



Domestic energy use and householders' energy behaviour

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ABSTRACT

This paper discusses domestic energy use and energy behaviour. It shows some improvement in domestic energy consumption and adoption of good energy practice. The survey conducted indicated that 35% of homes could improve their energy efficiency by improved tank insulation. In the last 5 years condensing boilers have been installed only in 3% of homes, indicating that householders are unaware of their advantages. Although 88% of surveyed homes had purchased a major appliance in the last 2 years, only 16% had any idea of the energy rating of their new appliances. Use of energy saving light bulbs is predominant in kitchens compared to other rooms. 70–80% of householders undertook some kind of day-to-day energy efficiency measures. 20–35% of householders would like to invest in energy-saving measures but found cost to be a key barrier. Approximately 84% of those surveyed were unaware of the energy rating of their household appliances. Price and brand were the most important factors determining the purchase of a new appliance. Significant energy-saving could be achieved by providing appropriate information to the general public regarding temperature control, efficiency of appliances and energy-saving heating systems.

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1. Introduction

Domestic energy use in the UK accounts for about 27% of the total energy-consumption (DTI, 2008). Domestic energy consumption depends on family size, climate, appliance ownership, lifestyle, physical characteristics of a house and human energy behaviour (Schipper et al., 1982; Mullaly, 1998; Palmborg, 1986; Brandon and Lewis, 1999; Baxter et al., 1986). Over the years, significant work (both practical and theoretical) has been done on energy issues in the areas of design, materials and installation; the study of energy use and energy behaviour is, however, relatively new.

Building energy efficiency is improving; the average Standard Assessment Procedure (SAP) rating (BRE, 2009) of houses is improving, and will continue to improve up to the limits of heat transfer due to improved thermal insulation, and improved construction. The thermal and energy performance of a house depends on climate, infiltration, insulation, efficiency of heating system (which is a function of type of boiler and fuel type), floor area, orientation, type of glazing, age of house and type of construction. In a temperate climate, total life-cycle domestic energy consumption is lower in a housing stock built with low-embodied energy materials (Yohanis and Norton, 2002, 2006), and orientated for solar gain with heavily insulated fabric and windows (Shanks et al., 2006).

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Domestic energy use is a function of the structure and intensity of energy use in a home (Schipper et al., 1982). Energy intensity is affected by heating demand, use of energy-intensive appliances, occupancy work patterns, standards of living, comfort expectations, energy use behaviour, types and frequency of use of appliances and cultural habits (Schipper et al., 1982; Mullaly, 1998; Jaber, 2002; Westergren et al., 1999; Deering et al., 1993). Domestic energy use can be reduced by using efficient domestic appliances, ventilation and lighting, minimising heating loads, and promoting energy-conscious behaviour (Wood and Newborough, 2003). While domestic energy use is increasing due to increased appliance usage, household efficiency in terms of adoption of energy-saving measures has also improved by 13% from 1996 to 2001 (HECR, 2003). CO₂ emissions have also reduced by refurbishment of heating systems, reducing waste consumption and continuous appraisal of new energy-saving information (CTNI, 2005). Further improvements can be realised by enhancing existing house insulation, constructing more energy-efficient dwellings, introducing centralised heating systems (i.e. replacing individual smaller boilers by cogeneration plants and larger boilers), reducing heat losses from heating systems and hot water tanks, reducing the use of immersion heaters and all-wash cycles, using higher-rated fridges and freezers, reducing appliance standby losses and greater use of medium, rather than high heat cooking hobs (Millward, 2002; DEFRA, 2003; HECR, 2003).

Several surveys have been conducted in the UK and other countries to investigate the factors that influence domestic energy efficiency (Brandon and Lewis, 1999; Mansouri et al., 1996; Nilssen, 2003; Andrade, 2001; Lee, 2000; Meier et al., 1992; Goldman, 1985;

Lam, 1998; Cohen et al., 1991; BRANZ, 2005). Investigations into domestic energy consumption in the UK have been conducted by government agencies and energy utilities (DTI, 2002; Millward, 2002; DEFRA, 2003). The methods used to carry out these studies included personal interviews, electricity metre readings and temperature measurements (Yohanis et al., 2008; Palmborg, 1986); questionnaires (Leach et al., 2000); self-recording energy diaries (Wilhite and Wilk, 1987); energy audits (Lee, 2000; Goldman, 1985); gathering information from utility bills; and, monitoring of individual household appliances (Lam, 1998).

The work reported in this paper is part of an on-going research programme starting from 2004 up to now. The aim of the work is to investigate the following: householders' awareness, attitudes and behaviour in relation to domestic energy use; and, the factors that determine domestic energy consumption to obtain a wider understanding of public views of energy saving, energy expenditure, and improvements in domestic energy efficiency. The factors considered in the investigation were household physical characteristics, and appliances, age of appliances, energy rating and number and frequency of use of cooking and lighting appliances. One of the difficulties in assessing energy behaviour is to decide who represents society's views, which range from one extreme to another depending on where people live, education, political persuasion, income, age, etc. For this work, a reasonable sample of the population has been selected and their demographic variables defined.

2. Household energy use and energy behaviour

'Energy behaviour' in this paper refers to actions taken by householders in their use of energy in their homes. It plays a major role in determining the pattern and magnitude of domestic energy use as has been shown by a number of researchers representing a number of disciplines including the science, environmental psychology and social policy (Seligman et al., 1977; Palmborg, 1986; Owens and Wilhite, 1988; Cordes, 1990; Mullaly, 1998; Poortinga et al., 2003; Abrahamse et al., 2005, 2007; Steg et al., 2005; Steg, 2008; Abrahamse and Steg, 2009; Lutzenhiser, 1993; Dietz, 2010; Stern et al., 2010; Jaffe and Stavins, 1994; Carrico et al., 2011). Total domestic energy consumption can be reduced by 10–30% solely by changing occupants' behaviour (Owens and Wilhite, 1988). Firth et al. (2008) investigated electricity use in UK dwellings and showed that overall electricity consumption is attributed to a 10% increase in consumption by standby appliances and nearly 5% increase in consumption of active appliances (e.g. lighting and kettles). However, seeking behavioural modifications in order to reduce energy consumption involves complex interactions of technical and social phenomena (Mansouri et al., 1996; Hitchcock, 1993).

There are three aspects to energy use behaviour, it is: usage-related, maintenance-related and/or purchase-related (Hitchcock, 1993). Usage-related behaviour is the day-to-day frequency, duration and intensity of use of appliances. Maintenance-related behaviour refers to servicing and repairs of heating and hot water systems and household appliances. Purchase-related behaviour includes the energy attributes of the products chosen and describes why occupants change characteristics of their dwelling; for instance, by adding thermal insulation or installing low-energy light bulbs.

A strong link between average annual electricity consumption and floor area has been established by Yohanis et al. (2008), thus larger floor area leads to greater electricity use. Yohanis and Mondol (2010) found three types of behaviour in home heating: homes where a reasonably comfortable temperature was maintained throughout the year and were heated only when occupied; homes where the average temperature is 21–23 °C all year round, irrespective of ambient temperature; and, homes where the indoor

temperature was only a few degrees above ambient temperature and the winter average temperature was below 15 °C. Druckman and Jackson (2008) explored domestic energy use at all levels of society; factors which contribute to determine the magnitude of energy use are: type of house, tenure, household composition and location (whether rural or urban). Income is an important factor affecting energy use, but the fact that the relationship of income to education and awareness of environmental issues is complex, makes the relationship of income and energy use complex (Kerkhof et al., 2009; Roberts, 2008; Summerfield et al., 2007; Wall and Crosbie, 2009).

One key factor in the reduction of household energy consumption is the provision of appropriate information. There has been significant effort by government bodies, electricity utilities (e.g. NIE, 2011), local and national energy-saving schemes to provide information regarding energy reduction measures and promotion of renewable energy (e.g. Action Renewables, 2011), the effectiveness of which is varied. Antecedent (prior to consumption) and feedback (about recent consumption) information and incentives are more effective in combination; however, withdrawal of feedback and incentives often results in a return of energy use to previous levels while sometimes energy conservation based on information only may persist, and appropriately delivered direct information might be an important source of future energy-efficiency gain (Lutzenhiser, 1993).

Dietz (2010) has discussed the issues involved pertinent to the narrowing of the energy-efficiency gap in the US. Householders fail to take advantage of the opportunity to save energy and play their part in preserving the environment (Dietz, 2010). Attari et al., (2010) suggest that people form quantitative judgements about risk, not through precise calculations but by using heuristics. Bridging the efficiency gap requires policy design principles grounded in research in the social, behavioural and decision sciences (Stern et al., 2010).

Jaffe and Stavins (1994) assert that there is a gap between actual and optimal energy use. They use the concept of 'market failure' and 'non-market failure' concepts to explain the gradual diffusion of energy-efficient technologies; 'market failures' are defined as market barriers that might justify a policy intervention to overcome them. Their work is an indication of how complex household energy analysis encompasses technical, economic and social disciplines, and the assumptions policymakers need to make. Gillingham et al. (2009) describe the need to identify the economically efficient level of energy-efficiency, and whether specific policy is necessary to achieve it. They have identified market and behavioural failures that may help to explain the gap.

Carrico et al. (2011) have reported the lack of accessible brief summary for policymakers of the key findings of behavioural and social science studies on household energy behaviour. They conclude that to maximise the potential for success, policymakers should combine multiple approaches to behaviour change, such as measures to reduce cognitive costs, increase motivation, and provide more actionable and pertinent information. In most cases, a single approach to changing behaviour, such as provision of information, is not sufficient to induce meaningful levels of behaviour change, and therefore, multiple strategies are needed to target a wider audience and to encourage greater rates of adoption.

3. Research methodology

3.1. Methodology

The study was carried out by means of a general population survey using a statistically significant sample and several separate questionnaires in different locations. The questionnaire was designed

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