



The effect of behavioural interventions on energy conservation in naturally ventilated offices[☆]

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ABSTRACT

This paper investigates the effects of behavioural interventions on energy conservation in naturally ventilated offices. Our aim is to inform building managers, environmental consultants, and social scientists on the effectiveness of low-cost, easy-to-implement interventions aimed at reducing energy waste and carbon emissions in a setting where individuals do not have direct financial gain and have low awareness of the environmental impact of their actions. The interventions consist of three types of emails with different information content aimed at encouraging recipients not to leave the windows of their office open overnight or during weekends. Our results show that these interventions are effective in promoting energy savings, as the percentage of windows left open by treated occupants is typically halved compared to a control group. We find that the impact of the treatment is stronger when we provide specific information about the energy waste of the building where the email recipients work or when we show them how their behaviour differs from that of their peers. Moreover, our results show that positive behavioural changes are still observed a few weeks after the interventions are terminated, thus suggesting that such interventions do not act only as temporary “cues” which are easily forgotten by recipients.

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1. Introduction

Market-based policies to reduce greenhouse gas emissions such as carbon cap-and-trade programs or subsidies to renewable energies have proved to be very effective.¹ However, the political resistance to the use of some of these approaches (as in the case of the market for trading carbon emissions in the US) and the financial cost involved in sustaining them (as in the case of the subsidies for solar and wind energy) have pushed in recent years, academics and policy makers to

shift their attention to alternative low-cost, non-price-based energy conservation programs (see Allcott and Mullainathan (2010) and Dietz et al. (2009) among others).

A large body of ongoing research on consumption feedback, appeals to environmental protection, and social comparisons has shown that behavioural interventions can be cost-effective in encouraging households to conserve energy (Abrahamse et al. (2005); Allcott and Mullainathan (2010)). For instance, in an influential study based on data from a randomized experiment involving thousands of US households, Allcott (2011) finds that Home-Energy-Report letters comparing the electricity bill of residential customers to that of their neighbours induce a 2% reduction in energy consumption.

Building upon these findings, the aim of this paper is to evaluate the effectiveness of a simple energy conservation intervention in the context of naturally ventilated office buildings, namely to remind participants to close the windows before leaving the office. Non-domestic buildings in UK are responsible for one quarter of the total emissions attributed to residential and non-residential buildings (which together represents around 18% of UK's CO₂ emissions) but, whereas emissions from residential buildings have gradually decreased over the last

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¹ According to the figures published by the EU, the EU Emission Trading System (ETS) has reduced greenhouse gases emitted by installations covered by the system by around 5% in the period 2013–2015. The EU estimates that in 2020, emissions from sectors covered by the system will be 21% lower than in 2005 (see https://ec.europa.eu/clima/policies/ets_en).

decade, emissions from non-domestic buildings have increased by 6% in the period 2007–2015 (Committee on Climate Change, 2016). This trend could be reversed if occupants were using building systems and controls more effectively. Several studies (Leaman and Bordass (2001) and Clements-Croome (2006), among others) have shown that people favour office spaces where they can interact with the facade to regulate their indoor environment. But this ability to individually change the internal environmental conditions does bear a risk of compromising the energy performance of the building as occupants are often oblivious to the necessity of minimizing energy use, especially in the absence of any direct costs as employees do not pay for the energy bills.

Behavioural interventions aimed at promoting energy conservation, such the OPOWER program studied by Allcott (2011), while non-price-based, do imply a financial gain for the subjects. It can be argued that the impact of social norms and pro-environment feedback may not be equally effective in a context where people receive no direct financial benefits. The findings from the literature on the impact of behavioural interventions in non-domestic buildings suggest that eco-feedback can be effective in encouraging energy conservation even in the absence of direct financial gains for participants.² However, existing studies on energy conservation in the workplace are scant; the effectiveness of the interventions is almost always measured in terms of aggregate electricity usage at the building level. In addition, little is known about the long-term effects of these interventions as employees' behaviour is generally not monitored over longer periods.³

Insights from psychology literature suggest that promoting behavioural change is more effective when the behaviour to be changed is carefully selected, interventions are well-tuned and not too costly to implement and feedback makes salient the relationship between one's action and a given outcome (Abrahamse et al., 2005; Steg and Vlek, 2009). In this respect, Carrico and Riemer (2011) note that "*feedback that is removed from the specific behaviour, either temporally or in unit of analysis (i.e. aggregated across many behaviours and/or individuals) will not provide the type of information that allows an individual to gauge whether his or her actions are having the desired effect*". Building upon these findings, the key contribution of our research is to investigate the effectiveness of environment appeals and social norms in the workplace in a setting where (a) the intervention refers to a single task, simple and easy to implement (i.e. close the window of your office), (b) feedback is at individual level and delivered at relatively high frequency (two emails a week) and (c) the link between the behaviour to be changed and the impact on energy consumption is less obvious.⁴ Moreover, as we monitor the behaviour of our subjects from two to seven weeks after the interventions have been discontinued, our study can shed light on the "medium-term" effects of our energy conservation program.

Our approach builds on a multi-disciplinary project (Bourikas et al., 2016), and it involved the development of a bespoke software system to monitor the status of windows starting from photos of the façade and which allowed the semi-automatic dispatch of emails (sent twice a week) to the individual in control of the windows, based on each window's status. Three types of intervention were defined around these emails, and they were designed based on insights from psychology science on the importance of moral obligations and social norms on behaviour (Steg and Vlek, 2009). The first intervention involved a generic email informing recipients about the problem of energy waste

due to windows being left open overnight. The second intervention involved a feedback email informing recipients about the average number of windows left open *in their building*. Finally, the third intervention involved an email based on social norms, which informed recipients about how many times they have left their office window open *compared to others* in their building. Our interest in comparing these three options is to examine whether tailored information specific to the working environment of the recipients and social norms, which have been found to be potent behavioural drivers in experimental settings (Cialdini and Goldstein, 2004), are confirmed to be a more powerful motivator of prosocial behaviour than a simple appeal to energy conservation also in a real context where subjects do not have direct financial gains. The three interventions were compared to a baseline period, before the interventions started, and to the performance of a group of participants who had their windows monitored, but did not receive any emails.

The results, detailed in Section 4, indicate that the interventions are effective in encouraging energy conservation and that the impact of the treatment is stronger when feedback and normative comparisons are included. We also found some evidence that our interventions may facilitate the formation of an energy conservation culture as the positive effects of the intervention are still observed some weeks after the interventions are terminated. Back-of-the-envelope calculations suggest that these types of intervention have the potential to lead to annual savings of more than £40,000 over a bill of £3.5 million on gas alone for an institution such as the University of Southampton.⁵

The rest of this paper is organized as follows. Section 2 reviews the existing literature on non-price interventions. Section 3 first explains the type and timing of the interventions and then provides information about the variables used in the empirical analysis. Section 4 details the empirical specification used to investigate the effects of the interventions and the results obtained. Section 5 concludes.

2. Literature review

This study sits in between different strands of literature. Research in economics and psychology has mainly focused on the effects of behavioural interventions on energy conservation in a domestic setting. The resulting literature has shown that social norms including feedback, energy conservation tips, or household energy reports comparing their energy usage to that of neighbours, can have substantial effects on reducing energy consumption, at least in the short-term (Allcott and Mullainathan, 2010 among others). Allcott and Rogers (2014) show that if interventions are sustained over time, individuals build a "capital stock" which eventually allows altered behaviours to become natural ones and thus to persist over time.⁶ The study by Asensio and Delmas (2015) compares the efficacy of price and non-price interventions. The authors find that providing feedback of the negative effects of energy use on the environment and human-health (e.g. pollution or child asthma) outperform monetary incentives to drive energy conservation.

Arguably, the extent to which information affects behaviour depends on the precision of the feedback provided. Nolan et al. (2008) find that messages notifying how neighbours engage with energy conservation are more effective in spurring behavioural changes than those encouraging standard appeals to the environment. Agarwal et al. (2017) also confirms that peers' comparisons have substantial influence on consumers' behaviour. They find that school children nudging their families to conform to efficient energy habits are an effective way of organizing "voluntary commitments" resulting in a 1.8% drop in household energy use. These simple experiments show how social norms

² See the papers by Carrico and Riemer (2011), Gulbinas and Taylor (2014) and Dixon et al. (2015) discussed in the literature review.

³ As noted by Abrahamse et al. (2005), most studies do not monitor energy usage after interventions have been discontinued and, consequently, it is difficult to know whether "*behavioural changes were maintained and whether new (energy-saving) habits were formed, or whether energy use returned to baseline levels*".

⁴ In a survey we conducted one year before the beginning of this study, we found that the vast majority of the respondents did not associate wasting heat with energy waste (Bourikas et al., 2016). Abrahamse et al. (2005) note that "*educational campaigns may especially be advisable when people are unaware of energy use and environmental problems*".

⁵ University of Southampton (UoS) Carbon management Plan, 2011

⁶ In a study on the effects of construction activities on residential electricity consumption, Agarwal et al. (2016) find evidence of persistent increase in electricity usage triggered by a temporary negative environmental externality.

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