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2013 EPRG Public Opinion Survey: Smart Energy Survey — Attitudes and Behaviours

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Keywords Public opinion survey, Consumption awareness, Electricity policy, Energy consumption behaviour, electricity monitor, Smart appliances, Supplier switching

JEL Classification Q40, Q48, Q42, L94

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1. Introduction

Growing concerns about climate change and energy security have led to a strong focus on energy efficiency as a strategy in energy policy. The threat posed by global warming to the existence of both humans and their natural environment has increased interests in reducing greenhouse gas emissions. The UK Government, for instance, has committed to cutting its greenhouse gas emissions to 80% below 1990 levels by 2050, as well as generating 15% of the total energy needs from the renewable energy sources by 2020. Recognising the need for consumer-integrated policies, there has been increasing attention on the roles of individual and communities in moving towards a low-carbon/carbon-free economy, and increasing awareness of different effective measures aimed at reducing domestic energy consumption (DECC, 2009a; Defra, 2008a; 2008b). The UK Carbon Emissions Reduction Target (CERT), from 2008 to 2011, required suppliers to promote carbon emissions reductions in the residential sector (Defra, 2008b). Also, two different Energy Market Assessments of March 2010 by Ofgem and DECC have stated that better demand side response[2] (DSR) should be pursued in all options set out for effective energy market reform (DECC, 2010; Ofgem, 2010).

Demand side policies/strategies – often referred to as demand side management (DSM) – aims to influence the quantities and patterns of energy use. The policies specifically aim at reducing energy consumption, encouraging efficiency, reducing wastage, and as a consequence reduce the carbon emissions to a possible minimal level. Today, the use of DSM as a response to climate challenge through emissions reduction is on the increase (Haney et al., 2010). In 2009, the UK Department for Energy and Climate Change (DECC) announced its intention to install smart meters with free standing real-time monitors in all the UK households by 2020. The rationale for this policy strategy is that the real-time information feedback made possible by this technology would trigger demand response management, culminating in decreased or efficient energy use and emissions reductions. The policy document specifically envisions that “These meters will provide consumers with

[2] Demand side response (DSR) refers to programs designed to encourage consumers to reduce their energy consumption during peak hours – load shifting. Typically, DSR actions include turning off or dimming banks of lighting, shifting of laundry or cooking activities, etc. Demand side management (DSM) programs encourage consumers to be more energy efficient, and DSM measures can include lighting retrofits, building automation upgrades, etc.

real-time information on their electricity use to help them control consumption, save money and reduce emissions” (DECC, 2009b p.7).

Energy in general and electricity in particular are invisible as ‘abstract force’ only enters the household through often hidden wires (Burgess and Nye, 2008; Hargreaves et al., 2010). Also, most energy consuming behaviours are part of households’ inconspicuous routines and habits (Shove, 2003), which makes it difficult for people to relate specific behaviour to the energy they consume (Hargreaves et al., 2010). In this context, it is particularly important to provide clear, high-quality feedback on energy use to consumers in terms of more informative bills (Wilhite and Ling, 1995), putting energy labels on domestic appliances (Boardman, 2004), in-depth energy advice via leaflets, online and face-to-face (Abrahamse et al., 2007; Brandon and Lewis, 1999; Darby, 2003) and most recently through various in-house real time/near real-time displays and monitors (Anderson and White, 2009; Mountain, 2006; Ofgem, 2009; Parker, Hoak, and Cummings, 2008; Ueno et al., 2005; Ueno et al., 2006; Wood and Newborough, 2007; Wood and Newborough, 2003). The provision of feedback information on energy use to consumers can help realise savings of between 5% and 15% depending on the quality and type of feedback provided (Burgess and Nye, 2008; Darby, 2006; Houde et al., 2013; Wilhite and Ling, 1995).

People differ in their beliefs, value, norms, opinions and attitudes, which can influence their consumption behaviour as well as how they weigh the costs and benefits of environmental changes. The use of information feedback when making energy consumption decisions is often negotiated among several household members, e.g. between husband and wife, parents and children, etc (Hargreaves et al., 2010; 2013). This complex interaction often makes changing energy consumption patterns difficult compared to industrial and commercial settings. This challenge has further generated a renewed interest in studying the potential for demand side management (DSM) in energy consumption in the UK, especially in the residential sector.

Both researchers and policy makers are presently paying more attention to the need to actively engage the residential sector in DSR. This attention arose from the fact that the UK household sector accounts for a significant proportion of energy and electricity consumption, and is a significant contributor to carbon emissions. In 2011, final domestic energy consumption accounted for 26.4% of UK final energy consumption, 35.1% of total electricity consumption, and 13.4% of total UK CO_2 emissions (DECC, 2012).

Every individual has dual roles to play in energy demand policy as both citizen and consumer (Reiner, 2006). As consumer, individual participates in making decision on the type and the level of energy to consume/in choosing consumption pattern to follow either solely for himself/herself or as part of negotiators in a particular setting – e.g., as a household member. This role is executed by adjusting the consumption behaviour of individual either by switching off some appliances at some particular times or by deciding to buy more energy efficient appliances. Most times, the motive/incentive for this behaviour adjustment is cost savings often made possible through reduction in energy use. As citizen, individual may participate both privately and collectively in policy-making processes, especially through social and political responsibilities on the other (Devine-Wright, 2007). It is therefore important to study the opinion of citizens in order to examine the potential support for and opposition to specific energy policies. Doing this would not only enable us measure the effectiveness of the existing DSM but also guide us in designing and implementing future energy policies. To understand how effective a DSM programme will be, it is essential to understand people's attitudes and behaviour, particularly the potential level of acceptance of various energy efficiency measures.

The existence of imperfection (as in other markets) in energy market further complicates the study of energy demand. Some of the market failures affecting energy consumption and demand response in the domestic sector include imperfect information, split incentives, and negative externalities (Haney et al., 2010). An incomplete information problem exists because of the inability of the traditional metering system to display information on real-time pricing and quantity of energy consumed. The separation between the principal investors in energy efficiency and the beneficiaries of efficiency improvements leads to split incentives problem. This problem arises when the landlord serves as the major investors in energy efficiency, but the tenants incur the costs and enjoy the benefits of efficiency improvements.[3] Split incentives are also a problem when some members of a household are responsible for the payment of energy bills whereas others have to make behavioural

[3] Other forms of the split incentive problem can occur when a landlord offers fixed rents which include the cost of utilities, or, more commonly, where landlords do not have an incentive to invest in more expensive energy-efficient appliances when tenants pay the utility bills.

changes that reduce energy costs – this type of incentive problem can exist between husband and wife or parents and children where the parent pays the bills but the children have to adjust their energy consumption behaviour. Finally, negative externalities arise when the environmental impacts of CO_2 are not included in the tariffs paid by energy consumers.

The underlying questions that inform this study are: 1) how conscious are people of their level of energy consumption? and 2) to what extent might energy saving measures, particularly smart devices, be accepted, used, and be an effective tool to achieve behavioural change? To address these questions, the Energy Policy Research Group (EPRG) conducted a public opinion survey in March 2013. In recent years, the use of public opinion surveys in addressing energy and climate change policies has been on the increase both in the UK and internationally (Akcura et al., 2011). Apart from the UK Department for Environment, Food and Rural Affairs (Defra), the Laboratory for Energy and the Environment, and the European Commission among others, EPRG has also run several surveys on public attitudes and behaviour towards energy and environment in the UK (see Curry et al., 2005; Defra, 2010; Platchkov et al., 2011; Reiner, 2006).

The 2013 EPRG survey focuses more on consumers' attitudes and behaviour towards smart energy technology. Specifically, the survey covered questions on: meter readings and awareness of consumption, billing and consumption behaviour, payment type and frequency, peer effects and consumption behaviour, remote controlled appliances and willingness to pay for them, concerns about (smart) technology, and consumer switching behaviour.

The rest of the paper is organised as follows: Section 2 reviews literature on information feedback and energy consumption with particular focus on smart metering and monitors; Section 3 presents an overview of the survey; Section 4 presents the survey results, including consumption awareness, change in energy consumption behaviour, subjective perception of attitude towards new (smart) technology, metering information, and willingness to accept changes in appliance usage: and finally, Section 5 offers some conclusions based on the findings.

2. Smart Metering and Consumer Behaviour

Increasing awareness of energy consumption through information feedback as a strategy for energy efficiency has dominated energy policy in recent times. The belief is that the provision of adequate and accurate feedback on energy consumption would help consumers reduce their energy use, and limits the emission of greenhouse gases. This information feedback takes various forms such as the provision of more informative bills (Wilhite and Ling, 1995), offering of in-depth energy advice to consumers via websites, flyers and face-to-face (Abrahamse et al., 2007; Brandon & Lewis, 1999; Darby, 2003), and more recently the provision of real-time/near real-time feedback from smart energy monitors (Anderson and White, 2009; Mountain, 2006; Ofgem, 2009; Parker, Hoak, and Cummings, 2008; Ueno et al., 2005; Ueno et al., 2006; Wood and Newborough, 2007; Wood and Newborough, 2003; National Audit Office, 2011).

There is no doubt that information displays can increase consumers' awareness and make them to be more conscious of their consumption. However, the extent to which information feedback influences consumption behaviour is unclear. A recent review of the effectiveness of smart monitors across the US revealed savings of between 3 and 13% with an average saving of 7% (Faruqui et al., 2010). In the UK however, the final analysis of a large-scale Energy Demand Research Project, involving 60,000 households including 18,000 smart meters householders, observed no statistically significant savings from standalone smart energy monitors (SEMs) and only 3% savings from SEMs when they were combined with smart meters (Ofgem, 2011). Meanwhile Fischer (2008) has noted that the effectiveness of feedback depends on its frequency, duration, content, medium of presentation, social comparisons and combination with other interventions.

The central assumption to the use of information feedback as a DSM strategy is that consumption awareness will encourage individuals to make a rational decision to cut their consumption, to reduce costs and carbon emissions. However, the complexity in consumer behaviour beyond information imperfection suggests that consumption awareness alone cannot fully achieve the desired policy results. Social norms, routines and habits, institutional and infrastructural constraints, and the decisions of some individuals to make bad choices even when provided with adequate and correct information are all factors that make policy interventions which aim to effect behavioural change extremely complex (Jackson, 2005; Thaler and Sunstein, 2008). The effectiveness of smart energy devices is influenced by social dynamics or interactions (Hargreaves, Nye, and Burgess, 2010; 2013), people's habits, preferences, and receptiveness (Paetz et al. , 2012; van Dam et al., 2010; Vassileva et al., 2012), and how long the householders have had it installed (van Dam, Bakker, and van Hal, 2010; Hargreaves, Nye, and Burgess, 2013),

Instead of focusing on the provision of information as the only instrument of demand policy response, a number of experts have argued that policymakers need to recognise the complexities in people's behaviour when designing energy policies. People have heterogeneous preferences and certain people are more receptive to interventions, thus careful customer group specific smart design is essential because a 'one-size-fits-all' approach cannot be justified (Vassileva, Wallin, and Dahlquist, 2012; van Dam, Bakker, and van Hal, 2010). Sustainable progress in energy management can only be achieved if members of the public are actively involved (Devine-Wright, 2007; Owens and Driffill, 2008). This underscores the need to constantly engage the public in discussion in order to understand and analyse their consumption patterns, preferences and attitudes towards behaviour change policies.

3. EPRG Public Opinion Surveys

The EPRG survey of public attitudes towards energy and environmental policies started in 2006 when it first commissioned YouGov to conduct a public opinion survey of UK household electricity users. This was followed by 2008 and 2010 surveys conducted by Accent, and the 2013 survey conducted again by YouGov. All the surveys shared some similar characteristics. They were all online based and surveys included questions on consumer switching behaviour and energy saving measures, many of which were kept consistent across surveys. This makes possible an examination of change of opinions on policy issues and energy usage.

While the three previous surveys focussed more on policy preferences for energy and environmental policies (e.g., national policy priorities), the 2013 public survey focuses more on consumption awareness and smart metering as potential strategies for energy savings, particularly through load shifting. Although some questions on willingness to accept (WTA) smart devices as a potential tool for load shifting were included in the 2010 survey, the potential discounts were framed as a percentage of total annual bills. This kind of framing could lead to heuristic judgement and makes the response to be cognitively biased. Bias might occur because respondents might not be able to devote enough time to compute the benefits or cost reductions before making decisions. To correct for this potential bias, the 2013 survey innovatively framed the benefits or discounts in actual amount (pounds) instead of percentages. Furthermore, the potential peer effects and the impacts of payment method on households' energy consumption behaviour, as well as public concerns about smart technology were examined in the 2013 survey.

3.1. Survey Overview

In March 2013, the EPRG commissioned YouGov, a leading public opinion firm, to conduct a public opinion survey on people's energy consumption behaviour and attitudes towards smart energy devices. This was the fourth EPRG survey in a series of regular opinion polls on public and individual attitudes towards electricity and energy consumption – the previous surveys were conducted in May 2006, October 2008 and August 2010. The 2013 survey involved 2000 households from England, Northern Ireland, Scotland, and Wales age 18 and over, of whom 1526 responded. The survey questionnaire was designed by EPRG, while YouGov programmed and hosted the online survey. YouGov uses Internet polling against the traditional methods of telephone or face-to-face interviewing system and also recruits its respondents via the Internet.

YouGov hosts a panel of over 360,000 eligible voters in the UK who were recruited via non-political websites through invitations and pop-up advertisements. The firm uses "active sampling" procedures where only the contacted people/sub-sample of the panel are allowed to participate. Active sampling also ensures that a respondent cannot participate twice on the same survey. The sub-sample is representative of UK adults in terms of age, gender, region and social class, among others. Respondents were provided some monetary incentive for their participation. Results are weighted to the national profile based on demographic information provided by the panellists to YouGov.

Choosing a survey-sampling method often involves a trade-off between accuracy and convenience. For instance, there is always a trade-off between the rigour of probability samples and the convenience of quota sampling. Although, a properly administered probability-sampling based survey provides a representative sample of the population of interest, it is usually prone to non-response bias which distorts how representative the survey can be. Because of the large non-response bias which has become problematic in probability samples, experts have begun to rely more heavily on quota sampling. Quota sampling ensures that responses meet pre-assigned quotas across predetermined groups. In an online based quota sampling survey, non-response is not easily defined as quota sampling substitutes an alternative respondent for an unwilling or unavailable potential respondent (Kalton, 1983).

However, quota sampling might not be totally free from bias. For instance, to the extent that the sampled or surveyed individuals are likely to be systematically different from those who would have been selected at random, a quota sampling may be biased even if it satisfies the required distribution across quota categories. Sources and the extent of this bias depend on the survey medium and on the method adopted in recruiting potential respondents. With internet survey, there are two possible potential sources of bias. These are under-representation and over-representation of some potential respondents. The underrepresented individuals are those who lack access to the internet and those who do not participate in online surveys on social websites. On the other hand, the overrepresented individuals might be the senior citizens who are always willing to respond to online survey. YouGov tries to minimise this potential bias by recruiting their respondents via different online media sources.

The possible bias due to the omission of those who do have access to the Internet is likely to not be substantial in the EPRG surveys. This is because of the regular and increasing access to the Internet by the majority of UK adults. According to the statistics released by the UK Office for National Statistics (2013), 81% of UK population aged 16 and over in 2012 had used the Internet within the three months preceding the interview for their study, and 68% access the Internet almost every day. This is compared to 59% and 35% access within three months and daily usage in 2006, and 78% and 60% respectively in 2010.

Table 1 compares the descriptive statistics of the survey to official figures from the national statistical office. Shares of respondents in the EPRG survey by age distribution are remarkably close to the shares from the official estimates. However, it appears that respondents in professional/managerial occupations (social grade AB) were oversampled, while supervisors, junior managerial/skilled workers (C1C2) were under-sampled. Also, while the shares of respondents in this survey by party affiliation are remarkably close (except for conservative) to the shares from a recent political poll taken by (ICM Research, 2013), the educated individuals were oversampled. Around 27% of adults in the UK have a bachelor degree or higher, but the corresponding share in the EPRG survey is 45%. This paper uses standard significance tests when presenting the findings; however, these significance tests assume that the data are generated through a random selection process. Robustness and the generalisation of the findings to the UK population were sensitive to the extent that the resulting sample deviates from the probability sampling procedure (Gschwend, 2005).

Table 1: Descriptive Statistics of the Sample

	Category	Share in EPRG survey (%)	95% confidence interval	Comparable official estimates of UK population
Gender	Male	47.90	45.39-50.41	49.20
	Female	52.10	49.59-54.61	50.80
Age	18-39	35.71	33.31-38.12	36.95
	40-59	34.80	32.40-37.19	34.22
	60 & over	29.49	27.20-31.78	28.83
Education	No bachelor degree	54.78	52.28-57.28	72.80
	Bachelor degree or higher	45.21	42.72-47.72	27.20*
Home ownership	Rent	25.23	23.05-27.41	31.67*
	Own	63.83	61.41-66.24	64.33
	Other	10.94	9.38-12.51	NA
Party affiliation[4]	Labour	23.46	21.33-25.59	22.00
	Conservative	22.02	19.94-24.10	18.00*
	Liberal Democrat	6.09	4.89-7.30	7.00
	SNP or Plaid Cymru	2.56	1.76-3.35	3.00
	Other Party	9.04	7.60-10.48	9.00
	None	31.39	29.06-33.72	NA
	Don't know	5.44	4.30-6.58	NA
Newspaper readership[5]	Guardian	13.30	11.60-15.01	1.80*
	Daily Mail	12.06	10.42-13.69	8.40*
	Sun	8.58	7.18-9.99	12.60*
	Daily Telegraph	7.99	6.63-9.36	2.60*
	Times	6.75	5.49-8.01	2.50*
	Mirror	4.59	3.54-5.64	5.40
	Independent	3.54	2.61-4.47	0.80*
	Daily Express	1.38	0.79-1.96	2.20
	Financial Times	1.05	0.05-1.56	0.60
	Star	0.72	0.03-1.15	2.40*
	Other	9.44	6.59-12.28	NA
	None	30.60	28.29-32.92	NA
Social Grade	AB	27.59	25.34-29.83	22.70*

[4] Party affiliation statistics are from an ICM Research (2013) survey, based on the question "If there were a general election tomorrow, which party do you think you would vote for?

[5] Newspaper readership estimates are from the National Readership Survey (NRS 2013).

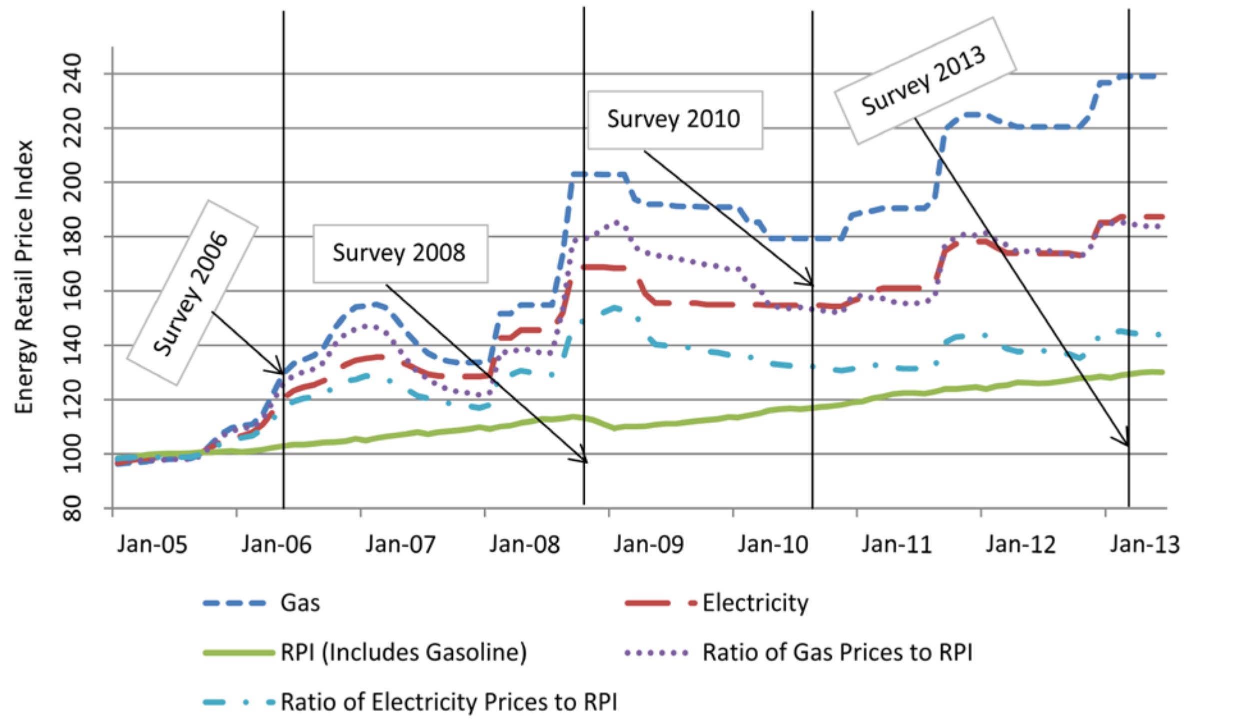
	CIC2	45.28	41.16-49.40	51.60*
	DE	27.13	23.71-30.55	25.70
Region	East Midlands	7.34	6.03-8.65	7.17
	East of England	9.31	7.85-10.76	9.27
	London	13.04	11.35-14.73	13.04
	North East	3.80	2.84-4.76	4.08
	North West	11.34	9.74-12.93	11.12
	Northern Ireland	1.11	0.59-1.64	2.86*
	South East	16.84	14.96-18.72	13.70
	South West	9.31	7.85-10.76	8.38
	West Midlands	7.01	5.73-8.29	8.86*
	Yorkshire and Humber	8.26	6.87-9.64	8.35
	Scotland	8.19	6.81-9.57	8.34
	Wales	4.46	3.42-5.49	4.83
				Percentile[a]
Income	<£5000	3.48	2.56-4.40	1st: £6800
	£5000-£9999	5.19	4.07-6.31	5th: £7970
	£10000-£14999	8.61	7.20-10.02	10th: £9510
	£15000-£19999	7.23	5.92-8.53	25th: £12900
	£20000-£24999	7.42	6.11-8.74	50th: £19600
	£25000-£29999	6.57	5.32-7.82	75th: £30900
	£30000-£34999	5.58	4.43-6.74	90th: £46600
	£35000-£39999	4.86	3.78-5.94	95th: 63200
	£40000-£44999	3.55	2.62-4.48	99th: £149000
	£45000-£49999	4.20	3.20-5.21	
	£50000-£59999	4.01	3.02-4.99	
	£60000-£69999	2.89	2.05-3.73	
	£70000-£99999	3.94	2.96-4.92	
	£100000-£149999	1.91	1.22-2.59	
	£150000 and above	0.92	0.44-1.40	
	Don't know	8.74	7.32-10.16	
	Prefer not to say	20.89	18.85-22.94	

Sources: EPRG Survey of UK Households 2013, and UK Office for National Statistics, 2013
* shows the official estimates that fell outside 95% confidence interval.
[a] Survey of Personal Income 2009-2010, UK Office for National Statistics

For the 2006 EPRG survey, YouGov contacted 2,254 individuals from its panel of 200,000, out of which 1,019 (45.2%) eventually responded. Responses were weighted based on socio-demographic variables. The 2008 and 2010 surveys were conducted by Accent using a quota system. The surveys covered 2,000 and 2,038 respondents respectively, and were based on quotas that correspond to data from the UK National Statistical Office (Akcura et al., 2011; Platchkov et al., 2011). One common feature of all these surveys is that they are all based on quota sampling rather than probability samples. Quota sampling often suffers from representativeness problems. However, we do not believe that representation could be a serious problem in these surveys because the polling firms tried to minimise this problem when recruiting and contacting their respondents.

Figure 1 shows the time series for the retail price index of electricity, gas, and the combined retail energy price index in the UK from 2005 through June 2013. The figure also indicates when the EPRG surveys were conducted in 2006, 2008, 2010 and 2013. The 2008 survey was conducted when energy prices peaked, after an increase of about 15% in electricity prices between July and October. As is obvious from the graph, as at the time the 2010 EPRG was conducted the prices of electricity had fallen but were still about 40% higher than in May 2006 – the period when the first EPRG survey took place. However, energy prices have continued to rise since few months after the 2010 survey was conducted. As at the time when the 2013 survey was conducted, electricity price was 11% higher than the price when the 2008 survey took place, and 21% higher than when the 2010 survey was conducted.

Figure 1: Retail Energy Price Index 2005-2013 (May 2005= 100)



Source: Department of Energy and Climate Change (DECC), 2013

4. Survey Results

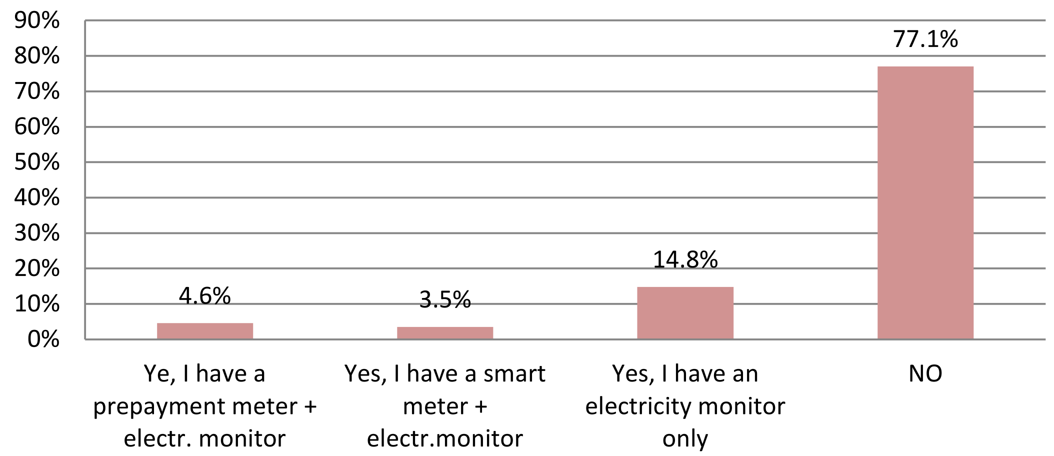
4.1. Consumption Awareness

Increasing population growth and changes in lifestyles suggest that people should be more concerned about their energy consumption at home. A major concern is how to ensure efficient use of energy, due to the increasing threats posed by climate change and the rising share energy bills play in household's overall budget. Rising energy cost can reduce consumer welfare as it affects other spending. Meanwhile, simple changes in people's behaviour can quickly lead to significant energy savings, but such changes will only happen if the people are aware of the ability they have to affect energy consumption. However, most households know little about the energy consumption rates of their home appliances (e.g. refrigerators, freezers, cookers, etc) or the overall monthly energy use. In an online survey of public perceptions of energy consumption and savings in US metropolitan areas conducted by Attari et al. (2010), participants underestimate energy use and savings by a factor of 2.8 on average, with smaller overestimates for low-energy activities and larger underestimates for high-energy consuming services. The first section of the 2013 EPRG survey questionnaire dealt with awareness of energy consumption, specifically through the use of smart devices.

4.1.1. In-house Electricity Monitor Ownership

Respondents were asked whether they had an in-house electricity monitor installed in their homes, and they were provided four options to choose from: a prepayment meter with an electricity monitor; a smart meter with an electricity monitor; an electricity monitor on its own; and no electricity monitor of any kind. Figure 2 presents the shares of the respondents according to the answers to the question. Out of a total of 1,526 respondents surveyed, only around 23% had electricity monitors installed in their homes. Among those with energy monitors, stand-alone electricity monitors were the most popular choice, representing about 15% of the total and about 65% of the electricity monitor households (Figures 2). This is followed by households with prepayment meters (4.6% of all respondents and 20% of households with monitors). Smart meter plus electricity monitors were the least common, amounting to just 3.5% of the total sampled households and 15.4% of the energy monitor households, which might reflect the smart meters being the newest technology.

Figure 2: Share (%) of Respondents by In-house Electricity Monitor Ownership Status



Source: EPRG Survey of UK Households 2013

Table 2 presents the share of respondents who indicated that they have electricity monitor installed in their various houses according to their education level, gender, age, home ownership, and income. While education, gender, age, home ownership and income do not play significant role in electricity monitor ownership, younger respondents are more likely to have in-house electricity monitor installed in their homes. This might reflect better awareness of this technology as a potential tool for energy savings. Unsurprisingly, respondents who are always eager to try a new technology are more likely to have in-house electricity monitor.

Table 2: Share of Respondents (%) that have In-house Monitor, By Education, Gender, Age, House Type and Income

Category	Share (%)	T-test
No bachelor degree	23.68	0.765
Bachelor degree or higher	22.03	
Male	23.12	0.163
Female	22.77	
Rent	24.42	0.886
Own	22.18	
Age 18-49[6]	26.29	3.428***
Age 50 & over	18.90	
Income per capita £7500 or less[7]	26.89	0.875

[6] Individuals 18-49 years old constituted 55% of all respondents, while individuals 50 years old and older were 45%.

[7] Gross income per capita is equal to estimated household income divided by number of individuals in the household. Estimated income is the median value for the self-reported annual income range selected by the respondent. For those respondents reporting that their gross income was over £150,000 (0.33%), the upper income bracket was set as £180,000. For households that reported having eight or more members (0.53 of

Income per capita £24000 or more	23.37	
Not eager to try new product	20.06	-2.649**
Always eager to try new product	31.18	
Overall	**22.94**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

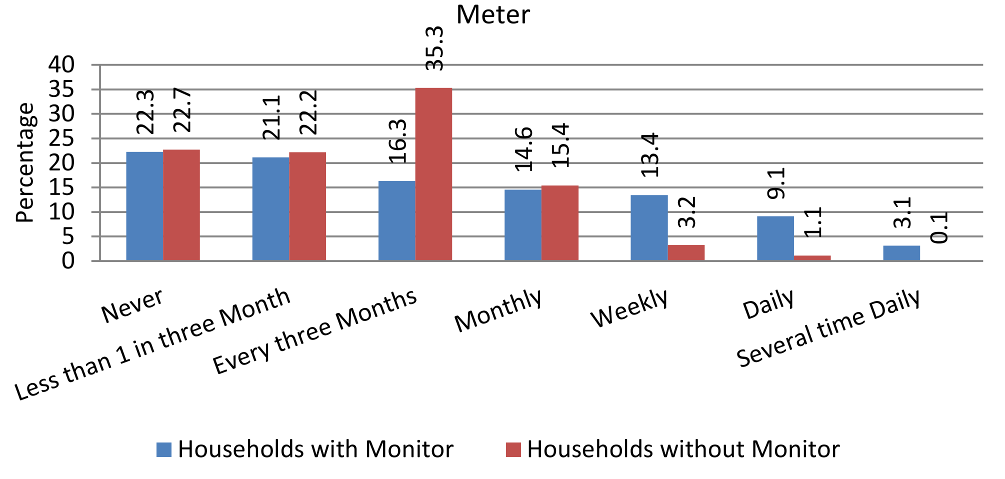
4.1.2. Electricity Monitor and Meter Reading Behaviour

Figure 3 presents the frequencies with which people monitor their electricity consumption according to whether they have electricity monitor or not. The majority of households do not check their energy consumption frequently. For instance, around 60% of respondents with electricity monitors either do not check their energy consumption at all or check less frequently than once in three months. Electricity monitor householders still check their energy consumption more frequently than households without energy monitors. About 26% of monitor householders maintain that they read their monitor at least once within a week, with about 9% indicating that they check it daily and 3% maintaining that they monitor their energy consumption several times a day. These are compared to less than 5% of non-monitor respondents indicating that they read their meter at least once within a week, and just 1% checks their consumption daily (which might reflect errors in survey response not actual behaviour). The majority of households without monitors read their electricity meter every three months, representing around 35% of the group.

The fact that roughly the same percentage (more than 22%) of households in the two groups claim to have never monitored their consumption underscores the need to review the effectiveness of information feedback on energy consumption. Aside from the volume and frequency of information flow, the success of a feedback measure critically depends on how consumers are motivated to interact with and use the information provided (Fischer, 2008).

respondents), the number of members was set as 8. These calculations apply to income per capita figures in all subsequent tables. 31% of respondents have estimated household income per capita of £7500 or less, while 13% of respondents have estimated household income per capita of £24000 or more.

Figure 3: Frequency of Households' Reading of Electricty Monitor or Meter



Source: EPRG Survey of UK Households 2013

Approximately 3% of monitor holders, regardless of their sex, stated that they monitor their consumption several times daily. While female holders perform better in checking their electricity consumption on a daily basis than men, men are more likely to check their consumption at least one time in a month than female holders. For instance, around 13% of female monitor holders read their monitors at least daily compared to 11% of men, whereas 44.6% of men monitor their consumption at least once in a month compared to 34.4% of female monitor holders.

Table 3 presents the frequencies with which households monitor their electricity consumption based on sex, age, and accommodation type. On average, male respondents are more likely to monitor their consumption more frequently than female consumers regardless of whether they own an electricity monitor. Although for electricity monitor owners there were no age and home ownership effects on monitoring behaviour, both younger respondents and renters without electricity monitors were more likely to read their meters more frequently. Interestingly, respondents that are responsible for the payments of their electricity bills either jointly or solely were more likely to monitor their energy consumption more frequently, regardless of whether they own an electricity monitor.

Table 3: Monitoring of Electricity Consumption

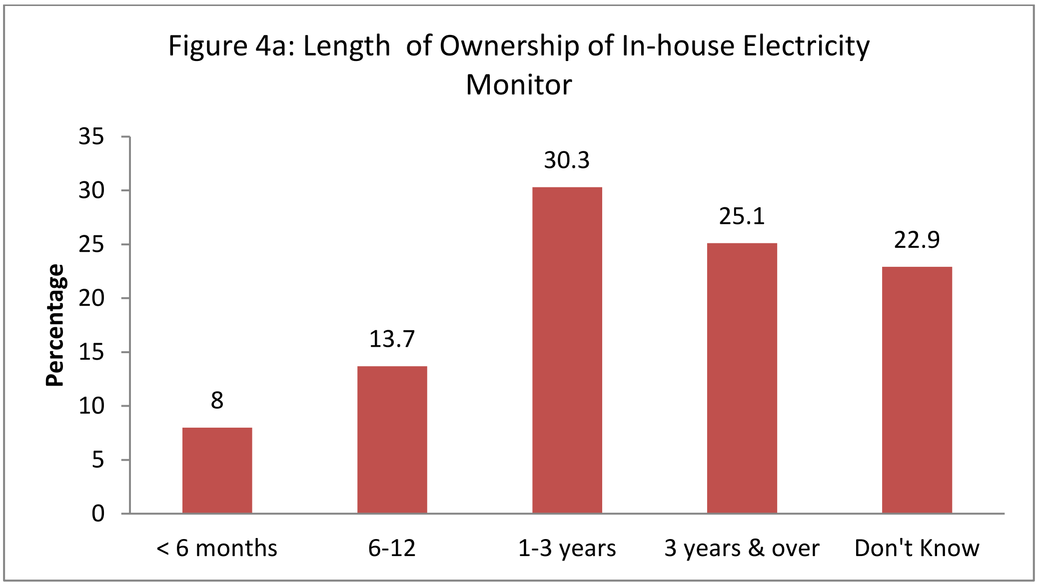
	Category	Average	T-test
Households with Monitor			
	No bachelor degree	3.25	1.158
	Bachelor degree	3.03	
	Male	3.29	1.370*

	Female	3.03	
	Age 18-49	3.01	-0.780
	Age 50 & above	3.25	
	Rent	3.04	-0.714
	Flat	3.20	
	Not responsible for bill	2.27	-3.660***
	Responsible for bill	3.27	
	Income per capita £7500 or less	3.28	0.983
	Income per capita £24000 or more	2.95	
Overall reading average		**3.16**	
No monitor households			
	No bachelor degree	2.58	0.027
	Bachelor degree or higher	2.58	
	Male	2.63	1.330*
	Female	2.54	
	Age 18-49	2.45	-4.02***
	Age 50 & above	2.72	
	Rent	2.45	-2.536***
	Flat	2.65	
	Not responsible for bill	1.91	-8.178***
	Responsible for bill	2.69	
	Income per capita £7500 or less	2.63	0.394
	Income per capita £24000 or more	2.58	
Overall reading average		**2.58**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Coding: 1-never; 2-less frequently than once in every 3 months; 3-every 3 months; 4-monthly; 5-weekly; 6-daily; 7-several times during the day.
Source: EPRG Survey of UK households 2013

4.1.3. Effect of Length of Ownership in Electricity Monitor Usage

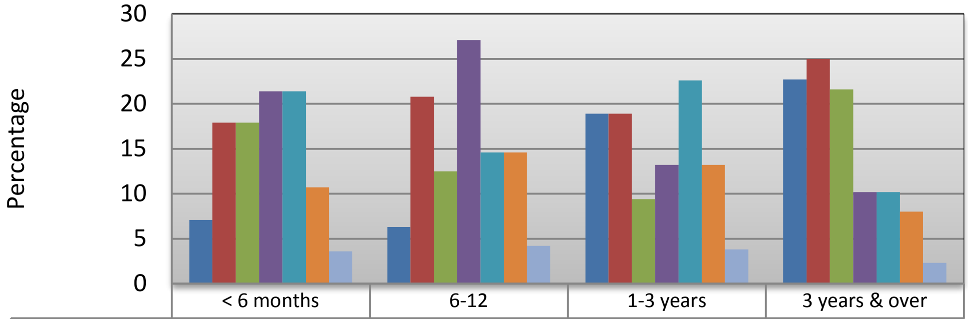
Many aspects of consumer behaviour change over time: attitudes, perceptions, motives and values, lifestyles, and the political, cultural and technological environment. Time is so essential that it may be the most important variable in consumer behaviour (Nicosia and Mayer, 1976). In the 2013 EPRG survey, respondents were asked to indicate how long they had their in-house monitors, the frequency with which they read their monitor, and if they had perceived any change in the frequency with which they read the monitor since it was installed. Figures 4a presents how long people have had monitors installed in their homes, while Figure 4b shows the relationship between the time people have had their in-house monitors and the frequency with which they monitor their consumption. The perceived changes in reading habits are presented in Figure 4c. Around 30% of monitor households indicated that they have had their monitor between 1 and 3 years, while 25% claimed to have had their monitor for 3 years or more (Figure 4a). Some 14% of the monitor holders had their monitors between 6-12 months before the survey, and just 8% had it in less than 6 months before the interview.



Source: EPRG Survey of UK Households 2013

The frequency with which people monitor their electricity consumption declines over time. Around 21% of those who had their monitor within the last six months indicated that they read their monitors weekly compared to just 10% of those who had it for 3 years and over (Figure 4b). Similarly, while 14.3% of those who had their monitors within the last 6 months before the survey read it at least once daily, only around 10% of those who had had it for 3 years and more monitor their consumption at least one time a day.

Figure 4b: Effects of Ownership Length on Frequency of In-house Monitor Reading



	< 6 months	6-12	1-3 years	3 years & over
Never	7.1	6.3	18.9	22.7
<1 in 3 months	17.9	20.8	18.9	25
Every 3months	17.9	12.5	9.4	21.6
Monthly	21.4	27.1	13.2	10.2
Weekly	21.4	14.6	22.6	10.2
Daily	10.7	14.6	13.2	8
Several times	3.6	4.2	3.8	2.3

Source: EPRG Survey of UK Households 2013

Table 4a presents the results of the effect of the length of ownership of monitors on the monitor reading frequencies by gender and monitor categories. On average, Male monitor holders are more likely to read their monitors more frequently than female holders. Respondents who had had their monitors for less than one year are more likely to read their monitor more frequently. While time does not seem to impact the frequencies with which the respondents that indicated having prepayment-plus-monitor, and stand alone monitors read their monitors, smart meter-plus-monitor's holders who had them for less than one year are more likely to read their monitors more frequently.

Table 4a: Share of Respondent based on the Length of Monitor Ownership and Reading Frequencies, by Monitor Categories

Category	Share (%)	T-test
All monitor holders		

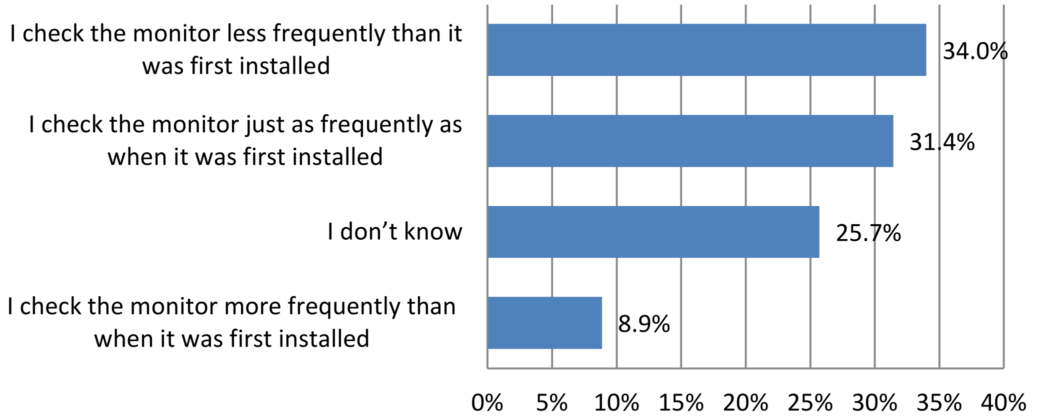
	Male	45.56	1.950*
	Female	35.36	
	1 year or less	59.21	2.449**
	1 year & over	42.78	
Prepayment + monitor			
	1 year or less	58.33	0.727
	1 year & over	46.15	
Smart meter + monitor			
	1 year or less	70.00	2.157**
	1 year & over	39.29	
Stand alone monitor			
	1 year or less	54.55	1.380
	1 year & over	42.52	
Overall		**40.29**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

4.1.4. Subjective Perception of Behaviour Change in Monitor Usage

Figure 4c shows differences in people's behaviour in monitoring their energy consumption relative to when they got their monitors. The results show heterogeneity in behaviour. Around 34% of the electricity monitor householders stated that they had been reading their monitors less frequently than when it was first installed. Approximately 31% reported that they had maintained the frequency with which they read their monitor, and 9% indicated that they had actually increased the frequency with which they read their monitors. Around 40% of smart meter holders had reduced the frequency with which they monitor their consumption (i.e., reading of their monitors) whereas only 16% reported they had increased the frequency with which they read their meters.

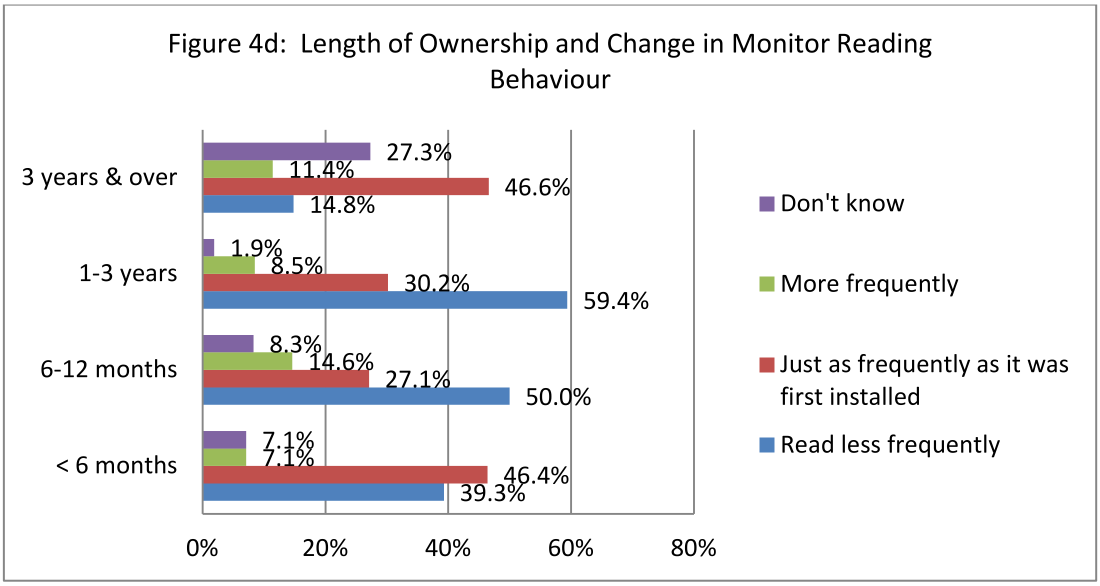
Figure 4c: Have you changed the frequency with which you check your in-house electricity monitor?



Source: EPRG Survey of UK Households 2013

Figure 4d further compares the subjective change in people's monitor reading behaviour and the length of in-house monitor ownership. Around 39% of those who had their monitor installed in less than six months have reduced the frequency with which they read their monitors, while 46% maintained a constant reading habit. Meanwhile, around 7% of them had increased the rate at which they monitor their consumption. Around 50% and 59% of those who had their monitor between 6 and 12 months, and for between 1 and 3 years, respectively stated that they had reduced the frequency with which they read their monitors. This is compared to just 15% of those who had their monitor for 3 years and over. On the other hand, while 15% and 9% of the formers have increased the rate at which they monitor their consumption, around 11% of those who had had the monitor for 3 years and over had increased their monitoring behaviour.

The implication of these findings is that, although reading of in-house electricity monitor declines over time, time alone cannot explain why and how people change their reading behaviour. For instance, why had only 15% of those who had installed in-house monitor for 3 years and over reduced their readings compared to 39% of those who had installed it just for less than 6 months? In the same vein, why had a higher percentage (11%) of the former (i.e., 3 years and over) increased their monitor readings compared to just 7% of the latter group (i.e., < 6 months)? This indicates that there is a need for more research to understand why people behave the way they do in the context of electricity consumption monitoring.



Source: EPRG Survey of UK Households 2013

Table 4b reports the results of the effect of the length of ownership of in-house monitors on the monitor reading frequencies, and the share of respondents that perceived changes in their monitor reading behaviour, by gender, age, housing type, and length of ownership. Respondents who had their monitor installed in less than one year prior the survey are more likely to read their monitors more frequently than those who had had their monitors for one year and over[8]. Surprisingly however, length of ownership, gender, age, and housing type are insignificant in respondents' subjective perceived behaviour change in the way they read their monitors compared to when it was first installed. This finding might reflect the differences between stated and revealed preferences.

Table 4b: Effects of Time on the Frequency of Monitor Reading & Change in Electricity Monitor Reading Behaviour

Category		Average/share (%)	T-test
Frequency of Monitor Reading by:			
Length of Installation		Average	
	< 1 year	3.82	2.270**
	1 year & over	3.28	
Claimed behaviour change by:		Share %	
	No bachelor degree	55.41	
	Bachelor degree or higher	60.71	-0.856
	Male	56.92	-0.250
	Female	58.46	
	Age 18-49	57.23	-0.188
	Age 50 & over	58.42	

[8] This confirms the finding in Table 4a. Note: Table 4 uses the share (%) of respondents while Table 4b is based on the reading frequencies.

	Rent	54.69	-0.651
	Own	59.41	
	Not responsible for bill	44.44	-1.148
	Responsible for bill	58.33	
	Income per capita £7500 or less	62.69	-0.398
	Income per capita £24000 or more	66.67	
Length of Installation			
	< 1 year	62.86	0.898
	1 year & over	56.55	
Overall		**57.69**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

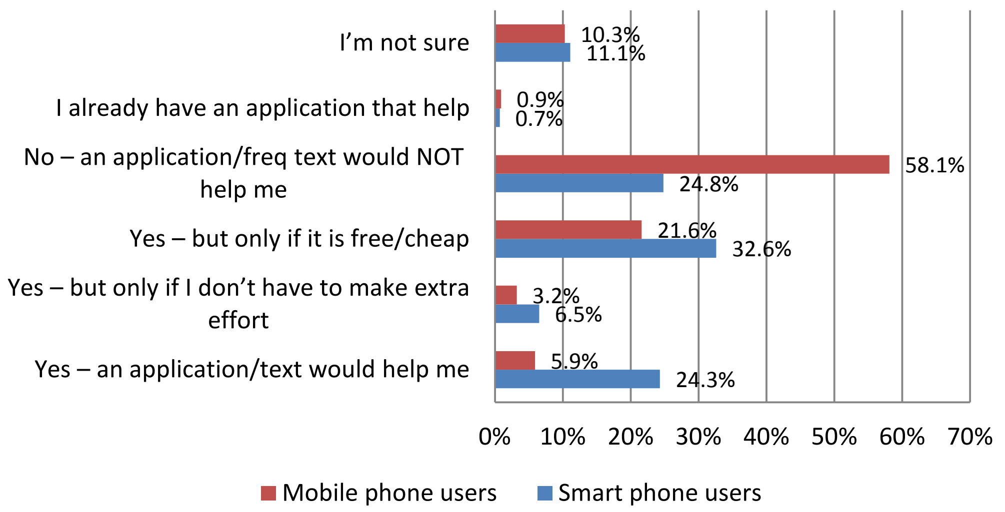
4.1.5. Smart Phone Applications and Consumption Awareness

There is an increasing awareness of the usefulness of smart phones in energy management. A study by Leslie et al. (2012) looks at how smart phones could significantly accelerate home energy audits for greater energy conservation over more traditional methods, like having trained energy auditors check heating and cooling systems once a year. They analysed 157,000 homes in South-eastern Ontario and found that it would take 55 years to complete an energy audit of every house using the inefficient traditional auditing system. With smart phones in every home, however, this same task could be completed much more quickly. According to a survey conducted by the consulting firm Accenture in 2011, involving some 10,199 respondents from 18 countries, some 32% of all respondents – including 36% of male respondents and 29% of female respondents – were interested in smart phone applications that allow them to measure their energy consumption in real time (Accenture, 2011).

In order to examine perceptions of how effective the use of smart phones can be in making individuals aware of their own electricity consumption, we asked a series of questions. Respondents were first asked whether they have an ordinary mobile phone or smart phone. Around 37% (561) of the respondents indicated that they have a mobile phone, 52% (859) had a smart phone while 7% (106) stated that they had neither a mobile phone nor a smart phone. Respondents who have a smart phone were asked if they think that an application on their smart phones would help them become more aware of their energy consumption. Similarly, respondents who indicated that they had only a mobile phone were asked if they think that frequent (i.e., weekly) text messages would help them become more aware of their energy consumption.

While the majority (58%) of mobile phone users did not believe that frequent text messages would not help them to become more aware of their consumption, a majority (63%) of smart phone users thought that they would like to have an application on their phones but slightly more than half of those (33%) would only agree if it was free or cheap (Figure 5). Around 24% of smart phone users perceived the application on their phones would help them become more aware of their consumption with no regards to the costs, whereas 7% would want the application if it requires no extra effort. Overall, smart phone users are optimistic that an application on their phone could make them more aware of their energy use, but they were concerned about the costs.

Figure 5: Do you think an application on your smart phone (frequent text messages) would help you become more aware of your energy consumption?

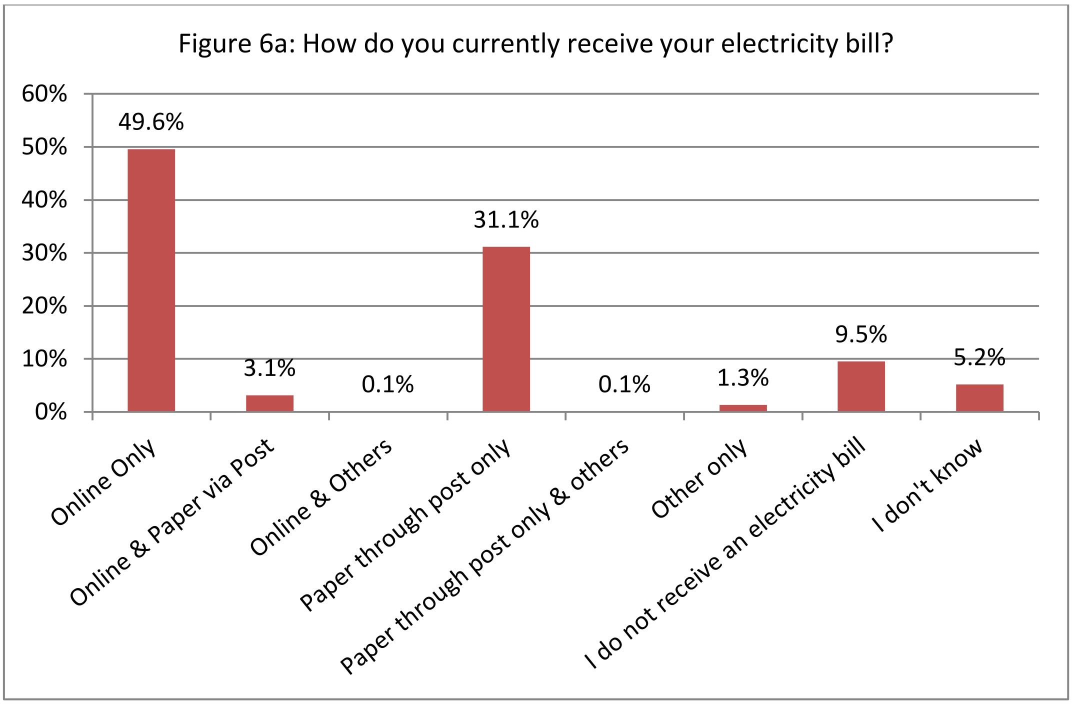


Source: EPRG Survey of UK Households 2013

4.2. Billing and Consumption Behaviour

Information feedback is an essential tool in energy efficiency management. Information feedback on energy use can significantly improve consumption awareness and lead to changes in consumption behaviour culminating in energy efficiency and conservation. However, the degree of behaviour change made possible depends on the nature and quality of such information. Darby (2006) reviews 51 different feedback projects – including some 38 direct feedback (e.g. direct displays, interactive feedback via PC, smart meters, etc) and 13 indirect feedback projects (e.g. more frequent bills, frequent bills plus historical feedback, etc) – carried out at different times between 1975 and 2000. The study finds that the projects demonstrate potential for energy savings, and concludes that feedback measures have a significant role to play in bringing about energy awareness and conservation.

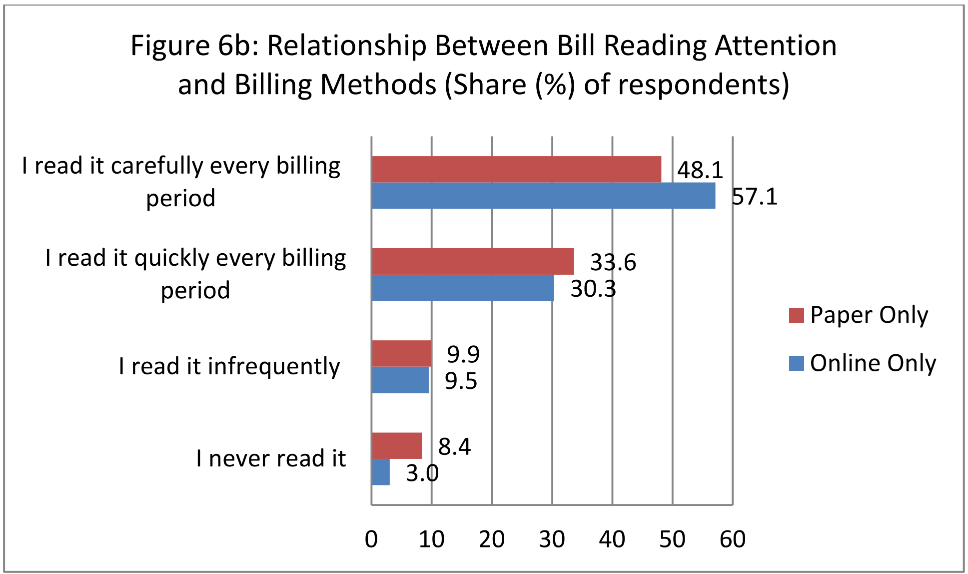
Comparing the potential savings made possible by direct and indirect feedbacks, the report concludes that the range of savings achieved via indirect feedback measures tends to be lower than the one reported in direct feedback studies; nevertheless, they (indirect feedbacks) may be important and may be achievable at relatively low cost. This demonstrates that indirect feedback via better billing can have a part to play in bringing about energy awareness and behaviour change — if used within a mixture of measures to encourage energy efficiency. In the 2013 EPRG survey, respondents were asked to indicate how they currently receive their bills and how often they read them (the bills). Figure 6a shows the distribution of respondents according to their billing methods. Online billing system appears to be the most popular choice among the UK households, representing more than 50% of respondents.[9] This is followed by those who receive paper bills via post, representing more than 30% of respondents.



Source: EPRG Survey of UK Households 2013

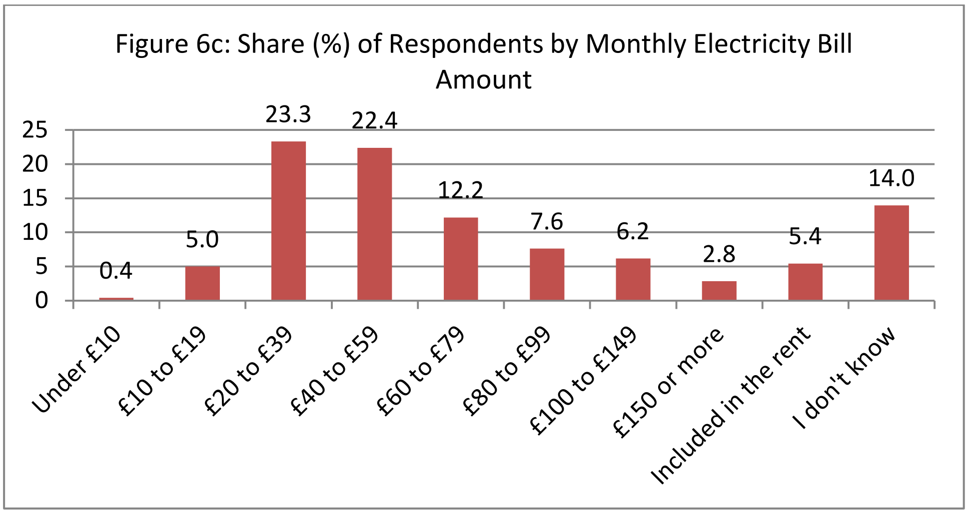
[9] The figure includes those who combine online with paper and other.

Figure 6b presents the relationship between billing method and how carefully people read their electricity bills based on the two most popular choices – i.e., online billing and paper bills. The results show that people who receive their bills online pay more attention to their bills compared to those that receive paper bills. For instance, around 57% of customers who receive their bills online only, maintained that they read their bills carefully every billing period compared to 48% of those who only receive paper bills. Similarly, while only 3% of online billing consumers indicated that they had never read their bills before, more than 8% of the paper billed customers claimed to have never done so.



Source: EPRG Survey of UK Households 2013

The majority of the respondents pay between £20 and £59 for electricity a month, representing around 46% of respondents whereas only 2.8% pay £150 or more per month (Figure 6c).



Source: EPRG Survey of UK Households 2013

Table 5 presents the attentiveness of respondents to their electricity bills by education, gender, age, type of accommodation, income, electricity bill payment responsibility, and the electricity monitor ownership. While men and women do not differ significantly in the attention paid to the reading of the electricity bills, younger respondents, those living in a rented accommodation, and those that are not responsible for the payments of their electricity bills, are more likely to pay less attention to the reading of their bills.

Table 5: Respondents' Attentiveness to Bill

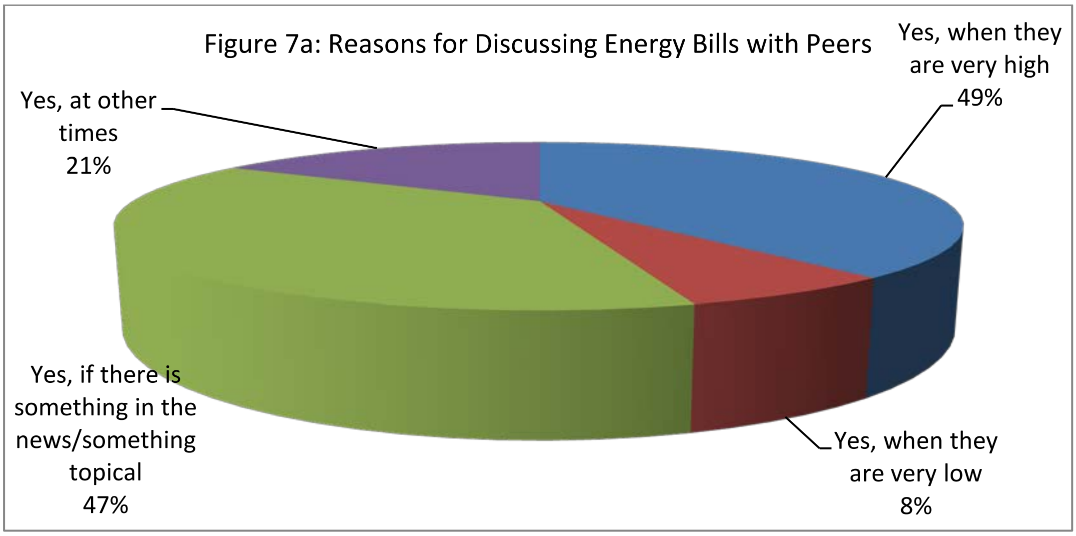
	Category	Share (%)	Test
Reading Attention by:	No bachelor degree	48.09	1.061
	Bachelor degree or higher	45.36	
	Male	46.24	-0.463
	Female	47.42	
	Age 18-49	36.61	-9.014***
	Age 50 & over	59.16	
	Rent	37.40	-4.703***
	Own	51.44	
	Not responsible for bill	21.36	-8.244***
	Responsible for bill	51.58	
	Income per capita £7500 or less	46.22	1.195
	Income per capita £24000 or more	40.76	
	No Monitor	47.11	0.365
	Have Monitor	46.00	
Overall		**46.85**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

4.3. Peer Effects and Changes in Consumption Behaviour

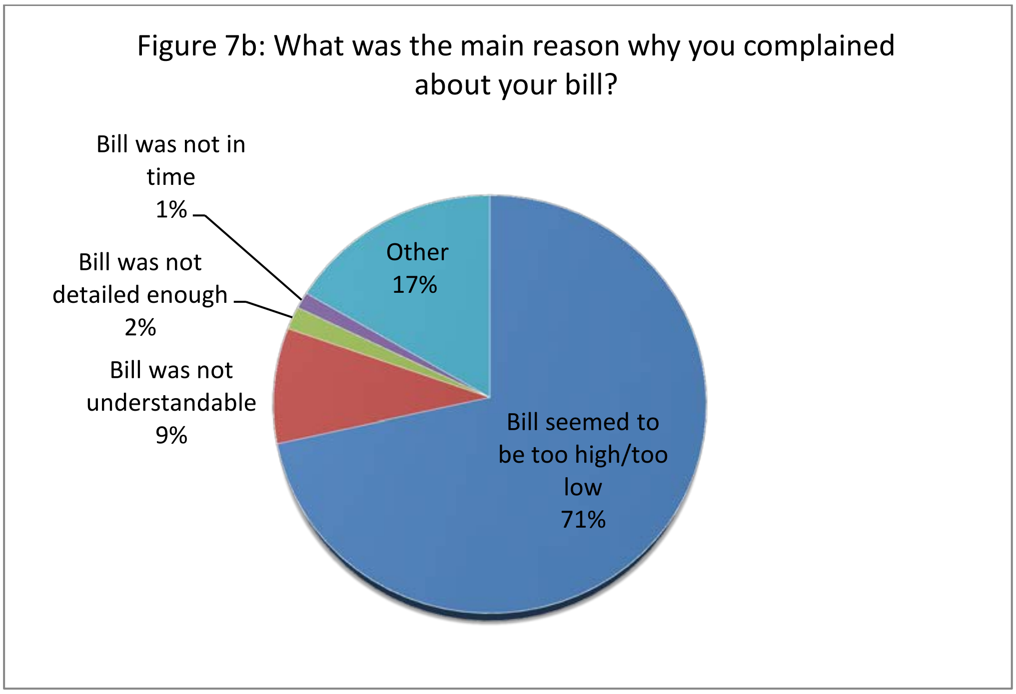
Social interactions can play a significant role in energy consumption behaviour. By providing feedback to customers on their household electricity and natural gas usage with a focus on peer comparisons, utility providers can reduce energy consumption at a low cost. Peer based comparative feedback can take several forms, such as one-time feedback, interval feedback, and real-time feedback (Ayres et al., 2009; Mahone and Haley, 2011). Peer-based comparative feedback compares an individual's energy usage to the average energy use in similar buildings in their neighbourhood or peer group (Mahone and Haley, 2011). Such comparisons help individuals put their energy use habits into context, and may help them to improve their energy consumption relative to their neighbours. These measures rely heavily on the power of social norms to encourage householders to reduce their energy use to be more in line with their more efficient neighbours or peers.

However, the extent to which peer comparisons can affect behaviour change depends on how individuals interact with their neighbours and the way they process and use the information provided. The 2013 EPRG survey investigates whether people do discuss their bills with others (e.g. neighbours/friends), the reasons for doing so, as well as the extent to which people condition their consumption behaviour on the actions of others. Around 42% of the respondents indicated that they had discussed their bills with peers, whereas 58% indicated that they had never discussed their bills with anyone. Figure 7a presents the reasons for discussing bills with others based on the share of respondents that had ever discussed their energy bills with peers. Economic considerations (i.e., high bills) and topical news, representing 49% and 47% respectively, are the major reasons why people discuss their bills with friends and neighbours. On the other hand, just 8% had discussed their bills with peers because they felt the bills were too low.



Source: EPRG Survey of UK Households 2013

Respondents were asked whether they had ever complained about their bills, and, if they had, the reason for the complaint. Just over one quarter (26%) indicated they had complained about their electricity bills while 10% said they couldn't remember if they had ever done so. Figure 7b shows the respondents reasons for complaining about their bills. Again, economic factors are the major reason why people complain about their bills, representing about 71%. Lack of understanding of the bills made up just 9% of complainants, and just 2% complained because they thought the bill was not informative.

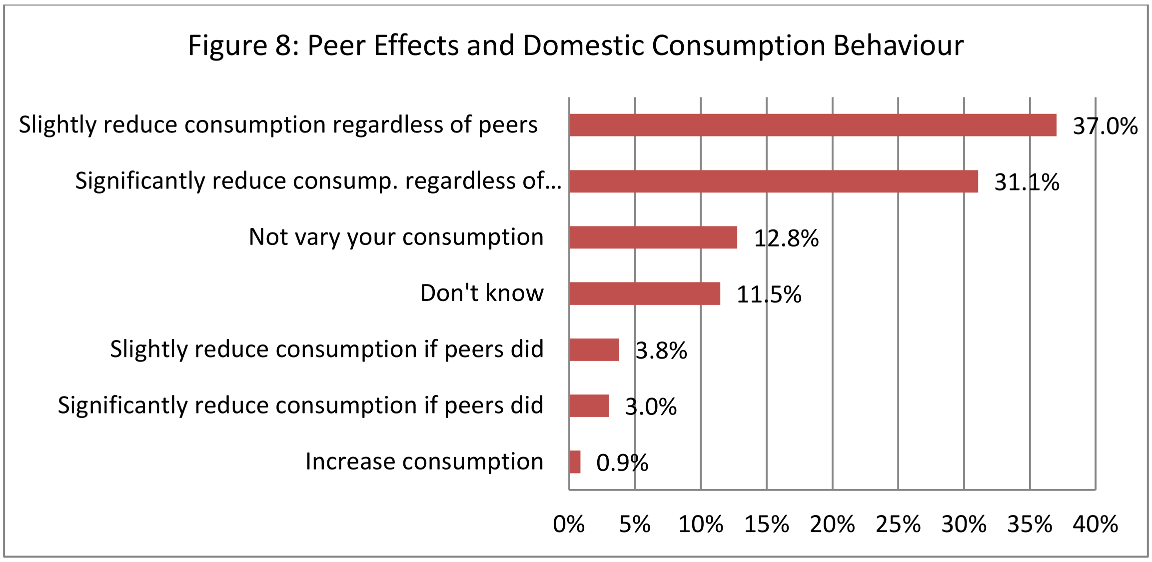


Source: EPRG Survey of UK Households 2013

To further examine the influence of peers on energy consumption behaviour, respondents were asked how their consumption behaviour would change considered what others have done, under the following scenario:

Consider the following situation that might arise in a future electricity system with a large amount of renewable electricity sources (such as wind power). It is announced that in three days time, between 3pm and 8pm, there is a risk of power outages due to an expected combination of cold weather and low wind speeds. All domestic electricity consumers are being asked to voluntarily reduce their electricity consumption during this period. Would you?...

Figure 8 presents the share of respondents according to the responses to the question. Peer effects seem less important in consumers' consumption behaviour based on their stated preferences. Just between 3% and 4% of the respondents would condition their consumption behaviour on what their neighbours/friends/colleagues might have done (Figure 8). This is significantly less than between 31% and 37% majority who chose to effect change in consumption regardless of the behaviour of their peers.



Source: EPRG Survey of UK Households 2013

Table 6 presents the share (%) of respondents taking into consideration the influence of peers in consumption decisions. All else being equal, male and younger respondents are more likely to voluntarily reduce their energy consumption only if others would be doing the same. In other words, they are more likely to base their consumption behaviour on what others would do. Similarly, lower income respondents also are more likely to reduce their energy consumption only if others would do the same. However, no monitor holders are less likely to base the decisions to voluntarily reduce their energy use on what others would do. In other words, they are more likely to voluntarily reduce their energy consumption regardless of what other would do.

Table 6: Peer Effects by Education, Gender, Age, Home Ownership, Payment of Bill, Income, and Monitor Ownership

	Share (%)	T-test
No bachelor degree	9.22	0.140
Bachelor degree or higher	8.98	
Male	11.47	2.568**
Female	7.10	
Age 18-49	11.45	3.021***
Age 50 & over	6.31	
Rent	9.39	0.346
Own	8.70	
Not responsible for bill	7.41	-0.674
Responsible for bill	9.17	
Income per capita £7500 or less	13.81	2.093**
Income per capita £24000 or more	7.05	
No Monitor	7.98	-2.388**
Have Monitor	12.78	
Conservative	10.66	0.218

Labour	10.07
Overall	**9.10**

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

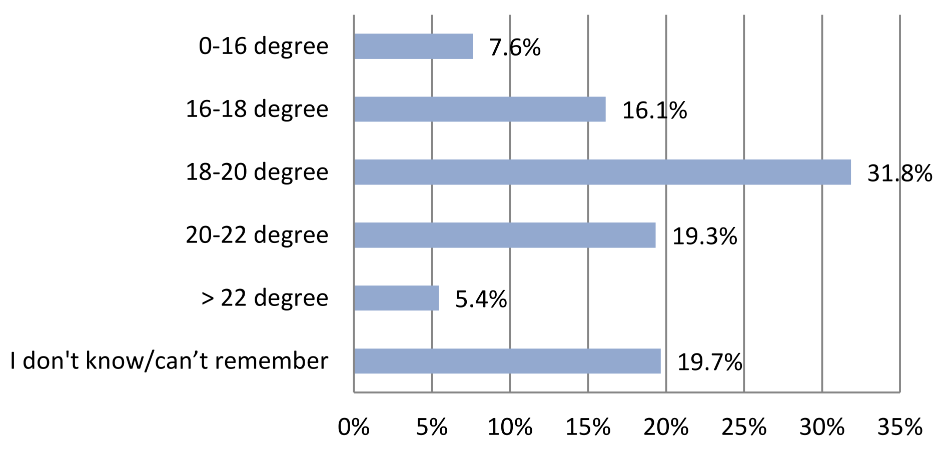
4.4. Change in Energy Consumption Behaviour, Motives & Information Sources

4.4.1. Conscious Change in Electricity Usage

The choices that people make – to consume certain products and services rather than others or to live in certain ways – all have direct and indirect impacts on the environment. However, sometimes people may feel they are 'locked in' to unsustainable consumption patterns and unable to exercise choice about what to consume or not. Consumer 'lock-in' can occur because of existing incentive structures that discourage behaviour change, institutional barriers, inequalities in access, social norms, expectations, and limited choices (Jackson, 2005).

In the 2013 EPRG survey, respondents were asked to indicate the temperature they normally set their thermostat during the winter, if they had ever consciously changed their energy use, the reasons for their behaviour change, and the source of the necessary information that helped them changed their energy use. Figure 9 shows the shares (%) of respondents based on the level they normally set their thermostats. Most of the respondents (32%) set their thermostat between 18-20^{0}C during the winter.

Figure 9: On average, what temperature (^{0}C) do you set your thermostat in your home during winter?



Source: EPRG Survey of UK Households 2013

Around 57% of the respondents indicated that they had consciously changed their energy use, while 5% stated they could not remember doing so and 38% said they had never consciously changed their energy use (Table 7). While gender, monitor ownership, and income do not play significant roles in consumption behaviour change, younger respondents (aged 18-49), less educated respondents, respondents living in rented houses, and those who are not responsible for the payment of the electricity bill, are less likely to have consciously changed their energy use compared to others. While the respondents who have changed their energy use are not different by the frequencies of laundry activities, those who indicated setting their thermostat at 20^{0}C or less and those who do cook more regularly, are likely to have changed their energy consumption behaviour.

Table 7: Conscious Change in Energy Consumption Behaviour

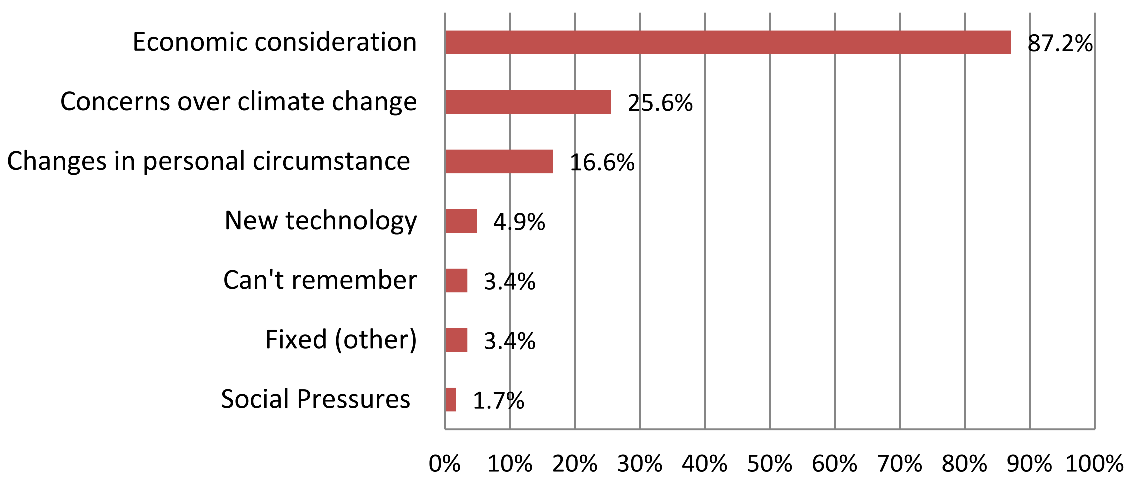
	Share (%)	T-test
Yes	57.14	
No	37.81	
Can't remember	5.05	
Change in consumption by:		
Monitor holders	63.03	1.204
Non-Monitor Holders	59.34	
No bachelor degree	56.44	-3.154***
Bachelor degree or higher	64.56	
Male	58.55	-1.230
Female	61.71	
Age 18-49	56.61	-2.974***
Age 50 & over	64.25	
Rent	54.14	-2.929***
Own	62.98	
Not responsible for bill	39.23	-6.345***
Responsible for bill	63.56	
Income per capita £7500 or less	64.63	1.050
Income per capita £24000 or more	59.89	
Setting thermostat at 20^{0}C or less	65.64	3.526***
Setting thermostat at more than 20^{0}C	59.92	
Doing cooking regularly	61.72	2.427**
Doing cooking occasionally or never	52.94	
Doing personal laundry regularly	60.86	0.873
Doing personal laundry occasionally or never	58.22	
Overall	**60.18**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

4.4.2. Why People Consciously Change their Energy Use Behaviour

Understanding the main drivers of behaviour change required to formulate effective policy to achieve greater demand side response. In the 2013 EPRG survey, respondents who indicated they changed their consumption behaviour were asked to provide the reasons for their actions. Figure 10 presents the shares (%) of respondents according to the stated reasons for behaviour change in energy consumption. Change in energy consumption behaviour is largely driven by economic considerations, i.e., motives to save money (87%). The second and the third most commonly cited drivers of behaviour change were concerns over climate change and change in personal circumstances (e.g. job loss, new baby, etc), which account for 26% and 17% respectively. Surprisingly, only around 5% of the respondents chose new technology such as smart meters/electricity monitors as a factor that motivated their behaviour change. Peer influence is the least important factor cited as driving changes in individual consumption behaviour.

Figure 10: Reason for changing consumption behaviour



Source: EPRG Survey of UK Households 2013

Table 8 reports the statistical analysis of the reasons for changing behaviour by respondents' demographic profiles focusing on the three major reasons offered. While gender and home ownership do not play a significant role in listing economic considerations as a driver for changes in energy use, age and the responsibility for the payment of energy bills do contribute significantly. Younger respondents and those that are not responsible for energy bills are less likely to offer economic reasons for their changes in energy consumption. Interestingly, both respondents are more likely to claim to be more concerned about climate change. Furthermore, younger respondents are likely to cite changing personal circumstances (e.g., job loss) as a reason for their behaviour change than older respondents. This suggests that young people are more concerned about climate change than economic gains when making decisions about energy usage. The implication of this finding is that energy saving awareness programmes directed at youths should not only focus on economic gains, but on environmental benefits as well. Although education does not play a significant role in listing economic consideration as a driver of change, less educated respondents are less likely to have changed their energy use behaviour due to environmental concerns.

Respondents living in a rented accommodation are more likely to change consumption behaviour for both change in personal circumstances and environmental benefits. Surprisingly however, while income does not play a significant role in citing economic reasons for behaviour change, low income respondents are less likely to have changed their energy use due to environmental concerns. Similarly, respondents who self-identified as supporting the labour party are more likely to state environmental reasons for their behaviour.

Table 8: Reasons Cited for Behaviour Change and Socio-Demographic Variables

Category	Share (%)	T-test
Economic Reason by:		
No bachelor degree	87.33	0.156
Bachelor degree or higher	86.98	
Male	87.83	0.565
Female	86.55	
Age 18-49	84.67	-2.204**
Age 50 & over	89.65	
Rent	88.78	0.884
Own	86.32	
Not responsible for bill	74.65	-3.336***
Responsible for bill	88.36	
Income per capita £7500 or less	85.07	0.781
Income per capita £24000 or more	81.65	
Conservative	88.52	-0.429
Labour	89.86	
Overall	**87.16**	
Environmental Concerns by:		
No bachelor degree	19.00	-4.556***
Bachelor degree or higher	32.33	
Male	24.09	-0.949

Female	26.90	
Age 18-49	34.78	6.385***
Age 50 & over	16.32	
Rent	33.16	2.953***
Own	22.64	
Not responsible for bill	46.48	4.267***
Responsible for bill	23.65	
Income per capita £7500 or less	21.39	-2.084**
Income per capita £24000 or more	32.11	
Conservative	18.03	-2.175**
Labour	27.19	
Overall	**25.57**	
Change in Personal Circum:		
No bachelor degree	17.42	0.637
Bachelor degree or higher	15.81	
Male	16.06	-0.426
Female	17.14	
Age 18-49	18.99	1.881**
Age 50 & over	14.25	
Rent	22.45	2.662**
Own	14.36	
Not responsible for bill	15.49	-0.277
Responsible for bill	16.77	
Income per capita £7500 or less	21.39	1.233
Income per capita £24000 or more	15.60	
Conservative	14.21	0.110
Labour	13.82	
Overall	**16.62**	

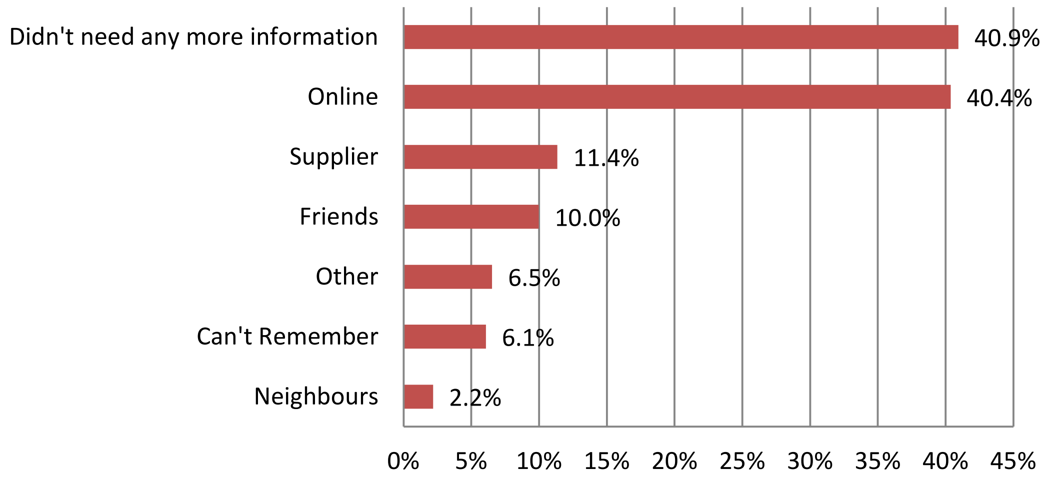
Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

4.4.3. Sources of Information for Energy-Saving Advice

Providing energy-saving advice may be one of the most effective means of encouraging energy efficiency. However, not all information sources can perform equally effectively, and different information sources may be perceived with different levels of trust by consumers. The effectiveness of information feedback depends on its frequency, duration, content, medium of presentation, social comparisons and combination with other interventions (Fischer, 2008). A study by Devine-Wright & Devine-Wright (2004) has shown that when identical letters were presented to consumers from the energy company, from a local authority, and from a local authority co-sponsoring an energy company, the letter from the local authority alone had a 25% higher effect in promoting energy efficiency.

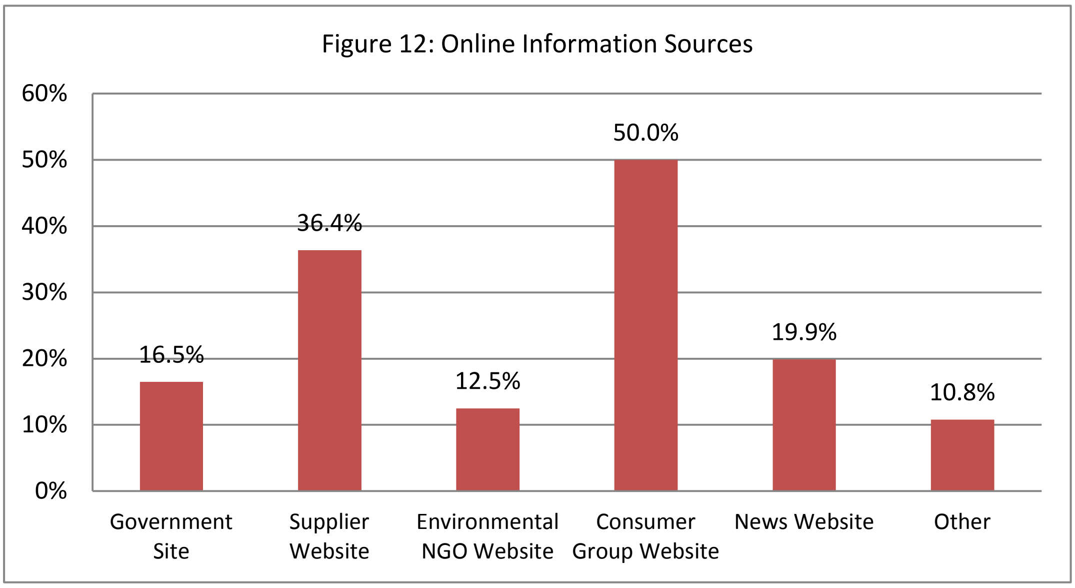
The leading official public provider of energy-saving advice to households in the UK is the Energy Saving Trust (EST). Some other sources include interactive websites, such as "Act on CO_2 calculator" – part of the government's Climate Change Communications Initiative – and "Big Green Switch" (Defra, 2008b). Other sources of energy-saving advice include energy suppliers and non-governmental organisations. Figure 11 reports the share of respondents who had changed their energy use according to the source of the necessary information that helped them change their behaviour. Around 40% of the respondents got information that helped them changes their energy consumption behaviour from the Internet, whereas 11% were provided the necessary information/advice by their energy suppliers. The impact of peers (i.e., neighbours) as information source for behaviour change is very low, representing just 2%.

Figure 11: Sources of Information for Behaviour Change



Source: EPRG Survey of UK Households 2013

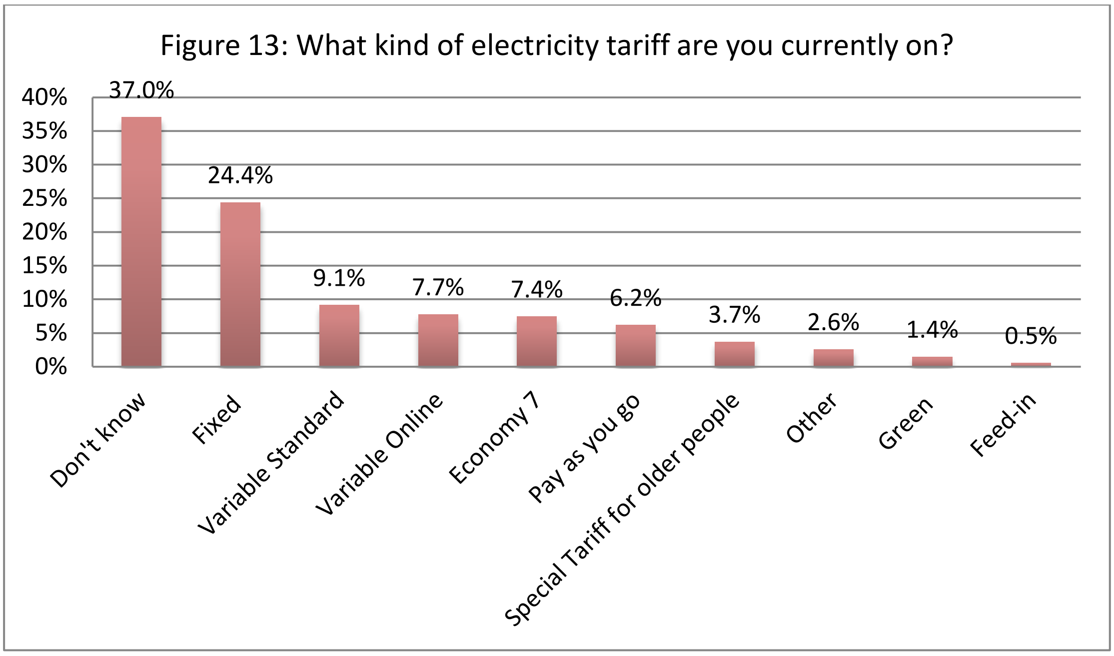
Figure 12 presents the sources of online information that helped consumers change their energy consumption behaviour. Consumer group and supplier websites are the most popular online information sources, representing 50% and 36% respectively.



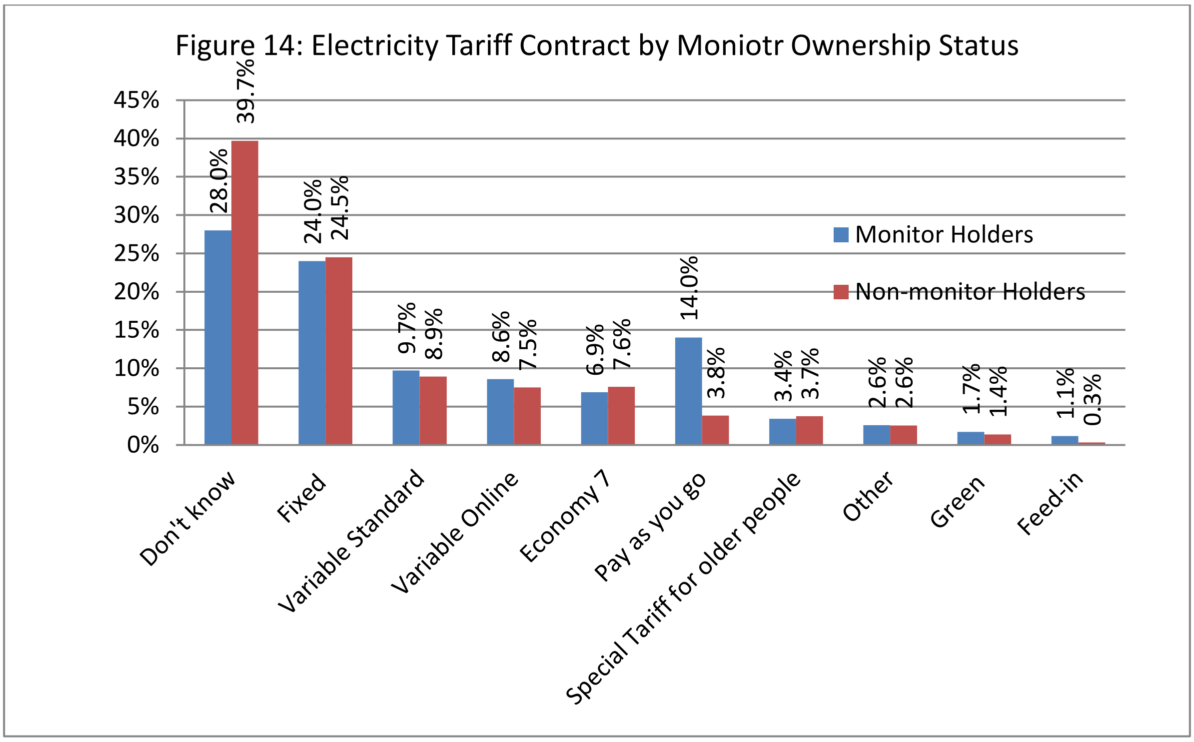
4.5. Payment Method and Frequency

How customers pay their bills may impact their energy consumption behaviour. The 2013 EPRG survey asked respondents a series of questions relating to the method they currently use to pay for their electricity consumption, whether they had changed their payment method since installing electricity monitor, the new method they changed to, their current electricity tariff contract, and the frequency with which they pay their bills. Having monitor does not seem to have influenced the choice of payment method. Just 6% of the electricity monitor householders had changed the method for paying their bills since they have had electricity monitor installed. The majority of those who had changed their payment method had changed from Standard Credit.

Figures 13&14 show the shares of respondents according to the type of electricity tariff contract they are currently on. Fixed contract, where a household pays a flat tariff rate regardless of time of the day or changes in provision costs, is the most popular utility contract as reported by the respondents. Utility contracts such as Economy 7 designed to compensate consumers based on time of use, or Variable standard which depends on provision costs, are less popular choices among the respondents. Less than 10% of respondents claim to be currently on each of these contracts (Figure 13). Even among the monitor households, ‘’Fixed tariff” contract is still the most popular choice, representing about a quarter of the monitor holder respondents (Figure 14).



Source: EPRG Survey of UK Households 2013



Source: EPRG Survey of UK Households 2013

The payment of electricity bills varies across respondents. Just less than half of the respondents (roughly 48%) pay their bills jointly with other members in their houses, whereas 38% are solely responsible for the payment of their bills. Just below 60% of respondents settle their bills monthly whereas roughly a quarter of them pay quarterly.

Table 9 presents the share of respondents that did not know their current tariff contract by education, gender, age, housing ownership, the responsibility for the payment of the bills, income, monitor ownership status, and payment method. Surprisingly, respondents who did not know their tariff contract are less likely to be on direct debit. Younger respondents, respondents living in a rented accommodation, those who are not responsible for the payment of their bills, and non-monitor holders are more likely to be ignorant of the tariff contract they are currently on.

Table 9: Share of Respondents that did not know their Tariff Contract

	Share (%)	T-test
No bachelor degree	37.08	0.050
Bachelor degree or higher	36.96	
Male	35.71	-1.024
Female	38.24	
Age 18-49	44.18	6.425***
Age 50 & over	28.43	
Rent	42.34	3.340***
Own	32.75	
Not responsible for bill	72.82	12.239***
Responsible for bill	30.67	
Income per capita £7500 or less	33.84	-0.711
Income per capita £24000 or more	36.96	
No Monitor	39.71	4.001***
Have Monitor	28.00	
Direct Debit	30.74	-2.954***
Standard Credit/Prepayment	39.62	
Overall	**37.02**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

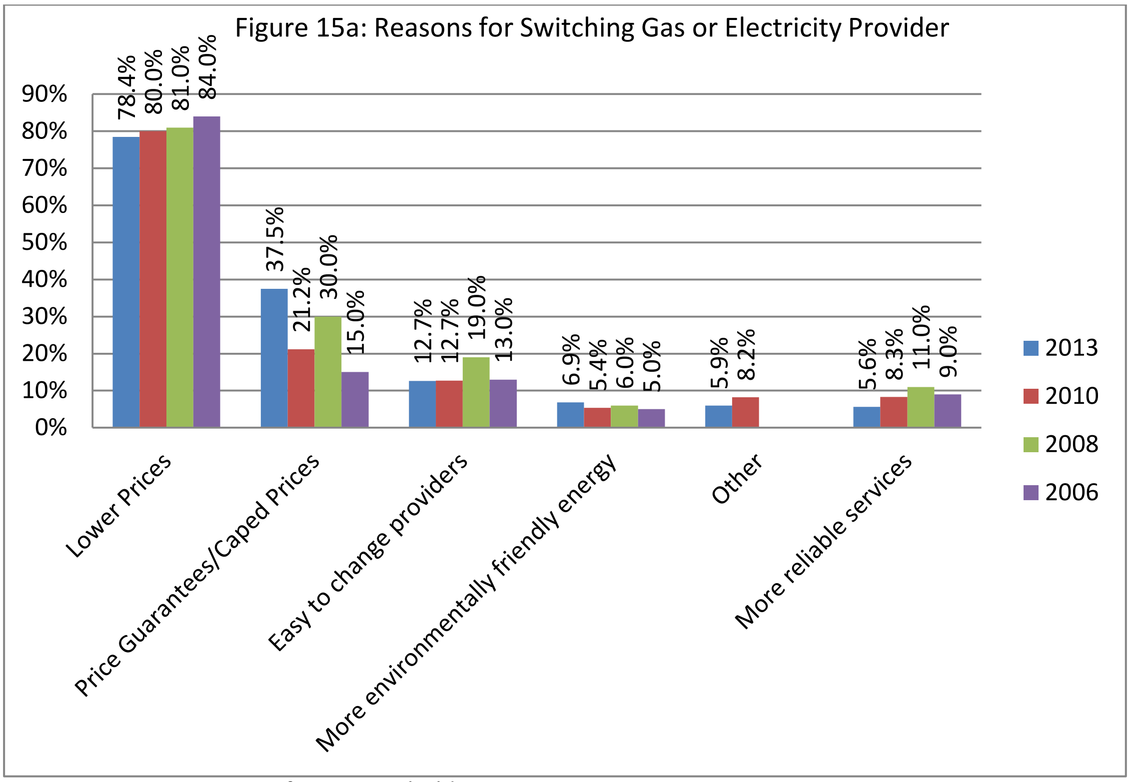
4.6. Utility Contracts and Metering Information

4.6.1. Supplier Switching Information

Since 1999, it has been possible for the UK residents to change suppliers of domestic energy (electricity and gas) without moving home. The 2013 EPRG survey (like previous ones) included questions on consumer switching behaviour and reasons for switching or not switching suppliers (Figure 15a and 15b). In 2013, around 42% of respondents reported having changed electricity or gas suppliers during the previous five years without moving homes. It is interesting to note that the share of respondents that reportedly having switched suppliers during the previous five years in the EPRG surveys of 2006, 2008 and

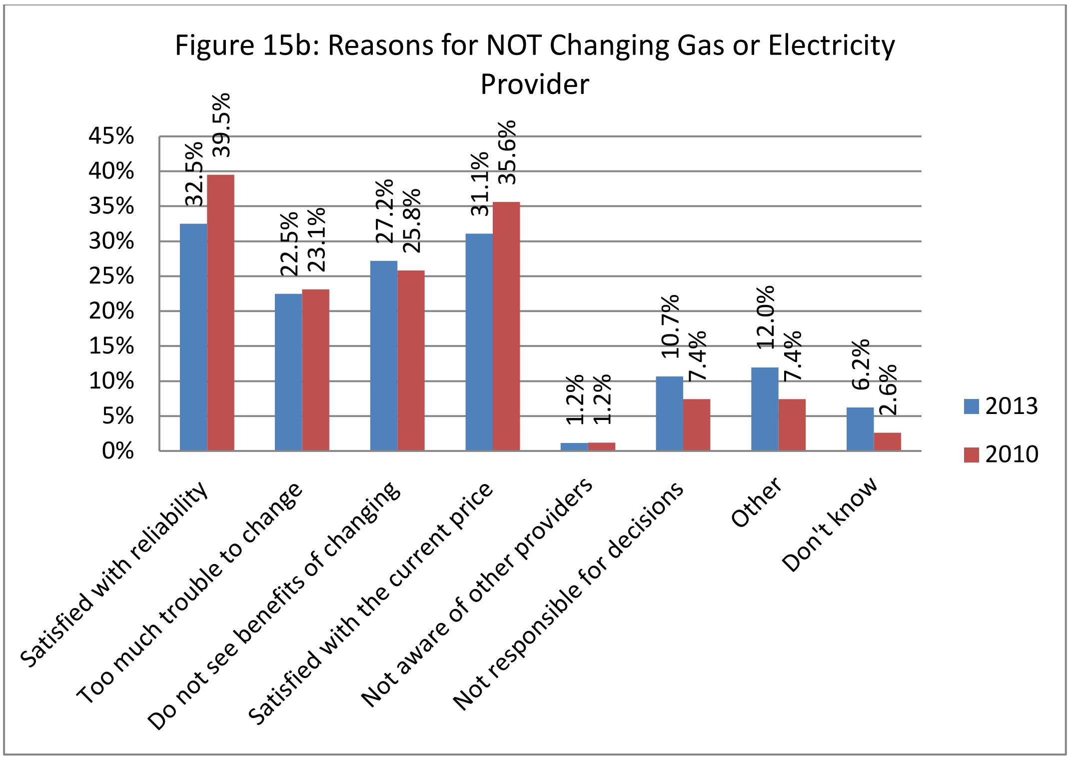
2010 were respectively 48%, 52%, and 47%. This suggests that the higher and peak electricity prices in 2008 encouraged more customers to be proactive and switch suppliers, and, since then, incidence of switching has continued decreasing, despite that the current electricity price being higher than the peak price of 2008.

Although the reason for switching cited most often in the 2013 EPRG Survey, as in previous surveys, was price-related, the pattern or the distribution of the responses was different. While those citing lower prices as a reason for switching declined slightly, capped prices increased significantly as an explanation. Around 78% of respondents in the 2013 survey cited lower prices as the reason for switching continuing a slow decline from 84% in 2006. However, around 38% of the respondents in 2013 cited capped prices as the reason for switching, the highest level observed thus far, higher even than in 2008 at a time of great economic uncertainty (Figure 15a).



Source: EPRG Survey of UK Households 2006, 2008, 2010, 2013

Reliability concerns dominate the reasons for respondents not to have switched their suppliers. Around 33% of respondents in the 2013 EPRG survey stated that their satisfaction with the reliability of supply from their current firm led them to stay put (Figure 15b). This reason is followed by customer satisfaction with the current price charged by their utility provider. It is interesting, however, to note that reliability concern and customers' satisfaction with current tariff as the reasons for not changing providers have gone done compared to 2010. The share of respondents that did not change their utility suppliers because they were satisfied with reliability and price were 40% and 36% respectively in the 2010 EPRG survey as against 33% and 31% in 2013, which implicitly reflects a decline in overall satisfaction with their current electricity provider (Figure 15b).



Source: EPRG Survey of UK Households 2010, 2013

The rate of switching is not statistically significantly different by gender, and less statistically significant (only at 10%) by income and smart monitor ownership. Younger respondents are less likely to have switched suppliers during the five years preceding this survey, reflecting a belief that it is too difficult to switch, and also lack of awareness of alternative suppliers in their areas. In the 2013 EPRG survey, 63% of the respondents who cited 'too much trouble to change' suppliers are younger respondents aged 18-39 years. Similarly, all of those who cited a lack of awareness of other providers as a reason to not have changed suppliers are younger respondents; although this is only 1% of the total. Similar to the 2013 EPRG survey, low levels of switching among young adults was reported in the 2010 EPRG survey.

Respondents who live a rented house and those that are not responsible for the payment of their bills are less likely to have switched their suppliers. Respondents who had previously complained about their bills in general and, in particular, those who had previously complained about the bill for being too high are more likely to have switched energy suppliers in the previous five years (Table 10). Also, respondents from households that have lower monthly bills have a higher switching rate. However, any causal interpretation warrants caution. It is possible that households that have lower bills had been able to secure lower tariff rates after they changed suppliers. In other words, it is also possible that lack of proactive action to seek out a better gas or electricity tariff were responsible for higher bills. A study of consumer switching behaviour by Wilson & Waddams Price (2007) found that 50% of consumers have not switched suppliers, even if they could have reduced their energy costs by doing so. Customers sometimes exhibit inertia, are prone to computation errors, face confusing information from suppliers, and may value non-monetary aspects of energy service – i.e., reliability (Patchkov and Pollitt, 2011).

Table 10: Share of Respondents (%) That Have Switched Suppliers within Last Five Years without Moving to Other Home, By Category

Category	Share (%)	T-test
No bachelor degree	45.16	-0.218
Bachelor degree or higher	45.74	
Male	46.05	0.451
Female	44.85	
Age 18-49	41.51	-3.069***
Age 50 & over	49.63	
Having In-House Monitor	49.37	-1.608*
Did NOT have In-House Monitor	44.27	
Rent	34.21	-5.542***
Own	51.51	
Not responsible for bill	30.92	-3.826***
Responsible for bill	47.21	
Income per capita £7500 or less	40.65	-1.702*
Income per capita £24000 or more	48.59	
Monthly Bill £39 or Less[10]	50.47	2.674***
Monthly Bill £80 or more	39.84	
Have complained about bill	53.72	3.833***
Did NOT complain about bill	42.09	
Complained about Bill for being too high	52.61	2.632***
Complained about Bill for other reasons	43.73	
Overall	**45.42**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

[10] Around 28% of respondents have monthly electricity bills of £39 or less, while 17% of respondents have monthly bills of £80 or more.

4.6. Concerns about Smart Technology

4.6.1. Smart Metering and Consumers' Concerns

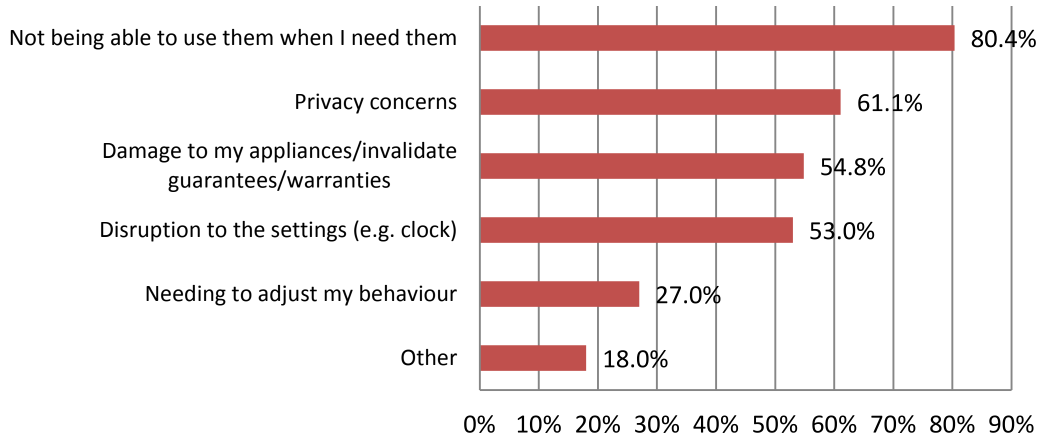
As noted, the UK Government has committed to rolling out smart meters and monitors to all households by 2020. Unlike traditional meters which display consumption in kWh and record consumption cumulatively, smart meters are capable of recording and displaying real-time, or near-real-time, energy consumption. Smart meters make it technically possible for energy consumption to be remotely recorded by the energy provider or a third party. One advantage of smart technology is that real-time recorded information may help in devising tariffs better suited for the energy usage patterns. Smart meters could also make it possible for demand to be better measured, monitored and managed, especially by the advanced smart meters that are capable of recording consumption data in disaggregated form by appliances.

There has been increasing awareness of smart technology as a potential tool for energy savings. For instance, there has been large scale deployment of electricity smart meters and monitors in Italy, Sweden, Ontario and Northern Ireland. Also, pilot trials have also intensified in other countries, including the UK. However, the extent of potential savings made possible by this technology is still unclear. A survey of international studies shows that real-time displays made possible by smart meters result in average reduction of 10% in energy consumption (DECC, 2009a). However, the final analysis of a large-scale Energy Demand Research Project involving some 18,000 smart meters households in the UK observed no statistically significant savings from standalone smart energy monitors (SEMs) and only 3% savings from SEMs when they were accompanied by smart meters (Ofgem, 2011).

Tapping in to potential savings from the smart meters in the EU will also depend on the extent that policy makers can overcome the barriers to deployment and adoption (Faruqui et al., 2010). One potential barrier is the privacy concerns expressed by consumer groups (US Department of Commerce, 2010; Krishnamurti et al., 2012). Privacy concerns have affected the deployment and installation of smart meters in some other countries. For instance, in 2008, the Dutch Government proposed to make smart meters mandatory for all Dutch homes. However, due to the possible violation of consumer privacy as enshrined in the Dutch Data Protection Act, the government had to reconsider its proposal and instead made the adoption of smart meters voluntary (Cuijpers and Koops, 2012).

The 2013 EPRG survey included questions that assessed consumers' concerns regarding possible remote control of their appliances by their local utility, the nature of their concerns, as well as their attitudes towards providing access to the recorded consumption information. Just over half (53%) of respondents had concerns regarding remote control of their appliances, whereas just less than a quarter respondents (22%) stated to not have concerns about remote controlled technology. 'Not being able to use the appliances' when they are needed top the major concerns by respondents, representing around 80%. However, need to adjust behaviour accounts for 27% (Figure 16).

Figure 16: What are your major concerns regarding remote control of your appliances? tick all that apply to you

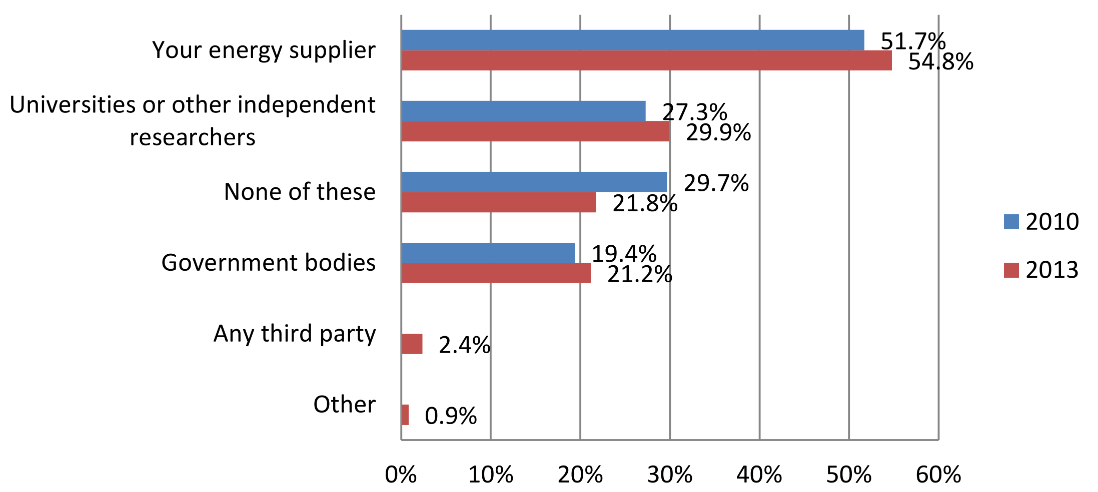


Source: EPRG Survey of UK Households 2013

To examine the extent of concerns due to privacy, respondents were asked to indicate the organisation they would agree to share their energy consumption data with. While over half of respondents (55%) would agree to have their consumption data recorded by their energy suppliers, they are more wary of having the data available to other entities. Only around 21% would agree to have the data recorded centrally by a government agency or institution, while around 30% would agree to have the data recorded by independent institutions for research purposes (Figure 17). Less than 3% would agree to share their consumption data with any third party, whereas 22% would not want their consumption data recorded at all.

Since 2010, the public attitudes towards making their energy consumption data accessible to third parties have not changed significantly other in terms of total opposition to sharing data. Similar to the 2013 survey, the 2010 EPRG survey found that slightly over half of respondents would agree to have their data recorded by their utility providers, this proportion only increased by 3% between 2010 and 2013. Similarly, support for having the data recorded by government bodies or research institutions rose by less than 3%. The one significant change in consumer attitudes towards data accessibility was the decrease in the proportion of respondents who would not want their data to be recorded at all, falling from 30% in 2010 to 22% in 2013. This might reflect rising consumer confidence and trust in policy makers' and other stakeholders' ability to protect their (consumers') privacy.

Figure 17: Which of the following would you agree to share your energy consumption data with?



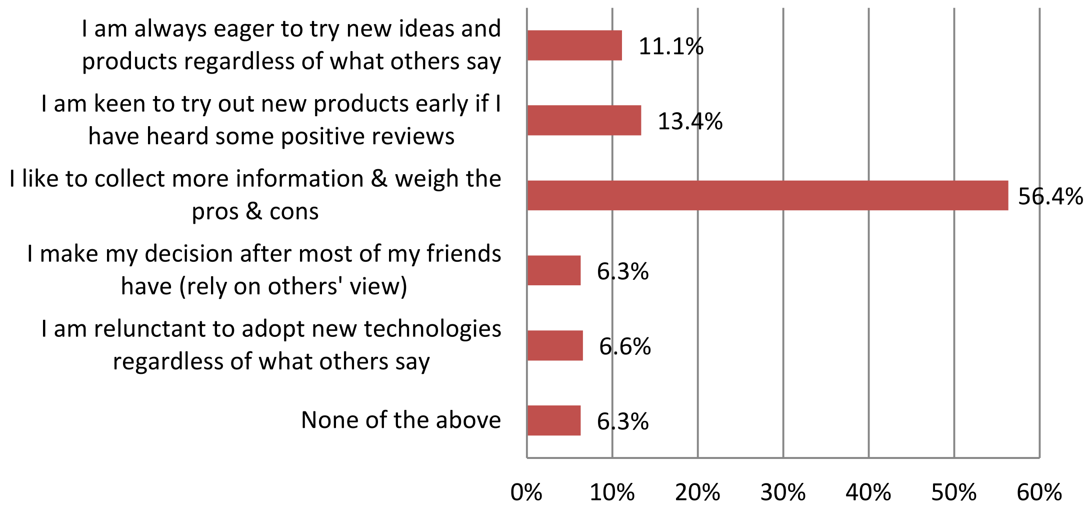
Source: EPRG Survey of UK Households 2010, 2013

4.6.2. Perceived Attitudes towards New Technology

Motivation to adopt new technologies can play a significant role in individuals' attitudes towards the adoption of smart energy devices. People often form attitudes and intentions toward trying to learn to use new technology prior to initiating efforts directed at using it. This attitude can however differ from one individual to another. Some may always be eager to try new ideas and products; some may like to collect more information before trying new products, while some may be reluctant to adopt new products. Understanding the technology readiness of people is important in technology adoption. Technology readiness is the people's tendency to embrace and use new technologies for accomplishing goals in home and at work (Parasuraman, 2000). Parasuraman and Colby (2001) have suggested that how new technology products are marketed to individuals should depend on their techno-readiness.

Technology product adoption differs from other product adoptions due to varying levels of optimism about technology, tendency to innovate, discomfort with technology and inherent insecurity (Parasuraman and Colby, 2001). The 2013 EPRG survey explored people's subjective perception of their own attitudes towards new technologies. Around 56% of the respondents stated that they always like to collect and analyse more information about a new product in order to weigh its costs and benefits before making decision about its adoption (Figure 18). This suggests that the provision of adequate information about smart technology or energy monitors as a potential energy-saving device can influence people's decision about its adoption.

Figure 18: Which of the following BEST describe your typical reaction to new technologies?



Source: EPRG Survey of UK Households 2013

Table 11 presents the share of respondents that expressed concerns over remote control of their appliances, and those that would not want their consumption data recorded, according to education, gender, age, in-house electricity monitor ownership, house type, etc, and type of concern expressed regarding the remote control of their appliances by the local utility. While male and female respondents do not differ significantly in their acceptance of remote control technology, younger respondents are less likely to have concerns. Those owning a smart monitor and living in a flat are less likely to have concerns about the proposed technology. Finding that those that did not have a monitor installed in their homes had concerns regarding remote controlled technology is not surprising, because these concerns might have been responsible for them not adopting electricity monitors in the first place. Furthermore, respondents who live in a rented house and those who are not responsible for the payment of their bills are less likely to express concerns for the proposed technology. However, respondents who are always eager to try a new product and those who self-identified their jobs to be highly technical are more likely to express concerns for remote control technology. It is surprising that respondents in highly technical jobs would still express more concerns for the proposed technology.

Male respondents and older respondents are more likely to oppose having their consumption data recorded. This further confirmed the findings in the 2010 EPRG survey, that female and younger respondents were likely to be less resistant to having their consumption data recorded. Unsurprisingly, respondents that listed privacy as the major concern regarding remote controlled technology and those who are not eager to try new technology, are more likely to oppose having their consumption data recorded. Interestingly, respondents that had in-house monitors were not significantly different from those that did not have monitors in their attitudes towards recording energy consumption data, despite having fewer concerns about the proposed technology. Interestingly, respondents who are not responsible for the payment of their bills and low income earners are more likely to oppose having their consumption data recorded.

Table 11: Shares of Respondents (%) That have Concerns and That Would Not Want Their Data Recorded, by Category

	Category	Share (%)	T-test
Have Concerns about Technology:	No bachelor degree	68.37	-1.722
	Bachelor degree or higher	73.00	
	Male	68.95	-1.211
	Female	72.20	
	Age 18-49	64.98	-4.627***
	Age 50 & over	77.35	
	Rent	65.12	-2.618**
	Own	73.10	
	Did NOT have monitor	71.51	1.287*
	Have a Monitor	67.42	
	Not responsible for bill	63.40	-2.093**
	Responsible for bill	71.67	
	Income per capita £7500 or less	68.48	-1.035

	Income per capita £24000 or more	73.43	
	Engage in low technical job[11]	68.74	-2.494**
	Engage in high technical job	76.69	
	Not eager to try new product	73.60	5.011***
	Always eager to try new product	52.67	
	Overall	**70.56**	
NOT want Data Recorded			
	No bachelor degree	23.21	1.511
	Bachelor degree or higher	20.00	
	Male	23.26	1.361*
	Female	20.38	
	Age 18-49	19.81	-2.024**
	Age 50 & over	24.10	
	Rent	18.44	-1.360
	Own	21.77	
	Have a Monitor	23.71	1.011
	Did NOT have Monitor	21.17	
	Mention Privacy as Concern	31.53	6.523***
	Did NOT mention privacy as concern	17.02	
	Not responsible for bill	32.52	3.958***
	Responsible for bill	20.29	
	Income per capita £7500 or less	22.05	1.719*
	Income per capita £24000 or more	15.76	
	Engage in low technical job	23.04	1.556
	Engage in high technical job	19.06	
	Not eager to try new product	22.94	3.333***
	Always eager to try new product	11.76	
	Overall	**21.75**	

Note: Two-sided T-test significance levels indicated by *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

4.7. Willingness to Accept Appliance Usage Interruption and Changes in Usage for Load-Shifting

The two principal policy objectives of demand side management (DSM) are to reduce demand for electricity and to shift ‘peaks’ in energy demand. The former is motivated by environmental imperatives such as limiting carbon emissions, while the latter is enthused by a desire to ensure technical and economic efficiencies in generation networks. Demand side management practices typically combine both technical and economic strategies to influence demand in order to achieve the desired policy objectives. In the domestic sector, DSM can include direct load control appliances that are programmed to be switched on or

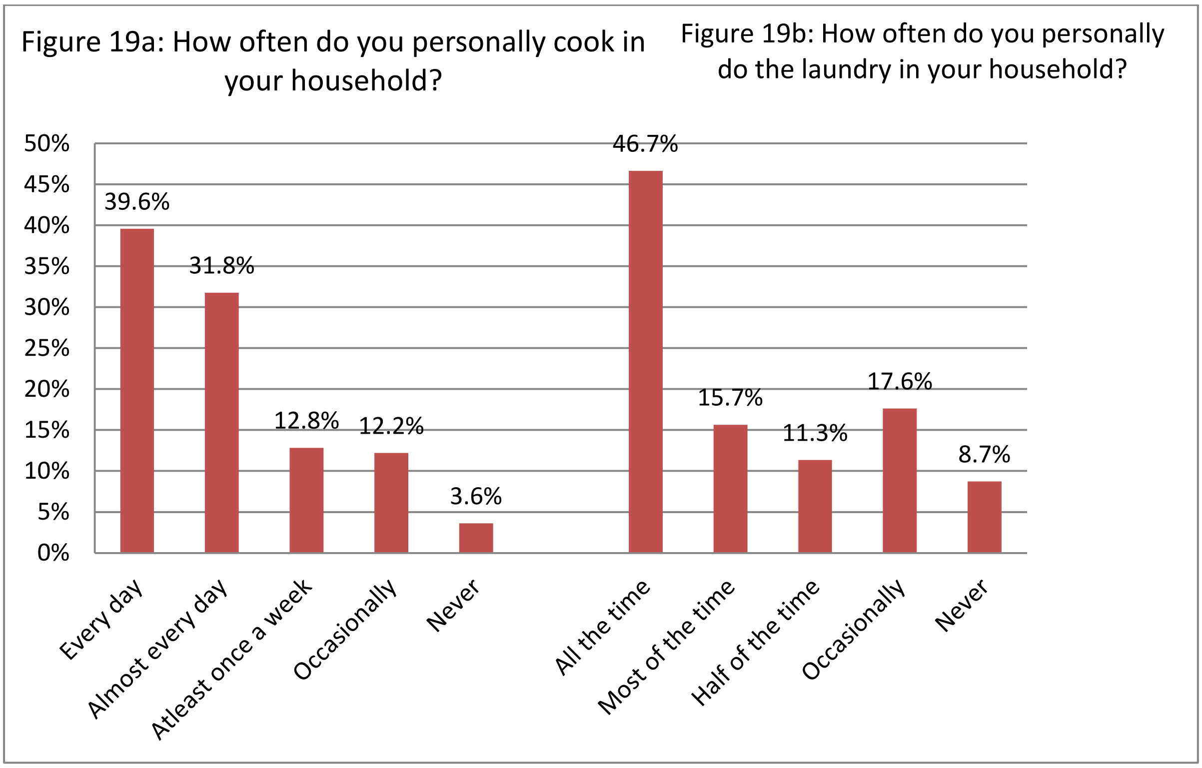
[11] Engage in high technical job refers to respondents who self-identified their jobs as professional/highly technical jobs, while low technical jobs are those who fall under managerial/senior administrative jobs, clerical, sales/services, etc.

off to match pricing information and/or consumer preferences, or real-time price information or financial incentives for using appliances during peak- or off-peak hours of the day. One typical way to stimulate demand response especially by load shifting is through financial incentives, such as time of use (ToU) tariffs, which encourage users to postpone some activities to other hours. Although some economic incentives – including ToU tariffs (e.g., Economy 7) – aim to encourage load shifting are currently operated in the UK electricity market, these types of financial inducements are still limited (Ofgem, 2010).

Load shifting aims to smooth out the demand by shifting load from peak hours to other times of the day, when electricity networks are less constrained and generation costs are lower. Even a modest demand response leading to a marginal decrease in peak demand could have significant technical and economic benefits for electricity markets and networks. Estimates are that between 6% and 37% of household peak electricity demand in the UK (i.e., 1 GW-6 GW of the total domestic peak demand of 17 GW) could be shifted (IHS Global Insights, 2009). This load shifting is valued at between £60m and £90m per annum, due to lower fuel costs, fewer EU ETS allowances needed, and deferred infrastructure investments (IHS Global Insights, 2009). Shifting loads would mean less generating capacity will be required to ensure adequate supply during peak demand times. Thus, a sustainable change in demand over time would limit capacity requirements and reduce investments needed to ensure adequate and reliable energy supply (Defra, 2008b).

Shifting loads to the times when supply is less costly might require significant behavioural changes in consumption patterns of users (Hong et al., 2011). Faruqui and Sergici (2010) have surveyed empirical evidence from 15 load-shifting pilot programmes in the US. The study finds that households respond to higher prices through usage reduction, and that the magnitude of price response depends on the enabling technologies and the associated incentive schemes. Specifically, they find that whereas ToU schemes are associated with an average reduction of 4% in peak usage, Critical Peak Price (CPP) programs result in average peak usage reduction of 17% and range between 13% and 20%. CPP accompanied by enabling technologies (e.g., smart devices) led to a reduction of 36% in peak demand and ranges from 27% to 44%. Their findings suggest that load shifting potential is significantly higher when combining economic incentives with enabling technologies (smart devices), rather than through ToU or CPP tariffs alone.

In order to examine the scope and potential for load shifting in the UK, the 2013 EPRG survey inquired about willingness to accept different hypothetical load shifting scenarios through smart appliances in exchange for a reduction in their total annual electricity bills. Before presenting the hypothetical load shifting scenarios, respondents were first asked about how often they personally cook and do laundry in their home. Figures 19a&b indicate the share of respondents based on the frequency with which they personally perform cooking and laundry activities in their households. Around 40% of respondents cook in their houses everyday, 32% do it almost every day while just about 4% had never cooked (personally) in their households (Figure 19a). For laundry, around 47% of respondents do their laundry in-house all the time, around 16% do laundry most of the time, while about 9% had never washed their clothes personally in their households (Figure 19b).



Source: EPRG Survey of UK Households 2013

In the UK, peak electricity loads occur in the morning from 7- 9 AM, and in the evening from 5-7 PM, when most people are at home and active. During peak periods, wholesale electricity prices rise due to the increasing marginal costs of generating the additional energy required. The increase in prices during peak demand reflects the costs of additional fuel needed to generate electricity from less efficient plants, which in turn require the purchase of more EU ETS allowances to compensate for the increase in CO_2 emissions. With the advent of smart grid technology combined with smart appliances however, it is possible to devise incentives to shift appliance usage from the periods of peak demand to other times when energy usage is lower. Pilot studies have shown that the use of enabling technologies (e.g., smart appliances) that limit user's interventions, has potential for load shifting (Faruqui and Sergici, 2010).

Since 2010, the EPRG surveys have started assessing the potential of load shifting through smart appliances. In the 2010 EPRG survey, respondents were asked if they would accept a 5% discount in their total annual electricity bills in exchange for the following scenarios: run wet appliances longer; interrupt white appliances; preset wet appliances; and limited use of cooker. If they did agree to the initial offer, they were presented with discounts of 2% followed by 1% depending on their responses. If they did not agree to the initial offer of 5%, they would be presented 10% and 20% discounts depending on their responses. However, one potential problem with the way the willingness to accept questions were presented is heuristic judgement bias. Respondents might not be able to devote enough time to work out the actual discount amount in their energy bills before making decisions. To minimise such bias, the 2013 EPRG Survey presented the incentives in absolute terms (in pounds) rather than as percentages.

The 2013 survey presented three hypothetical scenarios of load shifting through smart appliances and dynamic supplier intervention (Table 12). The respondents were first asked if they would accept each of these scenarios (which were presented in random order) if they received an amount £X, a random amount drawn from a uniform distribution over the interval [11, 50]. If they did agree, they were asked if they would be willing to accept a value £(X-10). However, if the respondents did not accept the initial amount £X, they were then offered a higher amount £(X+10).

The first scenario (having cold appliances interrupted) appears to be less disruptive a priori, as it represents the way cold appliances work already, and one would expect that it would have higher acceptance among respondents. The second, and third scenarios (presetting wet appliances to run off-peak hours only and limiting the use of the cookers/hot appliances to 30-minute intervals) are more disruptive, because they restrict the usage of the appliances to specific times. Furthermore, the third scenario was split in two with half being asked to limit their cooker usage 10 times a year and the other half to a less disruptive once a year. The estimated acceptance rates for reduction on annual electricity bill in exchange for appliance usage modification are presented in Tables 13a&b.

Table 12: Hypothetical Load Shifting Scenarios through Smart Appliances

Scenario	Appliance usage modification scenario	Description
1: All sample	Interrupt white/cold appliances	Having cold appliances (refrigerators, freezers) interrupt for 1-to 3 minutes intervals
2: All sample	Preset wet appliances	Having wet appliances (dishwasher, washing machine, tumble dryer) preset to operate only between 9 PM and 7AM
3a: Split sample 1	Limited use of cooker	Having usage of cooker/oven capped, so household would not be able to use it for 30-minute intervals 10 times per year during peak demand spikes.
3b: Split sample 2	Limited use of cooker	Having usage of cooker/oven capped, so household would not be able to use it for 30-minute intervals 1 time per year during a peak demand spike.

Between 32% and 36% of respondents would agree to limited use of cookers/hot appliances for less than a £20 discount on annual electricity bill. The acceptance rate is even higher for cold appliance usage interruptions: half of the respondents would agree to have their cold appliances interrupted in exchange for less than £20 reduction in total annual electricity bill. By contrast, presetting wet appliances have the lowest acceptance rates, probably reflecting the level of inconvenience the restriction would cause the users: only 30% of respondents would agree to preset wet appliances to be used after 9 PM for less than £20 off their electricity bill.

Although comparing the current acceptance rates with the 2010 EPRG survey warrants caution given the differences in the way in which the questions were framed, it is important to point out some similarities or differences in the findings. In contrast to the 2010 EPRG survey where limited use of cookers/hot appliances received the lowest acceptance; presetting wet appliances had the lowest acceptance rates in the 2013 EPRG survey.

One would expect that respondents who had in-house electricity monitors installed in their homes would be more willing to modify appliance usage in exchange for a reduction in bills. Surprisingly, however, acceptance of appliance usage modification in exchange for discounted bills did not vary significantly by respondents' in-house monitor ownership status, except for a one-off limited use of cookers for 30 minutes where monitor householders had significantly higher acceptance rates (Table 13a). Overall and consistently, respondents who had indicated concerns over remote control of appliances had significantly lower acceptance rates. Although doing cooking and laundry more frequently do not significantly affect respondents' acceptance rates, respondents who had claimed to always like to try new technology/products had significantly higher acceptance rates for having white/cold appliances interrupted and for having wet appliances preset to run after 9 PM.

Table 13a: Share of Respondents (%) Willing To Accept Change in Appliance Usage[12]

	Average Reduction in Annual Bill Accepted	Having Monitor	Always eager to try new products	Laundry More frequently	Do Cooking more frequently	Having technology concern	Overall
Interrupt white/cold appliances	£10-£50	55.1 (49.9-60.4)	67.6* (60.5-74.8)	56.9 (53.7-60.0)	56.7 (53.7-59.6)	52.2* (48.6-55.5)	55.1 (52.5-57.5)
	Less than £20	53.7 (41.7-65.8)	65.7* (49.2-82.3)	52.2 (45.3-59.1)	49.6 (43.1-56.0)	46.4 (39.0-53.7)	50.0 (44.6-55.4)
	£20-£30	49.1 (39.6-58.6)	66.7* (53.3-80.1)	53.9 (47.6-60.2)	54.4 (48.7-60.1)	48.8 (42.0-55.6)	51.4 (46.6-56.2)
	£31-£40	52.5 (42.6-62.4)	55.6 (38.5-72.6)	58.3 (51.9-64.3)	57.0 (51.2-62.9)	50.6* (44.5-56.7)	55.7 (51.0-60.4)
	£41-50	62.0 (52.4-71.6)	79.2* (67.2-91.1)	62.4 (56.4-68.3)	64.5 (58.9-70.2)	58.0 (51.5-64.5)	61.2 (56.6-65.8)
	Lower reduction	67.9 (61.3-74.5)	47.0* (37.7-56.2)	34.6* (30.5-38.6)	34.2* (30.4-38.0)	63.9 (59.3-68.5)	65.2 (62.0-68.5)
	Higher reduction	21.0 (14.6-27.4)	27.3 (15.1-39.4)	22.2 (18.2-26.2)	20.1 (16.5-23.8)	14.1 (10.6-17.5)	19.5 (16.6-22.5)
Preset wet appliances	£10-£50	40.0 (34.9-45.1)	48.2* (40.6-55.8)	39.2 (36.1-42.3)	38.5 (35.6-41.4)	30.4* (27.3-33.6)	37.4 (35.0-39.8)
	Less than £20	34.7 (23.8-45.5)	44.7 (28.2-61.3)	30.9 (24.5-37.3)	30.4 (24.4-36.4)	21.1* (15.2-27.0)	29.5 (24.6-34.3)
	£20-£30	32.4 (23.2-41.5)	40.0 (25.9-54.0)	33.5 (27.8-39.1)	33.7 (28.3-39.0)	27.0* (21.2-32.7)	33.9 (29.4-38.4)
	£31-£40	40.2 (30.1-50.3)	56.1* (40.2-72.0)	40.0 (33.9-46.1)	39.3 (33.6-45.0)	34.3 (27.8-40.8)	38.9 (34.1-43.8)
	£41-50	54.3 (43.4-65.3)	53.7 (37.7-69.6)	53.2 (46.5-59.8)	49.8 (43.8-55.8)	39.4* (32.4-46.3)	47.0 (41.9-52.1)
	Lower reduction	60.0 (51.8-68.2)	63.4 (52.8-74.1)	60.1 (55.1-65.0)	57.0 (52.3-61.8)	54.4 (48.2-60.7)	56.6 (52.5-60.6)
	Higher reduction	14.3 (9.5-19.0)	19.3* (10.9-27.7)	9.3 (7.0-11.7)	10.0 (7.7-12.3)	8.8* (6.5-11.2)	10.8 (8.8-12.8)
Limited use of cooker: 30 mins, 10 times	£10-£50	40.1 (32.9-47.4)	47.1 (36.2-57.9)	41.2 (36.8-45.6)	39.6 (35.6-43.7)	33.5* (29.0-38.0)	38.2 (34.8-41.6)
	Less than £20	34.0 (20.6-47.4)	41.7 (20.4-62.9)	36.3 (27.3-45.3)	33.6 (25.5-41.7)	26.0 (17.1-34.9)	31.6 (24.8-38.3)
	£20-£30	39.5 (23.6-55.3)	42.9 (19.8-65.9)	41.9 (33.2-50.5)	43.6 (35.3-51.9)	34.7 (25.1-44.2)	39.9 (32.6-47.2)
	£31-£40	34.8 (20.8-48.8)	68.2* (47.0-89.3)	38.2 (29.0-47.4)	38.6 (30.4-46.7)	34.0 (24.8-43.1)	38.3 (31.4-45.3)
	£41-50	55.3 (39.1-71.4)	33.3 (9.2-57.5)	47.3 (38.7-56.0)	42.3 (34.5-50.1)	37.3 (28.1-46.4)	42.0 (35.1-48.9)
	Lower reduction	56.3 (44.7-68.0)	50.0 (33.8-66.2)	55.3 (48.3-62.2)	54.4 (47.9-61.0)	53.6 (45.2-61.9)	54.7 (49.0-60.4)
	Higher reduction	17.0 (9.8-24.2)	17.8 (6.2-29.4)	15.8 (11.6-20.1)	14.0 (10.3-17.6)	13.3 (9.3-17.3)	15.0 (11.8-18.2)
Limited use of cooker: 30 mins, 1 time	£10-£50	46.2 (38.8-53.7)	58.8 (48.1-69.5)	50.9 (46.3-55.4)	51.1 (46.7-55.4)	43.1* (38.2-48.0)	48.9 (45.3-52.5)
	Less than £20	32.4 (17.0-47.8)	53.3 (24.7-81.9)	33.0 (23.6-42.4)	35.4 (26.4-44.4)	33.7 (23.9-43.5)	36.3 (28.7-43.8)
	£20-£30	45.8 (31.5-60.2)	44.8 (25.6-64.1)	46.0 (37.7-54.4)	48.0 (39.8-56.1)	43.6 (34.3-53.0)	47.6 (40.8-54.4)
	£31-£40	45.2 (29.9-60.6)	70.0 (48.0-92.0)	57.4 (47.9-66.9)	57.9 (49.2-66.7)	43.7* (33.1-54.3)	53.1 (45.7-60.5)

[12] 95% Confidence interval indicated in parentheses. Acceptance rates by category that are significantly different from overall acceptance rates at 95% confidence interval level are indicated by an asterisk (*).

	£41-50	64.3 (49.5-79.0)	71.4 (50.4-92.5)	65.3 (56.7-73.9)	61.4 (52.9-69.8)	54.6 (44.6-64.7)	59.1 (52.0-66.3)
	Lower reduction	73.8* (64.0-83.5)	70.0 (56.8-83.2)	67.2 (61.2-73.2)	67.2 (61.5-72.9)	59.6 (52.2-67.1)	64.6 (59.7-69.5)
	Higher reduction	15.1 (7.7-22.4)	11.4 (0.3-22.5)	12.6 (8.3-16.9)	11.8 (7.8-15.8)	8.0* (4.4-11.5)	12.8 (9.4-16.1)

Table 13b: Share of Respondents (%) Willing To Accept Change in Appliance Usage, by Gender, Age, and Income[13]

	Average Reduction in Annual Bill Accepted	Male	Female	Age 18-49	Age 50 and over	income per capita £7500 or less	Income per capita £24000 or more	Overall
Interrupt white/cold appliances	£10-£50	54 .0 (50.4-57.7)	56.0 (52.5-59.4)	54.1 (50.8-57.5)	56.1 (52.4-59.8)	57.4 (52.0-62.8)	53.3 (46.0-60.5)	55.1 (52.5-57.5)
	Less than £20	45.5 (37.6-53.4)	54.1 (46.6-61.6)	52.5 (44.7-60.3)	47.6 (40.0-55.2)	59.8 (48.9-70.6)	55.8 (40.3-71.3)	50.0 (44.6-55.4)
	£20-£30	49.3 (42.5-56.1)	53.6 (46.8-60.5)	50.6 (44.3-56.9)	52.6 (45.1-60.1)	50.0 (39.1-60.9)	52.0 (37.7-63.3)	51.4 (46.6-56.2)
	£31-£40	57.3 (50.5-64.1)	54.2 (47.7-60.7)	54.8 (48.3-61.2)	56.7 (49.8-63.5)	62.5 (51.0-74.0)	53.8 (39.8-67.9)	55.7 (51.0-60.4)
	£41-50	59.5 (52.6-66.4)	62.6 (56.4-68.8)	58.8 (52.5-65.1)	64.1 (57.3-70.9)	58.1 (47.8-68.3)	51.3 (34.9-67.7)	61.2 (56.6-65.8)
	Lower reduction	65.8 (61.1-70.5)	64.7 (60.3-69.2)	65.0 (60.6-69.4)	65.6 (60.8-70.3)	65.3 (58.4-70.1)	67.3 (57.9-76.8)	65.2 (62.0-68.5)
	Higher reduction	19.6 (15.4-23.9)	19.4 (15.3-23.6)	19.4 (15.4-23.3)	19.7 (15.2-24.2)	26.2 (18.9-33.6)	16.3 (8.3-24.2)	19.5 (16.6-22.5)
Preset wet appliances	£10-£50	40.4 (36.8-43.9)	34.7 (31.4-38.0)	36.9 (33.6-40.1)	38.1 (34.5-41.7)	40.5 (35.2-45.8)	31.0 (24.2-37.7)	37.4 (35.0-39.8)
	Less than £20	30.2 (23.0-37.4)	28.8 (22.1-35.5)	30.2 (23.8-36.6)	28.4 (20.7-36.0)	32.1 (21.7-42.5)	16.3* (4.8-27.8)	29.5 (24.6-34.3)
	£20-£30	39.0 (32.2-45.8)	29.3 (23.3-35.3)	32.4 (26.2-38.7)	35.5 (28.9-42.1)	30.4 (20.9-40.0)	27.1 (14.0-40.1)	33.9 (29.4-38.4)
	£31-£40	42.7 (35.7-49.7)	35.4 (28.9-42.0)	38.9 (32.3-45.6)	38.9 (32.0-45.9)	47.6 (36.7-58.5)	33.3 (19.0-47.7)	38.9 (34.1-43.8)
	£41-50	48.3 (41.0 -55.6)	45.8 (38.7-52.9)	46.1 (39.2-53.0)	48.2 (40.5-55.8)	54.1 (42.4-65.7)	45.8 (31.2-60.5)	47.0 (41.9-52.1)
	Lower reduction	50.8 (45.1-56.6)	62.7* (57.0-68.4)	51.8 * (46.2-57.4)	62.1* (56.2-68.0)	52.2 (43.7-60.8)	56.1 (42.9-69.4)	56.6 (52.5-60.6)
	Higher reduction	10.6 (7.7-13.4)	11.0 (8.3-13.7)	11.8 (9.0-14.5)	9.6 (6.8-12.3)	14.2 (9.3-19.1)	7.1 (2.6-11.6)	10.8 (8.8-12.8)
Limited use of cooker: 30 mins, 10 times	£10-£50	37.8 (32.8-42.7)	38.6 (33.8-43.3)	37.4 (32.7-42.0)	39.2 (34.1-44.3)	43.2 (35.8-50.6)	36.5 (26.7-46.3)	38.2 (34.8-41.6)
	Less than £20	32.9 (22.8-43.1)	30.4 (21.4-39.4)	26.8 (17.9-35.7)	36.7 (26.6-46.7)	36.7 (22.7-50.7)	36.8 (13.0-60.7)	31.6 (24.8-38.3)
	£20-£30	38.2 (28.0-48.4)	41.6 (31.2-51.9)	41.8 (32.5-51.1)	36.7 (25.1-48.4)	40.5 (29.9-57.1)	43.3 (24.5-62.2)	39.9 (32.6-47.2)
	£31-£40	42.1 (32.1-52.1)	34.7 (25.2-44.2)	35.0 (25.6-44.3)	42.2 (31.9-52.5)	50.0 (32.3-67.7)	40.0 (19.4-60.6)	38.3 (31.4-45.3)
	£41-50	36.3 (26.3-46.3)	46.8 (37.3-56.3)	42.3 (32.7-51.9)	41.7 (31.7-51.6)	46.4 (33.0-59.9)	22.7* (3.7-41.7)	42.0 (35.1-48.9)
	Lower reduction	53.2 (44.9-61.6)	56.1 (48.2-63.9)	55.7 (47.9-63.5)	53.6 (45.2-62.0)	56.6 (45.2-68.0)	45.47 (28.4-63.1)	54.7 (49.0-60.4)
	Higher reduction	14.4 (9.8-19.0)	15.6 (11.1-20.1)	15.8 (11.4-20.3)	14.0 (9.3-18.7)	14.0 (7.1-20.9)	13.1 (4.4-21.8)	15.0 (11.8-18.2)
cooker: 30 mins, 1 time	£10-£50	44.9 (39.8-50.0)	52.6 (47.6-57.6)	48.5 (43.7-53.4)	49.3 (43.9-54.6)	49.7 (41.7-57.6)	40.9 (30.4-51.4)	48.9 (45.3-52.5)
	Less than £20	36.7 (25.9-47.5)	35.8 (25.2-46.4)	38.7 (28.7-48.7)	32.8 (21.4-44.3)	39.5 (23.2-55.8)	37.5 (10.9-64.1)	36.3 (28.7-43.8)
	£20-£30	44.0 (34.6-53.5)	51.5 (41.661.3)	46.1 (36.9-55.3)	49.5 (39.3-59.6)	46.2 (29.8-62.5)	37.5 (16.6-58.4)	47.6 (40.8-54.4)

[13] 95% Confidence interval indicated in parentheses. Acceptance rates by category that are significantly different from overall acceptance rates at 95% confidence interval level are indicated by an asterisk (*).

	£31-£40	46.7 (36.4-57.1)	60.0 (49.5-70.5)	54.9 (44.5-65.3)	51.2 (40.5-61.9)	48.6 (31.2-66.0)	52.4 (29.1-75.7)	53.1 (45.7-60.5)
	£41-50	55.3 (43.9-66.6)	61.8 (52.6-71.0)	57.4 (47.7-67.2)	61.2 (50.7-71.7)	62.8 (47.7-77.8)	37.0* (17.6-56.5)	59.1 (52.0-66.3)
	Lower reduction	59.5 (51.9-67.1)	68.6 (62.2-75.0)	66.8 (60.3-73.4)	61.9 (54.5-69.3)	67.5 (56.8-78.2)	75.5 (60.1-89.9)	64.6 (59.7-69.5)
	Higher reduction	14.4 (9.8-19.0)	15.6 (11.1-20.1)	15.8 (11.4-20.3)	14.0 (9.3-18.7)	12.8 (5.2-20.4)	3.8* (1.6-9.3)	15.0 (11.8-18.2)

4.7.1. Willingness to Accept (WTA)

Table 14 presents the average willingness to accept (WTA) amount for the interruption scenarios, as well as the factors that influence respondents' WTA decisions. Consumer concerns about remote controlled technology play the most important roles in willingness to accept load interruptions, especially white/cold and wet appliances interruptions. Ceteris paribus, consumers that express concerns for smart controlled technology would be willing to be offered additional discounts of £11.93 to accept 1-3 minute interval interruptions of white/cold appliances and £13.21 to have wet appliances preset to off-peaks, compared to consumers/respondents that have no concerns about smart controlled technology. Although households having in-house monitors may accept lower compensation to be interrupted, having in-house monitor does not really play a significant role in WTA. Respondents who claimed to be always eager to try new products and those who claimed to do laundry more frequently would accept £16.15 and £9.89 lower than others in order to have their wet appliances preset to 9PM.

On average, the willingness to accept amount estimates show that having wet appliances preset to off-peak hours attracts the highest financial compensation among the scenarios. This is followed by limited cooker use for 30 minutes 10 times a year. All else being equal, an average consumer would require between £46.24-£49.85 and £43.86-£44.67 discounts respectively to accept wet appliances being preset to off-peak periods and to accept hot appliances (kettle, cookers/ovens) usage being capped for 10 times of 30 minutes duration each per year, when controlling for respondents' characteristics. On the other hand, interrupting white/cold appliances would require the lowest financial incentives. An average household would require between £28.39 and £29.95 to accept white/cold appliances (such as fridges/freezers) being interrupted for 1-3 minutes over the course of the day. Similarly, limiting hot appliances usage for 30 minute duration once a year would attract financial incentives of between £35.34 and £38.97 off the total annual electricity bill.

Economic incentives have potential for people's acceptance of load shifting through smart appliances. Silva et al. (2011) found that of the 77% of the consumers that would accept postponing wet appliances operation's cycles, the majority of them would be willing to do so in exchange for a reduction in electricity prices or a discount on their electricity bills. Only a minority would accept shifting their appliances for environmental benefits (i.e., if it increases their use of clean energy). Shifting wet appliances – Washing machine (WM), Washer-dryer (WD) and Dishwasher (DW) – has a potential for saving at least 20 GW of wind capacity per annum (Silva et al., 2011).

Table 14: Willingness to Accept (WTA) Load Interruptions and its Determinants

Dependent Variable: WTA	Interrupting White/cold Appliances	Preset wet appliances	Limited cooker usage, 10 times	Limited cooker usage, 1 time
Female (=1 if female, 0 otherwise)	3.35 (4.03)	5.78 (4.51)	1.13 (5.80)	-7.76 (7.19)
Age (= 1 if 18-49, 0 otherwise)	3.98 (3.64)	2.92 (4.15)	1.61 (5.34)	-5.98 (6.23)
House type (=1 if own, 0 otherwise)	1.48 (3.95)	3.92 (4.48)	8.69 (5.89)	1.14 (6.72)
Have monitor (=1 if resp. has monitor, 0 otherwise)	-4.51 (3.88)	-4.14 (4.35)	-7.67 (5.72)	-5.82 (6.93)
Annual income per capita	1.69X10-4 (1.30x10-5)	2.35 x10-4 (1.51x10-5)	1.36x10-4 (2.37x10-4)	4.46x10-4 (2.04x10-4)**
Technology Concern (=1 if had concern about smart tech., 0 otherwise)	11.93 (3.78)***	13.21 (4.28)***	8.40 (5.55)	10.84 (6.63)
Responsible for bill	-2.58 (6.19)	-1.09 (7.11)	-15.47 (9.61)	-14.21 (11.17)
Always eager to try new products	-0.10 (5.04)	-16.15 (5.78)**	-11.97 (7.62)	-5.35 (8.32)
Do laundry more frequently	1.38 (4.89)	-9.89 (5.56)*	-5.68 (7.17)	12.13 (8.64)
Do cooking more frequently	-8.23 (5.22)	-5.88 (6.06)	1.11 (8.00)	-25.37 (9.24)***
Education	-0.74 (3.69)	0.94 (4.23)	-5.35 (5.29)	3.49 (6.60)
Engage in more technical job	-1.75 (4.24)	0.32 (4.85)	1.32 (6.14)	-3.62 (7.67)
Constant	22.08 (8.79)**	49.60 (10.10)***	50.61 (13.41)***	56.42 (15.76)***
Log likelihood	-665.81	-570.93	-317.82	-279.54
Wald (chi)	16.79	30.03	14.84	17.65
Willingness to accept amount (£)				
	Interrupting cold/white appliances	Preset wet appliances	Limited cooker usage 10 times	Limited cooker usage 1 time
No explanatory variables	29.95	46.24	43.86	35.34
With explanatory variables	28.39	49.85	44.67	38.97

Note: *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

To gauge the level of confidence of respondents with respect to the answers on willingness to accept the proposed bill changes, respondents were asked to rate how confident they were on a scale of 1-7, where 1 indicates "not confident at all" and 7 indicates "very confident". Table 15 presents the average rating of respondents under the four load shifting scenarios. On average, the responses to the proposed bill changes were rated well above the median, suggesting that the stated willingness to accept can (to a greater extent) translate into their revealed preferences. Interrupting white/cold appliances received the highest confidence rating (ca. 5.02), whereas limited use of hot appliances/cookers were rated lowest (ca. 4.87). All things being equal, male respondents are likely to be more confident than females in their decisions to accept the proposed bill changes. However, younger respondents are less confident than older respondents in their responses to accept white/cold appliances interruptions.

Table 15: Rating of Respondents' Confidence

Scenario	Category	Mean ca.	T-test
Interrupting white/Cold Appliances	Male	5.16	3.410***
	Female	4.88	
	Age 18-49	4.97	-1.393*
	Age 50 & over	5.08	
	Overall	**5.02**	
Preset Wet Appliances	Male	5.09	2.638**
	Female	4.85	
	Age 18-49	4.97	0.114
	Age 50 & over	4.96	
	Overall	**4.97**	
Limited Cooker use 30 mins 10 times a year	Male	5.07	3.159***
	Female	4.69	
	Age 18-49	4.80	-1.244
	Age 50 & over	4.95	
	Overall	**4.87**	
Limited Cooker use 30 mins once a year	Male	4.96	-0.541
	Female	5.03	
	Age 18-49	5.00	0.204
	Age 50 & over	4.98	
	Overall	**4.99**	

Note: *** for p<0.01, **for p<0.05, and *for p<0.10.
Source: EPRG Survey of UK households 2013

5. Conclusions

The results of our 2013 survey indicate that smarter devices do lead to behavioural response but the challenge is to sustain this behaviour change over time. Around 26% of respondents that have in-house electricity monitors read the monitor at least once a week, with about 9% indicating that they check it daily and 3% maintaining that they monitor their energy consumption several times a day. However, the reading habit declines over time. Around 39% of respondents who had installed in-house monitors for less than 6 months had reduced the frequency with which they read their monitors since it was first installed, compared to 50% and 59% of respondents who had installed their monitors for between 6-12 months, and 1-3 years, respectively.

Applications on smart phones are promising to raise consumption awareness and induce behaviour change. Around 64% of respondents that use smart phones believed that having an application on their smart phones could make them more aware of their energy consumption. However, the major concerns about this proposed application are the cost and its flexibility/ease of use. Around 33% of respondents who perceived increasing awareness through the use of application on smart phones to be beneficial would want such application only if it is free or cheap, while 7% would accept it only if its usage requires no extra effort.

Economic considerations are the main drivers of behaviour change. Peer pressures were not perceived as strong in changing behaviour. More than 87% of respondents who had deliberately changed their consumption behaviour were motivated by cost savings. This is followed by concerns about climate change, representing 26%. Only 5% of the respondents have consciously changed their energy use because of the installation of new technology, such as smart meters and monitors. Just 2% of respondents have changed their behaviour due to pressures from friends, neighbours and/or colleagues.

Change in energy use varies significantly by age: older respondents are more likely to have changed their energy use than younger respondents. Similarly, the reasons for behaviour change vary significantly by age: Older people are more likely to have changed their behaviour for economic gains, while younger respondents are more likely than older people to claim environmental concerns but they are still more likely to cite economic than environmental considerations. Since economic reasons are the main drivers of behaviour change, it suggests that smart technologies are a promising way of promoting consumption behaviour change if they are economically designed and incentive compatible. Also, the variation in the reasons for behaviour change suggests that energy awareness directed at older population should emphasise economic issues more, while those targeting young people should focus more on both economic and environmental benefits.

Switching behaviour has declined relative to previous studies, and there have been differences in the distribution patterns of the reasons for switching suppliers. Only 42% of respondents switched energy providers in the five years prior to this study. By contrast, the switching rates in the previous EPRG surveys were 48% in 2006, 48% in 2008, and 47% in 2010. Share of respondents that have changed providers because of the opportunity to get lower tariffs elsewhere has decreased to 78% from its peak of 84% in 2006. However, respondents choosing capped prices as a reason for switching suppliers have further increased to 38% from its highest share of 30% in 2008.

Although the share of respondents that would agree to have their metered consumption information recorded has increased, issues of privacy still remains a major concern. While more than half would agree to have detailed metered consumption information recorded by their energy providers through smart meters, they are wary of having their data available to third parties. Female and younger respondents are less likely to oppose having their consumption information recorded through smart meters.

There is potential scope for shifting discretionary electricity loads off-peaks, through the use of smart appliances that require limited user intervention. However, the potential of appliances not being available when they are needed and privacy are the major concerns. As in the 2010 EPRG survey, acceptance of supplier control of smart appliances is high, even for small discounts on the electricity bill. We find little indication that gender, age, and housing type impact willingness to accept a discount in exchange for the ability of supplier to remotely control appliance usage. However, concerns about smart technology especially as it affects the availability and functionality of the appliances, and privacy, significantly affect respondents' acceptance. This finding suggests that remote controlled appliances must minimise impact on availability and functionality, and privacy concerns must be taken seriously in order to increase consumer adoption.

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