The Green, Green-Eyed Monster

Exploring the Impact of Group Cohesion and Environmental Attitudes and using this Evidence for Energy Policy

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Abstract

Using tools from behavioural economics and psychology to establish non-financial ways to incentivise people to reduce domestic energy usage has become a popular and ever-expanding area of research. This study builds upon the existing literature by providing subjects with energy performance information at group-level in a controlled field experiment setting. Results suggest that the provision of relative information does stimulate energy-conserving behaviour, with this being most pronounced among those who held pre-trial preferences for sustainable living. These variations in usage and responsiveness indicate evidence that the attitudes and structure of social groups are key drivers in determining the extent to which behavioural change is achievable. This in turn has relevance for energy policy, and implies that whilst both regulators and firms could improve consumer welfare and optimise the management of their resources within their industry by issuing relative information on performance. Nevertheless, the role of group cohesion and affiliation could heavily determine the magnitude of these benefits.

Key Words: Energy Monitoring, Behavioural Nudges, Energy Economics, Group Co-ordination, Sustainability, Environmental Economics

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1. Introduction

Given both the environmental and economic benefits which can be enjoyed from efficient domestic energy usage, exploring the best way to incentivise a reduction in the wasteful consumption of electricity, heating and water has become a popular and valuable research area. Consumers are seemingly averse to switching energy tariffs despite the advertised and proven financial savings this could afford them. Consequently, there has been an intense move in recent years to discover whether lessons can be learned from behavioural psychology and the use of non-pecuniary 'nudges' to stimulate action and also instil positive environmental habits.

Student halls of residence have proven to be a popular setting for assessing these alternative stimuli within a controlled field environment. A major reason for this relates to the fact that this demographic are less experienced in their routine consumption of such utilities than the average member of the population, and may therefore hold a more open attitude to behavioural adaptation. Moreover, in these settings the student's rent is typically both pre-defined and inclusive of utility bills. This means that throughout the course of a study trial, no financial gains can be made through energy efficiency, implying that any changes in behaviour stem from an intrinsic response to the imposed treatment. This study builds upon the existing literature by conducting a controlled field experiment within student halls of residence in a UK university. Students were provided with their absolute and relative energy consumption via a weekly email between January and May 2016. The research questions posed through this work are whether (a) information creates a fall in consumption per se; (b) the degree of group co-ordination aid these endeavours and (c) pre-existing attitudes regarding sustainable living induce response differences?

This project seeks to both complement and strengthen the existing literature. Its first contribution is an ability to confirm that small (3-4 percentage point) yet significant reduction in energy usage can materialise by providing people with information regarding their performance. In fact, students within the treatment switch from performing above to below the baseline usage of those living in their university residences.

The study also provides two new contributions through its experimental design, each of which may prove insightful from both a social and policy-based standpoint. To answer the second research objective, energy data is monitored and the associated information issued at a flat (apartment)-level of separation, as opposed to at an individual level. By doing this, it assesses the extent to which reductions in energy differ by presenting data through a group dynamic. Post-treatment questionnaires explore this relationship and suggest the ability to co-ordinate on energy conservation could be driven by the degree of flat-level cohesion.

The second novel element for this research field which is used to address the final research question is that the study compares the different responses which emerge between students living in a standard flat against those who self-select to reside in a sustainable (or 'Green') residency. This affords a unique opportunity to see if those who signal pre-existing preferences for a pro-environmental lifestyle deviate from the main cohort. Such differences could be anticipated in relation to either general (base) intensity of usage or, perhaps more interestingly, regarding their response to the information stimulus of relative energy performance. The results show that whilst students in the green flats do not hold an initially lower baseline usage than their peers, they do respond more competitively to information on their relative performance, reducing their energy consumption to a greater extent than others within the treatment group.

The findings therefore imply that policy-makers should consider the important role that non-financial stimuli can play for inciting small and yet significant improvements in energy reseource utilisation. However, success may hinge crucially on both the degree of integration and the existing environmental attitudes of residents being targeted.

Section 2 outlines the literature on environmental nudging in the energy sector and the potential roles which group cohesion may play in enhancing this. Section 3 describes the study, including its methodology and statistical testing. Section 4 provides the results and associated data analyses. Section 5 proceeds with some further discussion before Section 6 concludes and recommends some next steps for research and policy in the field.

2. Background to The Study

Researchers have consistently shown that whilst people frequently find themselves on sub-optimal energy tariffs, providing information on the financial savings they can enjoy from switching to a more efficient system or tariff fails to incite action (Guilietti et al, 2005). Domestic energy constitutes around 27% of the UK's demand for fuel (DECC, 2015), meaning that these savings can be substantial, both for the individual and at an aggregate level. It has also been well established that many people utilise energy in a wasteful manner yet, once more, disseminating the advantages to them from more efficient consumption patterns still rarely achieves its desired behavioural alteration. Incorrect perceptions can also play a crucial role here, and studies show users to frequently hold untrue or incorrectly weighted ideas on the relative energy requirements of domestic appliances (Atteri et al, 2010; Allcott, 2011a). The impact of this is that, when compared to the true breakdown of UK energy usage (HM Government, 2006), acting individuals will often undertake 'energy-saving behaviour' which leads to financial savings that will fall short of their expectations.

This persistent combination of themes has created an intense level of research looking to identify whether tools from behavioural economics and psychology can be more successful in combatting people's lack of meaningful action (Abrahamse et al, 2005; Allcott & Mullainathan (2010); Croson & Treich, 2014). These tools seek to provide usage data in an easy and visible way, providing clarity on how well consumers meet their energy requirements efficiently and in many cases offering remedies to areas of sub-optimality (Hargreaves et al, 2013). Moreover, such studies seek to uncover whether, given the apparent futility of issuing information on possible pecuniary savings, people might instead be incentivised to reduce their inefficient energy usage through alternative channels.

"Nudge" (Sunstein & Thaler, 2008) is now synonymous with behavioural psychology and 'nudges' have constituted some the best applied examples to demonstrate the power of the field in adjusting decision-making. One leading example used by energy economists tests the role of social norms and comparisons (Bault et al, 2008; Griskevicius et al, 2008; Czajkowski et al, 2014; Sexton & Sexton, 2014; Dasgupta et al, 2016). The theoretical concept that underpins this is that people tend to be overly pre-occupied by their relative performance against people they deem similar to themselves. Therefore, by informing individuals where they are situated on an 'energy-efficiency scale' alongside their peers could spur them into reducing their consumption to improve their relative standing. The mechanism for providing this information has be applied in a number of ways. Popular methods combine percentile information with a diagrammatic trigger, for example a happy or sad face (Allcott, 2011b) or 'green stars' (Costa & Kahn, 2013) to reinforce comparative performance. By contrast, some studies provide an explicit rankings breakdown to illustrate precisely where a given participant lies in relation to their peer group (Delmas & Lessem, 2014; Alberts et al, 2016). The results are encouraging, and research has shown that consequential action can create falls in energy consumption of magnitudes between 0 - 10% (Allcott, 2011b; Delmas & Lessem, 2014). Moreover, these gains can be substantially greater in other areas where environmental nudges have been trialled (Convery et al, 2007; Kallbekken & Sælen, 2013). The studies typically show that reductions are mostly driven by initially poor performers, although counter-arguments have been made that under certain conditions social comparisons can create a discouragement effect which disincentives weaker participants (Hargreaves et al, 2013; Alberts et al, 2016). Delmas & Lessem (2014) instead illustrate that alongside incentivising the worst performers, relative information can also lead to a reduction in the energy consumption of already relatively high performers. They attribute this to a desire for maintaining a high status. This would defy the associated theory of the "Jevons Paradox" (Alcott, 2005) which argues that informing people that they are high performers would cause them to *raise* their energy consumption. This empirical response heterogeneity implies that 'targeted' information (regarding both how the information is presented and to whom) could be a crucial element when one seeks to maximise the potential environmental gains that can be made from such intervention (Allcott & Rogers, 2014; Alberts et al, 2016).

One difficult element when conducting this type of research is to uncover the underlying motivations that drive participant action (or lack thereof). This is particularly tasking in energy markets where positive behavioural change provides a 'win-win', both reducing the harmful social or environmental externalities caused by excessive usage and also issuing (at times substantial) financial private gains to an acting agent (Kallbekken & Sælen, 2013). Consequently, energy conservation holds attributes akin to an impure public good (Cornes & Sandler, 1994; Kotchen, 2005; Kotchen, 2009) and disentangling these two complementary motives and deciphering which has most greatly impacted upon the individual's decision-making is difficult, if not impossible, to achieve.

This complication has led many researchers to use student accommodation in a controlled field experiment setting (Delmas & Lessem, 2014; Alberts et al, 2016). This is because for most university residences, the associated rental contract is inclusive of utility bills. Furthermore, prices are fixed prior to and remain constant throughout the duration of the tenancy. Thus, if changes in energy usage are witnessed as a consequence of providing subjects with relative performance information, pecuniary motivations can be ruled out, giving a more pure indication that their action has been driven by a desire to improve status or act pro-socially. In this respect, the study setting is perceived as 'cleaner'. There is also evidence to suggest that this age-group are, on average, both more impressionable and more flexible to adapting their behaviour in this context (Guiliano & Spilimbergo, 2009). There is a common belief that student cohorts do not always represent the wider population, although research does exist to the contrary in this particular setting (Druckman & Kam, 2011). Nonetheless, an air of caution is applied regarding the exact extent to which any findings can unequivocally be transferred to a wider population.

Whilst this project broadly follows the methodology of the studies mentioned above, it builds upon the existing literature in two domains. The first is that information is provided to *groups* of respondents sharing the same living area (here on in referred to as "flats"). The reason this is assessed comes from the evidence across both laboratory and field settings which suggest that, under circumstances of social cohesion, groups can exhibit stronger tendencies for pro-social action than when people act independently (Olson, 1971; Fehr & Schmidt, 1999; Frank, 2003; Isaac & Walker, 1988). This finding spans contributions in public good games, voluntary action, waste reduction and environmental affiliation. The notion is also supported by the literature on subjective well-being, which believes "inter-connectivity" and feeling part of something bigger than oneself instils a greater societal construct and level of psychological happiness (Putnam, 1995; Diener & Biswas-Diener, 2008). This in itself can facilitate greater instances of altruism (Andreoni, 1990), reciprocity (Sugden, 1984) or positive social action (Czajkowski et al, 2014).

An alternative argument is that a collective-group framing could incentivise energy conservation through the competitive atmosphere it imposes. Indeed, when presented as a "team", respondents have frequently been shown to react more fiercely in order to improve their standing relative to rival units (Terry D.J. et al, 1999; Baik, 2008; Konrad, 2009; Nitzan & Ueda, 2009). Regardless of which of these two dispositions may motivate them, issuing information as group performance seeks to understand if (and to what extent) this adjusts the scale of behavioural change. The degree of inter-connectivity between flats was crudely tested by asking questions in this domain in the follow-up respondent survey and these correlations are analysed in the discussion section of the paper.

The second novel element within this study is its attempt to understand if and how those who have already committed to an environmentally-sustainable living domain react to performance data differently to their peers. How and why individuals develop pro-social (Kahnemann & Knetsch, 1992; Weimann, 1994; Putnam, 1995) or pro-environmental (Costa & Kahn, 2013; Czajkowski et al, 2014; Steg et al, 2016) attitudes has been widely explored and so this study does not seek to decipher the reasons for their stance *per se.* However, it does look to uncover the extent to which these beliefs correspond to their action. Indeed, attitude heterogeneity has already been shown to impact upon efficiency in other areas of environmental action (for example Perez Urdiales et al, 2016), which implies this an aspect of interest to the field as is seeks to enhance instances of socially responsible green behaviour. To test this, a proportion of our treatment group are selected from a long-standing movement at the university, known as 'The Green Flats Project'. These are students who, when completing their accommodation application form, indicate a preference to reside with people that share a desire to live in a sustainable way. This study treatment proves insightful in numerous ways, namely assessing whether green flat residents (i) hold 'below-average' baseline usage *prior* to information dissemination, (ii) are then more or less responsive to social comparison data and (iii) display a performance that follows a different trajectory over the study period.

By imposing these two new elements onto the existing research framework, this study can look not only to confirm and reinforce some of the current beliefs regarding whether non-financial stimuli can incentivise behavioural change, but further this exploration by examining how action might be affected by group cohesion and prior attitudes towards sustainability.

3. <u>The Study</u>

The experiment ran from January to May 2016 at the University of East Anglia (UEA), Norwich, UK. Eight flats were selected for the study, housing a total of 76 students. Prior to monitoring, students were informed that energy usage would be recorded and they would receive a weekly email displaying both their absolute usage and how this compared to seven comparable residences. The full research objectives were deliberately omitted in the briefing to avoid excess instances of strategy or participant pressure. It was, however, made explicitly clear that a flat's performance would not induce any alteration in accommodation fees.

The residences selected for monitoring sought to test factors that could potentially impact upon the ability for students to co-ordinate collectively. Other elements were included because the current literature held an *a priori* belief that this could or should influence energy efficiency. An overview of the flats and their status regarding these dimensions are given in Table 1.

Flat Name	Number of Students	En-Suite?	Green?	Silent?
AA	10	✓	✓	
BB	10	✓	✓	
CC	10	✓		
DD	9	✓		
EE	10		✓	
FF	9			
GG	9			✓
HH	9			✓

Table 1: The Monitored Flats and Their Characteristics

One aspect, touched upon in the previous section, was that three of the flats constituted those where students had self-selected to live in a residency that housed like-minded people with regards to sustainable living. Whilst the 'Green Flats Project' has existed at UEA for a number of years, no direct obligation or onus is placed upon these residents whilst residing on campus through the academic year. Nevertheless, the theoretical assumption from an energy monitoring standpoint is that these students would (a) consume an on average lower level of energy and (b) respond more strongly to the ranking information given that this affords them an opportunity to signal or uphold a status (Dasgupta et al, 2016).

Another factor the study sought to examine was whether any disparity occurred between the energy consumption patterns of those living in En-Suite facilities against those sharing bathroom space. One argument to suggest the latter should be more energy efficient is that, particularly at busy periods of the day, showering and bathing time is limited, causing these residents to use less heated water than those with a private bathroom. An argument to the contrary is one free-riding and the fact that communal shower facilities more visibly display public goods properties could create tendencies for excessive usage. This dynamic is also interesting behaviourally, and regarding social cohesion and may elicit whether housing that holds a greater proportion of shared-space facilities enable residents to construct more co-ordinated group relationships. Four En-Suite and four shared bathroom flats were therefore used in the experiment. It should be noted that the En-Suite residencies were newer and therefore potentially more energy-efficient buildings. Unfortunately, the university contains no accommodation building holding a combination of rooms with both private and communal bathroom facilities at the time of the project, meaning this potentially distorting factor of building age and efficiency could not be overcome.

A third element explored the role of issuing relative information itself. To do this, two of the eight flats (Flats GG and HH) received no correspondence despite being monitored. These still appeared on the rankings list (see Figure 2), meaning that the remaining six flats would still perceive them as 'active competitors' in the game. These residences were labelled the 'Silent Flats'.

The final aspect investigated here assessed how usage adjusted both out of semester time and once the emails stopped being sent. Figure 1 shows the study chronology in light of the 2015/16 academic calendar for the university. It confirms that, following the initial nine weeks of teaching, the Spring Semester was bisected with a four week Easter break. Students then returned and for a period of seven weeks the monitoring continued. However, email communications ceased after the third of these seven weeks, affording a chance to see if habits persisted short-term in the absence of the rankings table reminder. This explores whether nudges need to be frequently reinforced to enable lasting behavioural change. This also has natural policy implications and, regarding energy conservation, means companies or regulators would need to appreciate if *and for how long* interventions should be implemented in order to create deep-seated changes in action. Existing evidence in this domain is varied, with some studies suggesting that behavioural habits can partially persist into the medium to long term (Abrahamse et al, 2005; Allcott & Rogers, 2014) whilst others indicate that any 'pro-social' action quickly dissipates once an initial impetus disappears (Dolan & Metcalfe, 2015).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Semester Part 1 (Email Sent)									Easter (Emails not Sent)				Semester Part 2 (Email Sent)			Post-Treatment (Emails not Sent)			

Figure 1: Timeline of Study

Flats were fitted with a monitor which is able to isolate, log and store energy data for each residency. Meter readings were taken at the same time of each week for a period of 20 weeks (as shown by Figure 1). Similarly, students were emailed at the same time and day of each week.

Week **10**

Your Flat Code **EE**

This Week

Rank	Team	Usage
1	**EE**	**8.83**
2	DD	14.94
3	FF	15.17
4	GG	16.60
5	CC	17.91
6	AA	18.17
7	HH	18.82
8	BB	20.20

Running Total

Rank	Team	Usage
1	DD	215.52
2	**EE**	**224.86**
3	AA	244.44
4	CC	269.26
5	BB	271.63
6	HH	272.05
7	GG	315.54
8	FF	411.56

Weekly Performance

Week	Rank
1	7th
2	6th
3	1st
4	1st
5	2nd
6	2nd
7	1st
8	1st
9	1st
10	1st
11	
12	

To opt out at any time, email michael.brock@uea.ac.uk

Figure 2: A Sample Email

Figure 2 shows that this communication was presented to them through three tables; one showing their weekly usage and associated ranking among the eight competing groups, a second giving the same information but for their overall usage and ranking since monitoring began. A third table provided a timeline of their weekly rankings history over the twelve weeks of the semester. Subsequent to the final week of email communication, a voluntary questionnaire was sent to students (see Appendix 1). This asked a range of socio-demographic, attitudinal and behavioural questions. The completion rate was 50% (29 of the 58 students who received the emails), a ratio which lies in accordance with social sciences questionnaires (Heberlein & Baumgartner, 1978).

4. Results & Analysis

Regression Models

Alongside the twenty weeks of meter readings, attributes included flat-level details, socio-demographics and information deemed relevant such as climatic data. Table 2 provides an overview of the explanatory variables, describing how they were coded and suggesting any *a priori* expected relationships.

Model 1 assessed whether any significant differences occurred between those flats which partook in the study. The associated regression equation takes the following form:

$$UPP_{it} = \beta_0 + \beta_1 WEEK_t + \beta_2 FlatAA_i + \beta_3 FlatBB_i + \beta_4 FlatCC_i + \beta_5 FlatDD_i + \beta_6 FlatEE_i + \beta_7 FlatGG_i + \beta_8 FlatHH_i + \beta_9 TEMPMAX_t + \beta_{10} TEMPMIN_t + \beta_{10} RANK_{it} + \beta_{11} RANKCHANGE_{it} + \beta_{12} TERMTIME_t + u_{it} \quad \textbf{(1)}$$

In the expression above, i indicates a variable that adjusts between individual from a flat within the study, whilst t assesses those which change over time across the experiment. Model (1) omits any socio-demographic terms as these are constant across a given flat and so would cause issues of collinearity. As such, this first model simply establishes whether energy usage differed between the residences over the study period. Flat FF was used as the base case, courtesy of it being a habitually poor performing residence and thus making interpretation easier in subsequent analyses In Model 2, these flat-level dummies were replaced with demographic aspects of gender and nationality, alongside flat 'types'. This is demonstrated by equation (2):

$$UPP_{it} = \beta_0 + \beta_1 WEEK_{it} + \beta_2 GREEN_i + \beta_3 ENSUITE_i + \beta_4 SILENT_i + \beta_5 TEMPMAX_t + \beta_6 TEMPMIN_t + \beta_7 RANK_{it} + \beta_8 RANKCHANGE_{it} + \beta_9 TERMTIME_t + \beta_{10} UKRATIO_i + \beta_{11} MALE_i + u_{it} \quad \textbf{(2)}$$

Variable Name	Description	Expected Sign
UPP	"Usage Per Person", illustrating average student usage each week for a given meter reading for the flat.	**--**
GREEN	1 if The flat was a 'Green Flat', 0 if not (See Table 1)	**-ve**
GREENRANK	An interaction term of "GREEN" x "RANK"	**-ve**
FLATXX	The Specific Flat, attributes of which are described in Table 1	**--**
TERMTIME	1 if a week that fell in the semester, 0 if not	**+ve**
ENSUITE	1 if The flat was En-Suite, 0 if not (See Table 1)	**--**
RANK	The weekly usage ranking achieved ("this week" in Figure 2)	**+ve**
RANKCH	The change in the weekly ranking position relative to the previous week	**+ve**
SILENT	1 if The flat was provided with the email, 0 if not (See Table 1)	**+ve**
WEEK	A time variable, beginning at Week 1 through to Week 20	**-ve**
MALE	Ratio of participants in a flat who were male	**--**
TEMPMAX*	The highest recorded daily temperature, averaged over a given week for each of the 20 within the study period	**-ve**
TEMPMIN*	The lowest recorded daily temperature, averaged over a given week for each of the 20 within the study period	**-ve**
UKRATIO	Ratio of participants who were registered as being from the UK	**--**

Data is gathered from* ***www.weatheronline.co.uk*

Table 2: A Matrix of Explanatory Variables

One analytical area explored here assesses whether those living in the green flats were more responsive to rankings information. The rationale for this is that these residents self-selected to live in an environment with like-minded peers regarding sustainability, which could easily encompass energy efficiency. Therefore, upon being issued with information on their comparative utilities usage, green flat participants may react more severely in order to maintain or improve an intrinsic reputation. To examine this, Model 3 includes ‘GREENRANK’, an interaction of “GREEN” and “RANK”. If those living in the green flats are more responsive to rankings information than those from a standard flat then ‘GREENRANK’ should be both negative and significant. The associated regression equation is shown by expression (3) and the results of all three models are provided in Table 3.

$$UPP_{it} = \beta_0 + \beta_1 WEEK_{it} + \beta_2 GREEN_i + \beta_3 ENSUITE_i + \beta_4 SILENT_i + \beta_5 RANK_{it} + \beta_6 RANKCHANGE_{it} + \beta_7 TERMTIME_t + \beta_8 GREENRANK_i + + u_{it} \quad \textbf{(3)}$$

	Model (1)		***Model(2)***		***Model (3)***	
	Coef.	*P>|z|*	*Coef.*	*P>|z|*	*Coef.*	*P>|z|*
Constant	7.562	0.000	6.221	0.001	5.835	0.000
WEEK	-0.418	0.499	-0.418	0.512		
FLATAA	-2.089	0.020				
FLATBB	-3.518	0.000				
FLATCC	-3.154	0.000				
FLATDD	-2.197	0.020				
FLATEE	-2.329	0.021				
FLATGG	-1.609	0.056				
FLATHH	-3.041	0.000				
TEMPMAX	-0.116	0.349	-0.116	0.365		
TEMPMIN	0.358	0.013	-0.001	0.016		
RANK	1.668	0.000	1.754	0.000	1.843	0.000
RANKCH	0.211	0.190	0.250	0.131	0.261	0.112
TERMTIME	6.588	0.000	6.588	0.000	6.198	0.000
GREEN			-1.206	0.042	0.810	0.457
ENSUITE			-1.332	0.025	-1.020	0.102
SILENT			-2.000	0.005	-1.857	0.022
UKRATIO			-2.130	0.523		
MALE			4.864	0.236		
GREENRANK					-0.413	0.086
Model Fit ($\boldsymbol{F}$)	44.47	0.000	48.27	0.000	73.81	0.000
$\boldsymbol{R^2}$	0.7984		0.782			0.7727
Observations	160		160			160

Table 3: Regression Results

<u>Main Findings</u>

The regression results from Model 1 confirm that all residences consistently used less energy than “Flat FF” each week *ceteris paribus*. All pass significance tests at the 10% threshold and, with the exception of Flat GG, also do so at the 5% significance level. Given weekly energy usage averaged around 20KwH per person, the coefficient magnitudes indicate considerable variation, with high performing flats using as much as 15% less energy each week than high-intensity users. Figure 3 demonstrates this graphically, combining the regression results with empirical ranks to illustrate usage differences.

Model 2 indicates that the variables “GREEN”, “EN-SUITE” and “SILENT” are all negative and significant. “GREEN” certainly complies with *a priori* intuition and it could be expected that the occupants of green flats, who self-select to live in a sustainable environment, consume less energy than ‘standard’ residents. In relation to “EN-SUITE”, it appears that improved buildings efficiency or the more visible public goods element of communal bathroom facilities outperform any (higher consumption) effects of having a private washroom. The sign and magnitude of ‘SILENT’ is treated cautiously bearing in mind that one of these flats (HH) was a consistently high performer throughout the trial, potentially providing a skewed representation. Whilst the interpretation for “GREEN” seems plausible, the results from Model (3) give a more intricate story for how green flat respondents seemingly reacted in the study. Here, the variable “GREEN” loses statistical significance, implying that those living in the green flats are not *inherently* better performers than their peers. Instead, their relative energy efficiency appears to be driven by the receipt of usage information. The negative and significant coefficient for “GREENRANK” would imply that they respond more vigorously when their ranking position weakens and could thus mean green flats are viewed as more ‘competitive’ groups.

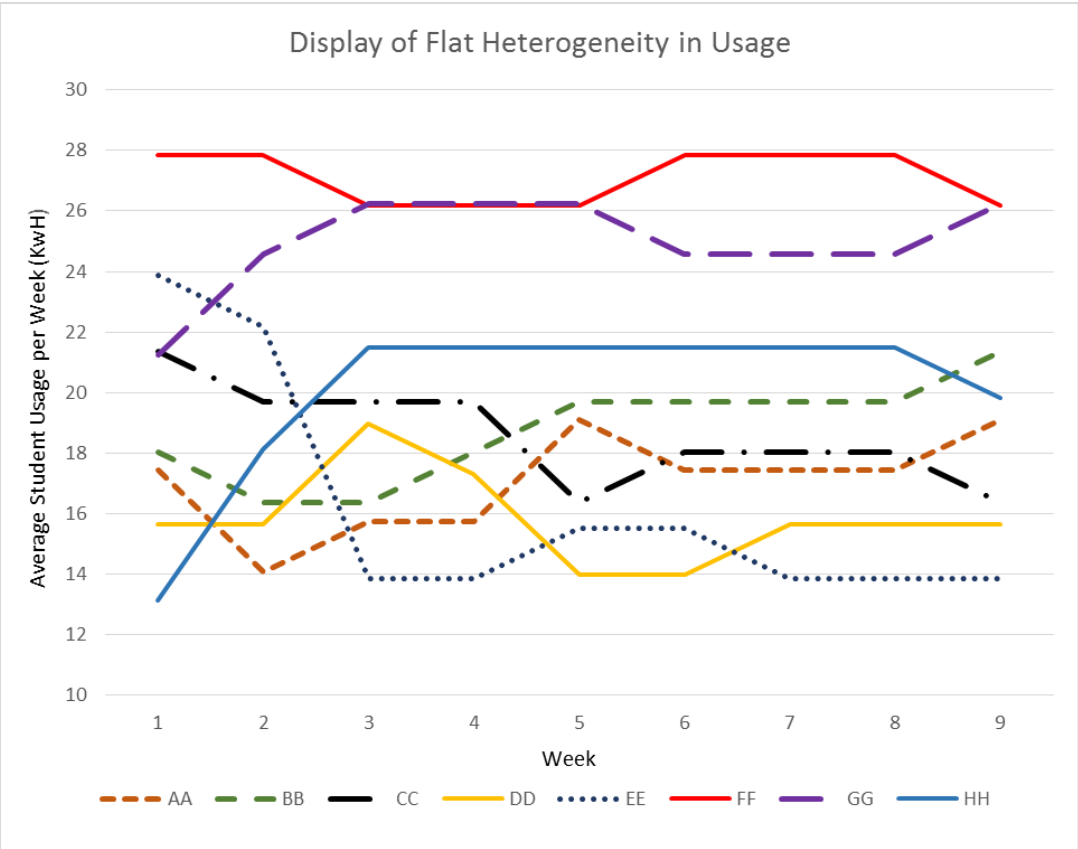

Figure 3: A Diagrammatic Illustration of Flat Heterogeneity

Of course, other explanations exist to explain the sign of 'GREENRANK'. One possibility is that because green flat residents have self-selected to live with 'like-minded sustainable students', general cohesion and group allegiance would be easier to achieve. This means that the email stimulant simply acts as a motive that spurs the group to react pro-environmentally. In other words, they are able to co-ordinate their endeavours to reduce usage in a better way regardless of ranking. Another explanation would be that green flats fell susceptible to the Jevons Paradox effect, increasing usage as their ranking improved. A crude inspection of the raw data would certainly reject this latter theory, and frequent instances are seen where a green flat, upon experiencing a fall in ranking, then 'bounce back' to the original or even better rank within the following week or fortnight. The contrary case is not seen so frequently.

The Role of Information

Another research extension sought to clarify the role that email information *per se* had upon energy conservation. Data was provided by the university's Estates Department on the monthly buildings usage over the study period. This was contrasted against the usage by (non-silent) treatment flats over the same timescale. The buildings chosen for the study almost entirely comprise student room accommodation, meaning that even for out-of-semester periods the two energy datasets are comparable. The results, given in Table 4, indicate a clear trend in energy conservation is exhibited by our treatment groups relative to this 'building-level' baseline.

	Average Weekly Usage [Building (KwH)]	Average Weekly Usage [Study Flats (KwH)]	**Difference (%)**	t-statistic *(p)*
January	18.33	18.51	**+ 0.98***	-1.492 *(0.07)*
February	19.91	20.04	**+ 0.65**	-1.078 *(0.14)*
March	15.96	15.45	**- 3.2****	4.229 *(<0.01)*
April	16.51	15.86	**- 3.94****	5.390 *(<0.01)*
May	19.88	19.30	**- 2.92****	4.809 *(<0.01)*

*** p<0.1 ** p < 0.05**

Table 4: A Comparison of Flat Usage against the Building Baseline

Table 4 and Figure 4 confirm that initially the treatment flats were above-average energy consumers. However, over the course of the study this effect eroded and then swung, to the point where monitored residency usage fell below that of the average consumption within the building they occupied. The magnitude of this effect, between three and four percentage points, is consistent with previously cited research and shows significant gains can be achievable by increasing the saliency of social comparisons for inciting action. This is encouraging with regards to the potential role that behavioural economics and psychology could play in creating tangible changes in the activities and perspectives of individuals. Nevertheless, it is also something that requires detailed and robust testing and is an element of this experiment which would be highly prioritised if repeated in years to come.

Although only a crude measure of persistence, the fall in efficiency between April and May (when flats were monitored but the information was not sent by email) serve as a warning that gains in energy conservation may only occur whilst frequent reminders are issued to residents on their absolute and relative usage. This coincides with the aforementioned literature which show that the improvements people make in this domain can quickly erode if the initial stimulus (here the email reminder) is removed.

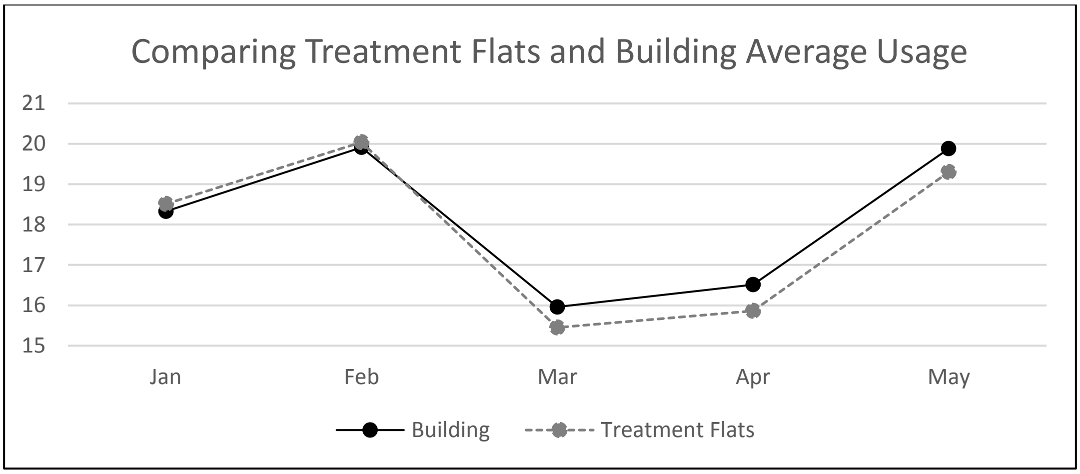

Figure 4: Comparing Treatment Flat and Building Usages

Further Regression Findings

The variables 'RANK' and 'TERMTIME' are included in all models as a check of intuition, robustness and consistency. For the former, we see an intuitively positive sign which retains a similar magnitude across the models. The size of the coefficient signals that slipping one ranking place translates, on average, to somebody increasing their weekly energy consumption by 1.7KwH. Given that the 'league' involves eight flats, this reinforces the implication that usage variation can be wide (nearly 10KwH) and poor performing groups may regularly consume more than double the energy of their most efficient peers. Perhaps due to its small variation across the study, there is no significant impact of positional change 'RANKCH'. As seen above, rankings relationships become more interesting when interacted over other flat-level characteristics.

The 'TERMTIME' coefficient is positive and highly significant. It provides a measure of the extra energy used when university accommodation buildings are in occupancy. The size of this coefficient across the three models imply that when lived in, domestic energy usage rise above latent 'running costs' by 30-40%. This means the scope for making savings when students occupy the building are by no means insignificant.

The variables for temperature ('TEMPMAX' and 'TEMPMIN') run against *a priori* intuitions here. The natural expectation is for both variables to be negative and significant and would represent, *ceteris paribus,* that as the temperature rises energy usage should fall through a reduced need to heat the living environment. By contrast, the maximum temperature coefficient is negative but insignificant variable across models, whilst the minimum temperature shows a positive and significant relationship. Minimum temperatures are typically recorded at night time and one possible explanation for this finding could relate to participant behaviour. For example, in very cold conditions, students may not engage in energy-intensive activities (for example inviting friends to socialise or cooking together, making food after an evening out or just to stay up late), whereas as night-time temperatures rise, which in the UK is combined with lighter evenings as daytimes draw longer, such activities may become more prolific and lead to an aggregate increase in overall consumption, offsetting and outperforming the higher costs required to keep the buildings sufficiently insulated in the coldest spells. Of course, such speculation forms purely conjecture, but it serves as a valuable reminder that behaviour may not always run in tandem with the expectations which initially seem most likely.

Model 2 implies that neither the nationality nor gender ratios hold any significant influence on energy consumption for our treatment groups. Confirmed by Table 2.1 of Appendix 2, the variation across these attributes is small, and so perhaps means there is little scope to truly test such influences here. If anything, the similarity across flats with regards to age, gender and nationality reinforce the trust we place for the other (significant) findings of the study, and allow us to dispel these as alternative determinants to explain usage differences. If future studies are run, then selecting flats with significant variation across these characteristics may be worth pursuing.

5. Discussion

These results are encouraging, yet the small number of participants and the fact the experiment was being run in its first year mean repeat testing would be advantageous for checking reliability and confirming robustness. Whilst pleasantly surprised at how complementary the findings are relative to previous studies of this nature, it is also appreciated that future trials and treatments in a number of domains could prove highly beneficial. As such, this work serves not only as a pioneering new study, assessing the roles of group cohesion and sustainability attitudes on energy consumption patterns, but also forms a platform from which to further explore this area in order to provide rigorous conclusions for both energy policy and the fields of behavioural and environmental science.

There appears to be strong evidence that the extent to which a group can co-operate will influence their ability to respond to peer-comparable information. The flat-level regression results relating to Model 1 show strong-performing groups can consistently consume as much as 15% less energy than relatively weak teams, even when living in residences that are identical in their structure and facilities. One possible explanation for this could be the ability for them to bond as a group and hence enact energy-saving behaviour. An index of 'cohesion' was therefore compiled using the responses of students from the post-treatment surveys (see Appendix 1) and Table 5 illustrates an apparently positive link between those living in a high-performing residency and their perception on the degree of unity within their flat. This numerical assertion was complemented by qualitative student statements, and those from energy-efficient groups said that they would openly discuss the emails in communal situations. This finding is undoubtedly important to consider and emphasises the additional benefits that may be yielded should one be able to find ways to harness a sense of peer-affiliation.

A second novel finding here relates to a greater competitive disposition which the 'Green Flat' participants exhibit (shown through Model 3). This additional responsiveness implies that, should identification be possible, there is an opportunity for policy-makers to target information to those with specific characteristics. This is something which the energy industry is already aware of through aforementioned studies in relation to performance (Abrahamse et al, 2005), political ideology (Costa & Kahn, 2013) and demographic status (Giulietti et al, 2005). However, this particular dynamic is possibly more poignant as these individuals had self-selected into a particular social setting. The inference here, given this study did not provide information on *how* students could reduce usage, is that people might already be aware of how to use energy more optimally. This means inefficiency cannot be solely attributed to a lack of information, but may ensue through complacency or ignorance regarding their patterns of energy consumption. To solve this sub-optimal situation requires regular and consistent reminders of relative usage, which would then stimulate users to employ the conservation techniques within their existing knowledge.

	"Cohesion"* | Rank		Average Rank | Rank		Overall Score	Number (Response %)
Flat AA	2.875	(2)	3.7	(3)	28.125	8 (80%)
Flat BB	3	(3)	5.6	(5)	27	2 (22%)
Flat CC	4	(5)	5.05	(4)	27.25	4 (40%)
Flat DD	3.5	(4)	2.7	(2)	27.75	4 (40%)
Flat EE	2.5	(1)	1.65	(1)	25.8	10 (90%)
Flat FF	4	(5)	5.95	(6)	34	1 (11%)
Total	**3.03**		**4.5**		**27.28**	**29 (50%)**

**Given the wording of this question (10), a low score indicates a stronger degree of social cohesion*

Table 5: The Potential Relationship between Performance and 'Social Cohesion'

The two results above respectively illustrate the role that group affiliation and attitudinal heterogeneity could have for creating positive social outcomes. This new contribution, whilst treated cautiously, serves as a necessary first step for further investigation in this area. If proven robust, these findings would benefit individuals, policy-makers and the energy industry alike. Moreover, they serve a wider purpose of illustrating how the dissemination of small, subtle yet salient pieces of information can incite significant and cost-effective behavioural change. These may not only have positive societal spill-overs, but yield both psychological and financial advantage to the individuals involved as they see both their relative performance improve and their personal expenditures fall. Such social and environmental “win-wins” are surely something which both the research field and wider society would desire.

6. Conclusion

This study builds upon an ever-growing evidence-base identifying that the provision of relatively costless behavioural triggers can influence people’s energy usage. To test this notion, students living in halls of residence in a UK university were issued with both absolute and comparative energy consumption data via a weekly email. Through its structure and design, this experiment introduced new insights by firstly issuing energy information at a flat (apartment) level and secondly by including a set of participants who had self-selected to reside in a ‘sustainable’ social environment. The former sought to assess whether reactions differed when providing data through a group dynamic, whilst the latter treatment tested if pre-existing environmental attitudes created differences in the responses of these students against those living in a ‘standard’ residency.

The results imply that issuing social rankings can incite behavioural chance, and a trend towards reducing usage below the baseline average is witnessed over the course of the trial period. Furthermore, the degree of group cohesion appears important, with certain flats consistently outperforming others through a more successful establishment of co-operation and conformity. Interestingly, students in the ‘Green Flats’ proved good performers through the trial, but further investigations show this to be driven by a greater response to relative performance and desire to establish a strong energy efficiency status. These findings appear highly relevant for the field of energy economics and policy, but given its novelty, advocating to extend and expand upon this experiment seems logical. Not only would this enable a further verification of these results, but an expanded setting would also offer a chance to test further aspects and potentially unveil answers to the questions arising from the initial wave of monitoring.

The implications of this study are that policymakers must consider the important role that non-financial stimuli can have for both inciting small yet significant changes to behaviour and optimising the utilisation of scarce energy resources. Moreover, the project implies that the extent to which interventions will be successful may crucially hinge on the degree of integration and the existing environmental attitudes of the individuals involved. Therefore an ability to nurture, or at least establish, the degree of somebody’s group affiliation and like-mindedness or their environmental pre-disposition is seemingly invaluable when targeting, managing and applying environmental interventions most effectively.

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Appendix 1: The Respondent Survey

Survey Number: [ ]

Respondent Survey

Thanks for taking the time to complete this questionnaire, and for taking part in the survey!
We hope that you have found it an interesting experience.

1. Student ID: [ ]

2. Age: [ ] 18-19 years [ ] 20-21 years [ ] 22-23 years [ ] 24 years +

3. Which flat were you part of?

[ ] AA [ ] DD
[ ] BB [ ] EE
[ ] CC [ ] FF

4. Gender: [ ] Male [ ] Female

5. Fee Status: [ ] Home/EU [ ] International

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6. Please indicate if you were away from halls of residence over any of the periods below:

	At UEA all 7 days	Away 1-2 days	Away more than 2 days		At UEA all 7 days	Away 1-2 days	Away more than 2 days
Week 1				Week 7			
Week 2				Week 8			
Week 3				Week 9			
Week 4				Week 10			
Week 5				Week 11			
Week 6				Week 12			

What dates (if at all) were you away for over the Easter Break (March 11th – April 11th)?

7. Which of these best describes how often you read the emails that were sent?

[ ] I never read the emails [ ] I occasionally read the emails
[ ] I frequently read the emails [ ] I always read the emails

Why did you take this level of interest/disinterest?

[ ]

8. Overall, please rate your opinion of the importance of each ranking table provided:

	Most Important	Second Most Important	Least Important
Weekly Rank Table			
Overall Rank Table			
Ranking History Table			

9. After receiving the emails, do you think you attempted to change your behaviour?

☐ Yes ☐ No

If 'Yes', please indicate in the box below how you tried to change your behaviour.
If 'No', are you able to explain why this did not incentivise you to change your behaviour?

10. Please rate the strength with which you agree with each of the following statements:

(1 = Strongly Disagree; 2 = Disagree; 3 = Neither Agree nor Disagree; 4 = Agree; 5 = Strongly Agree)

	1	2	3	4	5
Being 'Energy-Efficient' is Important:	○	○	○	○	○
I tried to be efficient, but felt my flatmates did not:	○	○	○	○	○
I felt the ranking email stimulated me to act:	○	○	○	○	○
Money incentives would have made me try harder:	○	○	○	○	○
I will try and be energy efficient in the future:	○	○	○	○	○
Penalties for unsustainable action would be more effective than incentives to acting in a green way:	○	○	○	○	○
Doing environmentally friendly actions are important to me:	○	○	○	○	○

11. Before coming to UEA, did the people you lived with instil ideas of energy efficiency?

☐ Definitely not ☐ Not really/slightly

☐ Quite a lot ☐ Very much so

12. Which of the following 'green actions' would you say you actively partake in?

- ☐ Recycling
- ☐ Energy Efficiency
- ☐ Walking or Cycling where possible
- ☐ Using Public Transport where possible
- ☐ Conservation Work or Volunteering
- ☐ Water Conservation
- ☐ A UEA Green Society
- ☐ Encourage others to act in a 'Green Way'
- ☐ Donating to Environmental Charities
- ☐ Other (please specify)

13. What information would mean you would pay more attention to your energy usage?

- ☐ Ongoing emails on relative usage
- ☐ Nothing would change my behaviour
- ☐ A personal meter (e.g. SMART Meter)
- ☐ How much money it would save
- ☐ Appliance-specific information (e.g. how much energy to boil a kettle)
- ☐ Other (please specify in the box below)

14. Would you take part in a Focus Group Session (of 30-60 mins) once the exams have ended?

☐ Yes ☐ No

15. Would you like to stay in touch when you move into private housing next year?

(This would be so you can keep us informed of how you have transitioned into managing your energy bills and usage next year).

☐ Yes ☐ No ☐ I will not be in private housing at UEA next year

If you have answered 'Yes' to Question 14 or 15, please leave an email address in the space provided:

Appendix 2: Socio-Demographics across Flats

Table 2.1: Socio-Demographics

	Average Age (Years)	Ratio of UK Students	Ratio of Males
Flat AA	19.4	0.7	0.4
Flat BB	19.2	0.9	0.4
Flat CC	19.1	0.9	0.4
Flat DD	19.1	0.67	0.33
Flat EE	19.5	0.7	0.5
Flat FF	19.2	0.78	0.33
Flat GG	18.6	0.89	0.56
Flat HH	19.3	0.56	0.22