Initial Effects of a Community-Based Initiative for Energy Saving: An Experimental Analysis

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This version: August 2013

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Abstract

Can community-based behavioural intervention reduce energy use in the home? We report on initial data from an ongoing matched case and control field experiment on energy saving. Household energy use in 175 households is measured using monitoring equipment, recording electrical power consumption and temperature. Participants in treatment and control groups received improvements to the thermal insulation of their homes. A behavioural intervention in the treatment group began with a 2 hour workshop on energy saving led by a community-based environmental group. We find some evidence of reductions in electrical power over the period of analysis, compared to the estimated counterfactual, but no evidence of reduced spatial heating or baseload power. The data are consistent with a substantial effect lasting over 3 months, although this cannot be inferred with confidence because of high variance. We explore the policy implications of the finding that a relatively modest level of community intervention has potentially substantial impact on energy use.

Keywords: energy saving, behaviour change, field experiment

1. Introduction

Twin themes of current energy policy are the need to reduce greenhouse gas emissions from fossil fuel use, and concern over potentially imminent energy scarcity and related cost or supply security problems. Engineering-based approaches to domestic energy saving have been an important component of the response to these issues. To achieve sustained and substantial energy use reductions plausibly implies changes beyond technological intervention, however, including efforts to change attitudes and behaviour.

A key reason for this is that the path of energy throughput reduction called for by climate change researchers seems too dramatic to be fully achievable by increased efficiency and non-fossil energy supply alone (Anderson and Bowes, 2008). A second reason is that behavioural factors are likely to impact on the resource savings that would be expected based on changes in the energy efficiency of appliances, perhaps radically at a macroeconomic level, through rebound effects (Polimeni *et al.* 2008; Sorrell *et al.* 2009). At the microeconomic level, such effects have been observed to contribute to disappointing and sometimes perverse results of home insulation improvements, as households may increase their use of spatial heating if it becomes cheaper to heat their rooms. For example, Hong e*t al.* (2006) observed an increase in mean energy consumed for spatial heating following home thermal performance improvements under the UK's Warm Font policy. The authors attributed this partly to inhabitants' behaviour, including comfort taking (a synonym for rebound), and partly to shortcomings in the implementation of the improvements.

There is already quantitative evidence from energy visibility studies that behaviour change can contribute to energy saving (Darby 2006), and we aim to advance understanding of its potential.

[1] [funding acknowledgement redacted for review].

We report on a study of household energy use in the context of thermal improvements to dwellings, coupled with behavioural intervention.

Progress on behaviour change may, conceivably, be able both to alleviate the behavioural undoing of engineered energy savings, and to drive such saving in its own right. Recently there has been considerable interest in the role of community-based organisations as possible mediators of behaviour change (Georg 1999, Hargreaves et al. 2008, Heiskanen 2010, Howell 2012, Middlemiss and Parrish 2010, Middlemiss 2008, Peters et al. 2010 and Seyfang et al. 2012; 2007). Those who posit the potential role of community organisations in encouraging behaviour change refer to the "bottom-up", voluntary nature of actions promoted by these initiatives (Peters et al. 2010: 13); greater levels of trust that community initiatives enjoy (Fudge and Peters, 2011: 801f., 805; Hale, 2010: 256) and greater "reach" that these initiatives have within society (Gardner and Stern, 1996: 143; HM Government, 2010: 3), compared to government or business action.

Whilst several studies found that the mere provision of information was not effective in influencing people's environmental behaviours (Abrahamse et al., 2005: 276ff.; Dwyer et al., 1993: 291), involvement with community initiatives is often assumed to be more successful in achieving change, especially if it involves interaction in small groups. Social interaction features prominently in theories of social practice (Wenger, 1999; Reckwitz, 2002; Shove et al., 2012) to account for the social constitution and generation of norms and identities. Of particular relevance to the present study is the associated view that interaction can transform social practices; see for example Georg, (1999); Hargreaves (2011); Hargreaves et al. (2008); Hobson (2003) and Nye and Hargreaves (2010).

Several evaluations of environmental community initiatives report that participants showed higher engagement in pro-environmental behaviours following the intervention. For example, evaluations of the Global Action Plan (GAP) Ecoteams approach, which involves attendance of a short, practically oriented seminar programme, have provided quantitative evidence based on both reported behaviours and measured energy use. This indicates that participants reduced household waste and electricity consumption and increased recycling (Davidson, 2010; Hargreaves et al., 2008; Nye and Burgess, 2008; Staats et al., 2004). Reviews of community waste programmes reported a reduction in waste or increase in recycling rates (Cox et al., 2010: 204; Gardner and Stern, 1996: 156ff.; Sharp and Luckin, 2006) and DEFRA's evaluations of the Environmental Action Fund projects found that several projects have encouraged behaviour changes, particularly in relation to waste reduction and home energy use (DEFRA, 2009: 4, 7f., 73).

However, in many of these studies it remains unclear whether participation in the initiative was the main reason for participants to change their behaviour, because they do not control for other factors. This can be achieved through an experimental design which not only compares energy use before and after the intervention but also compares to a control group that did not receive any behavioural intervention.

We report initial data from the first year of a three-year experimental study of a community-based initiative on household energy consumption. Central to the project is a field experiment using a matched treatment and control area. A village where a community environmental group (CEG) is active was matched with a nearby control site with no equivalent community activity. The CEG consists of a group of residents formed with the aim of promoting environmental awareness and reducing greenhouse gas emissions locally. Households in both settings received loft insulation and cavity wall insulation, which are among the cheapest and simplest engineering improvements per unit of potential energy saving (EST 2010), along with energy monitoring equipment. The CEG is working with participants in a number of ways, including through householder events, supported by a University-based research team. Our intentions regarding the intervention were that the community group be genuinely and proactively involved, rather than simply acting as a front for the researchers, that it would be something that government or local authorities could take up working with similar groups, and that it be well informed scientifically. Prior to the project the CEG and the researchers agreed that the CEG would run at least one householder event for all project participants per year. Administrative and planning support was offered by the researchers, plus assistance with costs.

This paper reports on the first such event and quantifies its effects on spatial heating and electricity use. The longer-term effect of a sustained series of such events and wider engagement by the community group, on a broader set of energy use metrics, is the subject of on-going research.

Since no other energy-saving interaction occurred between the CEG and the householders between the start of the project and the first householders' event, in this report we treat the effect of this event as a singular entity. Considered in itself the occurrence of such an event, which lasted around two hours, is a relatively modest intervention and was not expected to have dramatic impact.

2. Procedures

The study is situated in the South of England, UK. A key feature of the design is the use of two matched settlements, which was implemented as follows. Characteristics of potential locations were assessed by their ONS Output Area Classification (OAC) profile (Vickers and Rees, 2007). The OAC characterises small areas using a *k*-means clustering algorithm run on 41 variables in the following categories: demographics, household composition, housing, socio-economics, and employment characteristics. General requirements for both treatment and control groups were as follows. Firstly, most households would not have qualified for Warm Front assistance, since these groups have been studied previously, for example by Hong *et al.* (2006). Rather, we were targeting privately owned dwellings, with higher incomes than Warm Front recipients. Relatively less research attention has been given thus far to this group, though the current UK government's Green Deal initiative might be argued to target it. Secondly, the residential building stock would generally be in need of thermal upgrades.

A settlement providing the sampling frame for the Treatment Group (TG) was selected on these criteria, and the fact that there was an active CEG that the researchers could work with. 50% of the Output Areas (OAs) of the TG were in Supergroup 4, 'prospering suburbs'. A set of potential matched settlements to act as the Control Group (CG) was then selected using ArcGIS to locate settlements with clusters of at least 3 Supergroup 4 OAs. The following additional criteria were then applied. Firstly, there was to be no comparable CEG active in the area at the outset of the project. Secondly, the settlement had to be large enough to accommodate a target combined sample size of 200 households. Finally, it had to be close enough to control for weather conditions yet far enough apart for the TG and the CG to be distinct, non-bordering local communities. Once potential matches were identified, site reconnaissance visits were also conducted by the research team to 'ground truth' the matching. That is, the team checked by site inspection visits that the locations appeared to be well matched, in particular with regard to similarity of housing stock, and to see whether any salient differences were evident that were not captured in the OAC.

The two settlements selected are approximately 10 miles (16km) apart by linear distance, in the same county. Most of the residential building stock was constructed since the 1960s in each case, and both settlements had a preponderance of housing likely to be poorly insulated.

Recruitment was conducted via leafleting in both locations, and additionally via email and mouth-to-mouth through the CEG's networks in the TG area, offering an insulation package and use of energy monitors in return for participation in the project. Participants had energy monitors and insulation installed and were requested to complete surveys on other aspects of their energy use at 4-monthly intervals. In the intervention community, subjects further agreed to attend at least one householder event per year co-organised by the CEG. Insulation consisted primarily of cavity wall and loft insulation; only households that fulfilled either or both of these requirements were included in the study. The energy monitors record electricity consumption, temperature and boiler activity, relaying this information to a central database run by the energy monitoring company, Alertme (TM), via the internet. Temperature sensors, which upload via the energy monitors, were placed in the lounge. Households can log onto a website run by Alertme (TM) to view their data over a given period.

Our target sample size was 200 households, half in each location. The realised sample size at the start of the project was 185 households, 75 in the TG and 110 in the CG. An imbalance in sample sizes occurred because we had overestimated the number of suitable dwellings in the TG settlement. We were able to compensate by increasing recruitment in the CG, but not fully given the project's time constraints. The difference between the designed and realised sample sizes had only a minor effect on the estimated statistical power of the design. Key characteristics of households in treatment and control group samples, measured at the start of the project, are compared in Table 1 below. There are no significant differences between households in the two locations on any of the measures. We infer from this that the matching appears to be broadly satisfactory.

location	adults	children	senior citizens	income (£)	loft insulation depth (mm)*	% with no loft insulation	floor area (m^2)
treatment	1.8	1.2	0.2	52,600	90	32	107
control	2.0	0.9	0.2	52,400	85	27	118

Table 1: Characteristics of participating households in treatment and control locations (mean values, unless otherwise indicated)

* mean for households with insulation

The content of the event was determined by the CEG with input and assistance from the research team. The CEG hosted the event: chairing and introducing / closing the event, and assisting with smaller group activities. Refreshments were provided during a break and this was advertised beforehand to encourage attendance. The CEG introduction reminded participants of the purpose of the research and clarified the relationship between the researchers and the group. It gave a succinct description of how their participation related to challenge of addressing climate change. Participants were made aware that their engagement in energy intense behaviours may work against energy demand reduction achieved through thermal upgrade improvements to their house, via rebound effects. For example, if they were to use money saved on space heating to fly abroad on holiday, this may result in a net energy increase, and a net increase in the household's greenhouse gas emissions, despite the thermal upgrades. The researchers gave an informal talk which started by reiterating the aims and method of the research project. The effect of insulating the participating households was set out, in the context of average annual household emissions. The energy monitoring was discussed at length. First the information available from energy monitoring (including the ability to estimate energy use for heating and hot water as well as direct measurement of temperature and electricity) was reviewed. Next, the equipment reliability challenges for both householders and researchers were set out accompanied by advice on how to troubleshoot to optimise their performance.

At the request of the CEG, typical electricity consumption profiles were discussed and given context with reference to the number of lightbulbs that would achieve the same consumption and in terms of the annual financial cost (which the CEG felt was very important to emphasise).   The way in which different loads add up to form a consumption profile was discussed. Householders were shown how to extract their 'always on' baseload from the system and identify different characteristic events in their consumption profiles. Typical contributions to these loads were discussed and the potential savings to be made in reducing them were then evaluated hypothetically. A group discussion exercise followed. Several different sets of electricity data were provided and participants were challenged with matching these with scenarios differentiated by household / lifestyle status (for example, 'retired couple', 'away on holiday', 'photovoltatics fitted to the roof'). Following a debrief there was a second group exercise ranking different hypothetical energy saving measures, including wider behavioural changes (for example, driving slower or forgoing a flight). After the ranking exercise there was discussion and feedback on the correct answers.

The meeting was concluded by returning to the insulation improvements that people had received as part of the project and explaining that these changes could be sustained and improved with certain behavioural changes. Take home messages were communicated, namely to try to lower the thermostat by 1 degree, to pay attention to making savings by learning about excess use from the electricity monitors and to avoid too many flights.

Because it was not possible for all participants to attend on a single occasion, the first event was held three times, at meetings on the October 18th and 20th 2011 and Feb 2nd 2012. (We use the term "event" to refer to the common processes that took place at these gatherings, and "meeting" to refer to a specific instance of the event.) The first meeting was conducted approximately 13 months after the beginning of the recruitment phase. By this time most households (60% of the CG and 69% of the TG households) had received insulation upgrades. A total of 51 householders attended the event (of which 5 were members of the CEG), 39 of whom attended one of the October meetings. We use data from the October meetings only, because of the difficulty of constructing meaningful control data with split event timings. We allow for the slight difference in timing of the two October meetings in our statistical comparisons, using means weighted by the share of attendance at each of these meetings.

In the next section, we present the raw data diagrammatically. We then compare statistically the measurements in the TG and the CG for the 4 weeks immediately prior to the meeting with the 4 weeks after the event. Time-variable external factors, such as the weather, are controlled through the locational matching. We then test statistically whether the event had any measurable effect on household heating consumption (as proxied by the mean lounge temperature) and household electricity consumption.

The appropriate statistical comparison between the TG and the CG is of the mean differences in mean readings for a given period of time either side of the intervention – that is, a test of "differences in differences".   We did not choose a period longer than 4 weeks partly because we expected changes in household energy use to be most evident in the period immediately after the event. But properties of the data also favour this comparison. There are constraints on the maximum period due to the diminishing reliability of the pre-event data. The fact that recruitment and insulation installation was on-going during the summer, prior to the event, limits the period of time that can be used, albeit with no single and clear cut-off. The longer the pre-event time period, that is, the fewer observations underlie the mean readings at the start. The comparison of temperature also loses relevance during the summer when households use less heating, and this suggests a suitable period of one month of prior data.

3. Results

Time series of lounge temperature are presented in Figure 1 below, which is used as a proxy for spatial heating energy consumption. Power readings are shown Figure 2 below. The results shown are for the TG households attending the event (that is, the two October meetings) and the CG households. We plot the values for each group for weekly means, with lines showing simple interpolation. Error bars are shown at points of maximum separation in the series. Week zero is the week ending 19th October, that is, the week leading up to the two householder meetings.

The ambient temperature is reducing during the period as winter was setting in. Lounge temperatures would be expected to fall on average over the period, since at least some of the households would be expected to get cooler in the colder weather. This expected relationship is borne out by the time series.

Prior to the event, temperature signals in the two groups are consistent. From inspection of Figure 1, mean lounge temperatures in the participants' dwellings appear to show at most only a very slight separation from those of the non-participants' up to 6 weeks after the event. Thereafter mean measured temperatures reconverge.

Figure 2 shows that the general trend of power consumption in both groups is upwards, which would be expected going into the winter. At this time of year, total electrical power consumption generally increases due to additional lighting and to people staying increasingly indoors and therefore using their appliances more. Baseload is conceptualised as the 'always on' load, and operationalised as the mean of the lowest 5% of power readings during the time-period, excluding any readings below 10W. Baseload power is relatively constant as would also be expected. The mean of power use readings tends to be slightly higher in the treatment group than the control group over the entire period. However, there appears to be a somewhat clearer separation in the two series following the event. After the event, the means show an apparent separation of between 1 and 2 standard errors by week 10. We next assess the results statistically.

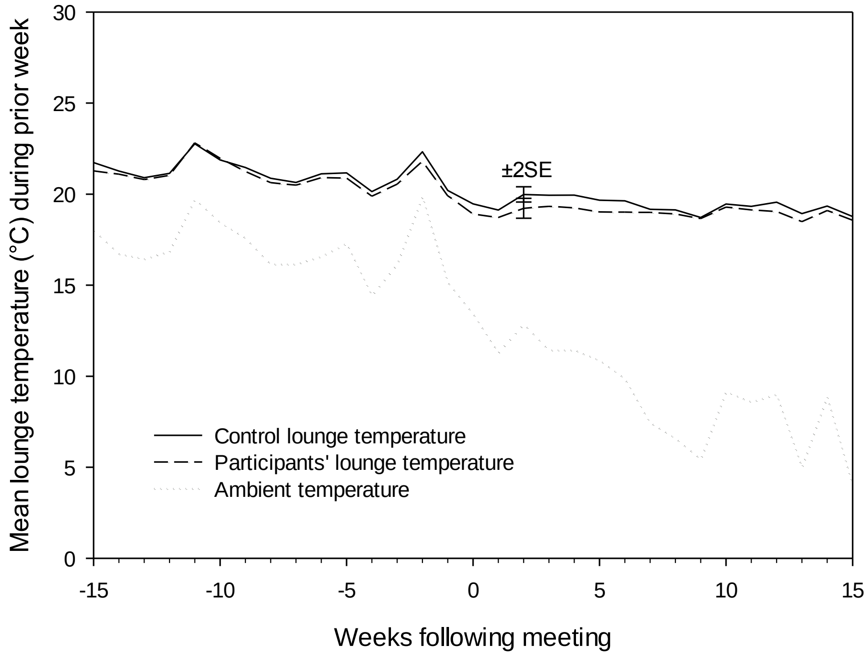

Figure 1: Mean lounge temperatures over 1 week.

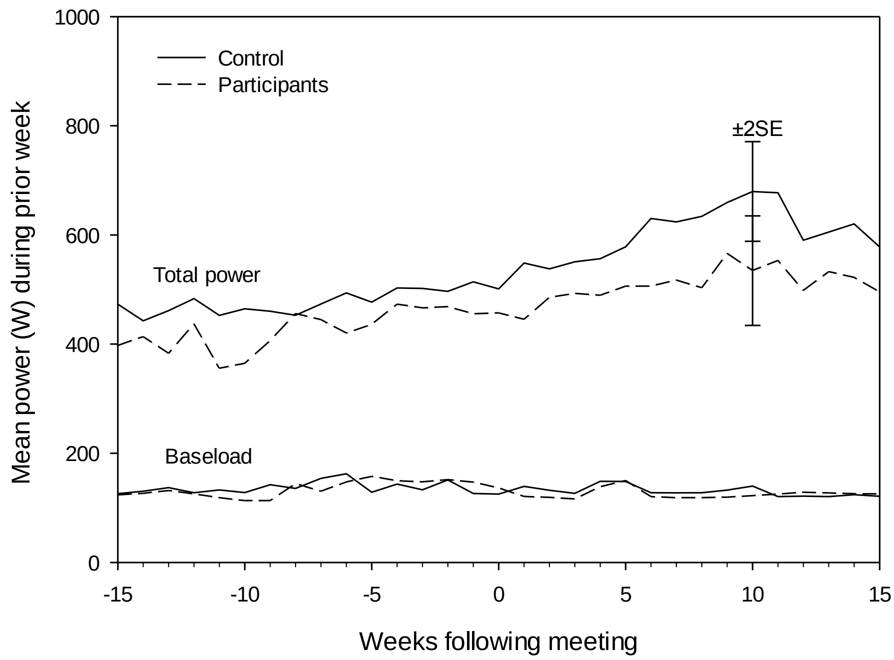

Figure 2: Mean electrical power consumption over 1 week.

Before – After	All Data				Observations with over 50% of datapoints			
	Temperature (°C)		Power (W)		Temperature (°C)		Power (W)	
	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
Mean difference, MD (SD of MD)	0.92 (0.83)	0.97 (1.41)	-34.4 (79.5)	-69.0 (165.9)	0.94 (0.68)	0.80 (1.35)	-18.2 (57.0)	-60.7 (152.6)
N	34	77	36	72	25	54	28	54
T-test on MD: 2-tailed p	0.82		0.14		0.53		0.07	
10% trimmed mean difference, TMD	0.91	0.93	-32.0	-50.8	0.98	0.87	-23.0	-50.4
Permutation test on TMD: 2-tailed p	0.91		0.26		0.46		0.10	
Bootstrap 95% c.i. (percentile method)	$-0.36 \leq$ TMD ≤ 0.34		-52.2 < TMD < 8.1		$-0.39 \leq$ TMD ≤ 0.24		-62.8 < TMD < 1.9	

Table 2: Difference in mean readings for each group 4 weeks before and 4 weeks after the event

Hypothesis tests are shown in Table 2 above. We report 2-tailed tests of "differences in differences". We take the mean difference, $\bar{d}_h$, between each household's measurements (of power or temperature) in the 4-week period up to and including the community group meeting, and the 4-week period after it. The mean difference in group *i*, $\bar{D}_i$, is given by

$$\bar{D}_i = \frac{1}{n_i}\sum_{h=1}^{n_i}\bar{d}_h, \quad i \in \{\mathrm{TG}, \mathrm{CG}\}$$

where

$$\bar{d}_h = \begin{cases} \frac{1}{m}\left(\sum_{s=1}^{m} a_{hs} - \sum_{t=1}^{m} a_{ht}\right) & \text{if } h \in \text{TG meeting 1} \\ \frac{1}{m}\left(\sum_{u=1}^{m} a_{hu} - \sum_{v=1}^{m} a_{hv}\right) & \text{if } h \in \text{TG meeting 2} \\ \frac{1}{m}\left(p\left(\sum_{s=1}^{m} a_{hs} - \sum_{t=1}^{m} a_{ht}\right) + (1-p)\left(\sum_{u=1}^{m} a_{hu} - \sum_{v=1}^{m} a_{hv}\right)\right) & \text{if } h \in \text{CG} \end{cases}$$

a_{hs} denotes the measurement in household *h* at time point s, *s* and *t* index the measurement time points in the 4 weeks before and 4 weeks after the first meeting respectively, *u* and *v* are the corresponding time point indices for the second meeting, n_i is the number of households in group *i*, *m* is the number of time points in a 4-week period and *p* is the proportion of attendees in the TG that attended the first meeting.

Thus for the TG each household's mean difference is calculated using the time of the meeting that was attended. For the CG we take a weighted average of the mean differences for each household, evaluated using each of the two times. The null hypothesis is

$$D = \bar{D}_{TG} - \bar{D}_{CG} = 0$$

Our statistical test compares measurements for households in the TG who attended the event with those for households in the CG settlement. We note in passing that there was a substantial number of non-attendees in the TG, and it would be possible to use these to augment the control group. However, these households had some contact with the CEG via the recruitment process and we cannot rule out other contact between attendees and absentees in the TG. We therefore concentrate on Table 2 in interpretation. We report the results and hypothesis tests inclusive of non-attendees in the CG in Table 3 of the Appendix, which is consistent with the analysis in the main text.

The left hand side of the Table 2 contains sample statistics from all energy monitor hubs which returned readings from periods both before and after the event. However, there are many households for which the resulting mean, $\bar{d}_h$, is based on a very small proportion of the potential energy monitor data points. This occurred because of frequent equipment or internet failure and lags in identifying and rectifying the problems. The variance of this data is, as would be expected, relatively high. For this reason the right hand side of the table reports results for households whose difference measure is based on more than 50% of the potential energy monitor data, and we concentrate on these data in interpretation. It is important to note that this does not bias the comparison, because the data missing due to equipment failure are missing at random.

The test returns no evidence of an effect on spatial heating from the event. For electrical power, the null hypothesis is rejected at the 10% level using a standard 2-sample T-test (Satterthwaite's test). It is well known, however, that outliers may render the assumptions behind standard parametric tests invalid (Wainer, 1976). In our dataset, several points could be seen as outliers in the sense of exerting undue influence over the test statistic (Figure 3, Appendix). A related problem is that even moderate skewness may render T-tests unreliable for samples of less than several thousand observations (Hesterberg, 2008). A robust non-parametric approach with such data is to use resampling methods (Davison and Hinkley, 1997) to compute p-values and confidence intervals. We report permutation tests and bootstrap 95% confidence intervals, with 100,000 repetitions. To negate the influence of outliers we use 10% trimmed means for these statistics. The proportion of simulated differences in differences greater or equal to the observed value in absolute magnitude constitutes the p-value of a 2-tailed test, and is reported in the penultimate row of Table 2. We focus on this test in interpretation.

The comparison of trimmed mean differences (TMD) is significant at the 10% level ($p=0.095$), and yields an estimated effect size of 27W. This is interpreted as a probable reduction from the mean level that would have obtained had households in the treatment group not attended the event. That is, for the four weeks after the event, households in the TG are estimated to have reduced their power consumption by a mean of 27W compared to the estimated mean value that would otherwise obtain (the counterfactual case). Judging by the time series in Figure 2, the data are consistent with a reduction which was sustained for the subsequent period.

4. Discussion and policy implications

Our main result is evidence of a relative reduction of power consumption, at the 10% significance level, which appears to be sustained over three months. Power use increased over the time period in both groups in absolute terms, as could be expected with decreasing temperatures. In colder and darker periods, occupancy of residential dwellings and associated energy use tend to increase. But mean power use in the treatment group during the 4 weeks after the event was an estimated 27W lower than it would have been without attending the event. DECC (2012) reports that the mean domestic electricity meter recorded 3790 kWh energy consumption over 2010-2011, and 27W continuous power over one year would amount to approximately 237 kWh. 27W would therefore equate to around 6% of the UK's 2010 national mean rate of household electricity use. This estimate therefore represents a non-negligible reduction in power use. The associated bootstrap 95% confidence interval is very broad however, spanning 65W, reflecting the high variance in the data. This is reported in the bottom row of Table 2. So we estimate a substantial effect, but cannot infer this with confidence.

In contrast, we observe no evidence of a reduction in lounge temperature (our proxy for spatial heating), despite the fact that at the event participants were specifically encouraged to reduce their thermostat setting by 1 degree Celsius as a 'take home' action. We note as a caveat to this, however, that lounge temperature may be a poor proxy of heating fuel consumption, because it ignores other rooms, and differences in insulation and boiler efficiency. It seems reasonable to speculate, notwithstanding this limitation, that any energy savings made were in consumption categories that are relatively easy to cut. Reducing discretionary power use presumably does not impact significantly on comfort levels, including such changes as turning off lighting and appliances when not in use, not leaving chargers in live sockets longer than necessary and so on. Reductions in spatial heating are more likely to impact perceptibly on comfort, and therefore to be more difficult to achieve.

That our results may show easier savings being made is confirmed by inspection of the baseload component of power (Figure 2). There is no apparent difference between the two groups, or over time. This was despite the fact that a section of the event was dedicated to identification and reduction of baseload. Therefore it seems that the effect on total power consumption is attributable to reductions in dynamic (switched) load and/or temperature-driven loads. (We do not report a hypothesis test for baseload power because it is a component of power as reported in Table 2. The two tests would not, therefore, be statistically independent.) We find it plausible that people find it relatively difficult to reduce their baseload electricity consumption, excepting perhaps relatively minor components such as appliances on standby.

We can only speculate at this stage over what happens to energy use in the longer term. One might expect a natural tendency for effects of a single event to wear off over time, but this is not yet evident in the series shown in Figure 2 after 15 weeks. The 3 year experiment from which these are early results involves a number of subsequent interventions which are intended to accumulate. This process will form the subject of further analysis.

We now consider policy implications of the results. Policy with regard to household energy use has tended to focus primarily on technical measures to enhance energy efficiency, and on schemes to subsidise and / or incentivise their adoption. Our initial results from what was a relatively modest level of intervention suggest that there could be an important role for enabling local community groups to run energy-focused events for local householders. This could be alongside ongoing engineering measures such as those promoted by the Green Deal (or similar initiatives), roll out of smart-meters or as stand-alone events. We engaged directly with a local group with explicit environmental aims, but the group had no experience of working directly on home energy issues. If generic materials and guidance were made available and incentives offered to any local community organisation (environmental or otherwise) to run such events, there is reason to expect similar reductions in energy use amongst participants. Such community engagement could be built into the Green Deal or similar programmes if suppliers were required to partner with a local community group, and/or could become part of the broader policy toolkit of government departments (such as DECC in the UK), local authorities and other relevant agencies.

Such interventions would be relatively inexpensive. The identifiable financial cost of support for the project was £3,000 as a lump sum to the CEG to support its activities over the course of the 3 year project and a further £4,000 was allocated to supporting a minumum of 3 householder events. There were also costs to the project team in developing the materials for the event. The incentive needed to motivate other community groups to run similar events would likely be smaller and the production of generic materials would make those costs negligible. It is also worth noting that the project has seeded some activity beyond the minimum requirement of the project of one meeting per year. The CEG has run an informal 'energy users group', looking at ways to reduce home energy use and save money, with some assistance from the research team. It is possible that providing an incentive for other local groups to run energy-focused events for householders would seed further local action in its wake.

Attendance at the event was 68% of the TG, with 51/75 households present at a meeting. Thus, the estimated 27W reduction should be interpreted as the mean treatment effect on the treated, rather than on the target population. We anticipate that further time and resources could be devoted to boosting attendance to good effect, however, if similar behavioural interventions were to be applied across a broader population.

5. Conclusions

Initial effects on power use and spatial heating due to a community-based behavioural intervention have been quantified using a field experiment, using two areas matched in terms of their geographical location and socio-economic characteristics. The population studied is middle income households in the South of England, UK. The level of intervention studied is very modest. We examine a single two-hour event at which energy saving measures, and the rationale for energy saving, were discussed in terms of climate change mitigation and financial savings. The data suggest that a reduction in electrical power use of 27W occurred on average in the TG, following an interactive session on energy topics conducted by a CEG. This effect is inferred using non-parametric statistics, namely resampling methods. The meeting that householders attended was constructed to resemble a behavioural intervention that might also be implemented by government acting in concert with third sector organisations. Mean power consumption was consistently lower for the TG compared to the CG following the event, and this is sustained for a period of 15 weeks. An effect of the meeting cannot be attributed with confidence, though, because of high variance of the data. Nonetheless, because the probable reduction in power use is estimated to be non-negligible (~6% of the mean rate of household power use) it is potentially important for policy. We found no evidence of a fall in spatial heating consumption, however, perhaps because even a slightly reduced temperature is experienced as a reduction in comfort.

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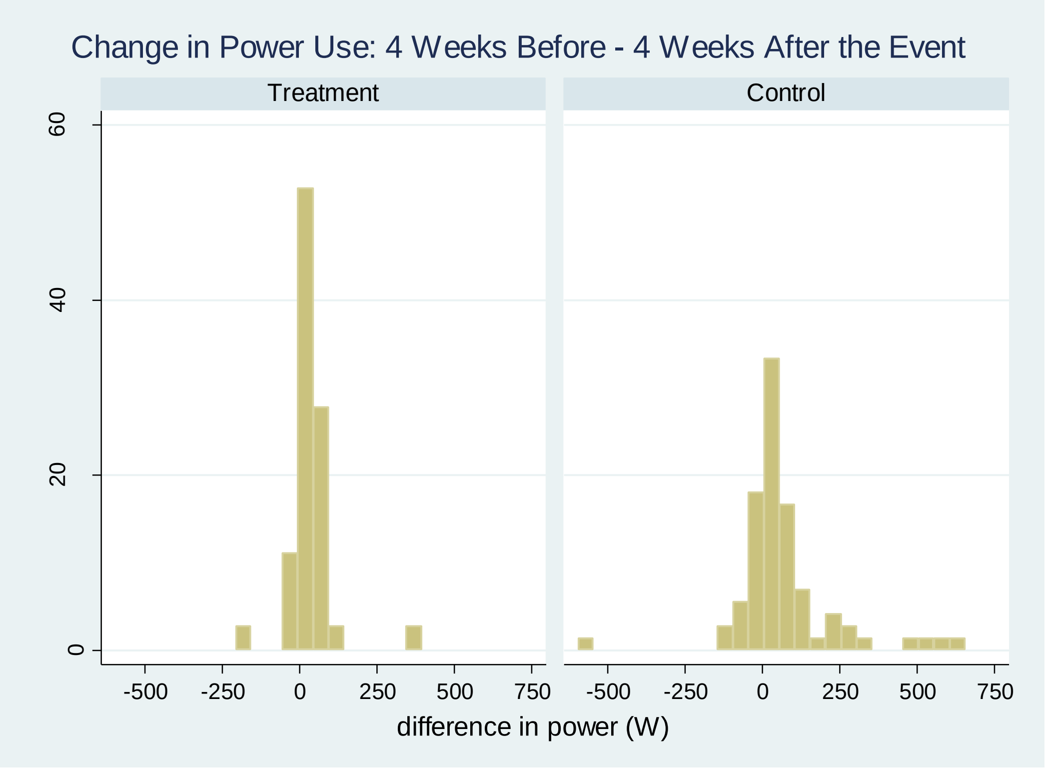
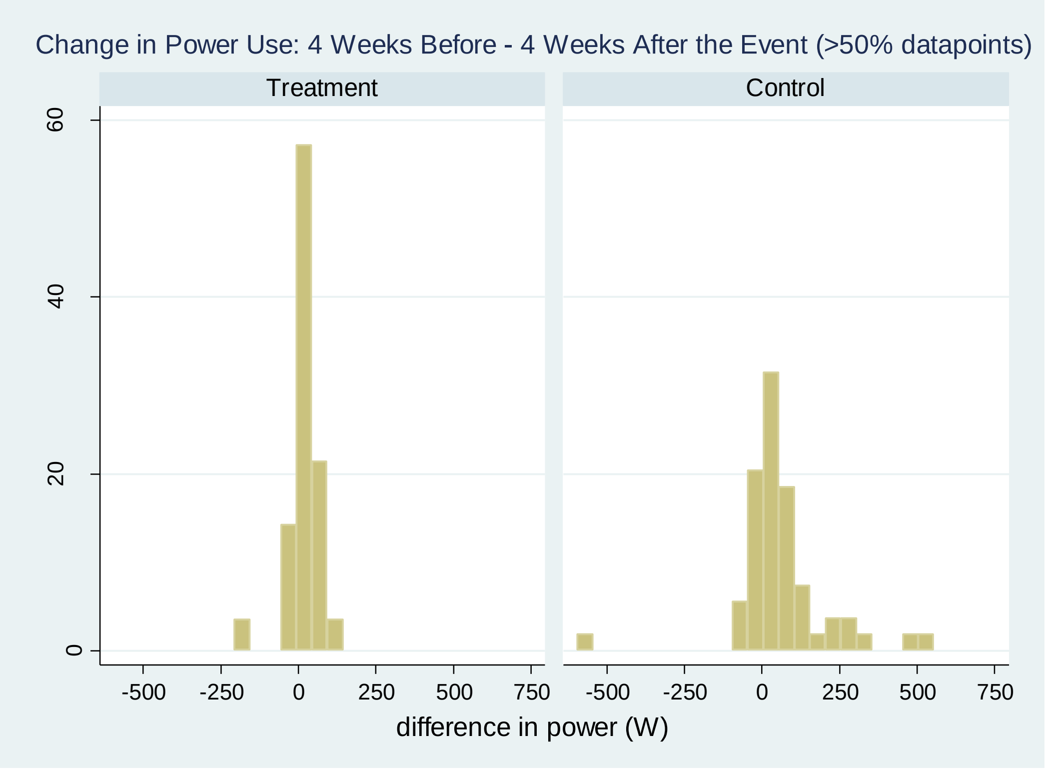
Appendix



Change in Power Use: 4 Weeks Before - 4 Weeks After the Event
Treatment
Control
0
20
40
60
-500
-250
0
250
500
750
difference in power (W)



Change in Power Use: 4 Weeks Before - 4 Weeks After the Event (>50% datapoints)
Treatment
Control
0
20
40
60
-500
-250
0
250
500
750
difference in power (W)

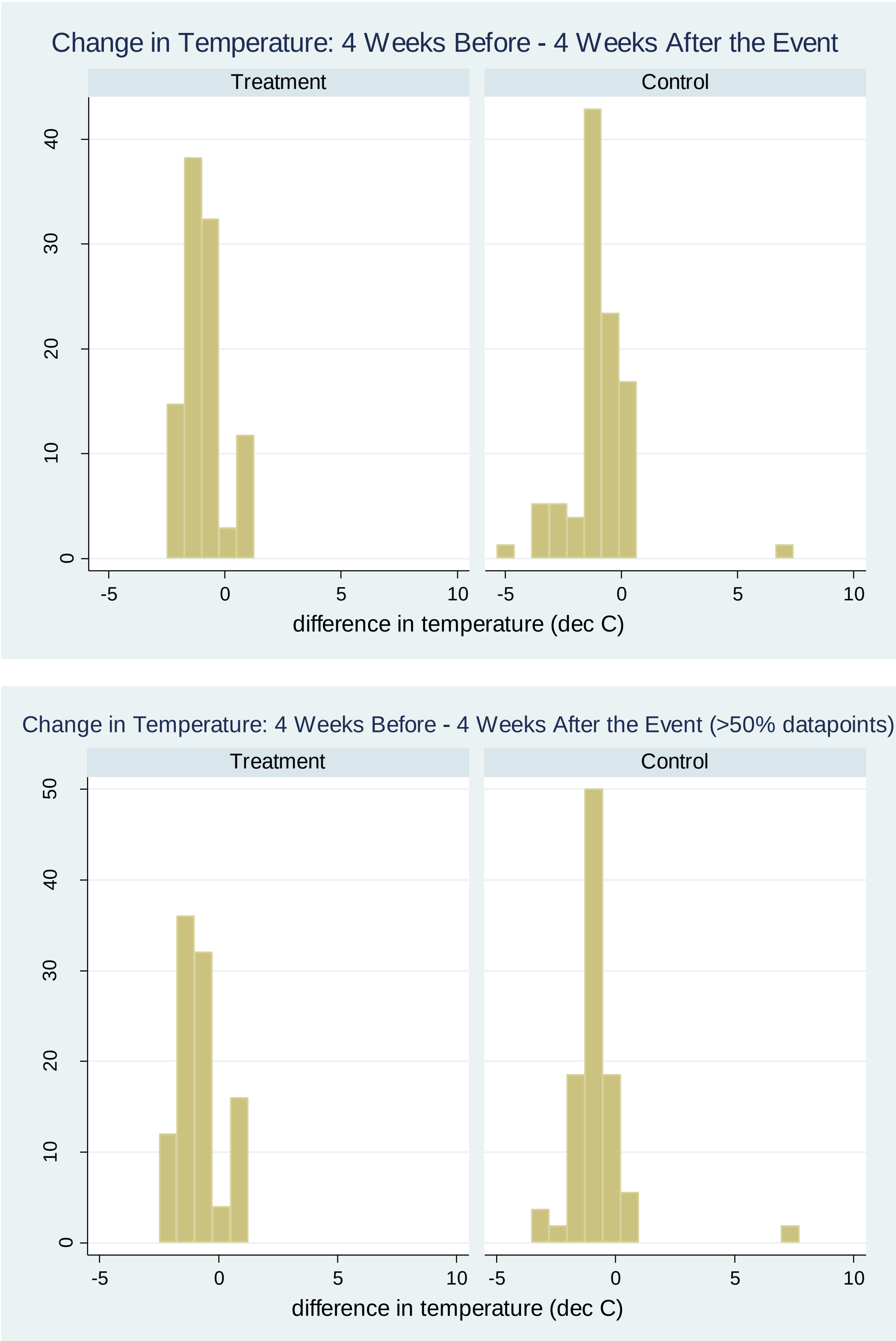


Figure 3: Histograms of Differences in Measurements Before and After the Event

Before – After	All Data				Observations with over 50% of datapoints			
	Temperature (°C)		Power (W)		Temperature (°C)		Power (W)	
	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
Mean difference, MD (SD of MD)	0.92 (0.83)	0.93 (1.30)	-34.4 (79.5)	-59.5 (153.9)	0.94 (0.68)	0.82 (1.23)	-18.2 (57.0)	-57.3 (142.1)
T test on MD: 2-tailed p	0.98		0.21		0.52		0.05	
N	34	101	36	98	25	75	28	75
10% trimmed Mean difference, TMD	0.96	0.90	-32.0	-46.3	0.98	0.87	-23.0	-49.8
Permutation test on TMD: 2-tailed p	0.91		0.36		0.34		0.11	
Bootstrap 95% c.i., percentile method	$-0.38 \leq TMD \leq 0.28$		$-41.2 \leq TMD \leq 9.3$		$-0.40 \leq TMD \leq 0.21$		$-57.4 \leq TMD \leq -1.9$	

Table 3: Difference in mean readings in each group 4 weeks before and 4 weeks after the event; augmented control group