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Neighbors, Knowledge, and Nuggets: Two Natural Field Experiments on the Role of Incentives on Energy Conservation

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Abstract

There is increasing research on the exogenous impact of descriptive social norms on economic behavior. The research to date has a number of limitations: 1) it has not de-coupled the impact of the norm and the knowledge required to understand how to change behavior based upon it; 2) it has exclusively used offline but not online (i.e. emails) methods; and 3) it has not understood the impact of financial incentives in conjunction with norms. We address these three limitations using two natural field experiments. We find, firstly, that norms change energy behavior over a 15 month treatment period irrespective of whether information is provided or not. We find that social norms reduce consumption by around 6% (0.2 standard deviations). Norms have has their largest impact on the day that information on the social norm is received, and then decreases over time. Secondly, we do not find that social norms work online (even with experienced consumers who are used to online billing) - social norms de- livered online may have very little beneficial effects on reducing energy use. Thirdly, we find that large financial rewards work very well online in reducing consumption, with a 0.35σ change in energy consumption over a four month period. Perhaps most interestingly, we find that the large effect of financial incentives is completely removed when information on social norms is added online.

Keywords: social norms; financial incentives; natural field experiments; energy consumption.
JEL Classifications: D01, D03, D83, Q41.

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1 Introduction

An increasing number of studies have suggested that reference to social norms can change a whole range of behaviors (Kluger & DeNisi, 1996; Parsons & Shils, 1951; Sherif, 1936). The exogenous impact of social norms has been tested by economists mainly in energy/resource use (Ayers et al., 2009; Costa & Kahn, 2010; Allcott, 2011; Ferraro & Price, 2013), charitable giving (Frey & Meier, 2004; Croson & Shang, 2008), voting (Gerber & Rogers, 2009), retirement savings (Duflo & Saez, 2003; Beshears et al., 2009) and employee effort (Fehr et al., 1998; Bandiera et al., 2006).

We extend this literature in three main ways. Firstly, we test the impact of social norms independent of the knowledge of how to change behavior. Secondly, we test whether social norms have an effect on behavior irrespective of the mode of delivery (i.e. offline letters versus online emails). There has been little evidence of the same intervention delivered in different formats. Thirdly, we test financial rewards, i.e. nuggets, to reduce consumption, and interact them with social norms. Incentives and norms have never before been tested in conjucntion with one another.

We now discuss these three issues in more depth. Firstly, the impact of norms on behaviors such as charitable giving and productivity might be quite different to that of other behaviors such as resource use. The key difference in these behaviors is understanding the production function of the behavior. For instance, in charitable giving, the input is in the same currency as the output, so the production function is very clear. So if an individual knows that the average person (i.e. the norm) contributes \$5 more than her, she knows that all she has to do is give \$5 more and she will be behaving according to the norm. For resource use, however, the norm is in resource use aggregates (such as total kilowatts per hour (kWh) over a three month period i.e. the output). So it requires a basic understanding about how inputs (i.e. behaviors such as temperature of heating in the home, cooking food, etc.) impact on the output (total resource use in kWh). So if an individual consumes 100kWh more energy than the average person, she may not know which behaviors can be modified and in which ways to reduce her energy consumption by 100kWh.

This is analogous to the research examining the education production function, where children may need to be incentivized on the inputs to educational attainment and not the output for effective motivation (see Fryer, 2011). This stream of research also suggests that traditional financial incentives provided to individuals might crowd out some intrinsic reasons for a behavior (Benabou & Tirole, 2003). There has also been evidence on the cognitive costs on individual behavior in a wide range of markets, such as retail purchases (Chetty et al., 2007), health (Kling et al, forthcoming) and retirement (Hastings & Tejeda-Ashton, 2008). This may be one of the reasons that the large field experiments to date in energy consumption have provided information on how to change behavior in addition to the social norm (see Ayers et al., 2009; Allcott, 2011) or a change in pricing (Kahn & Wolak, 2013; Ida et al., 2013). Such information has eased the cognitive costs of understanding how to change behavior (in terms of search, learning and attention costs) if the individual wants to conform to the norm.

While these studies have shown consistent positive effects on behavior from the norm with information (Allcott & Mullainathan, 2011; Allcott & Rodgers, 2012), we might have overstated the importance of the norm and understated the impact of basic information and knowledge. We have little knowledge of whether the social norm works on its own without basic information provision and very little evidence in field experimental settings. This is exactly what we test in our first natural field experiment, i.e. the impact of norms with and without basic information. The closest study to ours is by Duflo & Saez (2003), who found that peer effects combined with incentives to obtain information on retirement decisions works well to encourage take up of tax deferral accounts. We use a private descriptive norm rather than using observable peers.

Secondly, there has been some evidence on the comparison of offline versus online behaviors. There have been attempts to use online as medium for behavior change, but these have mainly been in auction design (Hossain & Morgan, 2006; Lucking-Reiley, 2000). More generally, Horton et al (2010) replicate various economic experiments in online laboratories, and suggest that their results are similar to offline behaviour. So there is increasing evidence that peoples online and offline behaviours are very similar. There is very little evidence however on the causal effect of mode of delivery on the treatment effect of social norm interventions. There are no large scale field experiments to date that have randomized whether the intervention is delivered online (via emails) or offline (via letters). The work on delivery reflects the increasing importance of how salient a message or price is to the consumer (Chetty et al., 2009), and how much attention they place on that message or price.

Thirdly, it is currently unknown how financial rewards can change energy behavior, and how such rewards interact with such social norms. Understanding the most cost-effective level of financial incentives to change different types of behavior is a largely untapped area (Gneezy & Rustichini, 2000; Gneezy et al., 2011). There are very few natural field experiments that have attempted to understand how important rewards are when the rewards are traditionally absent from such behaviors. Monetary rewards can influence behavior through both a direct price effect and an indirect psychological effect, which may not work in the same direction (Gneezy et al., 2011). The former effect incentivizes the rewarded behavior by increasing its financial appeal, while the latter effect can work in both directions depending on the signals it sends about the given behavior. Benabou & Tirole (2006) modeled individual utility from performance of a behavior as a function of extrinsic rewards, public or personal image, and enjoyment from the activity. It is clear that when the reward provides a signal that the current behavior is seen as undesirable from a norm perspective, people may treat the reward as a bribe to change their behavior in accordance with the norm. When the reward is absent from a norm, the target may seem less like a bribe and more of a basic financial incentive.

Interestingly, the framing of the behavior and the norm may affect the impact of incentives. Heyman & Ariely (2004) showed that monetary incentives in a laboratory experiment altered perceptions of the rewarded behavior, decreasing the behaviors social value by increasing its private value. Similarly, it is possible that monetary rewards alter recipients beliefs about social norms, as recipients may view incentives as necessary to overcome a countervailing norm (see also Fuster & Meier, 2010). One of our natural field experiments (NFEs) is the first to randomise financial rewards for energy conservation. We also interact such rewards with social norms to understand their additive effects.

So our first NFE is the first to test social norms on their own and the impact of information in combination with the norms. The second NFE is the first to understand how financial rewards impact on such behaviors when the social norm is both present and absent. We also test whether social norms information is motivating the change in behavior per se, or whether there is motivations to be energy efficient is driving the results. We also test the generalizability of social norms with respect to the mode of delivery – i.e. offline versus online.

For the first NFE, we used daily energy consumption from a natural field experiment (see Harrison & List, 2004) during 2010-2012. We use 569 households and randomize them into three groups: (i) control with a basic energy statement; (ii) treatment 1 – norms only; (iii) treatment 2 – norms with information. The control group had a basic energy statement, and the norms only group had the basic statement with a bar graph illustrating their consumption in comparison to the average in their neighborhood for their property size – the descriptive social norm. So our definition of social norms here is the average consumption of similar sized properties in the neighborhood. This definition is similar to that used in the recent literature (see Goldstein et al., 2008; Postlewaite, 2010; Allcott, 2011; Benabou & Tirole, 2011; Herbrich et al., 2011), but it must be noted that the norm in our study is not present to enforce cooperation (Axelrod, 1986) or to sanction those who do not behave according to the norm (see Fehr & Gaechter, 2002).

The norms with information group had the same social norm statement, but on the back of the statement was basic information demonstrating how to change their behavior to increase their knowledge. This information was very rudimentary in terms of consumer energy knowledge, and it is information that they may have already seen when their energy controls were installed.

It is important to note that we have two further important differences to the previous literature on social norms and energy use. Firstly, our statements are households actual energy statements. Allcott (2011) and Allcott & Rodgers (2012) use the social norm intervention provided and implemented by OPower (opower.com), which is the Home Energy Report (HER), but these are sent separate to the energy statement from their utility company. Secondly, our control group has an energy statement, although they do not have the social norm information. The control group in the previous studies does not have a HER. So we need to understand the impact that social norms have when everyone receives the energy statement. It might be that the HER is a treatment in itself and is delivering the change as opposed to the social norm information itself. Moreover, when people have the HER they might believe that their consumption is being watched, which might trigger a Hawthorne effect, irrespective of the social norm. So the previous literature has not shown the impact of social norms only on behavior. These are important methodological issues in examining the role of non-pecuniary incentives in changing behavior.

We started reading the energy (gas) meters in October 2010, and have consumption data per day until March 2012. We randomized households by their consumption in October 2010. The first intervention took place in December 2010 (high energy season), the second intervention took place in June 2011 (low energy season), and the third took place in January 2012 (high energy season). For each intervention time period the treatments were identical and the households remained in the same groups for the study period. Using these data, we find some striking results.

Firstly, both treatment groups reduce their consumption, so norms only and norms with information reduce consumption overall. Secondly, the norms with information effect size is at least twice as large as the norms only effect size in the first month. We demonstrate however that norms only does work as well over the long-term in terms of changing energy behavior. The 'norms only' groups seemed to have caught up with the 'norms with information' group over the 15 month treatment period. Norms work well even when basic information on how to change behavior accompanies the norm statement. Thirdly, the social norm treatment works instantaneously on behavior. The first day that people receive the energy statements is the day with the largest per day behavior change. This suggests that while norms might decay over time, they require little learning or feedback they seem to be an instant attention grabber. Given our high frequency field experiment, we are one of the first to show the abrupt behavioral response to social norms. Fourthly, those who are above the social norm are more likely to change their behavior than those below the social norm.

For the second NFE, we used monthly energy consumption involving 2,142 private households during 2012. These households were First Utility energy customers in the U.K. and they receive billing information from the supplier by email – so they are used to information being delivered online. We randomized households into one of eight groups: (i) control (ii) online (i.e. email) social norm; (iii) offline (i.e. letter) social norm; (iv) high-user frame (online); (v) high-user frame with social norm (online); (vi) social norm and £10 incentive for reaching an exogenous target (online); (vii) social norm and £100 incentive for reaching an exogenous target (online); (viii) £100 incentive for reaching an exogenous target (online). This will allow us to test social norms and how they interact with the mode of delivery, high-user frame, and financial rewards. The importance of comparing (iv) and (v) will demonstrate whether the norm is related to being energy inefficient, in that we notify individuals that they are a high end user to determine whether this is any different to a norm (even though social averages are not used). The importance of (vi), (vii) and (viii) will demonstrate whetherfinancial rewards help or hinder social norms for energy conservation.

Using 2,142 households over a four-month experimental period, we demonstrate four important findings. Firstly, we show that offline social norms work better than online social norms. This is surprising given that these customers are used to information being delivered online. It is also surprising given the unequivocal impact that norms have in an offline delivery mode. Secondly, we show that basic monetary rewards (given online) have a large effect on reducing energy consumption (0.35σ) both in the two-month treatment period, and the two-month post treatment period, which demonstrates no crowding out effect of monetary incentives over time. Thirdly, the interaction of social norms with basic monetary incentives, however, has no effect on energy consumption. This suggests that there may be a crowding out effect of placing social norms in the same frame as financial incentives, in that they are not complementary and can even backfire. Given the large effect of financial incentives, it is clear that social norms crowd out any extrinsic reason to reduce energy consumption. Fourthly, we demonstrate that providing online information stating that they (i.e. the consumers) are inefficient users of energy had no impact on energy behavior. So we can rule out a Becker-type household production argument against norms. Such an argument would be that consumers care about saving money on their energy bill, and when they are informed that they are a high end user, suggesting that they are inefficient, they might realize that they are not saving enough money through energy.

Taking these two natural field experiments together, our research suggests that: social descriptive norms can only be used to change long-term energy behavior when delivered offline; descriptive norms delivered online via emails do not work; descriptive norms and financial incentives are a different concept to being informed about energy inefficiency; and social norms crowd out the positive effects of financial rewards on energy consumption. The first result demonstrates the constructive power of social norms, and the third result demonstrates the destructive power of social norms. Financial incentives can change long-term energy behavior, with no crowding out of the behavior once the rewards have been removed.

The next section will outline the theoretical framework of using norms and financial incentives for energy conservation. Section 3 will introduce the field experiments, and will provide details on the treatments used and the data that are gathered. The results will be presented in section 4 for both natural field experiments. We will also price the treatment effects from this study to understand the benefit-cost ratios for each intervention. We will then discuss these results in section 5 and highlight the implications they have for public policy.

2 Theoretical framework

From the outset, we will assume that people care about norms, and their relative position away from the norm, and that these enter peoples deep utility functions (see the evidence in Akerlof, 1982; Jones, 1984; Frank, 1985; Okuno-Fujiwara & Postlewaite, 1995; Ball et al., 2001; Arrow et al., 2004; Luttmer, 2005; Bault et al., 2008; Benabou & Tirole, 2011). One could think of the impact of social norms more formally by using Levitt and List's (2006) framework. The payoff for each individual in our model depends on the benefits of consuming energy (i.e. cooking, washing, heating), the costs of consumption (i.e. price), and the utility demand from the social norm. The benefit term $b_i(g_i)$ is increasing in the amount of gas consumed. Each person also has a cost of consuming gas, which is the market price, p_i, where the cost becomes $c_i(g_i,p_i)$.The consumers also derive utility from being below the norm and lose utility from being above the norm. The utility from the norm depends on how much g_i is consumed, and how much the norm consumes $\bar{g}$. This becomes $n_i(g_i,\bar{g}_i)$, but we also have an additional saliency of information term, I, that makes the norm information transferable into small behaviors, $n_i(g_i,\bar{g}_i)I$.

So people choose their gas consumption simultaneously to maximize the payoff:

$$u(g_i) = max_g[b_i(g_i) - c_i(p_i, g_i) + n_i^1(g_i, \bar{g}) + n_i^2(g_i, \bar{g}).I \qquad (1)$$

We would like to examine the function of n^1 and n^2. The function can be negative when people want to do better than their neighbors, but it can be positive when their gas consumption is lower than average so people want to increase consumption to conform to the norm. Or it might be that some individuals only care about their financial payoff from the gas consumption, $b_i(g_i)$ - $c_i(g_i,p_i)$, but not the norm.

Our first experiment allows us to robustly test the impact of the n functions, by randomizing across three groups: no one with the norm or information; norm only; norm and basic information. Those who are not told about the norm form a belief of how much gas they want to consume based on the available information and prior experience. The price of gas is fixed into the future (as it is a public utility) and individuals know this price ex ante, so there is no uncertainty in the price of future gas in the next time period. The norms only group firstly chooses their gas based on a prior belief of gas against the norm. The second group learnt about the norm and how far they are from it, and adjust their gas consumption based on the update. The norms with information group have the basic information made salient by being on the norm statement, and this information provides knowledge of the infrastructure in their home that allows them to change their gas consumption (i.e. inputs to the energy production function).

Overall, the norm could be a good update, in that your position against the norm was better than the prior belief. So we can denote $\alpha(g_i, \bar{g}_i; g_i \leq \bar{g}_i)$ to be the marginal change in gas consumption where there is a good update. The use of injunctive norm will notify individuals that they are behaving in a good way. If the update is bad (i.e. above the norm or worse than expected), then we have $\beta(g_i, \bar{g}_i; g_i > \bar{g}_i)$. By intuition of the descriptive norm of β, we expect this to have a dampening effect on consumption. The salient basic information will allow individuals to change their behavior if they want to conform to the norm. When I = 0, then we are left with either α or β. When I = 1, then we have two marginal effects as above. We can denote $\chi(g_i, \bar{g}_i; g_i \leq \bar{g}_i | I)$ to be the marginal change in gas consumption where there is a good update with basic information. If the update is bad, then we have $\phi(g_i, \bar{g}_i; g_i > \bar{g}_i | I)$.

The utility function of each individual is therefore:

$$u_i(g) = b(g_i) - p(g_i) + \alpha g D_\alpha + \beta g D_\beta + \chi g D_\chi + \phi g D_\phi \tag{2}$$

where b is the benefit from gas consumption (i.e. heating, cooking, washing), $D_\alpha=1$ when $g_i \leq \bar{g}_i$ and no basic information is provided, and zero otherwise. $D_\beta=1$ when $g_i > \bar{g}_i$ and no basic information is provided, and zero otherwise; $D_\chi=1$ when $g_i \leq \bar{g}_i$ and basic information is provided, and zero otherwise; and $D_\phi=1$ when $g_i > \bar{g}_i$ and basic information is provided, and zero otherwise. When we have norms only, the optimal level of gas to maximize utility is:

g^*_i = b - p + α if $g_i \leq \bar{g}_i$

g^*_i = b - p + β if $g_i > \bar{g}_i$

When we have norms and basic information, we have:

g^*_i = b - p + χ if $g_i \leq \bar{g}_i$

g^*_i = b - p + ϕ if $g_i > \bar{g}_i$

We will assume that, due to both the descriptive norms and the injunctive norms, α and χ are both negative i.e. there is an acceleration effect of even less consumption and that β and ϕ are also negative i.e. an encouragement effect to reduce consumption to conform to the norm.

The studies to date though, have made the social norm salient through the

Home Energy Reports (see Allcott, 2011), and the average effect across consumers is that the χ and ϕ of the utility function reduces energy consumption by approximately 2-3%. What is missing here, as explained above, is the ability of the person to understand how to transform that norm into observable behavior change. Therefore the norm has to be accompanied by the information to actually change behavior. This information parameter might include peoples cognitive skills, which allows the individual to understand what the norm actually means and whether it is a good or bad thing socially.

We will test the equality of effects in these utility functions using our first natural field experiment. The null hypothesis of no impact of norms on utility is what we initially test, i.e. $\alpha = \beta = 0$, and then we test the null of no impact of norms and basic information on utility, i.e. $\chi = \phi = 0$. Comparing the marginal effects against one another allows us to examine the impact of basic information itself on gas consumption. Importantly for our first NFE, we will be interested in the differences between the same treatment coefficients. So we will test two equalities: $\alpha = \chi$ and $\beta = \phi$. The former will test the importance of information for people consuming below norm energy, and the latter will test the importance of information for people consuming above norm energy.

For the impact of the salience of the social norm, inefficient frames, and financial rewards, we can be a little more specific. We know very little about the mode of delivery of the norms and the impact of rewards in conjunction with the norms. Furthermore, the effect of norms on utility is dependent upon the households knowledge of the norm. To incorporate such knowledge into the model, we include a term to represent the salience of or attention to the norm, as follows:

$$u_i(g) = b(g_i) - c_i(g_i, p_i) + [1 - \theta(s, o)]n_i(g_i, \bar{g}) \tag{3}$$

where $\theta \in [0,1]$ represents the degree of inattention, which is a function of salience, s, and other competing stimuli, o (as in DellaVigna, 2009). The inattention term, θ, simply captures the degree to which the individuals attention is directed toward the norm (where $\theta = 0$ represents full attention). If it is the case that offline norm information is more salient, then θ will be lower for those receiving norms information offline as opposed to online; therefore, for those receiving the norm offline, the effect of norms on energy consumption would be greater.

Within this framework, norms can be distinguished from a Becker-type model of household production, in that norms may be a frame that notifies people that they are inefficient users of energy. We provide a treatment frame of high-energy user only and then interact that with a social norm. When rewards are possible, the receipt of monetary incentives affects households expected utility. Including rewards in the utility function, we have:

$$u_i(g) = b(g_i) - c_i(g_i, p_i) + [1 - \theta(s, o)]n_i(g_i, \bar{g}) + r(g_i, \bar{g}) \tag{4}$$

where r represents monetary rewards for reaching target consumption and is a function of a households consumption and the given norm. Similar to the effect of norms, r will yield positive utility if the households consumption reaches the target consumption (here, the norm), but will yield no utility otherwise.

If we assume that norms and financial rewards operate independently from each other, the above utility function is complete. On the other hand, if these mechanisms elicit different behaviors in combination than they do independently, an additional parameter is necessary:

$$u_i(g) = b(g_i) - c_i(g_i, p_i) + [1 - \theta(s, o)]n_i(g_i, \bar{g}) + r_i(g_i, \bar{g}) + \kappa_i(.) \tag{5}$$

where κ represents an interaction effect between social norms and rewards. In statistical terms, it represents the coefficient on the interaction term n(g_i,$\bar{g}$) $\times$ r(g_i,$\bar{g}$). There is no existing literature on the relations between norms and incentives, so its effect is thus far theoretically ambiguous.

Accordingly, we have the following partial derivatives:

$$\partial u_i(g_i)/\partial b_i(g_i) > 0 \tag{6}$$

$$\partial u_i(g_i)/\partial c_i(g_i) > 0 \tag{7}$$

If $g_i < \bar{g}$:

$$\partial u_i(g_i)/\partial n_i(g_i, \bar{g}) > 0 \tag{8}$$

$$\partial u_i(g_i)/\partial r_i(g_i, \bar{g}) > 0 \tag{9}$$

If $g_i > \bar{g}$:

$$\partial u_i(g_i)/\partial n_i(g_i, \bar{g}) < 0 \tag{10}$$

$$\partial u_i(g_i)/\partial r_i(g_i, \bar{g}) = 0 \tag{11}$$

We subsequently obtain:

$$\partial u_i(g_i)/\partial \kappa > \partial u_i(g_i)/\partial n_i(g_i, \bar{g}) = 0 \tag{12}$$

$$\partial u_i(g_i)/\partial \kappa > \partial u_i(g_i)/\partial r_i(g_i, \bar{g}) = 0 \tag{13}$$

The partial derivatives in (6) and (7) capture the positive and negative effects of increases in benefits and costs (respectively) on household utility. Since all of the individuals sampled in the second field experiment consume more than the average customer, the social norm information should theoretically have a negative impact on utility and enhance effort to reduce energy consumption e_i; assuming offline norms are more salient, the norm effect in (8) and (9) may be stronger for those receiving norm information offline rather than online in the first experimental subgroup described in the next section.

Moreover, since incentives increase the expected utility of reducing energy consumption in (10) and (11), rewards should increase effort to reduce consumption as well. Therefore, if the norm and incentive mechanisms operate independently from each other, those with both social norms information and rewards are expected to achieve the highest energy reductions, as shown by (12) and (13). Additionally, higher rewards should yield greater reductions; as such rewards will exceed more individuals marginal cost of efforts to reduce energy consumption. We expect however that given the direction of change from both social norms and financial rewards independently, their effect when combined should also have a reducing impact on energy consumption.

3 Methodology

3.1 First NFE

We use a large housing estate owned by Camden Council, London, that was recently re-developed to meet energy efficiency standards. The estate received individual gas boilers with zonal controls, double-glazing, and external wall insulation. There are a total of 569 households that have been redeveloped and used in this experiment. The completed metered system provides gas from a communal source, and the installation of individual controls (thermostats and programmers) in each property gives residents full control over when and how they use gas for heating, cooking, and hot water. These were all installed in mid-2010. Individuals pay for their energy at a subsidized rate of 2.5p/kWh – this is extremely low (due to subsidization) and significantly well below the market price. We were able to remotely read gas consumption per day anonymously for each property. These households were selected by the Council and there was no self-selection onto this heating scheme.

We use a standard randomization process for our natural field experiment (see Harrison & List, 2004). We created six cells with the same number of people in each of the six cells these are described in Table 1. We took the average of the overall sample and split them into two groups: high users (above the norm); low users (below the norm). Then we unconditionally randomized the households into the three groups based on their consumption in November 2010, and the treatment started on the December 22, 2010. The actual numbers of households, their mean consumption, and the standard deviations are presented in Table 2. There were no significant differences between the treatment and control groups in terms of their baseline mean gas consumption. All of the energy statements were sent out by Camden Council and were received by all households on the same day.

We use both descriptive and injunctive norms for this experiment. The descriptive norm element comes in the form of a household's energy use that is compared to that of its neighbors. This is represented by the bar graph, where households are either below or above average consumption, and the length of the bar on the statement measures this difference.

Due to the fact that descriptive norms do not signal good and bad behaviors, it has been claimed that people who were below the norm use more energy – called the boomerang effect (Clee & Wicklund, 1980). The experiment by Schultz et al. (2007) used injunctive norms to mitigate the boomerang effect. These included 'smiley faces' (or emoticons) on the descriptive norm feedback reports given to these relatively low users, although Allcott (2011) questions their importance. Nonetheless, we used smiley faces for only those residents below the norm (i.e. groups C and E), and for group C a statement saying 'Congratulations. You are an energy efficient consumer.' and for group E 'Congratulations. You are an energy efficient consumer. On the back of this statement recommends ways for you to carry on saving energy and money.'. Those who were above the norm did not have a face (either happy or unhappy). They also did not have any injunctive language suggesting that they were behaving inefficiently on the statement.

The basic information given to the norms with information group did not specifically mention how much energy they would save with the small behaviors. There was also no measure of cost or effort needed for these small behaviors. The 'norms only' treatment is different from the basic information provided, since in the norm statement, there is no information about how they can change their energy behaviors. Moreover, the basic information has no social norm or pressure element. We carefully framed the information so there is no reference to desired behavior from a societal point of view. While the consumers in our study were freely allowed to believe that the basic steps to change their behavior were easy steps to conform to the norm, there was no reference to what the desired behavior was.

We do need to address the issue of contamination of the control group by the treatment group. There are five important reasons that allow us to argue that contamination is not generating important biases in the estimated treatment effects. Firstly, people did not know that there was an experiment and were not told at any point that their energy was being monitored for any research or experimental purposes. Secondly, the energy statements were private, i.e. not at all public. If people in the study talked to other people in the study, they: (a) would not know that they potentially had a different energy statement; and (b) might not necessarily talk about their energy bills. Thirdly, our energy statements were household specific, and the norms presented were based on similar sized properties. Peoples neighbors live in different sized households, so they would have different norms. Fourthly, and shown in our empirical section, the largest treatment effects from our study happen on the day that residents receive the energy statement, before any communication can realistically take place. So contamination would not in this case cause an inflation of the treatment effect. Fifthly, the interaction term between the treatment variables and the variable measuring the proportion of treated neighbors is not significant. This proportion of treated neighbors is the proportion of the seven closest neighbors that are treated for each individual household. Thus we do not find any contamination effects.

Due to the structure of our dataset, we can run a panel model and ascertain a treatment effect through a difference-in-difference specification:

$$G_{it} = \beta.P_{it} + \tau_1(T_{1i} \text{ x } P_{it}) + \tau_2(T_{2i} \text{ x } P_{it}) + u_i + \epsilon_{it}$$

where G_{it} is the gas consumption (measured in cubic meters) of the individual household, i, per day, t. τ_1 is the average treatment affect for the norms only group, and τ_2 is the average treatment effect for the norms with information group. This specification will model energy use conditional on treatment groups (T_{1i} and T_{2i}), post-treatment indicator (P_{it}), and household fixed effects u_i. This specification is estimated in OLS using the standard fixed effects estimator, using robust standard errors clustered by household to be consistent with any correlation in the errors within households over the study duration (Bertrand et al., 2004). We do not have to account for attrition or selection effects since no one can opt out of the treatment, and no one moved property in the research period. We see this as a very tight natural field experiment.

We will also examine the possible boomerang effects by segmenting the above and below norm users, and we include deviation terms to determine the effects of the treatments as consumers get further away from the social norm. We will also examine heterogeneity to the treatment using the background variables that may impact energy consumption. We have detailed data on size of property (using number of bedrooms as a proxy for household size), asset wealth (i.e. whether they own their property – leaseholder – or whether they are a social tenant), gender of the head of household, and age of the head of household. We also control for daily temperature from the nearest weather station, which is situated less than one kilometer away.

3.2 Second NFE

The second NFE consists of First Utility customers in the U.K. that consume more electricity than the average of all First Utility customers but are not in the extreme tail of the distribution. In other words, subjects in the experiment use more energy than average. The sample is stratified into four subgroups based on energy consumption over the three months prior to the intervention. This stratification of experimental subjects essentially yields a dataset that can be divided into four smaller experiments; three of which contain two treatment groups and one of which contains a single treatment group, and each with its own corresponding control group (see Table 3). Stratification allows for sorting on energy consumption (a continuous variable), which enables selection of subgroups of First Utility customers with minimal variance of the dependent variable and randomization within subgroups (List et al., 2009). Due to the variance in consumption being reduced, we can use smaller samples to detect treatment effects. the control period was January 2012 to March 2012, and the treatment period was April 2012 to May 2012, amnd we measured consumption until the end of July 2012.

The first subgroup (Subgroup 1) consists of 676 households whose energy consumption ranges from 1100-1850kWh for the control period, and its purpose is to isolate the effect of receiving social norms information in both online (i.e. emails) and offline (i.e. posted letters) formats. This subsample is the only one in which some subjects receive energy bills offline. They received the same statements as those used in the first experiment.

Subgroup 2 is comprised of 608 households in the consumption range of 1160-1970 kWh from January 2012 through March 2012. In both treatment groups, households receive a message that their household consumption is above the norm, while those in only one treatment group also receive information on what the norm is (in kWh) so that they may compare their own consumption to the average. This high-end user frame told households how much they consumed, and then stated 'This consumption would be regarded as HIGH for your property type.'

Subgroup 3 compares 539 households with consumption between 1350-2000kWh in the control period to discern the effect of receiving social norm information in addition to a financial incentive to reduce their consumption over the next two months (predicted using the previous three months consumption) by 30%. The reward is £100 in one treatment group five and £10 in treatment group six. The final subgroup (Subgroup 4) contains 319 households with consumption levels in the range of 1500-2100kWh from January 2012 through March 2012, and this treatment group is offered a reward of £100 for 30% reduction without any social norm disclosure. the reward was framed as: 'To encourage you to save energy, we would like to offer you an incentive. If you can keep below [target] kWh over the next two months (April 2012 May 2012) so that your electric usage is more in line with the average consumption of other similar homes, then we will reward you with 100!'.

To randomize the 2,142 households, we first created four subgroups with monthly pre-treatment consumption means close to 475kWh, 525kWh, 575kWh, and 615kWh. By centering each group upon a different mean instead of randomizing around the mean of the entire sample, we decreased the variance in the four subgroups in order to detect the same size treatment effect with smaller sample sizes. To ensure that no subject belonged to more than one treatment or control group, we defined groups in the following way. First, we chose people whose pre-treatment consumption ranged from 1100-1850kWh and randomized 91 households into Treatment Group 1 and 86 into Treatment Group 2. Second, we identified households who consumed 1160-1970kWh and randomized 90 into Treatment Group 3 and 89 into Treatment Group 4. Third, we chose households whose consumption ranged from 1350-2000kWh and randomized 84 to receive Treatment 5 and 87 to receive Treatment 6. Lastly, we randomized 75 households in the range of 1500-2100kWh into Treatment Group 7.

We randomized households into four subgroups using a random number generator and did this only once before achieving balance. We subsequently generated t-tests to ensure that there was no difference of means (i.e. balance) within any subgroup at the 10% significance level (as shown in Table 4); this process ensures that the treatment groups have been properly randomized.

Our conjectures are that:

Conjecture 1: Social norms information will cause high using subjects to consume less energy. This effect will be enhanced by the salience of the information, which is expected to be higher for those receiving the norms offline (i.e. letter) as opposed to online (i.e. email).

Conjecture 2: Learning that one is a 'high-end user' will cause a reduction in energy consumption. For those who are told the norm in addition to their 'high-end user' status, their reductions will depend on their own consumption relative to the norm.

Conjecture 3: When financial incentives are included with social norms information, energy reductions will be higher than when social norms are given on their own. In addition, the high (i.e. £100) reward will induce higher effort to reduce energy consumption than will the low (i.e. £10) reward.

Conjecture 4: Financial rewards on their own will achieve significant energy reductions, though not quite as high as if social norms information were also involved. This hypothesis assumes that social norms and financial incentives operate independently and therefore have an additive effect. If, instead, intrinsic motivation is important, the crowding out effect may mean that financial incentives will be more effective in isolation.

4 Results

4.1 First experiment

We provide data on 569 households from the start of October 2010 to March 2012. The results are provided in three main sections. The first analyzes the individual level daily data across the whole time period. The second examines the robustness of the results to time-varying characteristics, and provides tests of heterogeneity based on personal characteristics. The third summarises the results in terms of its comparison to the elasticity of demand, and the actual energy, money and carbon saved as a result of the intervention.

Table 5 illustrates the fixed effects regressions for two months worth of daily data – one month pre-treatment and one month post-treatment. The difference-in-difference estimators are (Post * Treat1), which is norms only, and (Post * Treat2), which is norms with information. It is clear that both difference-in-difference coefficients are negative and significant in the basic econometric specification (1). Once we control for daily temperature (2) and the correlation of the error within households over time (3), we find that the difference-in-difference coefficients do not change. But the standard errors increase when we cluster the standard errors, suggesting a correlation in the error within households across time. The norms only treatment does not remain significant at the ten per cent level once we cluster the standard errors.

To work out these effect size, we need to show the impact against the behavior of the control group post treatment. The control group post treatment until the end of January consumed on average 4.068m3 of gas per day. The norms only effect size across these four regressions is around -0.18, suggesting an average treatment effect of 4.4%. With our norms with information effect size being around -0.44, the short-term effect of this treatment on energy consumption is 10.8%.

Column (1) of Table 6 examines only one treatment day – i.e. the first treatment day (December 23, 2010). So this will examine the behavior straight after the treatment has been given. It is clear that the effect size is very large for this one day of treatment. The treatment effect for norms only is 11.7% (0.18σ), and the norms with information treatment effect is 15.4% (0.25σ).

The other specifications in Table 6 examine longer time periods for both pre and post intervention. This is to provide some sensitivity over the control period used, and to examine the durability of these treatment effects. Increasing the post-treatment time period to February 2011 (two months) in specification (2), we find that the treatment coefficient is estimated at -0.366. The control consumption across the post intervention period was 3.808m3 per day. Therefore, the average treatment effect for norms only and norms with information are 2.9% and 9.6% respectively. Specification (4) includes the Share variable, which denotes the proportion of the closest seven neighbors that are in a treatment group. By interacting this with both treatments, we find negligible effects, which allows us to rule out any contamination of the treatment to other households (as referred to in section 3).

Specification (7) analyses the whole dataset with respect to time (i.e. October 2010 to March 2012). We find we find that the treatment effect for groups 1 and 2 are 7% (0.03σ) and 6% (0.03σ) respectively. These effects are quite similar to that found for the few months, but the standard deviation effect sizes are smaller due to greater variance in 18 months gas consumption. We observe that when we examine the impact of the three interventions (dec2010, June2011, Jan2012), we find that 'norms only' catches up with the 'norms with information' treatment. Actually, giving information with the norms has a coeffiicient of -0.161 while the 'norms only' has a coefficient of -0.195. This suggests that the extra information that might have increased knowledge does not produice any beneficial effects over the long-run. For the shorter time period in specification (6) (examining a month before and a month after the third intervention period), we find that the treatment effects for groups 1 and 2 are 8% (0.1σ) and 5% (0.06σ) (the difference is p=0.38) respectively. This evidence points to the fact that norms on their own actively increases energy conservation.

We now examine those individuals who were above and below the norm separately. We will split the data and analysis into those above and below respectively. Table 7 presents four specifications. The first two represent above norm customers only and the second two represent the below norm customers, with regressions (1) and (3) examining the whole time period and regressions (2) and (4) examining the last intervention in January 2012. Firstly, there are no significant differences between the two treatments for those above the norm for the whole experimental duration. Secondly, the treatments did not have an effect for those below the norm over the whole experimental period. This is consistent with Allcott (2011). The last treatment did seem to have an initial impact on those who received the norms only and not on those who received norms plus information.

Table 8 presents the heterogeneous interactions with the treatments across the whole sample period. As mentioned above, we will examine the impact of the treatments based on household size, asset wealth, age, and gender of the head of household. Specification (1) shows that larger households are more responsive to both treatments than those from smaller households, but larger for the 'norms only' group. Specification (2) clearly shows that the more wealthy households are less responsive to the norms with information treatment than the less wealthy households. Specification (3) shows that the age of the head of the household has no effect on the treatments. Specification (4) demonstrates that males are much less responsive to norms only than females – the difference being around 0.400m3 of energy consumption per day. Once we control for these background variables in specification (5), the only variable that remains important is size of property. Interestingly, once we control for baseline consumption in specification (6), the results do not change. The coefficients on the variable to denote whether a household is under consumption are positive, suggesting that those under the above are more likely to change their behavior, once we control for background characteristics.

Within this section, we examine the differences in consumption in terms of the elasticity of demand, money saved, and the carbon saved. Firstly, it is important to examine what type of price increases would be equivalent to such a short-term change in consumption across the sample. Many of the studies examining the price elasticity of energy demand for households around the world provide an estimate of around -0.1 to -0.3 (Lijesen, 2007). These are the similar values used by the UK Governments long-term projections (CCC, 2008a). Using the range estimate above for the short-run elasticity, we can estimate the price equivalent effect of the social norm. Using our 7% estimate of the norms with information treatment effect, this would be equivalent to increasing short-term energy prices by around 20% to 60%. Given that energy is fairly price-inelastic, our comparable estimates are very large. This is especially so given that the treatment is only one letter sent by the Council.

Our norms only treatment effect being -0.195m3 per day over 15 months (450 days), the cumulative energy reduction per household is 87.75m3 of gas. The conversion factor is 1m3 = 11.4kWh, so each household reduced their consumption by 1000kWh over this time period on average. For the monetary value, each kWh is charged to these households at around £0.025. So during the project time frame, the interventions saved the average resident around £25. For our norms with information sample, they saved around £4,725 altogether. If we use market gas prices, which is currently around £0.09 per kWh, the amount saved per resident would be around £90, with an overall saving of £17,000 for the whole experimental group.

For carbon dioxide, we know that 1000kWh is equal to 0.18322 tons of carbon dioxide (DEFRA, 2011). Thus, we saved around 0.18 tons of carbon dioxide per household. If the current market value of carbon dioxide per ton is £40 (CCC, 2008b), then the external cost saved in this case is £7.20 per household. These private and social costs are large given that the cost of the intervention per household was less than £3, so for each £1 spent, we saved 333kWh. In fact, such saving is the most cost-effective way to conserve energy around the world (see Policy Exchange, 2013).

4.2 Second experiment

We will present the individual level results from the second NFE here, and price the results as we develop the specifications. The dataset we acquired from First Utility was anonymized and had no household level information, so we do not discuss any heterogeneity of our treatments. We will discuss the results by each subgroup as in the methodology section. The results stem from data on 2,142 households from the beginning of January 2012 through July 2012, with the intervention starting on April 2, 2012, for all treatment groups. The following four tables (Tables 9-12) report the results of the regressions for several post-treatment months to allow for detection of decay and persistence effects after removal of the treatment. Each table shows the results of the four subgroups where all regressions include dummies for each treatment group, interactions between each treatment group and the post-treatment dummy, and the post-treatment dummy on its own.

Table 9 provides the effect of offline social norms and online norms, versus the control group. The first column of Table 9 shows the results of the regression described above for Subgroup 1 only; that is, the pre-treatment period constitutes January-March 2012 and the post-treatment period is from April 2012 onwards. The regressions yield some very interesting results. With respect to the medium through which subjects receive social norms information, it seems that offline norms can have a higher effect on conservation than online norms, although the difference is not significant at the ten per cent level. Offline social norms have a negative effect on energy consumption, which is significant to the 5% level for both July on its own as well as the two-month period of June and July. The offline norm reduces average energy consumption in July by 5.73% or 0.22σ compared to the control group. These results support what is found in the first natural field experiment in this paper. Offline social norms have a higher effect on conservation only once we examine the long-term — specification (3). This difference is significantly different to the online social norm group ($p<0.05$).

Using the same demand elasticity as above, the offline norm has the equivalent effect of an increase in short-term energy prices of 13 to 39% for June and

July together. In terms of carbon savings for July, we first multiply the average monthly kWh reduction (15kWh) by the treatment group size (n=86) to calculate the total kWh savings of 1,290 kWh. Since 1000kWh of energy usage emits 0.183 tons of carbon dioxide, the offline social norm treatment saved 0.47 tons of carbon dioxide in the months of June and July alone. Contrary to its offline counterpart, the online norm appears to have little to no effect on energy consumption; the coefficient for offline norms is, in fact, positive (though not significant) for most post-treatment months. This results supports organizations, such as Opower, using offline methods to conserve energy.

Table 10 presents the energy inefficient frame results — i.e. 'high-end user'. As we can clearly see, the 'high-user' frame (treatment group 3) has positive coefficients throughout, which suggests that it increases energy consumption (although none significant at the ten per cent level). This clearly does point toward the interpretation that social norms are very different from being notified that the household is a high user and therefore is acting inefficiently. In fact, when social norms are used in addition to high-end user, these coefficients reduce but none are significantly different from one another. This does point to the fact that notifying people that they are a high-end user does not make them conserve energy.

Perhaps the most interesting findings are those associated with social norms, financial incentives, and their interaction. In accordance with standard theory, large financial incentives (e.g. £100 reward) decrease consumption for all post-treatment months at the 5% significance level and even at the 1% level for regressions in some post-treatment months see table 12. The difference in difference coefficients for the June-July regression are highly negative and significant to the 1% level, a result that shows persistent effects of financial incentives (i.e. no crowding-out effect). Two t-tests comparing the coefficients for April-May to those for June-July show no signs of decay ($p=0.89$).

The interaction between social norms information and small monetary incentives (i.e. £10 rewards) appears to be mildly counterproductive, as indicated by the positive coefficients for the interaction of Treatment 6 with the post-treatment dummy in Table 11. In fact, the interaction of norms with the smaller incentive is highly counterproductive for those below the pre-treatment consumption mean in Treatment 6 (575kWh for January-March); the difference-in-difference coefficient is 16.2 ($p<0.05$). A t-test shows that these coefficients are statistically different from each other ($p<0.05$). This suggests that giving a £100 reward had a better effect of reducing consumption than £10.

The immediate effect of large financial incentives is around 8% (0.35σ) across all time periods. In regression output units, these reductions are equivalent to the average monthly energy consumption of 1.8 to 2.4 household LCD televisions (Energy Saving Trust, 2012). Using the method described above, these energy savings translate to carbon savings of 0.4-0.6 tons per month. These results suggest that financial incentives do not crowd out energy behaviors in the future. In fact such rewards crowd in energy behaviors since the reduction is maintained up until two months after the trial period. Finally, when all post-treatment months are included in the regression, the effect of the incentive is to reduce consumption by 7.75% (0.32σ). These average treatment effects are larger than those found in any previous NFE that aims to alter residential energy consumption.

It is very interesting to compare treatment groups 5 (£100 reward and social norms) and 7 (£100 reward). It is difficult to explain from standard theory why an identical monetary incentive produces no effect when interacted with social norm information. Not a single coefficient for the Treatment 5 interaction is as negative or significant as those for Treatment 7, and the coefficients are not consistently positive or negative for all post-treatment months. When comparing coefficients, we find that the £100 only group has a significantly larger reduction in energy consumption than £100 plus social norms for all periods (every t-test has a p-value$<$0.05). This provides robust evidence that financial rewards to promote energy conservation can be highly effective, and remain long-lasting even after the reward has been removed for the individual.

5 Discussion

These two natural field experiments clearly demonstrate that social norms can change energy behavior. Our research is consistent with the work that has found that non-pecuniary strategies can have long lasting effects on behavior.

Our first field experiment demonstrates some key results that differ from previous work in this area. Firstly, we show that social norms work well irrespective of basic information. Secondly, we show that social norms work in addition to a standard energy statement. Thirdly, we show that social norms can have sustainable effects over a number of months and years after the first energy statement. This is very interesting given that there were no punishments or sanctions if people did not conform to the norm, and no covenants were used

(Ostrom et al., 1992).

We show that social norms have an immediate impact on behavior, and that this immediate impact is the largest impact, with a slight wane over time. The immediate impact of social norms with information on consumption is around 0.25σ, which is comparably large to other effect sizes in energy consumption. This finding suggests that such social norms do not take time to embed within habits or behaviors. Rather they produce an instantaneous reaction to the treatment, which has implications for the diffusion models of social learning (Young, 2009). We do find some heterogeneity in response to the social norm statements. Those with larger properties are less likely to reduce their consumption with the treatment over the long-run. We do not find any strong results for gender and wealth of the head of household.

Our effect sizes are much larger than those from the U.S. causal studies (Allcott, 2011; Ferraro & Price, 2011) and correlation studies (Arimura et al., 2011; Darby, 2006; Fischer, 2008; Reiss & White, 2008; Friedrich et al., 2009). There are potentially five reasons for the difference. Firstly, we use primarily social housing where the tenant rents the property from the Council or a private landlord. The U.S. studies use private households. This is extremely interesting since our households pay very little for their energy, so you would expect the effects to be larger when the price of energy is higher. Secondly, our sample is from the U.K., and not from the U.S. Thirdly, our intervention is on the actual energy statement from the energy provider. The Opower intervention is separate from the energy provider statement. Fourthly, our design is somewhat different. For instance, we do not use the most energy efficient neighbors on the statement and do not place any other information on the front page apart from the norm. Fifthly, our households do not have smart meters or in-home displays, so they did not receive immediate feedback from their behavior change. So it could be that some in-home displays provide more information than is optimal to reduce consumption, i.e. some uncertainty in the outcome of the behavior change may be good for sustaining long-term effects. These five factors might come together to collectively produce a large difference in the effect sizes found in different field experiments. Further research should attempt to identify the differences across various studies.

Our second field experiment further shows the impacts of social norms online and offline, and how such norms are different to energy inefficiency concerns, and that when financial rewards are overlaid with social norms we do not find the positive impact of norm information. We find that social norms only work when they are delivered offline via letters through the post, but do not work when sent by email. This is the first finding of norms working differently for different modes within the same study.

We do find that the effects of financial rewards for energy conservation to be large and persistent over time. The energy conservation remains even when the financial reward is removed. We find however that the strength of the financial incentive is reduced when social norm information is provided. This differs from the literature that financial incentives can change the social norm (see Fuster & Meier, 2010). Energy consumption may be one domain where providing social norms interact with the price effect. This corroborates the results from Herberich et al. (2011) where price effects and social norms work on different margins. Nonetheless, using large financial rewards to motivate energy behavior change can be long-lasting and cost-effective.

Interestingly, how research suggests that financial rewards do not crowd out any intrinsic reasons to conserve energy. Though energy-saving behaviors are similar to charitable giving (Gneezy& Rustichini, 2000) and blood donation (Titmuss, 1970; Mellstrm & Johannesson, 2008; Lacetera et al., 2012) in certain respects (i.e. both yield negligible private payoffs relative to their public benefits), public image or reputation is largely irrelevant in the context of residential energy consumption. Therefore, the extent of intrinsic motivation is likely not dependent on image motivation and is only a function of ones enjoyment as well as personal image and beliefs (Ariely et al., 2009). Thus, problems of crowding out intrinsic motivation due to rewards effects on personal or public image are likely absent in this study focused on energy consumption.

There are further questions that arise out of this research that we have not addressed. Firstly, to what extent are there spillovers to other behaviors within the same household? For instance, if a household saves money on their energy bills, what do they spend that money on and does this spending offset the benefits (the indirect rebound effect) or increase energy and money savings (e.g. buying energy efficient light bulbs) (Greening et al., 2000)? Secondly, previous research on the impact of positional goods suggests that energy is one of the least visible goods and therefore people do not necessarily compete on energy (Heffetz, 2011). It would be theoretically and empirically interesting to determine whether providing information on the norms of other low visible goods, such as insurance and healthcare, can also have large effects by minimizing incorrect beliefs about normal behavior (Miller & Prentice, 1994). Answering these questions will lead to better understanding of the efficacy of pecuniary and non-pecuniary incentives on behavior, as well as how they can be used effectively for policy purposes.

Overall, providing information on the average neighbor can promote energy conservation. We find that the information on the average is enough to motivate people to reduce their consumption, and that financial rewards are effective in reducing consumption, even once they are removed. So we recommend that governments take such financial incentives and social norms seriously if they want to change energy consumption.

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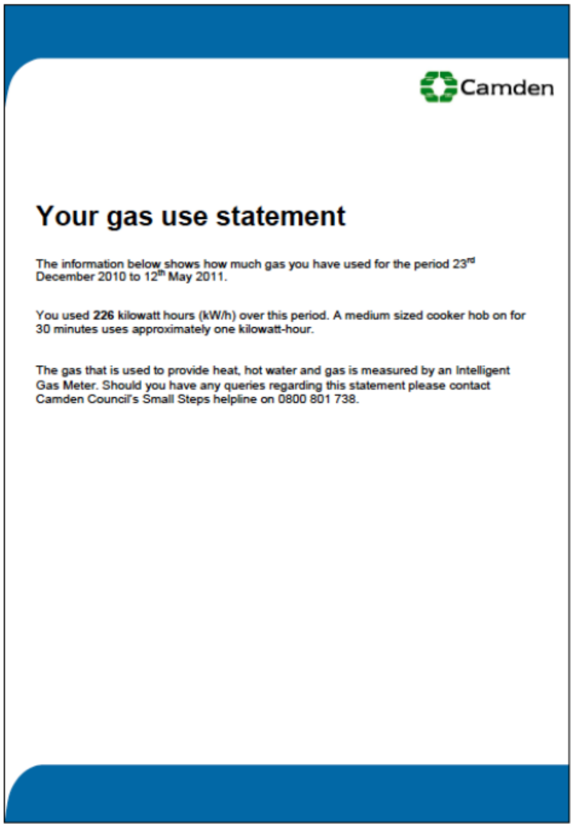
Figures of the treatment groups

Control



Camden

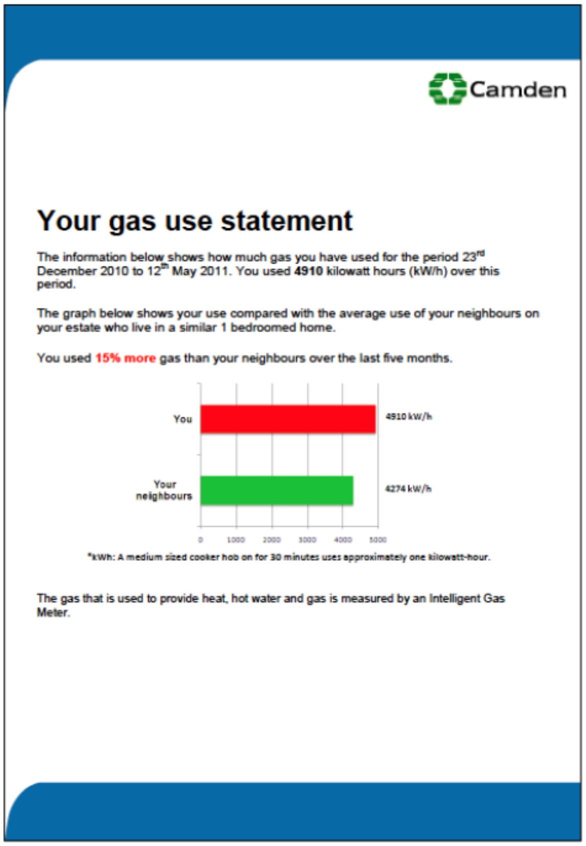
Your gas use statement

The information below shows how much gas you have used for the period 23rd December 2010 to 12th May 2011.

You used **226** kilowatt hours (kW/h) over this period. A medium sized cooker hob on for 30 minutes uses approximately one kilowatt-hour.

The gas that is used to provide heat, hot water and gas is measured by an Intelligent Gas Meter. Should you have any queries regarding this statement please contact Camden Council's Small Steps helpline on 0800 801 738.

Norms only - over



Camden

Your gas use statement

The information below shows how much gas you have used for the period 23rd December 2010 to 12th May 2011. You used **4910** kilowatt hours (kW/h) over this period.

The graph below shows your use compared with the average use of your neighbours on your estate who live in a similar 1 bedroomed home.

You used **15% more** gas than your neighbours over the last five months.

*kWh: A medium sized cooker hob on for 30 minutes uses approximately one kilowatt-hour.

The gas that is used to provide heat, hot water and gas is measured by an Intelligent Gas Meter.

Norms only - under

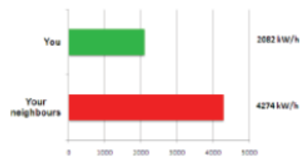
Camden

Your gas use statement

The information below shows how much gas you have used for the 23rd December 2010 to 12th May 2011. You used 2082 kilowatt hours (kW/h) over this period.

The graph below shows your use compared with the average use of your neighbours on your estate who live in a similar 1 bedroomed home

You used 51% less gas than your neighbours over the last five months.

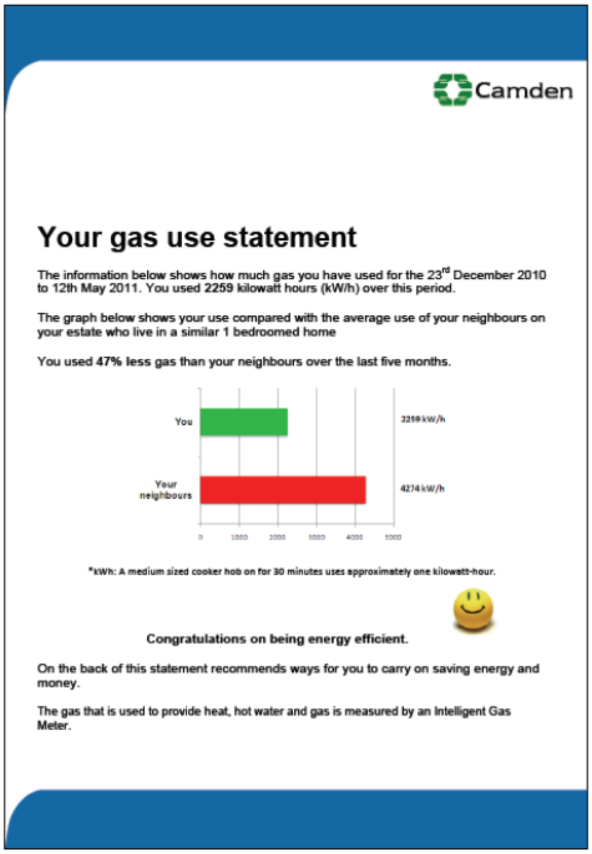


***kWh: A medium sized cooker hob on for 30 minutes uses approximately one kilowatt-hour.**

Congratulations on being energy efficient.

The gas that is used to provide heat, hot water and gas is measured by an Intelligent Gas Meter.

Norms plus information - under



Camden

Your gas use statement

The information below shows how much gas you have used for the 23rd December 2010 to 12th May 2011. You used **2259** kilowatt hours (kW/h) over this period.

The graph below shows your use compared with the average use of your neighbours on your estate who live in a similar 1 bedroomed home

You used **47% less** gas than your neighbours over the last five months.

*kWh: A medium sized cooker hob on for 30 minutes uses approximately one kilowatt-hour.

Congratulations on being energy efficient.

On the back of this statement recommends ways for you to carry on saving energy and money.

The gas that is used to provide heat, hot water and gas is measured by an Intelligent Gas Meter.

The information

Warm your home, cool your bills

Tips for saving energy and money at home.

One of the most effective ways of saving energy and money is to control your heating. Use controls to turn your heating down when it's too hot, or simply turn it off completely if you don't need it.

You can control your heating in the following ways:

A programmer - use this to decide the times that your heating and hot water come on and off. You may find that since the insulation has been installed you do not need to heat your home for as long in order to reach your required temperature.

Radiator valves - used to control the temperature in an individual room. The Energy Saving Trust recommend reducing the temperature in unoccupied rooms.

A room thermostat - use this to control how warm your home gets. Reducing the temperature a little bit can make a big difference on your heating bills.

You can reduce your gas use in other ways by using less hot water for washing and cooking and by washing clothes at a lower temperature.

For more tips on saving energy and money at home visit **camden.gov.uk/smallsteps** or call us on 0800 801738.

Camden

Table 1: The groups of the first field experiment

Treatment	Above norm 1	Below norm
Control	A. Plain energy statement	B. Plain energy statement
Intervention 1	C. Plain energy statement + Norms	D. Plain energy statement + Norms
Intervention 2	E. Plain energy statement + Norms + Info	F. Plain energy statement + Norms + Info

Table 2: The control gas consumption (m3) of the groups - randomization check

	Control	Intervention1	Intervention2	Average
Above	N=95 Mean=5.2 (2.6)	N=92 Mean=5.3 (2.9)	N=95 Mean=5.3 (2.9)	N=282 Mean=5.2 (2.8)
Below	N=90 Mean=2.3 (2.0)	N=93 Mean=2.3 (1.9)	N=96 Mean=2.3 (2.0)	N=279 Mean=2.3 (2.0)
Average	N=185 Mean=3.7 (2.7)	N=185 Mean=3.8 (2.9)	N=191 Mean=3.8 (2.9)	N=569 Mean=5.0 (2.5)

Note: Standard deviations in parantheses.

Table 3: Second experiment stratification

Subgroup	Treatment groups	Consumption (kWh)	N
Subgroup 1	1: Online social norm	1098-1833	676
	2: Offline social norm		
	Control 1		
Subgroup 2	3: 'High-end user'	1164-1968	608
	4: 'High-end user' + social norm		
	Control 2		
Subgroup 3	5: £100 reward + social norm	1351-1998	539
	5: £10 reward + social norm		
	Control 3		
Subgroup 4	7: £100 reward	1501-2095	319
	Control 4		

Note: The consumption relates to the three months consumption before the experiment started.

Table 4: Randomization check

Subgroup	Treatment groups	Consumption (kWh)	σ	N	t-stat
Subgroup 1	TG1	467.7	66.1	91	-0.735 (p=0.46)
	TG2	476.9	76.5	86	1.190 (p=0.23)
	Control1	471.2	71.9	499	
Subgroup 2	TG3	525.6	71.8	90	0.039 (p=0.97)
	TG4	522.9	78.7	89	-0.392 (p=0.70)
	Control2	525.3	109.0	429	
Subgroup 3	TG5	568.8	87.0	84	-0.586 (p=0.56)
	TG6	582.5	76.2	87	1.481 (p=0.14)
	Control3	572.8	99.3	368	
Subgroup 4	TG7	616.1	93.4	75	0.654 (p=0.51)
	Control4	611.4	92.8	244	

Note: The consumption relates to the average of the three months consumption before the experiment started. The t-tests are comparisons with the control in each subgroup.

Table 5: Gas consumption over December 2010 - January 2011

	(1)	(2)	(3)	(4)
Post-intervention	-0.576***	-0.412***	-0.576***	-0.412***
	(0.037)	(0.039)	(0.090)	(0.091)
Post * treat1	-0.180***	-0.178***	-0.180	-0.178
	(0.052)	(0.052)	(0.124)	(0.124)
Post * treat2	-0.441***	-0.439***	-0.441***	-0.439***
	(0.052)	(0.052)	(0.123)	(0.123)
Constant	4.876***	4.876***	4.942***	4.876***
	(0.017)	(0.018)	(0.032)	(0.032)
Temperature	N	Y	N	Y
Clustered errors	N	N	Y	Y
R2	0.01	0.01	0.01	0.01
N	34,646	34,646	34,646	34,646

Note: Standard errors are reported in parentheses below the coefficients. Significance levels are noted by * p<0.1, ** p<0.05, and *** p<0.01. The variable (Post * Treat1) is the difference-in-difference estimator for the norms only treatment, and the (Post * Treat2) variable is the difference-in-difference estimator for the norms with information treatment.

Table 6: Gas consumption over different time periods

	(1)	(2)	(3)	(4)	(5)	(6)
Post-intervention	0.410***	-0.636***	-0.242***	-0.242***	-0.854***	-0.453***
	(0.147)	(0.090)	(0.075)	(0.075)	(0.070)	(0.074)
Post * treat1	-0.553***	-0.111	-0.120	-0.211	-0.195*	-0.280***
	(0.209)	(0.126)	(0.118)	(0.240)	(0.114)	(0.088)
Post * treat2	-0.768***	-0.366***	-0.211***	-0.287	-0.161	-0.170*
	(0.206)	(0.127)	(0.114)	(0.233)	(0.109)	(0.094)
Post * treat1 * share				0.026		
				(0.058)		
Post * treat2 * share				0.020		
				(0.060)		
Constant	4.970***	4.876***	4.339***	4.339***	3.551***	3.179***
	(0.088)	(0.038)	(0.038)	(0.038)	(0.039)	(0.016)
Temperature	Y	Y	Y	Y	Y	Y
R2	0.01	0.02	0.10	0.10	0.01	0.01
N	12,989	50,399	117,033	117,033	294,562	79,765
Time frame	Dec2010 - one day	Dec2010 - Feb2011	Nov2010 - May2011	Nov2010 - May2011	Oct2010 - Mar2012	Nov2011 - Mar2012

Note: Standard errors are reported in parentheses below the coefficients. Significance levels are noted by * p<0.1, ** p<0.05, and *** p<0.01. The variable (Post * Treat1) is the difference-in-difference estimator for the norms only treatment, and the (Post * Treat2) variable is the difference-in-difference estimator for the norms with information treatment.

Table 7: Gas consumption split between above and below norm consumers

	(1) Above norm	(2) Above norm	(3) Below norm	(4) Below norm
Post-intervention	1.148***	0.471***	0.498	0.434***
	(0.107)	(0.096)	(0.100)	(0.112)
Post * treat1	-0.364***	-0.228**	0.001	-0.304**
	(0.160)	(0.121)	(0.131)	(0.128)
Post * treat2	-0.410***	-0.213*	0.109	-0.127
	(0.131)	(0.126)	(0.140)	(0.140))
Constant	4.900***	4.149***	2.185***	2.197***
	(0.053)	(0.022)	(0.046)	(0.023)
R2	0.01	0.01	0.01	0.01
N	148,068	40,119	146,494	39,646
Time frame	Oct2010 - Mar2012	Nov2011 - Mar2012	Oct2010 - Mar2012	Nov2011 Mar2012

Note: Standard errors are reported in parentheses below the coefficients. Significance levels are noted by * p<0.1, ** p<0.05, and *** p<0.01. The variable (Post * Treat1) is the difference-in-difference estimator for the norms only treatment, and the (Post * Treat2) variable is the difference-in-difference estimator for the norms with information treatment.

Table 8: Gas consumption over October 2010 - March 2012 - heterogeneous effects

	(1)	(2)	(3)	(4)	(5)	(6)
Post-intervention	-0.854***	-0.854***	-0.830***	-0.854***	-0.830***	-0.830***
	(0.070)	(0.070)	(0.071)	(0.070)	(0.071)	(0.071)
Post * treat1	0.383**	-0.170	-0.263	-0.332**	-0.038	-0.195
	(0.166)	(0.122)	(0.358)	(0.138)	(0.387)	(0.373)
Post * treat2	0.052	-0.252*	-0.037	-0.127	-0.212	-0.315
	(0.168)	(0.114)	(0.201)	(0.134)	(0.333)	(0.229)
Post * treat1 * beds	-0.301***				-0.310***	-0.292***
	(0.069)				(0.090)	(0.083)
Post * treat2 * beds	-0.112				0.179**	0.173**
	(0.079)				(0.090)	(0.076)
Post * treat1 * lease		-0.166			0.139	-0.288
		(0.216)			(0.422)	(0.356)
Post * treat2 * lease		0.543**			-0.046	-0.122
		(0.222)			(0.449)	(0.345)
Post * treat1 * age			0.001		0.007	0.0003
			(0.006)		(0.007)	(0.006)
Post * treat2 * age			-0.006		-0.004	-0.003
			(0.006)		(0.006)	(0.005)
Post * treat1 * male				0.396**	0.103	0.020
				(0.173)	(0.186)	(0.165)
Post * treat2 * male				-0.090	-0.071	-0.121
				(0.163)	(0.201)	(0.170)
Post * treat1 * under						1.087***
						(0.156)
Post * treat2 * under						1.132***
						(0.154)
Constant	4.970***	4.876***	4.339***	4.339***	3.551***	3.179***
	(0.088)	(0.038)	(0.038)	(0.038)	(0.039)	(0.016)
R2	0.01	0.02	0.10	0.10	0.01	0.01
N	12,989	50,399	117,033	117,033	294,562	79,765

Note: Standard errors are reported in parentheses below the coefficients. Significance levels are noted by * p<0.1, ** p<0.05, and *** p<0.01. The variable (Post * Treat1) is the difference-in-difference estimator for the norms only treatment, and the (Post * Treat2) variable is the difference-in-difference estimator for the norms with information treatment.

Table 9: Difference-in-difference electricity (kWh) regressions for subgroup 1

	(1)	(2)	(3)	(4)
Post-intervention	-59.470***	-72.962***	-100.076***	-86.519***
	(3.257)	(2.530)	(2.828)	(2.225)
Post * treat1	1.915	4.143	-4.283	-0.070
	(8.292)	(6.441)	(7.200)	(5.666)
Post * treat2	-4.153	-3.752	-15.014**	-9.383
	(8.493)	(6.597)	(7.375)	(5.803)
R2	0.11	0.18	0.28	0.22
N	2,704	3,380	3,380	4,732
Time period	April	April-May	June-July	April-July

Note: Standard errors are reported in parentheses below the coefficients. Significance levels are noted by * p<0.1, ** p<0.05, and *** p<0.01. The variable (Post * Treat1) is the difference-in-difference estimator for the norms only treatment, and the (Post * Treat2) variable is the difference-in-difference estimator for the norms with information treatment.

Table 10: Difference-in-difference electricity (kWh) regressions for subgroup 2

	(1)	(2)	(3)	(4)
Post-intervention	-64.734***	-79.926***	-114.884***	-97.405***
	(5.691)	(4.250)	(4.190)	(3.340)
Post * treat3	11.469	7.755	6.296	7.025
	(13.665)	(10.206)	(10.061)	(8.021)
Post * treat4	8.555	4.802	1.721	3.262
	(13.729)	(10.253)	(10.108)	(8.058)
R2	0.06	0.12	0.22	0.16
N	2,432	3,040	3,040	4,256
Time period	April	April-May	June-July	April-July

Note: Standard errors are reported in parentheses below the coefficients. Significance levels are noted by * p<0.1, ** p<0.05, and *** p<0.01. The variable (Post * Treat1) is the difference-in-difference estimator for the norms only treatment, and the (Post * Treat2) variable is the difference-in-difference estimator for the norms with information treatment.

Table 11: Difference-in-difference electricity (kWh) regressions for subgroup 3

	(1)	(2)	(3)	(4)
Post-intervention	-80.696***	-97.571***	-135.256***	-116.413***
	(5.589)	(4.349)	(4.901)	(3.806)
Post * treat5	6.204	-0.836	-1.420	-1.128
	(12.965)	(10.090)	(11.369)	(8.829)
Post * treat6	4.94	5.862	14.774	10.318
	(12.781)	(9.947)	(11.208)	(8.704)
R2	0.11	0.18	0.24	0.20
N	2,156	2,695	2,695	3,773
Time period	April	April-May	June-July	April-July

Note: Standard errors are reported in parentheses below the coefficients. Significance levels are noted by * p<0.1, ** p<0.05, and *** p<0.01. The variable (Post * Treat1) is the difference-in-difference estimator for the norms only treatment, and the (Post * Treat2) variable is the difference-in-difference estimator for the norms with information treatment.

Table 12: Difference-in-difference electricity (kWh) regressions for subgroup 4

	(1)	(2)	(3)	(4)
Post-intervention	-88.692***	-104.558***	-152.087***	-128.322***
	(7.077)	(5.413)	(5.661)	(4.478)
Post * treat7	-30.566***	-38.462***	-36.443***	-37.453***
	(14.596)	(9.630)	(11.674)	(9.234)
R2	0.16	0.24	0.36	0.29
N	1,276	1,595	1,595	2,233
Time period	April	April-May	June-July	April-July

Note: Standard errors are reported in parentheses below the coefficients. Significance levels are noted by * $p<0.1$, ** $p<0.05$, and *** $p<0.01$. The variable (Post * Treat1) is the difference-in-difference estimator for the norms only treatment, and the (Post * Treat2) variable is the difference-in-difference estimator for the norms with information treatment.

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