Period 2+3 vs 1									
Mean	-0.06	0.04	0.06	-0.19	0.05	0.005	-0.08	0.02	0.15
St. dev	0.48	0.27	0.13	0.44	0.29	0.09	0.32	0.18	0.09
Period 3 vs 2									
Mean	0.29	0.04	0.02	-0.35	-0.04	0.10	-0.12	-0.01	0.05
St. dev	1.07	0.27	0.23	0.60	0.24	0.24	0.48	0.36	0.16

A.4 Results

4.1 Electricity Use

4.1.1 Group A vs Group B

H_0: Relative change in daily electricity use in Group A = Relative change in daily electricity use in Group B									
	Total			**Baseline electricity usage above median**			**Baseline electricity usage below median**		
	Rank sum	Expected	p-value	Rank sum	Expected	p-value	Rank sum	Expected	p-value
Period 2 vs Period 1	A: 3151 B: 2735	A: 3052 B: 2834	0.5427	A: 869 B: 671	A: 784 B: 756	0.1524	A: 682 B: 696	A: 715.5 B: 662.5	0.5395
Period 3 vs Period 1	A: 3150 B: 2736	A: 3052 B: 2834	0.5468	A: 881 B: 659	A: 784 B: 756	0.1025	A: 681 B: 697	A: 715.5 B: 662.5	0.5275
Period 2+3 vs Period 1	A: 3175 B: 2711	A: 3052 B: 2834	0.4495	A: 891 B: 649	A: 784 B: 756	0.0716*	A: 683 B: 695	A: 715.5 B: 662.5	0.5517
Period 3 vs Period 2	A: 3031 B: 2855	A: 3052 B: 2834	0.8973	A: 783 B: 757	A: 784 B: 756	0.9866	A: 714 B: 664	A: 715.5 B: 662.5	0.9781

4.1.2 Group A vs C

H_0: Relative change in daily electricity use in Group A = Relative change in daily electricity use in Group C									
	Total			**Baseline electricity usage above median**			**Baseline electricity usage below median**		
	Rank sum	Expected	p-value	Rank sum	Expected	p-value	Rank sum	Expected	p-value
Period 2 vs Period 1	A: 2948 C: 3157	A: 3108 C: 2997	0.3387	A: 765 C: 775	A: 784 C: 756	0.7491	A: 689 C: 796	A: 742.5 C: 742.5	0.3547
Period 3 vs Period 1	A: 3180 C: 2925	A: 3108 C: 2997	0.6668	A: 822 C: 718	A: 784 C: 756	0.5223	A: 744 C: 741	A: 742.5 C: 742.5	0.9793
Period 2+3 vs Period 1	A: 3096 C: 3009	A: 3108 C: 2997	0.9428	A: 810 C: 730	A: 784 C: 756	0.6616	A: 706 C: 779	A: 742.5 C: 742.5	0.5277
Period 3 vs Period 2	A: 3264 C: 2841	A: 3108 C: 2997	0.3510	A: 838 C: 702	A: 784 C: 756	0.3633	A: 778 C: 707	A: 742.5 C: 742.5	0.5391

4.1.3 Group A vs B+C

H_0: Relative change in daily electricity use in Group A = Relative change in daily electricity use in Group B and Group C combined									
	Total			**Baseline electricity usage above median**			**Baseline electricity usage below median**		
	Rank sum	Expected	p-value	Rank sum	Expected	p-value	Rank sum	Expected	p-value
Period 2 vs Period 1	A: 4503 BC: 8700	A: 4564 BC: 8639	0.8299	A: 1228 BC: 2175	A: 1162 BC: 2241	0.5187	A: 993 BC: 2167	A: 1080 BC: 2080	0.3685
Period 3 vs Period 1	A: 4734 BC: 8469	A: 4564 BC: 8639	0.5494	A: 1297 BC: 2106	A: 1162 BC: 2241	0.1868	A: 1047 BC: 2113	A: 1080 BC: 2080	0.7330
Period 2+3 vs Period 1	A: 4675 BC: 8528	A: 4564 BC: 8639	0.6959	A: 1295 BC: 2108	A: 1162 BC: 2241	0.1934	A: 1011 BC: 2149	A: 1080 BC: 2080	0.4757
Period 3 vs Period 2	A: 4699 BC: 8504	A: 4564 BC: 8639	0.6345	A: 1215 BC: 2188	A: 1162 BC: 2241	0.6043	A: 1114 BC: 2046	A: 1080 BC: 2080	0.7253

4.1.4 Group B vs C

H_0: Relative change in daily electricity use in Group B = Relative change in daily electricity use in Group C									
	Total			**Baseline electricity usage above median**			**Baseline electricity usage below median**		
	Rank sum	Expected	p-value	Rank sum	Expected	p-value	Rank sum	Expected	p-value
Period 2 vs Period 1	B: 2575 C: 3096	B: 2782 C: 2889	0.1908	B: 646 C: 839	B: 742.5 C: 742.5	0.0950*	B: 650 C: 728	B: 662.5 C: 715.5	0.8189
Period 3 vs Period 1	B: 2743 C: 2928	B: 2782 C: 2889	0.8053	B: 683 C: 802	B: 742.5 C: 742.5	0.3033	B: 702 C: 676	B: 662.5 C: 715.5	0.4694
Period 2+3 vs Period 1	B: 2643 C: 3028	B: 2782 C: 2889	0.3797	B: 661 C: 824	B: 742.5 C: 742.5	0.1586	B: 669 C: 709	B: 662.5 C: 715.5	0.9052
Period 3 vs Period 2	B: 2976 C: 2695	B: 2782 C: 2889	0.2202	B: 802 C: 683	B: 742.5 C: 742.5	0.3033	B: 706 C: 672	B: 662.5 C: 715.5	0.4256

4.2 Water Use

4.2.1 Group A vs Group B

H_0: Relative change in daily water use in Group A = Relative change in daily water use in Group B									
	Total			**Baseline electricity usage above median**			**Baseline electricity usage below median**		
	Rank sum	Expected	p-value	Rank sum	Expected	p-value	Rank sum	Expected	p-value
Period 2 vs Period 1	A: 3128 B: 2758	A: 3052 B: 2834	0.6403	A: 882 B: 658	A: 784 B: 756	0.0990*	A: 674 B: 704	A: 715.5 B: 662.5	0.4472
Period 3 vs Period 1	A: 3180 B: 2706	A: 3052 B: 2834	0.4313	A: 839 B: 701	A: 784 B: 756	0.3545	A: 736 B: 642	A: 715.5 B: 662.5	0.7073
Period 2+3 vs Period 1	A: 3168 B: 2718s	A: 3052 B: 2834	0.4757	A: 883 B: 657	A: 784 B: 756	0.0956*	A: 699 B: 679	A: 715.5 B: 662.5	0.7625
Period 3 vs Period 2	A: 3058 B: 2828	A: 3052 B: 2834	0.9706	A: 796 B: 744	A: 784 B: 756	0.8399	A: 719 B: 659	A: 715.5 B: 662.5	0.9489

4.2.2 Group A vs C

H_0: Relative change in daily water use in Group A = Relative change in daily water use in Group C									
	Total			**Baseline electricity usage above median**			**Baseline electricity usage below median**		
	Rank sum	Expected	p-value	Rank sum	Expected	p-value	Rank sum	Expected	p-value
Period 2 vs Period 1	A: 3240 C: 2865	A: 3108 C: 2997	0.4300	A: 873 C: 667	A: 784 C: 756	0.1340	A: 722 C: 763	A: 742.5 C: 742.5	0.7229
Period 3 vs Period 1	A: 3359 C: 2746	A: 3108 C: 2997	0.1334	A: 871 C: 669	A: 784 C: 756	0.1430	A: 790 C: 695	A: 742.5 C: 742.5	0.4112
Period 2+3 vs Period 1	A: 3321 C: 2784	A: 3108 C: 2997	0.2028	A: 894 C: 646	A: 784 C: 756	0.0640*	A: 746 C: 739	A: 742.5 C: 742.5	0.9517
Period 3 vs Period 2	A: 3345 C: 2760	A: 3108 C: 2997	0.1565	A: 848 C: 692	A: 784 C: 756	0.2813	A: 810 C: 675	A: 742.5 C: 742.5	0.2429

4.2.3 Group A vs B+C

H_0: Relative change in daily water use in Group A = Relative change in daily water use in Group B and Group C combined									
	Total			**Baseline electricity usage above median**			**Baseline electricity usage below median**		
	Rank sum	Expected	p-value	Rank sum	Expected	p-value	Rank sum	Expected	p-value
Period 2 vs Period 1	A: 4772 BC: 8431	A: 4564 BC: 8639	0.4639	A: 1349 BC: 2054	A: 1162 BC: 2241	0.0675*	A: 1018 BC: 2142	A: 1080 BC: 2080	0.5216
Period 3 vs Period 1	A: 4943 BC: 8260	A: 4564 BC: 8639	0.1820	A: 1304 BC: 2099	A: 1162 BC: 2241	0.1650	A: 1148 BC: 2012	A: 1080 BC: 2080	0.4821
Period 2+3 vs Period 1	A: 4893 BC: 8310	A: 4564 BC: 8639	0.2466	A: 1371 BC: 2032	A: 1162 BC: 2241	0.0410**	A: 1067 BC: 2093	A: 1080 BC: 2080	0.8931
Period 3 vs Period 2	A: 4807 BC: 8396	A: 4564 BC: 8639	0.3921	A: 1238 BC: 2165	A: 1162 BC: 2241	0.4574	A: 1151 BC: 2009	A: 1080 BC: 2080	0.4630

4.2.4 Group B vs C

H_0: Relative change in daily water use in Group B = Relative change in daily water use in Group C									
	Total			**Baseline electricity usage above median**			**Baseline electricity usage below median**		
	Rank sum	Expected	p-value	Rank sum	Expected	p-value	Rank sum	Expected	p-value
Period 2 vs Period 1	B: 2841 C: 2830	B: 2782 C: 2889	0.7092	B: 757 C: 728	B: 742.5 C: 742.5	0.8019	B: 685 C: 693	B: 662.5 C: 715.5	0.6803
Period 3 vs Period 1	B: 2878 C: 2793	B: 2782 C: 2889	0.5441	B: 784 C: 701	B: 742.5 C: 742.5	0.4728	B: 681 C: 697	B: 662.5 C: 715.5	0.7347
Period 2+3 vs Period 1	B: 2853 C: 2818	B: 2782 C: 2889	0.6536	B: 777 C: 708	B: 742.5 C: 742.5	0.5506	B: 688 C: 690	B: 662.5 C: 715.5	0.6405
Period 3 vs Period 2	B: 2952 C: 2719	B: 2782 C: 2889	0.2827	B: 794 C: 691	B: 742.5 C: 742.5	0.3730	B: 697 C: 681	B: 662.5 C: 715.5	0.5275