Gathering and Presenting Social Feedback to Change Domestic Electricity Consumption

Matthew Studley and Simon Chambers
University of the West of England
matthew2.studley@uwe.ac.uk

Ruth Rettie and Kevin Burchell
Kingston University
r.rettie@kingston.ac.uk

ABSTRACT
This paper describes the CHARM Energy Study in which mobile technology is used to study the impact of social group feedback on household energy consumption. We describe the background and rationale behind the study, the technology which supports the study, and the study's methodology. The work described herein builds upon similar studies by using mobile technology and on-line feedback to increase the frequency of accurate social group feedback to the participants.

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Nudge, Social Norms, Smart Meters

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: User Interfaces—*Evaluation and Methodology*

INTRODUCTION

It is widely recognized [10] that lowering domestic energy consumption could make a significant contribution in reducing CO_2 emissions and hence mitigate against the risk of anthropogenic climate change and promote economic well-being. There are significant challenges to the achievement of this goal; to change a household's energy consumption the householders must be motivated to change and to have the tools available to enact this change.

CHARM is a three-year EPSRC funded UK project that evaluates the impact of individual and social group feedback on behaviour in three different contexts, including electricity consumption. The research aims to develop, evaluate and understand the ways in which digital technology can be used to shape individual behaviour by informing and thereby challenging 'normal' practice. Social norm research suggests that we can influence behaviour by telling people what other people do [14].

Traditional approaches that try to change behaviour by directly influencing attitudes and intentions often prove ineffective [1]. Rather than telling people what to do, it can be more effective to use 'social proof' [6]; influencing behaviour by showing people what others do. Studies in several related disciplines suggest that everyday practices are malleable, and can be 'nudged' in a socially desirable direction by subtle forms of social influence [21]. In particular, research indicates that feedback on an individual's level of performance (e.g. electricity consumption) can change their behaviour, and moreover, that this effect is enhanced if supplemented by feedback on the performance of a relevant social group.

THEORETICAL FRAMEWORK

Writing from a sociological perspective, Shove [18] explores the social organization of normality and argues that patterns of consumption are shaped by the taken-for-granted practices of everyday life: 'much consumption is customary, governed by collective norms and undertaken in a world of things and socio-technical systems that have stabilizing effects on routines and habits' (p. 9). Shove emphasises the collective conventions that underlie individual conceptions of basic needs such as cleanliness and comfort. Thus, a year-round indoor temperature of 22°C has become an accepted standard of comfort that shapes buildings, clothing habits and energy consumption patterns, while daily showering has become an accepted cleanliness practice in the UK, with consequent impact on energy and water consumption. These expectations are taken-for-granted, and treated as inherent aspects of 'comfort' and 'cleanliness', but their contingency is demonstrated by historical and global variation. Although Shove highlights the complex socio-technical, economic, cultural and symbolic systems that underlie conceptions of 'normal' practices, she argues that what people take to be normal is not fixed but 'immensely malleable' (p. 199). Consequently, she claims, it is important to understand the 'dynamics of normalization', that is, how do the habits and practices of everyday life change and evolve?

Whereas Shove avoids a rational choice model with its focus on individual choices, the relatively new field of behavioural economics retains a focus on individual choice, but contests the assumption of a rational economic agent, in the light of research on the psychology of choice. Thaler and Sunstein[21] argue that choices are inevitably influenced by the context or 'choice architecture', and that it is legitimate to deliberately 'nudge' people's behaviour in order to improve their lives. A 'nudge' is 'any aspect of the choice architecture that alters people's behaviour in a predictable

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way without forbidding any options or significantly changing their economic incentives' (p. 6). Thaler and Sunstein highlight research in social psychology that shows one can nudge people simply by telling them what other people do.

Whereas earlier research on conformity [5] [12] relied on overt social pressure, more recent research [7] has focused on subtle, indirect influences of which participants may be unaware; these are more analogous to nudges. Cialdini *et al.* [8] distinguish between two types of social norms, descriptive and injunctive. The former simply state what most people actually do, the latter express an overtly normative message about what people should do. Both can be effective, but descriptive norms are less invasive. Social norm research typically [14] includes descriptive social norms, e.g. '70% of students on this campus do not take drugs', and has been widely used in social-norm marketing campaigns aimed at alcohol and substance abuse among young people. Research suggests that the impact of social norms depends on the extent to which they are focal (i.e. salient) and in alignment [7].

Two field studies are directly relevant to electricity efficiency. In these studies participants' electricity meters were read by research assistants who provided feedback on door-hangers. Nolan *et al.* [13] tested descriptive social norms such as:

> In a recent survey of households in your community, researchers at Cal State San Marcos found that 77% of San Marcos residents often use fans instead of air conditioning to keep cool in the summer. Using fans on energy instead of air conditioning — Your Community's Popular Choice!

The study found that these had significantly more effect on consumption than injunctive appeals to self interest, protection of the environment or social responsibility, although respondents in an earlier study (reported in the same paper) thought that the descriptive norm message would be least motivational. A study using a similar methodology by Schultz *et al.*, [17] again used door-hangers, giving participants feedback on their individual and local neighbourhood electricity usage figures. This research compared a feedback only condition (descriptive social norm) with an intervention than combined feedback with a positive or negative emoticon or 'smiley' (descriptive and injunctive social norms). In the feedback only condition, participants who were using more than their neighbours used significantly less after the intervention, but those who were using less moved towards the norm, and started to use more electricity (the 'boomerang' effect). In the second condition, when descriptive and injunctive social norms were combined, the 'destructive' movement towards the norm was avoided: usage of those below the norm remained stable while the usage of those above declined. Note, these two studies used personal meters readers attached handwritten feedback to respondents' front doors; this personal element may have enhanced the normative effect of the communication. A large scale year long trial conducted by Cialdini at Positive Energy (O Power) combines descriptive and injunctive social norms in energy bills, with promising results [3].

The study by Schultz *et al.* combined individual and social group feedback, but did not distinguish between the impacts of these two interventions. There is considerable research on the impact of individual feedback in energy efficiency. Darby [9] identifies feedback as the single most promising method for reducing household energy consumption, and calls for more field testing. Research shows that more frequent feedback is more effective, and that feedback can be effectively conveyed through a website [2]. Research on social group feedback in energy bills is more equivocal. Surveys conducted in the US and Norway indicate that consumers are receptive to comparisons of their energy consumption with relevant social groups, but Roberts *et al.* found the idea of social comparison was unpopular in UK focus group research [15]. Iyer [11] reviews different expressions and formats of comparative social feedback and advocates small comparison groups preferably based on physical location.

Methodology

We performed two pilot tests, the former involving ten participants recruited from University staff, the latter twenty participants recruited from two coherent geographical areas chosen to represent different socio-economic groups. Due to the small size of the pilots no statistically valid inferences can be drawn from their output; these trials were performed to test technology, recruitment and communications. The main study includes four hundred and twenty participants professionally recruited in these two target areas. Participants are paid an incentive for their participation. Recruiters administered a pre-trial questionnaire (e.g. ascertaining house type, the number of rooms in the house, heating type, et c..). A matching questionnaire will be administered after the trial to see what change has taken place in the way the participants see themselves and their behaviour. We believe that the CHARM Energy Study is unique in using mobile technology to study the effect of frequent online social feedback in a UK study large enough to enable statistically-valid conclusions to be drawn.

Households were randomly assigned to one of three conditions; control (no feedback), individual feedback only, or both individual and social group feedback. The control groups have their energy use monitored but receive no communications from the team during the study, and do not receive any feedback on their energy use. We will use the data on the control groups' usage to account for environmental factors which effect electricity use (cold weather, mass use of TV to watch landmark events, et c.) and to allow us to take into account the fact that simply having an 'electricity monitor' in the home may have an effect on the energy behaviours of the household.

In addition to the questionnaires, we will conduct approximately 35 face-to-face semi-structured interviews, with a purposive sample of subjects. Interviews will occur in respondents' homes and involve as many adult household members as feasible, and will include observation and discussion

of home configuration, energy efficiency features, types of energy consumed and appliances used. A number of respondents will be interviewed both before and after the experiments, in order to benchmark conceptions and practices and to facilitate identification of changes (these respondents will be excluded from the field trial analysis). A number of respondents will be re-interviewed at least six months after the trial to identify any long term changes in overall levels and underlying practices. Respondents will receive an additional incentive for their participation in the interviews. In addition, we plan three professionally moderated focus groups, to elicit discussion of the trials and normative discourse in a social context; the focus groups will be reconvened after a period of six months to explore the longevity of any changes in practices.

Technology

Each respondent who volunteers to take part in the study is supplied with a box containing three components

1. A *current-clamp* which attaches to the meter tail and which transmits usage data every two seconds via a 433 MHz wireless link.
2. A *monitor* which stores this data and sends the data to our server via GPRS using a roaming SIM.
3. A *power adapter* which supplies the monitor with power for operation.

There is no real-time display visible to the individuals in the household. It has been shown [4] that real-time displays are a powerful tool in effecting behavioural change since they promote experimentation to see what effect individual appliances have upon power consumption, but have not been included in this study in order to focus on the effects of social feedback.

The monitor and current-clamp make use of a commercially-available off-the-shelf home energy monitor with a real-time display. We hide the display from view in the box that contains the GPRS modem and microcontroller. Using a COTS solution allowed a significant saving in development time and the time taken to meet regulatory and safety requirements.

As a result of field-testing in the pilot studies, the embedded controller has evolved through several iterations to account for network outages, automatically reloads new versions of firmware as we release them, and can be remotely controlled *in situ* to trigger recovery from several abnormal conditions.

Usage information is gathered via GPRS upload by the HTTP 'GET' mechanism to a web-server where it is logged in a relational database. The web-server provides an password-controlled management interface which allows us to track the performance of each monitoring unit and participant household, to determine for example when participants in a household have not viewed their data on the website, and to track the frequency of data transmission from monitors enabling the team to track network outages, request user interventions such as checking the unit is receiving power, ask the householder to reboot the unit, et c..

Feedback

Information is supplied to the participants in the individual and social experimental groups in a number of ways. They can view information about their electricity use on the website (see below). They receive weekly emails which encourage them to maintain their participation in the study. Individuals known to be infrequent visitors to the website may receive SMS text messages prompting them to participate, a mechanism which was shown to be an effective way of encouraging re-engagement in the initial field trial.

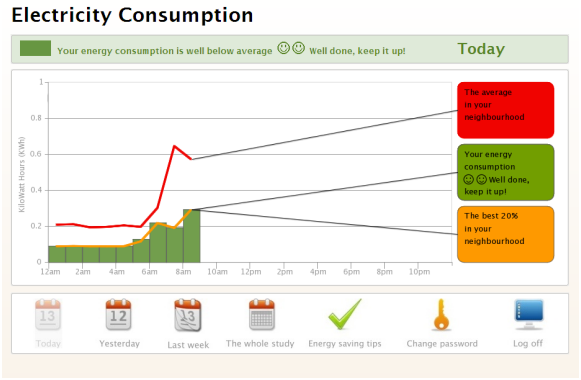

Figure 1. Social Feedback on Web Interface

As previously stated, households are assigned to one of three experimental groups which define the type of feedback they receive. The feedback provided to households in the social feedback category is illustrated in fig. 1. We hope to create the conditions where we may most easily see an effect of social proof in changing behaviour in the following ways. Firstly, we attempt to increase saliency as recommended in [7] and focus on small geographic areas as recommended in [11]. Secondly, we provide descriptive and injunctive feedback in the form of emoticons after Schultz [17] to reduce the possibility of the 'boomerang' effect. Finally, we provide easy access to energy saving tips which we hope will provide householders with the means to lower their energy consumption. The website also provides the user with views of his electricity consumption in a context suited to his experimental group for previous time periods; yesterday, last week, and the whole of the study thus far.

Initial results from the participants in the twenty-strong second test indicate that the feedback is viewed as both interesting and useful, and we look forward to reporting the results of the full trial in the near future. Recruitment for the main trial started in January, 2011, and we expect to present results after the trial in the Autumn of that year.

Novelty

The CHARM Energy Study differs from the work reviewed above in the following ways. There have been studies involving more people with monthly feedback on paper-based bills [3], and studies involving small numbers of people with

weekly paper-based feedback [17]. We believe that ours is the first study testing the social norm approach with frequent automated data collection and feedback. Further, ours is the first such study in the UK where there may be resistance to the social norm approach [15].

Conclusion

It is planned [19] that all UK homes will have Smart Meters installed by 2020, and the EU Smart Meter market has been predicted [16] to be worth 25 Billion Dollars US in the ten years from 2010 to 2020. Although the emerging UK standard [20] mandates that UK Smart Meters will provide bidirectional communications and support in-house displays, we are unaware that there is yet a standard for the type of information that will be displayed to the consumer.

If the study shows a real reduction in domestic electricity use resulting from social feedback methods, we hope that we may influence the emerging Smart Meter standard to provide for this means of change.

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