



# The energy efficiency behaviour of individuals in large organisations: A case study of a major UK infrastructure operator



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## ABSTRACT

Energy consumption behaviours are gradually becoming better-understood. However, there is still a deficit in terms of knowledge of individuals' energy-use behaviours in organisations, despite a variety of available theories. This paper addresses this need in three main stages, based on a survey among mid-level managers at a major infrastructure operator in Great Britain. Firstly, a principal components analysis is performed to identify key determinant constructs driving energy-efficient behaviours in organisations, revealing the importance of perceived benefit to the organisation and flexibility of existing performance goals and targets. Secondly, cluster analysis is undertaken, in an effort to identify differences in behavioural influences between demographic groups. These clusters highlight the heterogeneity of employee populations' energy behaviours, demonstrating that assumptions cannot be made about these based on single responses to cross-industry surveys. Finally, a structural equation model of individuals' energy use intentions and behaviours using the newly-identified constructs is developed, revealing some similarities with existing behavioural frameworks such as the Theory of Planned Behaviour (Ajzen, 1991). Implications for policymakers are then discussed, in terms of encouraging individual employees' curtailment of energy consumption in organisations through tailored engagement programmes.

## 1. Introduction

Emissions of greenhouse gas originating from electricity production are a key contributor to climate change processes (IPCC, 2014). The UK has set a target for an 80% reduction in greenhouse gas emissions by 2050 (against 1990 levels) (Climate Change Act, 2008). Transport accounts for 21% of the country's total greenhouse gas emissions (DECC, 2015). Management of transport infrastructure accounts for a large proportion of this consumption; railways in the UK consume 1% of the national electricity supply (over 4 TWh/year) (MacLeay et al., 2015), and the management of transport infrastructure (as opposed to operation of trains) represents approximately one eighth of this total. The railway industry in the UK is currently under regulatory pressure to reduce its financial costs (Shaw, 2016), this imposing a further need for energy efficiency programmes to be implemented. However, studies of other industries (discussed below) suggest that economic drivers alone are not necessarily sufficient to drive improvements in energy efficiency.

Management of energy consumption at the point of use is a key element in efforts to reduce greenhouse gas emissions across any organisational setting (Warren, 2014). Energy behaviours have been

investigated from a wide variety of perspectives, including economics, engineering, psychology and sociology (Lopes et al., 2012). Allen and Chatterton (2013) recommend that a low carbon future should be led by greening businesses and making demand-side improvements, with an emphasis on addressing individuals' behaviours. However, energy attitude and behaviour studies in organisational settings are far less common than those undertaken for consumers or individuals in households (Andrews and Johnson, 2016). This is despite recognition that reducing energy demand in organisational settings is likely to be more difficult than previously assumed, due to multiple overlapping non-price-related barriers (Sorrell, 2015). Some efforts have been made to overcome this by looking at retail firms (Christina et al., 2014a, 2014b) specifically, but larger organisations remain under-researched (Andrews and Johnson, 2016). This suggests a need for further case studies of energy consumption behaviours in larger businesses, to allow observations of employee energy consumption behaviours and their role in improving energy efficiency to be better-understood across a range of operational scales.

The majority of energy behaviour studies to date have focused on domestic settings (Lopes et al., 2012; Greaves et al., 2013; Boomsma et al., 2016). Energy consumption behaviours in households often

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deviate from established economic decision-making theories (Zhou and Yang, 2016). However, it appears that some assumptions are currently made about the uniformity of energy consumption behaviours by individuals within organisations, whereas earlier studies of pro-environmental behaviours suggest that this is not the case (Wehrmeyer and McNeil, 2000). Qualitative analysis by Goulden and Spence (2015) also suggests that commercial organisations need to be treated as heterogeneous networks when considering individuals' approaches to energy use. Whitmarsh (2009) also shows that attitudes toward mitigating climate change do not equate with attitudes towards saving energy, suggesting the value of investigating energy behaviours in greater depth generally. Furthermore, Murtagh et al. (2013) point out the distinction people make between home and the workplace, in terms of personal pro-environmental behaviours. This paper therefore investigates the structure of energy behaviours of individuals in a large organisation and aims to address the question of whether behavioural frameworks developed to understand consumer- or domestic behaviours can be successfully applied to organisational settings.

### 1.1. Economic and Engineering approaches

The reluctance of organisations to undertake energy efficiency measures despite the profitability of doing so, known as the 'energy efficiency paradox' is well-documented in economic literature (DeCanio, 1998; Kounetas and Tsekouras, 2008; Martin, 2012). A set of barriers to energy efficiency proposed by Sorrell et al., (2000, 2004, 2011) have received repeated attention in recent years, and are commonly referred to by other authors in the field of organisational energy behaviours (e.g. Schleich and Gruber, 2008; Schleich, 2009; Fleiter et al., 2012). However, these were based on an initial case studies within three industries (Sorrell et al., 2000) (higher education, brewing and mechanical engineering), none of which share many characteristics with transport infrastructure operation. This body of research seems to largely downplay the role of behavioural influences on organisational energy efficiency. In particular, credibility and trust in information (Testa et al., 2016), and individually-held values (Papagiannakis and Lioukas, 2012) have both been found to have significant relationships with the environmental performance of organisations, contradicting the aforementioned economics-led studies. Even economically-framed studies suggest that behavioural factors may play a greater part in determining energy efficiency than originally thought (Cagno and Trianni (2014), and that economic incentives only explain a portion of observed behaviour (Sorrell, 2015). This suggests a need for further research into behavioural influences affecting energy consumption in organisational settings. This also raises the possibility that employee performance measures should focus on non-financial goals, if a reduction in employees' energy consumption is to be achieved.

### 1.2. Psychological and Sociological approaches

General theories of individual behaviour have often previously been applied to analyse pro-environmental, energy consumption, and technology adoption attitudes and behaviours in organisations. The Theory of Planned Behaviour (TPB) (Ajzen, 1991) (following on from Ajzen and Fishbein, 1977) has often been used to characterize both pro-environmental and energy-saving behaviours. This theory assumes that individuals are rational actors, who make decisions based on a consideration of all known factors. However, debates have often arisen around the validity of particular constructs within the overall framework. The association of the 'Subjective Norm' construct with intentions and behaviours in particular is a subject of much debate, either seeming to exert greater (Papagiannakis and Lioukas, 2012) or lesser (Dixon et al., 2015; Tetlow et al., 2015) influence than attitudes in organisational settings. Littleford et al. (2014) suggest the differences between organisational- or home settings are a defining feature of

energy consumption behaviours. However, they believe that there are fewer applications of the Theory of Planned Behaviour in organisational settings than are necessary to fully understand these characteristics.

The Theory of Interpersonal Behaviour (TIB) (Triandis, 1977) shares many similarities with Ajzen's theory, but has not been tested as often (Jackson, 2005). This theory includes a 'Habit' component, to account for behaviours which may be made as a result of familiarity and repetition rather than conscious decision-making. Rare comparisons with the TPB have been favourable, such as for pro-environmental travel behaviours (Bamberg and Schmidt, 2003). Again, the validity of some constituent constructs have been questioned, albeit in contexts other than energy conservation (e.g. Gagnon et al., 2003; Moody and Siponen, 2013). Despite this, The TIB is consistently raised in support literature for UK policy-makers (e.g. Darnton, 2008; Chatterton, 2011). The structure of Triandis' theory closely reflects an energy technology acceptance framework proposed by Huijts et al. (2012) and later tested in Huijts et al. (2014). This suggests that the TIB as a possible framework for describing the determinants of energy-efficient technology adoption.

Observations of pro-environmental behaviour in the workplace are not limited to these two frameworks. Boiral and Paillé (2012) and Paillé and Boiral (2013) find that the level of perceived organisational support is related to 'organisational citizenship behaviours for the environment'. Andersson et al. (2005) found mixed levels of support for constructs proposed by Value-Belief-Norm theory, suggesting that this theory would require revision for application in corporate settings. The profusion of theoretical constructs offered as methods of explaining intentions and behaviours suggests that further research is needed to identify which of these may apply to organisational settings. Given that it is not clear which of these theories might apply in a large-scale organisational context, this raises the proposition that an exploratory analysis method may be used to identify whether any aspects of these existing frameworks are applicable in workplace settings.

### 1.3. Principal components analysis in energy behaviour research

Principal components analysis (PCA) is often used to identify factors influencing general pro-environmental behaviours, adoption of new (pro-environmental) technologies, and energy conservation, which we draw upon below. This technique has been applied in both consumer- and organisational settings, as described below. However, as with studies of energy behaviour in organisational settings more generally, exploratory, quantitative case studies of this type are not currently widespread in the literature.

Aksen et al. (2012) used principal axis factoring (a close analogue of PCA) to compare general lifestyle practices and pro-environmental technology adoption, finding that the two groups of practices were largely independent of one another. Subsequent cluster analysis also classified groups who were either 'green' or 'technology' oriented. Similarly, Sütterlin et al. (2011) applied PCA and cluster analysis to classify market segments of consumers with commonly-shared energy-saving behaviours, broadly identified as energy 'savers' or 'consumers'. Barr et al. (2005) also identified groups which portrayed varying degrees of environmentalism (or lack thereof). Michelsen and Madlener (2013) investigated homeowners' decisions to adopt types of residential heating systems, identifying cost, general attitude, available grants, energy security considerations, comfort considerations and the influence of peers all played a part in this process. Again, these were broken down into those preferring the convenience of existing technologies, and those who were motivated to adopt new ones, with a third group who were aware of the consequences of energy-efficient technology adoption but experienced other barriers.

Gadenne et al. (2011) used PCA to identify specific characteristics of environmental attitudes and norms relating to energy-saving behaviours for consumers. Their paper takes the additional step of

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