Energy Consumption Behaviour and Home Performance:
Community Energy Saving Programme in Aspley, Nottingham

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ABSTRACT: The present study reflects on how energy policy is being enacted through policy and regulation in the existing domestic sector in the UK, through one of the Community Energy Saving Programme (CESP) schemes, rolled out by the UK government in 2009. The research illustrates some of the results of a survey questionnaire administered to the residents of this CESP scheme in Aspley, Nottingham. Designed and executed in two phases, the first phase of the survey sought to understand residents' attitudes and behaviour and explore how this related to home energy use and performance prior to extensive energy-related upgrades to their dwellings. The second survey phase examined changes in users' energy consumption behaviour and dwelling performance after their homes were upgraded to higher energy efficiency standards. The outcome of the research provides a comparative analysis between both phases in terms of home performance and the possible reasons for any change in energy consumption behaviour depicted; whether it was due to policy uptake, information provided or means of communicating.
Keywords: energy consumption, domestic sector, home improvements, energy upgrade, behaviour

INTRODUCTION

The UK domestic sector accounts for approximately 30 per cent of the total national energy consumption [1]. In 2010, of the 30 per cent total national energy consumption, 48 per cent was used for heating purposes; 58 per cent of which was consumed by the domestic sector [2]. Whilst major home improvements fuelled in part by various government initiatives have in principal helped curtail overall energy use, which according to Eyre et al. (2011) may have doubled without such improvements, overall energy consumption in the domestic sector is rising, with increasing numbers of new -build houses coming on stream [3].

One of the key determinants of energy consumption is the way that users behave and in particular the lifestyles they adopt. A major part of most individuals' lifestyles involves some form of energy consumption, whether it be for commuting, entertainment, cooking, personal hygiene, heating or cooling purposes. As such, habits develop through repeated and frequent patterns of behaviour; these in turn are often reinforced through the numerous unconscious decisions that take place in everyday life [4]. Thus, to 'unlock' the old habits and establish new ones, intervention strategies need to be tailored according to each and every problem or scenario identified.

The present study attempts to identify key features from policy instruments that can improve the chances of reducing energy consumption within the UK domestic sector. The study implies the importance of adopting a comprehensive, interdisciplinary perspective in energy conservation policies, in order to examine current behavioural patterns and to use policy instruments appropriately to improve them. It seeks to identify gaps in knowledge about energy-efficient behaviour in households, and to identify measures that could motivate behaviour change through policy instruments.

ENERGY CONSUMPTION BEHAVIOUR

With a growing world population characterised in part by an increasing number of people seeking to live in urban areas, achieving holistic sustainable behaviour poses numerous significant challenges. Among these is overcoming the barriers that society itself poses; those of behavioural and social patterns which in turn drive energy consumption and resource use. Although governments can play a pivotal role in helping people foster more sustainable behavioural patterns, they must do so in a manner that engages individuals and the public at large. Ultimately, the aim of the research is to understand residents' lifestyle and behaviour with a view to developing appropriately tailored approaches that support and maintain effective delivery of current and future policy initiatives.

People, however, often make daily decisions in response to their needs; but it can prove challenging to purchase sustainable products or uptake habits that may not provide the level of comfort required. It is argued that factors forming the basis of choices, habits and values of individuals dictate an individual's decision to either adopt environmentally sustainable behaviour, or not [5, 6]. Those factors include socio-demographic variables and psychological variables [7].

Studies [8, 9] have shown that age, gender and income often dictate the amount of energy used in households. Additionally significant differences in energy consumption patterns can for example be correlated between different income groups among diverse ethnic groups and cultures [10, 11]. Meanwhile, attitudes, norms and beliefs can also be considered very powerful energy consumption variables [5]. Stern et al. (1997) suggest that domestic energy use determinants are interdependent and act within a range of combinations rather than additively [12]. Thus, to understand this complex phenomenon, it is essential that research transcends traditional disciplinary boundaries, therefore encouraging interdisciplinary collaboration between say sociologists, psychologists, economists, anthropologists, among others.

Another implication of energy consumption behaviour is Jevon's Paradox (otherwise known as the 'rebound effect' [13] which may happen with energy efficiency developments. With lowered energy consumption through, for example, energy efficiency measures, it has been mooted that any cost savings (and as a result availability of more disposable income) could be diverted to other, equally environmentally damaging means such as purchasing more power-hungry appliances, increasing frequency of travel (such as flying abroad), purchasing of cars and so on [14]. Indeed, the UK Energy Research Centre predicts that the rebound effect could offset 10-30 per cent of energy savings [15]. In line with the previous implications to energy consumption, Gardner and Stern (2002) propose four basic types of interventions to drive pro-social and pro-environmental individual behaviour; the use of government regulations and incentives is one of these [10]. This method is examined and investigated in the present research as one of the potential instruments for driving sustainable energy-consumption behaviour.

POLICY INITIATIVES FOR REDUCING ENERGY USE IN THE DOMESTIC SECTOR

Climate change policy planning has been closely connected to energy policy in the UK where policy initiatives have been in place, and continuously developing, for the last 40 years. During the last decade, the UK has set a major priority to achieve low carbon and secure energy supplies [16] driven by three core objectives; climate change, energy security and fuel poverty. Given its contribution to energy consumption and carbon emissions, the UK's domestic sector has been seen as a worthwhile vehicle against which the Government's 2050 carbon reduction targets can in part be met. To meet the 2050 targets, domestic sector carbon dioxide emissions have to reduce by 17 MtC p.a. (million tonnes of carbon dioxide per annum) [17].

Recently, European governments have been setting more regulations and incentives to encourage the adoption of energy efficiency measures and behaviours in the domestic sector [18]. As part of the UK government's strategy to reduce carbon emissions and meet the climate change targets, the EU Energy Performance of Buildings Directive (EPBD) was introduced in the UK in 2006 with a three year implementation period ending 2009 [19]. The EPBD objective was to improve energy efficiency and introduced higher standards of energy conservation for new and refurbished buildings obliging energy performance certification for all buildings when sold or rented out. This resulted directly in numerous initiatives and policies to evolve in the UK and these have flowed down to national policy and legislation. For instance, the EPBD has had a significant influence on some core building regulations such as Part L, Conservation of Fuel and Power, which was first introduced in 1965 for limiting energy loss through buildings [17], but further requirements have been introduced to reinforce it. A tool developed for this was the Standard Assessment Procedure (SAP) which was introduced in 1992 to provide a useful measure of potential energy performance. SAP feeds directly into Part L of the Building Regulations [20]

Moreover, Building Regulations for new buildings set the target of zero carbon homes by 2016 and zero carbon buildings by 2019 [21]. All new homes are required to have a mandatory Code for Sustainable Homes indicating whether they had been assessed, and the performance of the home against the Code. The Code builds on the Energy Performance Certificate (EPC), which has been required since 2008 whenever a building has been built, sold or rented out.

Policies for new built housing stock, however, will not provide significant improvement to the existing stock. Existing housing stock constitutes around 99 per cent of total building stock at any one time [22]. Thus, retrofitting existing domestic stock has been identified as a major priority by the UK, and the current vision is to upgrade seven million homes by 2020 [23]. To help achieve this target, several strategies and programmes have been introduced recently. Primary among these is the Heat and Energy Saving Strategy (HESS), introduced in 2009 with a view to "saving energy and decarbonising our heating", and it incorporates several schemes such as Carbon Emissions Reduction Target (CERT), Community Energy Saving Programme (CESP), and Feed in Tariffs (FiTs) among others. The CESP, under study in this research, has been created as part of the Heat and Energy Saving Strategy (HESS), where whole-house energy efficiency measures are installed

in street-by-street approach in specific priority areas [24].

Thus, policy instruments could possibly reinforce the importance of programmes that aim to change organisational, household and individual behaviour. Although policies could remove structural and institutional barriers to behavioural change to some extent, the residual energy consumption will always vary between households due to varying individual behavioural patterns. Emphasis on using economic instruments for delivering carbon reduction needs to shift towards crucial behavioural change to ensure successful policy delivery. This has been highlighted in the most recent Sustainable Development Strategy [25]. Environmental policy need not only focus on the economic instruments, but needs to incorporate complementary informative instruments that would possibly develop politically skilled and engaged individuals [26]. A focus on the bottom-up approach in policy instruments, by actively engaging the public through more information dissemination and communication, could possibly improve policy uptake and delivery.

Implications for environmental policy have been stated as three propositions [26]. First, the probability for policy and legislation to control households is low when it comes to people's personal privacy and autonomy concerning their own lifestyle-choices and behaviour. Another implication is the evident lack of infrastructure planning that facilitates pro-environmental behaviour at the household level.

RESEARCH METHODOLOGY

The primary underlying basis of the research is to identify current knowledge and understanding of energy consumption behaviour and how lifestyles of individuals could, both negatively and positively, drive the delivery of policy initiatives. To ensure systematic analysis of the key aim and objectives, a mixed methods research design is employed. The study is driven by the pragmatist approach which advocates the use of different views, methods and assumptions as well as data collection and analysis in mixed methods research. This mixed methods approach has the benefit of combining qualitative and quantitative data in order to explore more fully the context of a case study. The study uses procedures drawn from concurrent forms of data collection, in which both the quantitative and qualitative data are collected simultaneously [27].

The research uses the Aspley Super Warm Zone (ASWZ) scheme, one of the pilot CESP schemes in Nottingham, as the primary vehicle from which data is generated and analysed. The Aspley area is identified as a socially and economically deprived area in Nottingham comprising inefficient solid-walled houses that are particularly 'hard to heat'. In addition, the area presents additional challenges to any successful policy implementation; these are founded in its unique demographic, economic and socio-cultural characteristics. For any energy reduction programme to be delivered successfully, it is essential that due consideration is given to these factors.

Thus, a two-phased survey questionnaire has been designed and planned to gauge households' energy performance and occupants' energy consumption behaviour and lifestyle both prior to and following the energy-saving measures implemented within their dwellings. It engaged a random sample of 122 households from eligible households within the ASWZ. Data collected was analysed to produce descriptive and frequency statistics and regression analyses tests were performed to compare levels and rationale for tenants' energy consumption behaviour and home energy performance in the ASWZ. The data and results from both phases have then undergone comparative analysis to draw the overall picture for the performance of the ASWZ scheme.

SURVEY RESULTS

Phase A results

The total annual income of 69 per cent of the respondents' households is less than 12 thousand pounds. The mean figures for monthly gas bills and monthly electric bills have been determined to be £51 and £50 respectively, which identifies that most of the 69 per cent might be in fuel poverty. Concerning problems in their homes, respondents always and sometimes experienced cold 64 per cent and draughts 62 per cent, followed by mould 48 per cent and condensation 44 per cent.

There appears to be a general problem with people understanding how their heating systems and controls work and how best they could make them perform. Also, 61 per cent either sometimes or never use their heating controls, and 53 per cent of households heated most of the rooms most of the time and when in the house, while only 20 per cent heated all the rooms all the time. Households with the dominant heating trend of heating most of the rooms when in the house seem to report inadequate loft insulation in their homes ($r = -0.3$, $p<0.05$). This could either be due to not having any loft insulation done during their occupancy or not knowing whether their lofts are appropriately insulated or not, which might reflect the problem of lack of information provided. Moreover, 72 per cent of the sample reported they never received energy advice. These issues have been further delved into in phase B to find out when exactly they use their controls and how often they do so after the energy upgrade works.

It has been noted that the higher the income of households, the more people would prioritise heating upgrades to improve their homes ($r=0.472$, $p<0.001$). This relates to the higher tendency for people to pay towards insulating their homes with the higher household income (0.375, $p<0.001$); yet 68 per cent would consider signing up for the ASWZ scheme. However, 75 per cent of the sample is not prepared to pay towards home insulation and energy-efficiency improvements. Notably, agreeing to join the scheme is positively and significantly associated with believing the scheme is good to improve the home ($r= 0.617$, $p< 0.001$). It is also positively and moderately related to anticipating improved home conditions ($r=0.38$, $p<0.05$).

Respondents appear to already undertake straightforward energy-saving activities, such as turning off unwanted lights, using energy-saving bulbs and replacing inefficient equipment; with 78, 57 and 47 per cent respectively always doing so. This is also clear in the positive correlations between taking energy-saving actions to save energy and using energy-saving lamps ($r=0.36$, $p<0.001$), replacing inefficient equipment ($r=0.3$, $p<0.05$), boiling only water needed in kettle ($r=0.341$, $p<0.05$) and drive less ($r=0.3$, $p< 0.05$). This may indicate that people who take actions to save energy might be more aware of energy-saving actions and thus take these actions intentionally to save energy. However, residents are less likely to use the heating and hot water controls to reduce energy use, as those might be more complicated and impractical to them. Personal carbon emissions from homes and transport account for almost half of the UK's carbon emissions. Choices people make - for example, to turn off lights, to cycle, etc. - have the potential to significantly contribute to the UK's climate change targets [21].

Phase A of the questionnaire thoroughly explored several factors that could possibly affect people's attitudes and behaviour concerning energy-efficiency measures. The analyses of this phase provided a reference for the second phase of the project; phase B questionnaire.

Phase B results

This section highlights the general findings of phase B of the survey, besides some sets of relations between dependant and independent variables. The mean figures for monthly gas bills reduced from £66 before home improvements to £55 after improvements whilst the monthly mean of electricity bills has reduced from £54 to £48 which means that an average household in Aspley could possibly save up to £200 of annual savings on energy bills. However, with the anticipated rise in energy prices, the savings might significantly diminish.

As for the frequency of using the heating controls available, 38 per cent of the sample always using the heating timer control. This was followed by 24 per cent always using the wall thermostats, 16 per cent always used the boiler thermostat, and only 10 per cent always used the TRVs. With some people never using any of their heating controls, this might indicate that they either cannot afford using their heating systems, or because they leave them as they were set as long as they provide them with adequate levels of comfort; they wouldn't consider adjusting their controls.

On correlating variables, several moderate and significant relations emerged. It appeared that the higher the income of households, the more people would tend to heat all rooms when in the house, where 67 per cent do so, and would not prefer to receive energy advice. Several correlations indicated that the ASWZ scheme did deliver on its aims of providing warmer homes with less problems of draught, condensation, damp and mould for some of the population. This appeared in finding that lower temperatures set on thermostats is positively associated with the less the heating is kept on after the home improvements. Besides, the significant drop in reporting problems of cold, draught, condensation and mould associated with saving money on energy bills prove the successful delivery of the scheme. Moreover, another positive relation associated paying less on energy bills and having heating on less than before improvements.

In this phase, it should be noted that many positive (strong) relations appeared between energy saving actions. For instance, the energy saving action of using energy saving lamps was found to have several positive (strong) relations with all the following energy saving actions: turn down heating, make more use of the programmer, heat occupied rooms, replace inefficient equipment, wash clothes at lower temperatures, and boil only water needed in kettle. Likewise, positive (moderate) relations were also evident between several aspects of lifestyle and energy-saving actions. This was clear in the positive relations between trying to use less gas and electricity and going for walks, sport/exercise and reading books. This might indicate that after the home improvements were done, people tended to try and save more energy through possible changes in lifestyle and energy-saving actions, which might indicate the 'spill-over effect'. Research describes this effect as the tendency of pro-environmental behaviour to spill and lead to other pro-environmental behaviour [28].

To conclude, phase B of the survey continued from phase A to thoroughly explore several factors that could possibly affect people's attitudes and behaviour concerning home energy use, performance, gauging problems experienced before and after improvements, lifestyle and energy saving actions. The analyses of this phase together with the first phase have provided

potential guidelines for researchers and policy-makers in the near future which are further discussed in the following section.

DISCUSSION AND CONCLUSION

Regarding home performance, all problems that respondents experienced before improvements have considerably reduced after their home improvements. Problems with the cold, condensation, damp and mould have reduced at a much higher rate than problems with draught. Problems with draught which had been always experienced by 66 per cent of respondents before improvements went down to 38 per cent after improvements. A viable reason for this might be that replacing external doors was not one of the ASWZ scheme measures while those are the primary source of draughts.

However, problems with draught did not reduce as significantly as the other problems experienced after the improvements. Similarly, problems with cold, condensation, damp, and mould have gone down from 46, 38, 28, and 27 per cent respectively to 13, 12, 3 and 8 per cent. The main reason reported and discussed in the previous chapters is that only around 35 per cent of front and back doors have been replaced, whereas the rest were the main source of draughts. This indicates that ASWZ scheme was relatively successful in delivering homes which are warmer, with less problems of draught, damp, condensation, and mould. In Arbed 1 Scheme, 60 per cent of people surveyed agreed their homes were much warmer after their home improvements and 35 per cent reported their homes were more comfortable [29].

Besides, the schemes have resulted in people saving money on energy bills, even though not to the extent predicted. This might be due to the rising fuel prices, or due to the lack of awareness of efficient use of the heating systems and controls. In response to the question concerning how people think the scheme could be better, many respondents stated that they believed all the benefits of the internal wall insulation and other measures provided by the ASWZ scheme are diminished by heat loss through the doors. Thus, most respondents suggested the old external doors to be replaced in order to make the most benefits of the scheme.

Occupants' behaviour has been found to explain 12 per cent of the variation of energy consumed for heating in a study performed on recently built Dutch housing [30]. Besides, patterns of occupancy determined by characteristics of households, socio-demographic variables, lifestyles, among other subjective factors have proved to cause significant variations in heating trends [31, 32]. The same study on the Dutch housing stock [30] found that one of the most important factors of energy consumption behaviour is the presence of people at home for long periods where they tend to keep their heating systems on for a longer time. Another demographic factor found to have a great impact on energy consumed for heating is the presence of elderly individuals, children or members with disabilities that drives energy use at significant rates.

In response to questions about energy awareness and behaviour in both phases; similar ranges have been found. Between 82 to 84 per cent of the samples always recycled their home waste while only 30 to 32 per cent always used their compost bins. This may be due to the consistent information campaigns communicated via media sources about recycling as opposed to composting, and also due to the accessible and available recycling facilities and points provided by Nottingham City Council across the city.

The following top actions always taken by respondents in both phases are to turn off unwanted lights between the range of 78 to 83 per cent, boil only water needed in kettle at 60 to 65 per cent, use energy-saving lamps at 56 per cent, and unplug unused equipment from 47 to 51 per cent. Besides, between 45 to 55 per cent always wash clothes at lower temperature with the same range reporting using less gas and electricity. This might reflect people's general awareness of basic energy-saving actions, or maybe their concerns about their fuel bills, which may be the main drivers for those actions. If people are aware to some extent of a few energy-saving actions, then they might be receptive to other more significant ones, such as more efficient use of their heating systems, if they were provided with sufficient guidance. Thus, it is possible that the home improvements done through ASWZ have had an impact on tenants' energy consumption behaviour.

With regards to 'reasons for taking any of the previous actions', saving money came first where the majority of both samples reported this to be the main reason, along with one or more of other reasons (save energy; due to habit; environmental concern). Around a quarter of the samples took these actions only to save money as the dominant reason; followed by to save energy and due to environmental concern, while around a fifth take these actions out of habit. This indicates that the first concern for most people in this area is to save money, which suggests that financial incentives could possibly be effective in encouraging policy uptake and delivery in this area. Steg and colleagues (2006) implied that one of the most important policy features that influence policy effectiveness and acceptability is the use of incentives and disincentives. In their research they affirm that people, in principle, are willing to take up pro-environmental behaviour and hence reduce CO_2 emissions provided that this will not be associated

with higher financial costs [33]. Thus, a 'carrot and stick' approach could be introduced when policy success depends predominantly on people's behaviour.

Ultimately, it is possible that government aspirations to reduce energy consumption will go unheeded if they are inconsistent with the social and physical context of real life. Although Government can play a pivotal role helping people foster more sustainable behaviour, it must do so in a manner that engages individuals and the public at large.

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