Improving the energy performance of UK households: Results from surveys of consumer adoption and use of low- and zero carbon technologies

Journal Item

Paper for Energy Efficiency, submitted 25 Oct 2007, revised 7 Feb & 11 Apr 2008 for re-submission

Improving the energy performance of UK households. Results from surveys of consumer adoption and use of low and zero carbon technologies

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Keywords

consumers, surveys, energy efficiency, renewable energy, low and zero carbon technologies, policies, user-centred design improvements

Abstract

This paper presents results from a UK Open University project which surveyed consumers' reasons for adoption, and non-adoption, of energy efficiency measures and renewable energy systems – collectively called low and zero carbon technologies – and their experiences of using these technologies. Data was gathered during 2006 via an online questionnaire with nearly 400 responses, plus 111 in-depth telephone interviews. The respondents were mainly environmentally-concerned, 'green' consumers and therefore these are purposive rather than representative surveys. The paper outlines results, for four energy efficiency measures (loft insulation, condensing boilers, heating controls, and energy-efficient lighting) and four household renewables (solar thermal water heating, solar photovoltaics, micro-wind turbines and wood-burning stoves). These green consumers typically adopted these technologies to save energy, money and/or the environment, which many considered they achieved despite rebound effects. The reasons for considering but rejecting these technologies include the familiar price barriers, but there were also other obstacles that varied according to the technology concerned. Nearly a third of the surveyed consumers had adopted household renewables, over half of which were wood stoves and 10% solar thermal water heating systems. Most adopters of renewables had previously installed several energy efficiency measures, but only a fifth of those who seriously considered renewables actually installed a system. This suggests sell energy efficiency first, then renewables. There seems to be considerable interest in household renewables in the UK, especially among older, middle-class green consumers, but so far only relatively few pioneers have managed to overcome the barriers to adoption.

1. Introduction

This project by the Design Innovation Group (part of the Open University Sustainable Technologies Group) surveyed the factors influencing UK consumer adoption, and non-adoption, of four established energy efficiency measures (loft insulation, condensing boilers, heating controls, and energy-efficient lighting) and four renewable energy technologies (solar thermal water heating, solar photovoltaics, micro-wind turbines and wood-burning stoves) – collectively termed low and zero carbon (LZC) technologies. In this paper we consider the more widely adopted energy efficiency measures separately from household renewables, which are rarely adopted by UK consumers despite their potential suitability for a high proportion of UK homes.

There is already a considerable body of work on the factors influencing consumer adoption of energy efficiency measures. For example, a survey for the UK's network of Energy Efficiency Advice Centres (EEACs) showed that the main reasons given by a random sample of 200 UK householders for installing energy efficiency measures, was to save money or increase comfort, while the main barrier to installing additional measures was their up-front costs (Central Office of Information, 2001). These findings are confirmed by more recent UK household surveys on drivers for adopting energy efficiency (e.g. nPower, 2007). A 1000 household interview survey and analysis for the UK Department of the Environment Food and Rural Affairs (DEFRA) showed that perceived cost far outweighs expected energy savings in consumer decisions on whether to install home energy efficiency measures, especially insulation (Oxera, 2006).

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DEFRA's Energy Efficiency Action Plan stated:

"In the household sector, there are different barriers to improving energy efficiency, and three predominate: lack of information, high upfront costs, and hassle and disruption.... Even relatively well informed consumers are often more interested in renewable energy… but will not install cost-effective energy efficiency measures in their home" (DEFRA, 2004, p.20).

Another EEAC survey found that a quarter of clients were very interested in receiving advice on renewables (Energy Saving Trust, 2002). This was supported by a general survey of 6000 UK consumers which found that a quarter favoured household microgeneration, especially micro-wind and solar PV, for generating electricity (EST, 2007, p. 4). But despite consumer interest in microgeneration and a potential UK market estimated at nearly a quarter of a million by 2011 and between 25 and 54 million installations by 2050 (Boardman et al., 2005, Boardman, 2007), in 2005 there were only 82,200 household installations in the UK (DTI, 2006).

Useful empirical data on the factors influencing UK consumer adoption of renewables comes from a survey for the Department of Trade and Industry (DTI) with 380 responses from enquirers to a solar thermal water heating (STWH) promotion scheme in London showed that the main drivers for installing STWH systems were environmental concern and saving money, while the main barriers were capital cost and lack of trustworthy information or reliable brands (SEA/RENUE 2005). In recent reports from the Energy Saving Trust, significant potential was identified for market growth, energy and carbon saving of microgeneration technologies; including solar photovoltaics, micro-wind, micro-combined heat and power, heat pumps, solar thermal and biomass heating. This depends on the main barriers to more widespread consumer adoption being overcome, namely: high costs; the low level of consumer awareness; restrictive planning laws; and the complexities of selling electricity back to the grid (EST/E-Connect/Element Energy, 2005; EST, 2007). Similar barriers were identified in a UK Parliamentary Trade and Industry Committee report *Local Energy* which also pointed to the considerable technical knowledge required to decide whether to invest in a renewable energy technology (House of Commons, 2007). Another UK study of the potential of solar PV, micro-CHP and micro-wind also identified the barriers of high upfront costs, long payback times and lack of information, also noting consumer scepticism regarding the performance and reliability of these technologies (Watson et al., 2006). Such findings are not confined to the UK and are in line with earlier studies of solar energy adoption in the USA and Australia (e.g. Guagnano et al., 1986; Foster, 1993).

Existing research on consumer adoption of both energy efficiency and renewables, at least that conducted on behalf of the UK government, has tended to focus on addressing the financial, regulatory and informational drivers and barriers to household adoption. However, there is a body of sociological and anthropological research (e.g. Veitch and Gifford, 1996; Guy and Shove, 2000) which suggests that peoples' motivations and actions on household energy are more complex than suggested by a rational model of decision-making based on information, regulations and economics. Papers given at recent ECEEE summer studies have also showed that the social context is crucial in understanding consumer energy behaviour (e.g. Hoekstra, 2005; Moreau and Wibrin, 2005; Bartiaux and Gram-Hanssen, 2005; Wilhite, 2007). An example is consumer diffusion of compact fluorescent lamps (CFLs), which has been slow despite their clear financial benefits, taking many years for 80% of UK households to have at least one CFL. Thus the National Consumer Council responding to the UK Government's 2006 energy policy consultation said,

"*a better understanding is needed of the key motivations and influences of different groups of consumers.... In this way, energy efficiency messages can be targeted and made more effective*" (NCC, 2006, p. 2).

Likewise, householders who install solar thermal water heating or other renewables often do so for non-economic reasons, given that the likely payback period may be longer than the expected system life. As the *Local Energy* report observed,

"*…most households that have purchased solar panels or wind turbines have tended to be early adopters who are not necessarily motivated by a rational cost benefit-analysis…. They are instead motivated by other factors. For example, they may be technology enthusiasts who are keen to own the latest environmental innovation...."* (House of Commons, 2007 p. 29).

The complex nature of consumer motivation is supported by a German study of 26 pioneer users of fuel cell micro-combined heat and power (micro-CHP) systems for home heating and electricity generation, which found that a keen interest in new technology and protecting the environment were the main motivations for adoption (Fischer, 2004).

There is also a lack of research about how consumers who adopted energy efficiency or renewables actually use them. This is important because even if people adopt these products and systems, they may not use them in an energy-saving manner because they lack understanding, experience problems in use or find it difficult to make adjustments in their lifestyle. For example, many people fail to understand, or could not be bothered with controls such as thermostatic radiator valves (TRVs) or central heating programmers. Solar thermal water heating system adopters may not know how best to use solar heated water to minimise back-up fossil fuel consumption. There may also be rebound effects, such as taking some or all of the benefits of insulation in higher room temperatures; leaving renewable space heating or energy efficient lighting on for longer, or installing extra lighting in the home or garden (Herring, 2005). Such rebound or 'comfort taking' effects are recognised in estimating the energy saved by home insulation, but are not generally understood or taken into account for other energy efficiency measures or for household renewables (DEFRA, 2007). Strategic reports on the role of domestic adoption of low and zero carbon technologies take no account of the users' contribution and whether widespread adoption will actually deliver the predicted energy and carbon savings.

Our research therefore attempted to examine consumer decisions to adopt, or decide against, energy efficiency measures and renewable energy technologies, moving beyond the usual focus on financial and informational barriers to include the influences of other factors, including the socio-economic context, consumer variables and the design and technology of the products and systems themselves (Roy, Caird and Potter 2007, p.1). We considered that consumer decisions about the adoption of products whose function is improving energy efficiency, such as loft insulation, may differ from those also involving user interaction, such as heating controls, or are part of interior design, such as lighting, and systems with symbolic or status value such as solar energy systems (Stokes et al., 2006; SEA/RENUE, 2005). We also aimed to investigate adopters' experiences of using these technologies and to obtain feedback on their ideas for improving them from the user perspective.

1.1 Aims and research questions

The main questions our research aimed to address were:

1. What are the factors influencing consumer adoption, and non-adoption, of household LZC energy technologies, including both energy efficiency measures and household renewables?
2. What are the problems and benefits which adopters of these technologies experience during installation and use; and do they use the products and systems in a way that saves energy and reduces carbon emissions, including rebound effects?
3. What ideas for improvements to, or innovations in, the products and systems would make them more desirable to consumers and effective in reducing carbon emissions?
4. What policies and actions by designers, manufacturers, service providers and government would promote the more widespread adoption of these LZC technologies?

1.2 Overview

The paper starts with an outline of the methodology of the project. Then – first for energy efficiency measures and second for renewables – it examines the characteristics of the adopters and non-adopters, the drivers and barriers to adoption and the benefits, problems and any rebound effects experienced by consumers who installed these products or systems. The paper ends with a summary of conclusions and recommendations for improving the up-take of LZC technologies. Full reports on the project are available for free download (Caird, Roy et al., 2007a and 2007b).

2. Methodology

The project comprised an exploratory study and a main phase. The exploratory study involved a literature review, 14 pilot interviews with volunteer consumers and a survey of 50 energy professionals, such as local authority housing officers, architects and consultants, conducted via an online energy newsletter. This data was used to identify the many factors influencing consumer adoption of energy efficiency and renewables and hence to develop the methodology for the main phase. From the findings of the exploratory study a consumer decision-making model of the adoption and use of LZC products and systems was developed (Figure 1). It identified four key groups of variables that influence consumers' adoption decisions and use behaviours:

- The socio-economic context (e.g. fuel prices, regulation);
- Communication sources (e.g. professional, interpersonal);
- Consumer variables (e.g. income, attitudes, lifestyle);
- The properties of the product or system itself (its functional utility, interconnectedness with other systems, symbolic value, and price).

FIGURE 1 HERE

From the pilot interviews different consumer categories were identified and incorporated into the model. These included: 'potential adopters' (i.e. those considering adoption); 'adopters' and 'adopter-users' (those who installed and used a LZC product or system); 'non-adopters' (those who considered but decided against adoption); and 'reject-users' (those who rejected a product or system after using it). The adopters were further categorised into 'engaged users' (those who adapted their behaviour to use the LZC product or system effectively e.g. to avoid rebound effects) and 'non-engaged users' (those who did not use the product or system effectively). The pilot interviews and energy professionals survey showed that the influences on the adoption and use of different LZC technologies varied, but all could be classified within our research model (see Roy, Caird and Potter, 2007). For the purposes of the main phase, adopters were defined as those who had purchased and installed a LZC technology for the home, some of whom may have experience of using this product or system. The non-adopters were those who had seriously considered purchasing a LZC technology before deciding against it – although this decision is not necessarily permanent.

For the main phase an online questionnaire was developed for completion via the websites of a 2006 BBC TV series on climate change and the Energy Saving Trust, UK. This questionnaire was designed to obtain both multiple-choice and open ended responses concerning at least one energy efficiency or renewable energy technology, with questions about the purchase, installation and use experience (e.g. What were the key reasons for deciding to install this technology? What improvements would you ideally like to see to this technology or how it is installed?) and questions about non-adoption of one or more seriously considered but rejected technologies (e.g. What were the main reasons for deciding against installing this technology? What improvements would encourage you to install it?) The survey also included questions on the household and property demographics (e.g. main earner's occupation, environmental attitudes and behaviour, household size, property type, etc.). This produced 390 responses from consumers who since mid 2002 had adopted, or seriously considered but rejected, one or more of the energy efficiency measures (loft insulation, etc), and/or renewables (solar thermal water heating, etc) listed above. Whilst the online survey provided easy access to large samples, a disadvantage arose with some respondents not replying to every question. A decision was made to exclude respondents who had responded to fewer than two questions about the adoption or non-adoption of any given technology.

The research team also conducted 111 telephone interviews in 2006, each lasting 30 to 60 minutes, in order to uncover more detailed information on reasons for adoption or non-adoption and experiences of use. The interviews were conducted with a different group selected as follows:

- A random selection of 83 clients who received advice between late 2004 and end 2005 from two of the UK's network of Energy Efficiency Advice Centres (EEACs) and who adopted, or considered but rejected, one or more of the four chosen energy efficiency measures;
- A random selection of 28 people who received advice from a renewable energy charity, the National Energy Foundation, in 2005-6 on solar thermal water heating; about half of whom went on to install a system.

The respondents to the online survey were self-selected and not unexpectedly were 'greener' and from higher socio-economic groups than the UK population as a whole. Of the interviewed sample, almost all the energy efficiency and solar thermal water heating enquirers we contacted agreed to be interviewed. They claimed similar levels of 'greenness' to the online respondents. This is therefore a purposive rather than a representative survey; necessary when investigating the pioneer adopters of innovative technologies such as household renewable energy, and to a lesser extent also for established energy efficiency measures many of which are still at the early adoption stage in the UK.

It should be pointed out that we did not investigate how seriously respondents had considered a particular LZC technology before deciding against it. Neither did we measure the household energy use of consumers, but relied on their responses and estimates. Thus we are not able to verify the magnitude, or even the existence of, savings following installation of LZC technologies and treat 'energy savings' as a consumer belief rather than an actuality. The online survey results were analysed for cross-tabulations and for descriptive statistics using SPSS and Excel software to provide results for all technologies combined and for the adopters and non-adopters of each LZC technology. Interview results were separately analysed using descriptive statistics and qualitative analysis methods, and were triangulated with the online survey results to provide in-depth understanding of drivers and barriers to LZC adoption and, particularly the experience of using these technologies in the home.

3. Energy efficiency technologies

Table 1 provides details of the numbers adopting, and considering but deciding against, the energy efficiency measures we investigated (the larger numbers refer to the online survey responses).

TABLE 1 HERE

3.1 Characteristics of energy efficiency adopters

The respondents to the online survey who adopted at least one of the chosen energy efficiency measures typically come from:

- Two-person adult households (about twice the UK national average of 34% of such households);
- A middle-class household, where the main earner's occupation is professional, managerial, or in education/medical services, with a proportion retired
- Semi-detached or detached houses with three or four bedrooms.

Most adopters of the energy efficiency measures in the online survey are 'green' consumers. Over 80% of adopters – and over 70% of non-adopters of individual measures – said that they were fairly or very concerned about reducing their environmental impacts. Almost all claimed to recycle their household waste; most adopters (75% to 87%, depending on the measure) and non-adopters (62% to 85%) attempt to save energy; while 57% to 79% try to cycle, walk or use public transport when possible.

While this was not surprising for the self-selected online respondents, the energy efficiency adopters we interviewed claimed similar levels of 'greenness' (65% to 81% being very or fairly concerned about the environment) with most recycling waste, trying to economise on energy, water and car use. The other characteristics of the interviewed adopters were also similar to the online respondents, but with a higher proportion of retired people (36%).

The majority of the online respondents had adopted at least two energy efficiency measures for their home. For example, half of the total sample adopted both loft insulation and central heating programmers, and at least half adopted three energy efficiency products, including programmers; thermostatic radiator valves (TRVs) and compact fluorescent lamps (CFLs). However, very few online respondents adopted both an energy efficiency and renewable energy technology. For example, as a percentage of the total sample just 6% adopted both loft insulation (LI) and solar thermal water heating; 2% adopted LI and solar photovoltaics; 1% adopted LI and a micro-wind turbine; while 11% adopted both LI and a wood burning stove. Nevertheless, more respondents adopted an energy efficiency technology and seriously considered (but did not adopt) renewable energy technologies. For example, as a percentage of the total sample 23% of loft insulation (LI) adopters considered but decided against solar thermal water heating; 21% of LI adopters considered a micro-wind turbine; and 20% of LI adopters considered but decided against photovoltaics (27%).

3.2 Drivers for adoption of energy efficiency measures

The adopters of energy efficiency measures do so for many reasons; but in the online survey the main drivers were saving energy; reducing fuel bills and concern for the environment. For loft insulation, these three drivers are matched by the desire for a warmer home (Table 2).

TABLE 2 HERE

3.3 Experience of energy efficiency adopters

About a third of those who installed one or more energy efficiency measures said they noticed reduced fuel bills, despite rising energy prices. Some of this saving could be due to the greater energy awareness claimed by many users following installation. However, nearly 60% of loft insulation, a third of condensing boiler and heating controls adopters felt they took at least some of the energy savings in more warmth, while 10% of CFL adopters agreed they used or installed additional lighting. Energy efficiency products caused few operational problems apart from the difficulties some people had in operating heating controls to optimise energy efficiency.

3.3.1 Loft insulation

The majority (58%) of adopters of loft insulation in the online survey said its main benefit was a warmer house, (compared to the 77% who said warmth was a driver for adoption) , while nearly a third said they also had lower fuel bills and/or energy consumption. There is thus, not unexpectedly, evidence of a rebound effect for loft insulation, with a small minority (4%) saying they took the entire benefit of greater energy efficiency in higher room temperatures, heating more of the house or heating for longer periods. However, over 40% of adopters (both online respondents and interviewees) said that they were more concerned about saving energy since installation. A few also mentioned that loft insulation helped keep their home cooler in summer; a benefit likely to become increasingly important with climate change, but not generally mentioned in insulation programmes. 10% of the online sample complained about the loss of storage space in their loft as a result of installing insulation and this has led some to remove insulation or compress it under boarding. These actions would reduce the energy savings of loft insulation.

3.3.2 Energy-efficient lighting

Some compact fluorescent lamp (CFL) adopters pointed out the labour-saving advantages of these long life lamps, as well as associated financial savings, because of less time spent purchasing and replacing them. Adopters liked CFLs' long life, but several expressed annoyance if a lamp failed after one to three years rather than the advertised eight to ten years. The life of CFLs thus acted as a driver, but also a barrier if it failed early. Although about a quarter of CFL adopters in the online survey noticed reduced electricity bills, there were some rebound effects, as about 10% of users chose to leave CFLs switched on longer than incandescent lamps and/or installed additional CFL lighting in the home, in the garden or for security. However, a third of users said they were more concerned about saving energy since adopting their CFLs.

Although about 70% of online respondents had one or more CFL lamps and over 80% of them were satisfied, many rejected CFLs for certain locations because of problems associated with colour quality, brightness, warm-up time and incompatibility with light fittings and lampshades. Only about 7% of the online respondents had bought light emitting diode (LED) lighting, a newer technology. The main problem reported by LED users concerned insufficient brightness, making existing LEDs mainly suitable for (additional) decorative lighting.

3.3.3 Central heating controls and condensing boilers

About 40% of the online adopters of improved heating controls (timer/programmers and thermostatic radiator valves (TRVs)) and condensing boilers noticed reductions in fuel bills and/or energy consumption, but a third also noted a warmer house and a quarter (23%) of heating control users and about 5% of condensing boiler owners said they took the main benefit in heating more of their house, for longer, or used more hot water. These energy efficiency products thus also appear to involve some rebound effects. However, over third of heating control and condensing boiler users said they were more concerned about saving energy since their adoption.

A few users (about 10% in the online survey) said they find electromechanical timer/programmers with adjuster tabs fiddly to adjust, others, especially the elderly, find the buttons and displays of electronic programmers difficult to see and the user interface difficult to understand. As a result settings are often not changed and some users said they turn heating on and off using the thermostat because it is easier. Users also mentioned problems using TRVs because they are fiddly, not calibrated by temperature and so difficult to set to achieve a desired room temperature.

3.4 Barriers to adoption of energy efficiency measures

The reasons given in the online survey for considering but rejecting energy efficiency measures, and backed up by the interviews, include the familiar issues of capital cost and anticipated payback time, but often other barriers specific to the particular technology were more important (see Table 3).

TABLE 3 HERE

3.4.1 Loft insulation

For loft insulation, available to UK households under subsidised or free installation schemes, the most frequently cited deterrents to installation to the recommended 250mm thickness or more were loss of storage space and/or trouble clearing the loft, i.e. the hassle factor identified in previous research. These were mentioned by about a third of non-adopters in the online survey. In open comments a few adopters and non-adopters mentioned they were deterred by the irritant effects of the glass or lava fibre normally used for loft insulation, some mentioning their preference for eco-friendly materials such as recycled paper; not available in UK subsidised schemes. An important insight gained from interviews with non-adopters is that there is a critical timing for installing loft insulation, when moving home and/or before any boarding is laid. Thus any delay by the homeowner to install loft insulation may lead to possessions being stored in and/or boarding of the loft, with the result that the insulation may never be laid.

3.4.2 Energy-efficient lighting

About 40% of non-adopters of compact fluorescent lamps (CFLs) in the online survey mentioned disliking their size and perceived ugliness, while about a third mentioned deterrents of cost, incompatibility with existing fittings and dimmers, their light quality and/or lack of brightness. The cold colour of CFLs may be unacceptable in rooms required for relaxation, since lighting is used to create mood, atmosphere and décor. One CFL non-adopter who preferred halogen spot lamps said "*I'm very fussy about my lighting*".

Light emitting diode (LED) lighting is a relatively new technology and some 40% of non-adopters of LEDs mentioned lack of availability and high prices. About a third of non-adopters of LEDs also said they were deterred by their incompatibility with existing fittings and/or their light quality and lack of brightness. But many people do not know what LED lighting is and would like more and better information about it.

3.4.3 Central heating controls and condensing boilers

Since April 2005 condensing boilers have been virtually mandatory under UK Building Regulations; hence non-adopter responses reflect their experiences before this date or post-2005 decisions against early replacement of a conventional boiler. The majority of non-adopters (70%) considered them too expensive compared to conventional (non-condensing) boilers or as an early replacement option. The reputation of condensing boilers for unreliability and having a shorter life was the second most frequently cited deterrent for nearly half (43%) of non-adopters. Other important deterrents affecting about a third of non-adopters were problems connecting to existing heating systems and the negative attitude of installers to condensing boilers at the time they considered getting one.

Apart from consumers' doubts whether the fuel savings of new or upgraded heating controls were worth their cost, the 'hassle' factor was the most important deterrent to installing them.

4. Renewable energy technologies

In the UK in 2005 there were about 82,200 domestic microgeneration and renewable energy systems, with solar thermal water heating (STWH) accounting over 95% of them (DTI, 2006). Although a typical flat plate or evacuated tube STWH system can provide about half of a household's hot water, they are still rare in Britain compared to other European countries. Even rarer are micro-CHP, ground source heat pumps, wood-pellet stoves and boilers, solar PV and micro-wind. It is estimated that there were only 3750 such systems in 2005 in the UK (DTI, 2006).

Table 4 provides details of the numbers adopting, and considering but deciding against the renewable energy technologies investigated in our surveys (the larger numbers refer to the online survey responses).

TABLE 4 HERE

4.1 Characteristics of renewables adopters and non-adopters

Based on our small online survey sample, the consumers who adopted household renewables typically come from:

- Two-person adult households. Only about a quarter of renewables' adopters come from households with children under 16 years, except for wood stoves nearly half of which were adopted by families;
- A middle-class household where the main earner earner's occupation is professional, managerial, or in education/medical services, with a significant proportion retired;
- Semi-detached or detached houses with three or four bedrooms;
- Environmentally-concerned households (depending on the technology, 83% to 90% of adopters were fairly or very concerned about reducing their environmental impacts).

The characteristics of the interviewed sample of solar thermal water heating adopters was similar, but with a higher proportion of retired people (45%).

The non-adopters' characteristics are similar to those of the adopters. This was unsurprising since all online respondents had accessed the survey via energy or environmental websites and so were at least potentially interested in renewables even if they had not adopted any at this stage. However, there were some differences. For example, more non-adopters than adopters of renewables had children living at home and so may have less time and money to investigate and install renewables. A higher percentage of non-adopters than adopters live in semi-detached three bedroom homes rather than the four bedroom, mainly detached homes of the adopters. Although we did not gather information on income, the larger homes of adopters suggests they have higher incomes than non-adopters.

4.2 Drivers and barriers to adoption of renewables

Household renewables are adopted for many reasons, but the survey results identify the three most frequently cited reasons as saving energy, reducing fuel bills, and concern for the environment (Table 5). These are the same main drivers as for the energy efficiency measures.

TABLE 5 HERE

Adopters of individual renewable energy technologies do so for similar reasons. Reducing fuel bills, saving energy and the environment were each cited by about 80% of online adopters of solar thermal water heating (STWH). Three quarters of interviewed STWH adopters were also influenced to adopt by friends, colleagues or neighbours who already owned a STWH system. For solar photovoltaics (PV) environmental concern, and for micro-wind, saving energy were the main drivers for adoption. Despite the existence of UK government grants, having funds available to invest was an important adoption factor for STWH and solar PV. For wood-burning stoves, saving energy, money and the environment are important, but they are mainly bought by people wanting the warmth and appearance of a real fire.

The responses from the online survey revealed that just 20% of those who considered getting one or more renewables (i.e. adoptions as a percentage of total adoptions and non-adoptions) actually installed one. Half of these 121 adopters bought a wood stove; a third STWH; 10% a solar PV system; and just 5% a micro-wind turbine (Table 4). Interestingly half of those who seriously considered getting a wood stove actually installed one, compared to 20% for STWH, 8% for PV and 5% for micro-wind. These results reflect the high up-front cost, long payback, uncertainty about suitability of the site and perceived unpredictability of performance of these technologies.

Whereas a simple wood-burning stove is an established product costing about 500 euros (although if you need to have your chimney lined this can triple the cost), STWH and micro-wind systems are more innovative and typically cost 3000-7500 euros, while a solar PV system might cost 15,000 euros or more.

There are grants available in the UK for household renewables – currently (2008) up to 600 euros for STWH and up to 3600 euros for micro-wind and solar PV. While these grants were mentioned by some of the renewables adopters – and at the time of the survey the grants for wind and solar PV were up to 7500 and 22,000 euros respectively – they were not the most frequent driver and having funds available to invest was mentioned more often, at least for the solar technologies. Wood-burning stoves (as opposed to automated pellet stoves and wood boilers) are not eligible for UK government grants.

High capital cost, and hence long payback times, was the universal reason for rejecting STWH (online and interviewed respondents) as well as solar PV and micro-wind. However, the survey found that there were other major obstacles (Table 6). Wood stoves were more often rejected because of difficulties in controlling their output, the extra dirt and labour they involve and finding the space to install and store fuel, rather than their cost. Other obstacles in about quarter of non-adoptions included: difficulties finding a trustworthy installer for STWH, solar PV and micro-wind; getting planning permission, finding a suitable location and worries about noise and vibration for micro-wind; and insufficient output for PV. More than one fifth of each group of non-adopters were also uncertain about the performance and reliability of domestic solar and wind systems (Table 6).

TABLE 6 HERE

4.3 Experience of renewable energy adopters

As well as helping to save money, energy and the environment, two-thirds (65%) of online respondents who had installed solar thermal water heating or a wood-burning stove, and a third (31%) of those who adopted solar photovoltaics said that using renewable energy or fuel gave them great pleasure, and focused their attention on saving more energy. Some also saw their installation as a green status symbol: one user said of his solar panels "*it is like flying a flag saying 'we're green'* ". This suggests renewables may be purchased as a form of conspicuous consumption; the environmentally-conscious consumers' equivalent of a four-wheel drive car (Jensen, 2005).

There are similarities as well as differences in the influences on adoption of different household renewables and their benefits and problems in use. Therefore, we next consider the technologies investigated in more detail.

4.3.1 Solar thermal water heating

In our online survey solar thermal water heating (STWH) was the most commonly adopted renewable energy technology with 39 installations (10% of the sample, compared to approximately 0.3% of UK households with STWH). Our findings for STWH come both from the online survey plus additional information from the 28 in-depth interviews with both adopters and non-adopters (Table 4).

The major hurdle after deciding to adopt STWH is finding a good installer. 12% of adopters had difficulties finding an installer, although more non-adopters (25%) cited this as a barrier (Table 6). Many interviewed adopters asked their local authority and were recommended installers in their area either directly or via the National Energy Foundation's 'Energy for Good' scheme. In general the recommended installers gave quotations for installing one model of STWH system. Most accepted the recommendation of installers, usually without understanding much about the technology. The issue of trust in the installer is crucial. One adopter recounted how the Council put him in contact with two local installers, who quoted similar prices, so he chose the one who inspired trust.

Only 20% of people we interviewed chose the installer offering the cheapest quote and accepted the STWH system that they recommended. About two-thirds of them chose evacuated tube, with the rest going for a flat-plate STWH system. Overall two-thirds (67%) of online and nearly half (47%) of interviewed STWH adopters were satisfied with their system. However about 80% of interviewed adopters reported problems with leaks, pumps and valves sometimes leading to several installer recalls for repairs undermining their trust in the reliability and performance of the system.

Another issue (31% online and 53% interviews) was whether solar heated water could be used in their dishwasher or washing machines. Often it could not due to plumbing constraints or because most new appliances are cold-fill only, a disappointment for some, although some were aware of this in advance. Adapter valves available in Germany and elsewhere to allow use of solar heated water in cold fill appliances were not supplied by UK installers. Several users had insufficient tank storage capacity on sunny days when their system could be delivering more solar heated water. There were also concerns about maintaining often inaccessible components of solar thermal systems in lofts or on roofs.

Despite such problems, two-thirds (65%) of adopters in the online survey mentioned their pleasure in using solar heated water. Other benefits mentioned by about half of STWH adopters were lower fuel bills (54%), greater energy efficiency (46%) while about third (35%) mentioned having a greater concern about saving energy since adoption. Some rebound effects were admitted by the online sample; 21% were less concerned about using hot water and 8% were aware that they used more, a potential rebound effect – while not consuming extra energy if the water is solar heated, at least using more water. The interviews showed that nearly half (47%) tried to use solar hot water when it was available, giving examples of showering or using their (hot-fill) washing machine in the afternoon or evening when the water is hot, rather than the morning. But more than half (53%) had made no changes to their behaviour. One potential adopter said that it was difficult to get good advice how to use a STWH system efficiently. He commented: "*I think that if you move to solar you need to rethink your use of hot water; you need to change your washing habits to the evening and reset the boiler so you are not heating the water*".

4.3.2 Micro-wind

Only seven people in our online survey had adopted a micro-wind turbine, mainly to save energy and/or the environment. However, a third had seriously considered this technology but decided against it. The main barriers to installation are capital cost, inadequate fuel savings and payback; one non-adopter stating "*I checked wind levels for my postcode to work out a payback period of over 15 years*". The other main obstacles are getting planning permission; finding an installer or a suitable location for the unit; and this technology's uncertain performance and reliability. Towns and cities were considered unsuitable for wind because of worries about noise and visual intrusion, with one non-adopter saying "*I live in a suburban area: imagine if everyone had one! Chaotic visual impacts and noise pollution*".

Four of the seven micro-wind adopters reported difficulties in gaining planning permission. Other problems mentioned by individual adopters were the difficulty in finding a good installer, insufficient electricity from the system and the experience that wind-generated electricity is not available when required. However, three reported being fairly or very satisfied with their system and only one was dissatisfied; even the person whose turbine was destroyed in a lightning strike would still recommend micro-wind to anyone living in a suitably windy area.

4.3.3 Solar photovoltaics (PV)

Only twelve people in our online survey had installed a solar photovoltaic (PV) system, mainly for environmental reasons or because they had the funds but, as for micro-wind, a third had seriously considered this technology but decided against it. The main barriers to the installation of PV is capital cost, and/or too long payback, but other deterrents included insufficient output, difficulties connecting to the National Grid; finding an installer, or a suitable location. One non-adopter stated,

"The cost per kWh hideously expensive; smaller systems would barely charge a car battery and to be useful would need to have a larger system integrated with 230V mains, with all the expense and issues with connecting to the grid. This type would require far too much roof space for me to consider".

The satisfaction with PV is mixed and below that for solar thermal water heating. Only a third of adopters were fairly or very satisfied, with about half of adopters unsure. This lack of satisfaction is probably due to not enough electricity being produced or available when required and the poor feed-in tariffs available. One non-adopter stated, "*Apparently you have to sell all your electricity to your supplier for say 3p per unit and buy back for 9p per unit, you cannot use your own electricity first then top up from supplier*". However, installing solar PV can have a beneficial influence on energy consumption. In our survey, half of users said they were more concerned about saving energy after installing PV, while a quarter tried to use their own solar-generated electricity when available, getting considerable satisfaction from doing so. One adopter reported 40% electricity saving, "*Installation caused me to monitor the daily electricity which when I started was an average 25 units a day. With a combination of the solar PV and energy saving actions…the average electrical usage has reduced to 15 units a day*".

These observations from a small number of respondents are supported by results from much larger surveys of solar PV users. Based on an Austrian study, Keirstead reported that "*PV can indeed reduce the consumption of a household, although there is a consumption threshold of about 3500 kWh/year below which consumption increases and above which it decreases"* However, he notes that PV is an "*energy conservation tool for the rich*", being one of the most expensive household renewables (Keirstead, 2005, p.1251).

4.3.4 Wood-burning stoves

Wood-burning stoves were the most widely adopted renewable energy device in our online survey (63 installations, 16% of the total sample). We did not distinguish simple manually-fed wood-burning stoves from automatic pellet stoves and boilers, but it is unlikely that many of the automatic type were included. Wood stoves' popularity is due to their relatively modest cost, but also due to fitting existing fireplaces and offering benefits other than using a renewable fuel. However, not all homes are suitable. One non-adopter stated "*We were replacing an open fire and considered a stove, but that required a flue liner and substantial remodelling to the hearth and chimney breast area - which made it several times the cost of a coal-effect gas fire*". Also wood stoves do involve physical work, the storage and carrying of fuel, the removal of ashes, and extra house cleaning. This can be a drawback for older or disabled people. As one stated "*As you get older you don't want the downside of this form of heating – or for an automatic system the cost is too high*".

However, most (82%) wood stove adopters are very satisfied and two-thirds (65%) mentioned the pleasure of using a renewable fuel. Other benefits mentioned by about a third of adopters were lower fuel bills (37%) and greater energy efficiency (33%), while 30% of wood stove users mentioned having a greater concern about saving energy since adoption. The main problems cited were; more dust and dirt in the home, connecting the stove to radiators and/or the hot water system and the difficulty of controlling the output of wood stoves leading to over-heating one or more rooms, a possible rebound effect. About 60% of users said their wood stove heated one or more rooms to a higher temperature.

Not everybody, however, considered wood-burning stoves as a desirable technology. A few respondents remarked that they are not environmentally friendly as they pollute the atmosphere. One stated, *"Surely a wood-burner emits carbon dioxide and particulates. Hardly clean!"* One respondent remarked that in New Zealand the local council is giving grants to remove wood stoves because of pollution. However, in this case the person was probably referring to older types of wood stove rather than modern smokeless designs.

5. Conclusions and policy recommendations

Our surveys show that the energy efficiency measures and renewable energy technologies we considered have broadly similar drivers, but often different barriers to adoption and different benefits and problems in actual use. Some of the findings support previous work, with an emphasis on the barriers of high up-front costs, the 'hassle factor' and lack of information and advice (e.g. DEFRA, 2004; Oxera, 2006; EST, 2007). But these surveys of mainly green consumers also reveal a more complex picture of householder experience with low and zero carbon technologies. Consumers' technical and non-technical ideas for improving these products and systems together with the other findings of the project, suggest that promoting the widespread adoption and effective use of energy efficiency measures and household renewables requires different actions and policies by government, manufacturers, energy suppliers and retailers tailored to the specific markets and technologies. Some recommendations for these different bodies are therefore discussed next.

5.1 Government

Up-front costs and uncertainties about the performance and reliability of unfamiliar products and systems were barriers to the adoption of several low and zero carbon (LZC) technologies. To address these issues, many of our online respondents observed in open comments that there was a need for a stronger government role, mentioning various measures they would like to see implemented. These included:

- financial incentives to reduce costs, such as tax breaks, increased subsidies and grants, and lower council tax bills (subject to balance in supporting fuel-poor consumers needing basic home insulation as well as well-off consumers wishing to install renewables);
- mandatory standards for product performance, reliability and durability, especially of condensing boilers and domestic solar energy systems; and

- better regulation to control 'cowboy' installers of renewables, notably solar thermal water heating systems.

People would also like more financial penalties, such as higher taxes on inefficient technologies, or even their phasing out and prohibition as proposed for incandescent lamps in Australia and, more recently, the UK.

Respondents also commented that all new housing should integrate solar thermal water heating or other renewable energy technologies in their design, enforced by tighter building regulations. New buildings, some said, are the best place to apply these technologies, since costs would be less than for retrofitting. It would help the industry to develop skills and the infrastructure for supporting sales, installation and servicing, and would help bring costs down through economies of scale, as well as helping to develop societal norms of energy saving. Also, a few believed that wider adoption would be achievable if renewables were installed more in public buildings, since this would inspire consumer confidence.

Lack of information did not feature very strongly in our surveys as a barrier to adoption of low and zero carbon technologies (with the exception of LED lighting), although other studies cite poor information and advice as a major barrier. The interviews and open comments in particular pointed to specific information and advice requirements of potential adopters of LZC technologies, such as online comparisons of manufacturers' specifications, independent assessments of performance, payback, etc. that would assist them to make the best energy investment decisions on a budget. Despite numerous existing government energy efficiency and renewables promotion, advice and support schemes some consumers surveyed want better information on compatibility of LZC technologies with their home; as well as on using controls and making changes to energy use habits to optimise efficiency. For example, some solar thermal water heating non-adopters wanted to know whether the weight of the panels might damage their house; and whether the hot water tank capacity was adequate for their household requirements. A single body, or 'one-stop-shop', to guide people through all the details of technology choice, grant applications, planning permission, installation, use and maintenance were suggested ways of promoting adoption, especially of renewables. A Green Homes service, based on the UK's network of Energy Efficiency Advice Centres, offering such one-stop-shop assistance was announced in early 2008.

5.2 Designers and manufacturers

A key challenge for designers is to offer lower cost, user-centred designs that guarantee efficiency, reliability and payback as well as achieving energy saving and carbon reductions. Designers need to think beyond individual low and zero carbon products or systems to how they interconnect with existing systems and the building structure, overcoming problems such as a lack of compatibility between solar thermal water heating systems and cold-fill appliances. Designers have a role in creating aesthetic products and systems, overcoming the stark contrast between people who regard solar panels or micro-wind turbines as unsightly "monstrosities" and those pleased with their symbolic display of environmental credentials.

The barriers to adoption, and the improvement ideas suggested by consumers, indicated a number of technical and design improvements that could improve the uptake of LZC technologies. These are the subject of another paper (Roy and Caird, 2007), but some of the most frequently requested improvements include:

- central heating controls designed for all users that provide feedback on efficient operation and use behaviour and/or automatically optimise energy efficiency and comfort;
- dimmable CFLs and LEDs suitable for general lighting;
- building-integrated solar thermal water heating panels and wind turbines;
- more user-friendly controls for solar thermal water heating and PV systems to provide feedback on efficient use and on energy and money saved; and
- wood-burning stoves whose heat output is easier to control.

It was clear from respondents' comments and design ideas such as the above, that many were unaware of improvements and innovations in the design and technology of LZC products and systems that have already taken place. Where products are changing, consumers need to be kept informed of developments if they are not to reject technologies based on their outdated perceptions or experience; for example, that CFLs are still bulky, insufficiently bright and slow to warm-up, or that dimmable CFLs and irritant-free thin loft insulation materials are unavailable.

5.3 Energy suppliers

A specific recommendation arising from the barriers to adoption of loft insulation would be for subsidised schemes operated by UK energy suppliers to offer a wider range materials of than the glass and lava fibre insulation, which some consumers wish to avoid for health reasons. A loft clearing and storage service as part of the installation process and better methods for providing post-installation storage would help overcome two of the main barriers to adoption.

Energy suppliers could also offer better methods of financing to move household renewables beyond the niche market of the environmentally-concerned middle classes. In particular, the majority of non-adopters of solar thermal water heating, solar PV and micro-wind systems said they would be encouraged to adopt if energy suppliers offered financial packages to install systems with repayment via fuel bills, while half of the non-adopters of PV wanted a better feed-in tariff for surplus electricity exported to the National Grid.

5.4 Retailers and installers

As noted in the Introduction, application of good marketing principles i.e. targeting different energy efficiency measures and renewables at receptive market segments, is vital to ensure their more rapid uptake. Our surveys indicate that installing one or more energy efficiency measures is likely to raise consumers' energy consciousness and could pave the way for interest and eventual commitment to renewables; Darby (2005) has suggested the idea of 'tipping-points' for consumer adoption of LZC techologies. Thus the market for household renewables might best be expanded by targeting the adopters of energy efficiency measures – in other words, sell energy efficiency first, then renewables.

This project found, like other surveys (e.g. SEA/RENUE, 2005) that in the UK solar thermal water heating and other household renewables is currently largely confined to a niche market of environmentally-concerned older, middle-class consumers. This finding was confirmed by the authors' subsequent research on consumer adoption of four microgeneration heat technologies, namely solar thermal water heating, ground source heat pumps, biomass pellet stoves and wood-fuelled boilers (Roy, Caird and Abelman, 2008). Other research indicates that while the over 50s have the highest carbon footprint of all UK age groups, they are most concerned about climate change and are motivated to take action (Haq et al., 2007), perhaps as compensation for their high carbon lifestyles. They may have a retirement lump sum and some at least are willing to invest some of it on a green, money-saving system. Retired people are also more likely to have the time needed to plan, apply for grants, install and operate renewable energy systems.

More generally, the results on drivers for adoption highlight the pleasure associated with using renewable energy as well as consumer associations of renewables with green status, morality and protectiveness towards future generations. Understanding consumer networks of communication between existing and potential adopters is also important in view of the evidence from our interviews of the strong influence of friends and neighbours in decisions to install insulation and solar thermal water heating.

Retailers also need to be aware that there is a critical timing for adopting energy efficiency measures and renewables since they are often installed when moving house or as part of other home improvements. Our survey found that the difficulty finding a trustworthy installer is a reason for non-adoption of renewables in particular. Where retailers or installers are slow to respond, this may lead to homeowners going ahead with their plans with the result that the LZC product or system may not be included as part of the improvements.

Promoting the widespread consumer adoption and carbon-saving use of energy efficiency measures and renewables requires a multiple approach that needs to be tailored to the different technologies concerned. This is supported by a recent Energy Saving Trust report which found that "*...no single policy will encourage the kind of mass adoption of microgeneration that is needed to get results*" EST (2007). Policies and actions need to go beyond addressing the financial, regulatory and information barriers to adoption, important as these are. They should include improving the user-centred design and technology of existing products and systems; improved communications about improvements to established energy efficiency measures; targeting of receptive market segments; detailed practical advice about the installation and use of renewable energy systems and guarantees regarding their performance, reliability and maintenance.

Acknowledgements

The authors would like to acknowledge the contribution of other members of the project team: Professor Stephen Potter, Georgy Holden and Karen Yarrow and the kind assistance of Jennie Abelman of the Energy Saving Trust; Brenda Kelly and Angus Murchie of Milton Keynes Energy Agency; Ian Byrne, Gareth Ellis and Safron Myhill-Hunt of the National Energy Foundation; Ellen Matschke, editor of NHER E-info; and the Open Broadcasting Unit and Survey Research Unit of the Open University.

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Figure 1

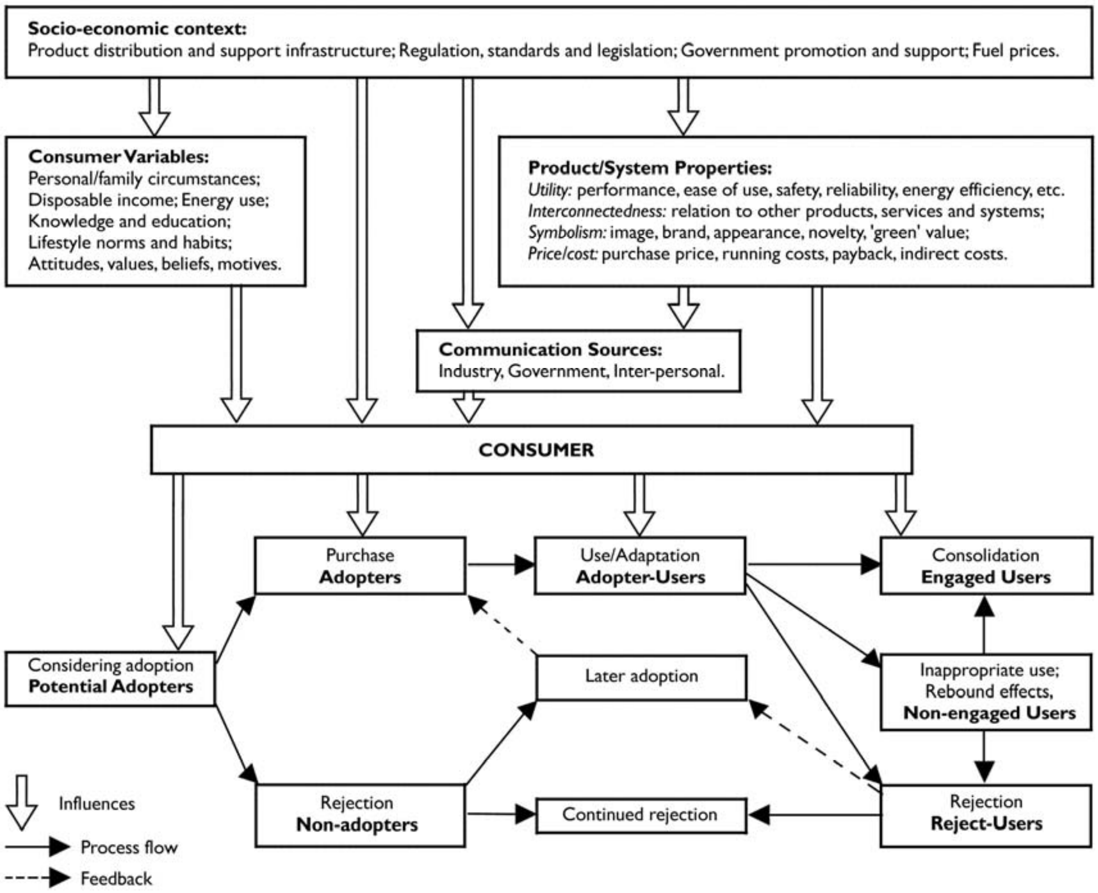

Fig. 1 Model of adoption and use of LZC products and systems (Roy, Caird and Potter, 2007, p. 51)

TABLES

Table 1 Adoption and non-adoption of energy efficiency measures

Energy efficiency measures	Adoptions [1]	Non-adoptions
New or additional loft insulation of up to 250mm depth (LI)	229 (59%) 28 interviews	59 (15%) 7 interviews
Central heating timer/programmer (T/P)	286 (73%) 21 interviews (bothT/P, TRV)	13 (3%) 0 interviews
Thermostatic radiator valves (TRVs)	214 (55%) (21 interviews: (both T/P,TRV))	53 (14%) 0 interviews
Condensing central heating boiler (CB)	109 (28%) 7 interviews	97 (25%) 0 interviews
Compact fluorescent lamp(s) (CFLs)	275 (71%) 17 interviews	23 (6%) 3 interviews
Light emitting diode (LED) lighting	28 (7%) 0 interviews	62 (16%) 0 interviews
Total online survey sample [2]	390	390
Number interviews	73	10

Notes: [1] Some multiple adoptions [2] Percentages are based on total online survey sample (which includes responses for both energy efficiency measures and renewables)

Table 2 Main drivers for adopting energy efficiency measures

Main driver [1]	New or extra loft insulation (250mm or more)	Heating Controls Timer/ programmer	TRVs	Condensing boiler	Energy efficient lamps CFLs	LEDs
Save energy/ reduce fuel consumption	200 (84%) 12 (43%) interview	220 (78%) 6 (29%) interview	154 (59%) 6 (29%) interview	75 (77%)	242 (91%)	20 (57%)
Reduce fuel bills/save money	192 (81%) 20 (71%) interview	210 (74%) 5 (24%) interview	148 (57%) 5 (24%) interview	68 (69%)	217 (82%)	12 (34%)
Increase comfort/ warmth/retain heat	182 (77%) 20 (71%) interview	104 (37%)	83 (32%)	34 (35%)	n/a [2]	n/a
Concern for environment/ global warming/reduce emissions	161 (68%) 6 (21%) interview	162 (57%)	117 (45%)	59 (60%)	218 (82%)	4 (11%)
Number online responses [3]	237	282	261	98	266	35

Notes: [1] Multiple reasons for adoption given [2] n/a = not applicable [3] Percentages are based on the number of responses to each question

Table 3 Main reasons for non-adoption of energy efficiency measures (online survey)

Barrier to adoption [1]	New/ extra loft insulation (250mm)	Heating Controls Timer/ programmer	Heating Controls TRVs	Condensing boiler	CFLs	LEDs
Fuel savings not worth cost.	11 (20%)	6 (26%)	6 (20%)	23 (26%)	3 (13%)	11 (19%)
Too expensive	n/a [2]	n/a	n/a	61 (70%)	8 (33%)	22 (39%)
Trouble in clearing loft	18 (33%)	n/a	n/a	n/a	n/a	n/a
Loss of loft storage space	20 (37%)	n/a	n/a	n/a	n/a	n/a
Disruption in home.	12 (22%)	n/a	n/a	8 (9%)	n/a	n/a
Too much trouble to install	n/a	4 (17%)	14 (47%)	n/a	n/a	n/a
Reputation for unreliability	n/a	n/a	n/a	37 (43%)	n/a	n/a
Don't fit existing light fittings.	n/a	n/a	n/a	n/a	8 (33%)	22 (39%)
Unpleasant or unsuitable quality or colour of light	n/a	n/a	n/a	n/a	8 (33%)	8 (14%)
Ugly and/or too large	n/a	n/a	n/a	n/a	10 (42%)	n/a
Not widely available	n/a	n/a	n/a	n/a	4 (17%)	23 (40%)
Number online responses [3]	59	23	30	87	24	57

Notes: [1] Multiple reasons for non-adoption given [2] n/a = not applicable [3] Percentages are based on the number of responses to each question

Table 4 Adoption and non-adoption of renewable energy technologies

Renewable energy systems	Adoptions [1]	Non-adoptions
Solar thermal water heating (STWH)	39 (10%) 15 interviews	151 (39%) 13 interviews
Solar photovoltaics (PV)	12 (3%)	130 (33%)
Micro-wind turbine (MWT)	7 (2%)	128 (33%)
Wood-burning stove	63 (16%)	65 (17%)
Number adoptions/non-adoptions (excluding interviews)	121	477
Total online survey sample [2]	390	390

Notes: [1] Some multiple adoptions [2] Percentages are based on total online survey sample (which includes responses for both energy efficiency measures and renewables)

Table 5 Main drivers for adoption of renewable energy technologies

Main driver [1]	Solar thermal water heating (STWH)	Solar photo-voltaics (PV)	Micro-wind	Wood-burning stove
Save energy/ reduce fuel consumption	43 (83%) 7 (47%) interview	5 (31%)	39 (65%)	39 (65%)
Reduce fuel bills/save money	40 (77%) 8 (53%) interview	4 (25%)	5 (28%)	37 (62%)
Concern for environment/ global warming/ reduce emissions	41 (79%) 11 (73%) interview	9 (56%)	6 (33%)	31 (52%)
Had funds available to invest	22 (42%)	7 (43%)	2 (11%)	19 (32%)
Received a grant/special offer	16 (31%)	4 (25%)	3 (17%)	n/a [2]
Like warmth/appearance of a real fire	n/a	n/a	n/a	49 (82%)
Number online responses [3]	52	16	18	60

Notes: [1] Multiple reasons for adoption given [2] n/a = not applicable [3] Percentages are based on the number of responses to each question

Table 6 Main reasons for non-adoption of renewable energy technologies (online survey)

Barriers to adoption [1]	Solar thermal water heating.(STWH)	Solar photo-voltaics (PV)	Micro wind turbine (MWT)	Wood-burning stove
Too expensive	109 (73%)	104 (85%)	67 (53%)	24 (35%)
Likely fuel savings not worth the cost	53 (36%)	49 (40%)	26 (21%)	n/a [2]
Difficulty finding good installer	37 (25%)	29 (24%)	32 (25%)	n/a
System not likely to last long enough to pay back	36 (24%)	34 (28%)	9 (15%)	n/a
New technology with uncertain performance and reliability	35 (23%)	23 (19%)	27 (21%)	n/a
Gaining planning permission	19 (13%)	16 (13%)	46 (37%)	n/a
Difficulty finding space or suitable location for unit	26 (17%)	20 (16%)	42 (33%)	24 (35%)
Insufficient electricity produced	n/a	35 (28%)	24 (19%)	n/a
Noise /vibration	n/a	n/a	33 (26%)	n/a
Lack of space to store fuel.	n/a	n/a	n/a	31 (45%)
Difficult to control heat output	n/a	n/a	n/a	30 (43%)
More dust/ dirt in home	n/a	n/a	n/a	28 (41%0
Number online responses [3]	149	123	126	69

Notes: [1] Multiple reasons for non-adoption given [2] n/a = not applicable [3] Percentages are based on the number of responses to each question