Efficient Household Appliances:

A field study of the contribution of appliance replacement and consumer behaviour to reducing energy use

Research Study Report

Prepared by Professor Matthew Leach, Dr Michael Peters and Dr Shane Fudge
Centre for Environmental Strategy, University of Surrey

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Subjects presented in the photography in this report include participants in the research study undertaken by the University of Surrey. Appliances shown in the photographs include new models given to the participants by AMDEA for trialling as part of the study. For reasons of academic research anonymity all participants are bound under the University of Surrey's Ethics Committee regulations and cannot be named. The images are the property of AMDEA.

EXECUTIVE SUMMARY

This research project involved a four-month study of five households in the Borough of Woking in order to ascertain what the role and interrelationship between technology and education might be in driving more energy efficient consumer use of modern domestic electrical appliances.

Energy consumption and user behaviour were monitored and a selection of the appliances replaced with newer models that were rated to have lower energy usage.

The research had three complementary objectives: (1) Assessing the inherent energy efficiency of the appliances; (2) Exploring opportunities to use energy-saving features; and (3) Investigating opportunities and challenges to changing habits and practices around particular appliances.

In all instances of appliance replacement, savings in energy use were achieved: fridge-freezer (and combined fridge plus freezer) replacement yielded savings between 39% and 66%; for dishwashers and washing machines the savings were between 8% and 21%; and 39% was saved for a tumble-dryer.

The study identified some disconnects between largely pro-environmental attitudes, and both stated behaviours and appliance usage - some of which are not currently maximising efficiency. This was qualified, in part, by a range of practical issues (effectively 'barriers') that in the consideration of some participants, limits their ability to use certain appliances in more energy efficient ways, e.g. disability, old age, young children etc.

In the 'test week' participants carried out a range of previously untested energy-efficient appliance practices. It became apparent that some of those barriers could in fact be quite easily overcome, with results that exceeded the expectations of some participants. For example, changing to a lower temperature wash, with an appropriate detergent, yielded reductions in energy use for washing machines of between 35% and 59% and for dishwashing of 19% to 34%. It should be noted that the cleaning results for one of the dishwashers were unsatisfactory; however this appliance was 8 years old.

Overall, replacement of an existing appliance with a new energy-efficient model in all cases yielded improvement in terms of energy consumption. Changed practices in most cases also enabled reduced energy consumption with both existing and newer appliances.

We postulate, therefore, that even greater savings are possible by combining some behavioural change with the purchase and use of new energy-efficient appliances: a case measured in this study, for example, showed combined savings of 48% when a 14+ year-old washing machine was replaced, and a low temperature wash and premium brand detergent were used. A larger study would be required to explore this area further, allowing incorporation of control groups and segmentation of the trial.

1. INTRODUCTION

This project involved a small scale study of the use and practices around white domestic appliances in five UK households. The relevance of the study relates to the fact that domestic energy use is responsible for approximately 31% of total primary energy consumption in the UK and 27% of total direct carbon dioxide emissions nationally (House of Commons, 2009; DECC 2011). Eighty-two percent of this total was accounted for by space and water heating with the remaining 18% attributable to energy used for lighting and appliances (DECC, 2011). This poses a particular dilemma for the government as it strives to meet rising housing demand with increasingly stringent environmental targets. In addition, an increase in incidence of fuel poverty can be linked to a doubling of electricity prices between 2004 and 2010.

Whilst there have been considerable increases in the energy efficiency of domestic appliances over the last ten years, the 'rebound effect' means that this has not necessarily resulted in a decrease in their *overall* energy consumption with much of the money and energy that is 'saved' being 'spent' elsewhere.

One approach to increase consumer awareness regarding the energy (in)efficiency of appliances (as well as to encourage innovation among manufacturers) is energy labelling, which is currently compulsory throughout the European Union for cold appliances (fridges and freezers), washing machines, tumble dryers, combined washer-dryers, dishwashers and ovens. As well as giving consumers a simple at-a-glance indication of how energy efficient a product is, the scheme has also had an impact on the product development of household appliances (Which, 2012; Norden, 2007).

Many of today's appliances are increasingly energy-efficient and there is evidence to suggest that consumers, in general, are satisfied with them. However, the test methods applied to energy labelling do not always correspond to the actual use of the appliances tested. As Norden (2007) points out, although the current energy-labelling scheme focuses on saving energy, appliances must also function in ways that are acceptable to the end user. Furthermore, end users perhaps need to become better versed in the possibilities offered by the appliances' energy saving functionality. Therefore, while energy labelling can aid households in purchasing appliances that save energy, there are more savings still to be made in relation to the ways in which the appliances are actually used in the home (Norden, 2007).

Patterns and trends around energy use in the home are the result of a complex interplay between changing lifestyles and practices, growing prosperity and a tendency towards increased ownership of labour-saving devices; an increasing number of people and households; and finally, a trend towards ignorance, misunderstanding, or misuse of the energy saving features of modern appliances, curtailing much of the potential for efficiency gains (Norden, 2007; Emmert *et al,* 2010).

1.1 Aims and objectives of the study

The project itself involved a four month study of five households in the Woking area in order to ascertain what the role and interrelationship between technology and education might be in driving more energy efficient consumer use of modern domestic electrical appliances. Whilst the main aim of the study was to explore the extent to which switching to more efficient modern appliances (cold and wet) can enable significant energy savings, the research itself comprised three complementary objectives:

1) Assessing the inherent energy efficiency of the appliances
2) Exploring opportunities to use energy-saving features
3) Investigating opportunities and challenges to changing habits and practices around particular appliances

1.1a Duration of the study

The total duration of the study was four months (beginning 1st January 2012 until the end of April 2012). This was split into three main monitoring 'phases' of one month each, with monitoring in two households extended to the end of May. A series of mid-point interventions involved the replacement of specified appliances and requests for participants to undertake particular changes to their routine practices relating to appliance use. Further details of these interventions are provided in the methodology section below.

1.2 Methodology

1.2a The study sample

The study sample was assembled in conjunction with Action Surrey - an organisation that offers advice to residents, schools and businesses on how to reduce energy and water consumption. It maintains a list of names and addresses of local residents who have expressed interest in a range of user engagement activities and initiatives in recent years. The main methodological objective was to connect with four separate households in the Borough of Woking representative of two principal categories: (a) single-occupant dwellings, and (b) family-occupant dwellings. Households representing these two categories were also chosen and roughly matched in terms of:

- Location
- Size and type of home
- Age and relevance of appliances
- Number of occupants
- Age of occupants

It was acknowledged from the outset that representation of the UK population as a whole was unrealistic given the small scale of the study. However, as depth of inquiry over breadth of investigation was considered to be one of the guiding principles for the project, it was felt that this approach would create the conditions for a) robust and interesting results in relation to the field of study b) providing the basis for further investigation and policy relevant findings.

In the initial phase of the project, a shortlist of eligible participants was gathered numbering approximately twenty households. From this shortlist, four households comprising two families and two single people were identified and contacted. Originally the study planned to investigate existing appliances of ten years or more in age across four households (in order to compare energy consumption between brand new appliances and those of a considerable, decade or more age difference). However, introductory telephone conversations with the prospective household participants revealed that this would not be possible, as there were too few appliances so old, and therefore the study was revised to ownership of large white appliances that were six years of age or more.

The four households contacted were all suitable in this regard, and each gave a commitment to participation involving four of their major white appliances (e.g. tumble dryer, fridge, washing machine, fridge freezer, dishwasher) being monitored for energy consumption over a period of twelve weeks, split into two six-week phases. From the outset, participants were made aware that a mid-point intervention (approximately six weeks into the study) would take place involving, either the replacement of their oldest appliance, or a request to undertake a series of changes to their routine habits and practices around use of their appliances. .

Following an initial site survey at each property, it was discovered that one of the family homes contained major white appliances which were significantly younger than the study's stipulated six year-plus age bracket. It was therefore decided to augment the sample with one extra family household – one which more closely matched the age stipulation of the appliances. This household was also sourced via the Action Surrey database. Full details of the household types, age of properties and household compositions, amongst other variables, can be found in Appendix 1.

1.2b Monitoring equipment

Following exploratory research by Action Surrey into suitable equipment for monitoring individual appliance and whole-of-house electricity consumption, it was decided that the EnviR Real Time Home Energy Monitor (manufactured by the Surrey-based company Current Cost) was the best option. This particular model was felt to be the most suitable technology for the aims of the project and was also awarded Best Buy status for energy monitors by Which? magazine in January 2011.

During the initial site visits, four appliances in each household were fitted with an individual appliance monitor (IAM) which, working in conjunction with the main monitoring device, would record the electricity consumption of each appliance continuously throughout the study.

1.2c Mid-point interventions

In order to address the first objective of the study (*assessing the inherent energy efficiency of the appliances*), a selection of the oldest monitored appliances were replaced with brand new, energy efficient models approximately halfway through the study. These choices were constrained by the need for the replacements to be like-for-like, most notably the cold appliances had to have the same capacity to form a reasonable comparison. The replacement appliances are therefore not all the very most efficient on the market. Analysis of consumption data for equal time intervals (approximately 4 weeks) before and after the switch-over would then be carried out in order to enable comparisons to be made (see Results section of this report). The first two four-week monitoring, or 'base phase' periods would underpin a subsequent 'business as usual' scenario to be assessed. Table 1 sets out the conditions which were set up for the different households and specifically details which appliances were monitored and which ones were replaced.

Table 1: Original appliances (age in years) and replacements (efficiency rating)

Household		Cold			Wet		Hot
		Fridge	Freezer	Fridge-freezer	Washing m/c	Dishwasher	Tumble dryer
1	Original	8	8		6	New	
	Replacement	A+	A++				
2	Original			10	14	10	
	Replacement			A	A++		
3	Original			5	5	1.5	2
	Replacement			A++			
4	Original		5	8	6	8	10+
	Replacement				A++		A++
5	Original			10	1.0	10	10
	Replacement			A+		A	

The second objective of the study (*Exploring opportunities to use energy-saving features)* was mobilized by providing households with a series of practical tips and recommendations on how to use the energy saving features on their new appliances.

The third study objective *(Investigating opportunities and challenges to changing habits and practices around particular appliances)* was introduced in the second monitoring phase of the study and meant that, for one week, households should change specific practices around their use of appliances. This followed the completion of a questionnaire-based interview administered face-to-face, in which participants were asked a series of questions in relation to use and practices regarding their appliances (Appendix 2).

2. RESULTS

In this section we present the research results and analysis. These are set out through the following sections:

1) Results from the initial site visit interviews (see Appendix 2 for a copy of the questionnaire protocol used);
2) Results from the monitored electricity consumption data; and
3) Supplementary qualitative data gathered during site visits to the participating households during the course of the study.

2.1 Results from the initial site visit interviews

Each interview began with a series of 'standard' socio-demographic questions (e.g., gender of respondents, age of occupants, working status). The answers to these questions can be found in Appendix 1, presented in graphic and tabular formats. The sample included two single occupant households and three family dwellings. For the purposes of this report the individual households are referred to henceforward using the labels 'Household 1, 2, 3, 4, 5' as shown in Table 2.

Table 2: Occupancy details for each participating household

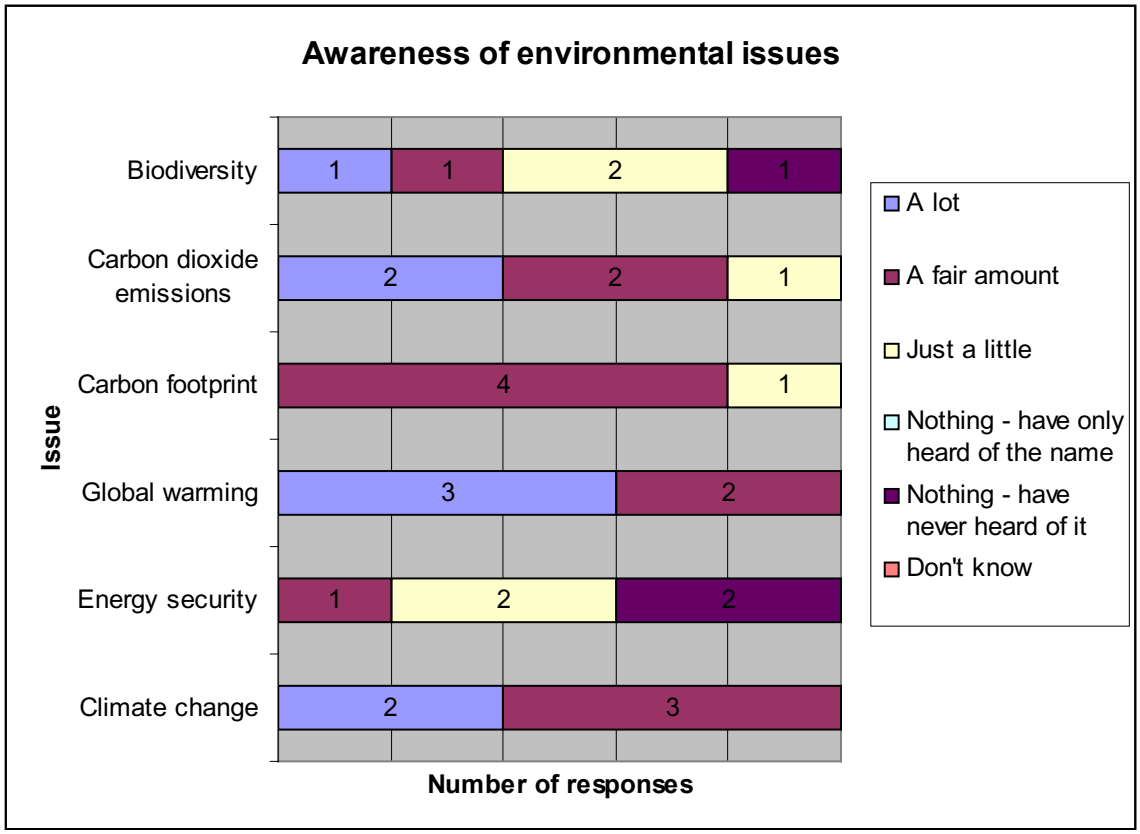
	Number of occupants
Household 1	1
Household 2	1
Household 3	5
Household 4	5
Household 5	3 (4 when student daughter at home during university vacations

2.1a Environmental and Energy Attitudes

One of the reasons that Woking was chosen as the location for the study was the fact that it is considered to be an area with a reasonably high awareness of environmental issues. For instance, Woking Borough Council has long been considered to be one of the more progressive local authorities in the UK (Vase and Tindale, 2011), developing both its own Combined Heat and Power (CHP) and renewable energy strategy and also engaging with the public on a range of environmental and energy initiatives. It was felt that involving participants who had a reasonable understanding of energy/environmental issues would be an interesting way to explore a) what they say and what they do, and b) compare their depth of knowledge and understanding in relation to both their behaviour and also their interaction with new technology.

Therefore, in the initial part of the interview, participants were asked a series of questions in order to explore their attitudes on issues related to energy, the environment and sustainability. In the first question, a range of environment/sustainability terms were shown and participants asked to state how much, if anything, they knew about those particular issues. The degree of stated knowledge for each issue is shown in Figure 1.

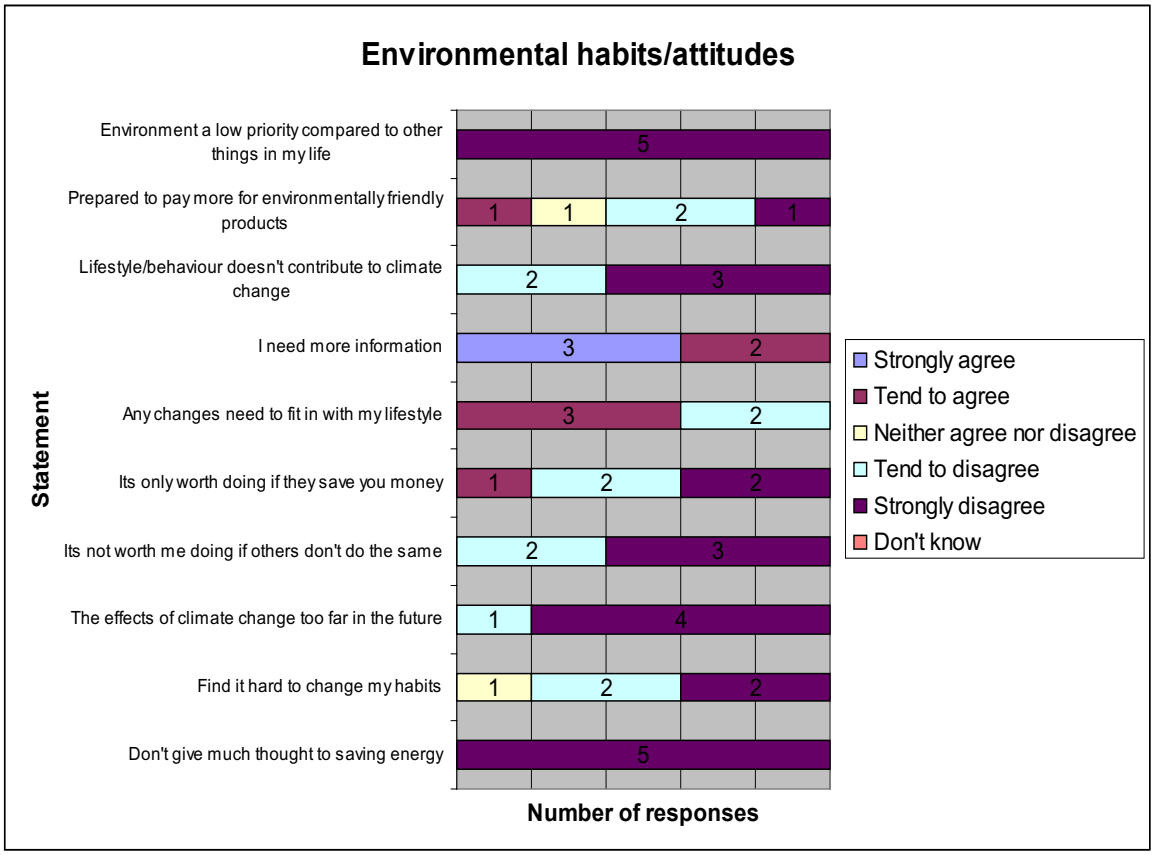
Figure 1: Degree of stated knowledge on environment/sustainability issues



It is perhaps surprising, given the high level of routine pro-environmental behaviour revealed in the next section (see Figure 3), that the level of awareness around some environmental issues was mixed (i.e. for several issues levels of stated knowledge included the response 'Just a little' - and in the case of *biodiversity* and *energy security* – 'Nothing, have never heard of it'). These findings are consistent with a number of studies (Fudge and Peters, 2011; Emmert *et al*, 2010), which found that environmental considerations are often couched in a 'hierarchical' knowledge structure and remain subject to the pragmatism of everyday lifestyle choices. House-by-house presentation of this data for each issue is presented in Appendix 3.

A related series of statements around habits and attitudes was also shown to the participants. They were asked to state the extent to which they agreed or disagreed with each statement (Figure 2).

Figure 2: How much do you agree or disagree with these statements?



2.1b Environmental and Energy Behaviour

The next part of the initial interview was devoted to the broad topic 'environmental and energy behaviour'. Here, participants were invited to discuss some of the key issues involved with home energy use and how this relates to everyday practices. The opening question invited participants to describe principal issues that influence their energy use in the home, with regard to both home heating and electricity use in a more general sense. It was clear from the responses that the overriding influences for the majority of participants include 'cost' and 'keeping warm', as indicated by the following interview extracts:

> *"Cost is the main issue... I switch everything off"* (Household 1)
>
> *"The three most important issues are cost, efficiency and the environment"* (Household 2)
>
> *"Primarily cost but also keeping the house adequately warm with having young children"* (Household 3)
>
> *"A bit of everything but consider warmth as the number one issue"* (Household 4)
>
> *"Cost, efficiency and environment…in that order"* (Household 5)

For all of the participants, 'environmental awareness' also featured as a key influencing factor, although in every case less so than cost and warmth. A series of practical considerations (meeting young children's needs, adequate ambient temperatures for the disabled, attempts to cut down on waste generally,…) were also cited as important. In one case (Household 4) it was clear that continual attempts

are made to reconcile energy efficiency with the maintenance of a sufficient level of household warmth: *"as far as possible we try to reduce the need to have heating on, but at the same time maintaining warmth in the house".*

Participants were asked whether they had thought about, or had tried adopting more efficient heating or electricity practices. This elicited a wide range of responses, encompassing the adoption of insulation measures and, in three cases, the installation of solar PV and solar hot water panels:

> *"Had a new central heating system installed which involves radiators with individual thermostats (rather than the previous hot air system that house had when moved in). Have had the house fully insulated and double glazed in the last ten years. I have also in the past month had solar PV panels fitted"* (Household 1)
>
> *"I had cavity wall insulation installed when I moved in and re-insulated the loft at the same time. Double glazing was installed. Hot water solar panels were installed about 12 years ago in anticipation of rising costs and the onset of old age"* (Household 2)
>
> *"Solar panels were connected 4/5 days ago. Cavity walls were insulated and 2 years ago we installed a new condenser boiler (the old one was inefficient and starting to show signs of age). We Installed double glazing and loft insulation"* (Household 4)

Three of the households were thus in the c1% of UK households that have solar panels of whatever sort.

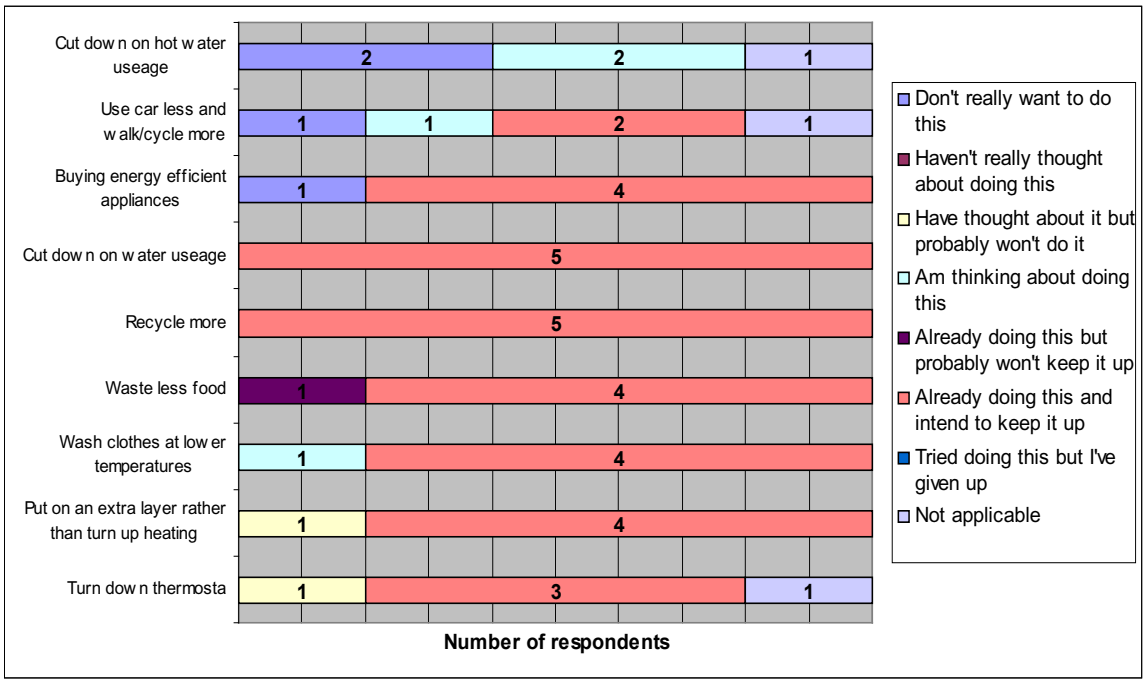
When asked about the sort of circumstances that might cause them to consider changing to more efficient ways of home heating and energy use, responses closely reflected the varied circumstances of the participants. For example, one of the more affluent family households said that, if moving house, they would consider under-floor heating and other options ("like on 'Grand Designs"), but were of the opinion that "we're not sure there's much else that we can do in this house". Similarly, one of the other families (Household 5) also conveyed a potential willingness to consider further changes if moving house. Both the single-occupancy participants alluded to cost saving as a key determinant of energy decision-making:

> *"I try to be as careful as possible anyway…in order to save money"* (Household 1)
>
> *"I wanted solar electric panels to give me cheaper electricity. Other than that, I am also interested in more efficient appliances, boilers, etc."* (Household 2).

Participants were also asked to consider a number of circumstances that might make them consider changing their practices to more efficient ways of heating their home and in relation to other forms of domestic energy use. They were asked to indicate the extent to which these changes applied to them at the present time (e.g. 'Don't

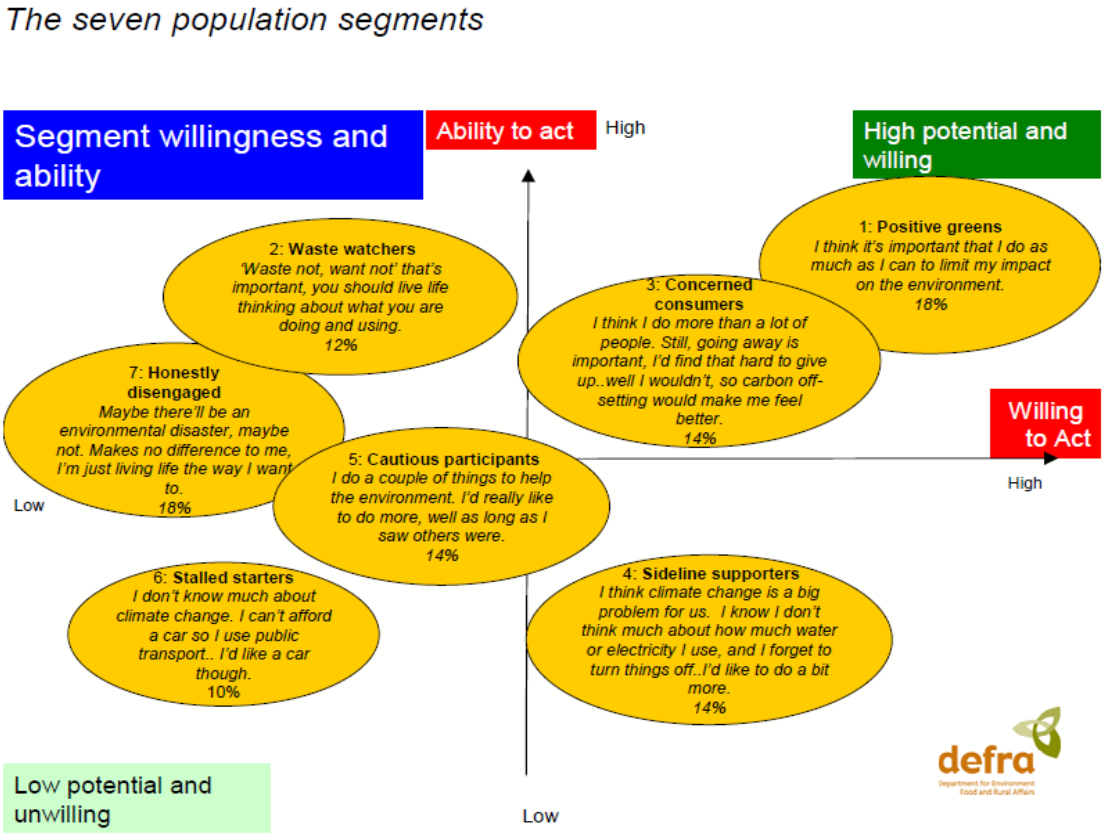
really want to do this'; 'Am thinking about doing this'; 'Am doing this and intend to keep it up' etc.). The results (Figure 3) show that a substantial majority of participants claimed to have already adopted a range of pro-environmental behaviours, with the intention of these being continued into the future. Notable in this respect were: buying energy efficient appliances; recycling more; wasting less food; washing clothes at lower temperatures; putting on extra layers of clothing and to a lesser extent; turning down thermostats. The two changes that received a majority of responses in the categories *'Don't really want to do this'* and *'Not applicable',* concerned using the car less and walking/cycling more, and cutting down on hot water usage.

Figure 3: Responses to statements about changes that people could make to their lifestyles: "which answer applies to you *personally* at the moment?"



In many ways these findings are indicative of the complexities contained within the framework for pro-environmental behaviours (including the 'segmentation model') developed by the Department for Environment, Food and Rural Affairs in 2008. The model comprises seven segments: (1) "Positive greens"; (2) "Waste watchers"; (3) "Concerned Participants"; (4) "Sideline supporters"; (5) "Cautious participants"; (6) "Stalled starters"; and (7) "Honestly disengaged" (Figure 5). The model includes detailed profiles of each segment covering, for example ecological worldview, socio-geo-demographics, lifestyle, attitudes towards behaviours and current behaviours, motivations and barriers, and knowledge and engagement (Defra, 2008). In Figure 5 each segment has been plotted against their relative willingness and ability to act.

Figure 5: Defra Segmentation model: 'framework for pro-environmental behaviours'



Results from the attitudinal and stated behaviour questions of this study strongly indicate that our participants are consistent with the 'Positive greens' and 'Concerned Consumers' segments as described in the model – believed to have both a high potential and a willingness to act.

2.1c Household Appliances

In this section participants were asked a range of questions about household appliances. The first area of inquiry concerned the main considerations that they take into account when purchasing a new electrical appliance. The results in Table 3 show that overall purpose, cost, reliability and longevity and brand were key factors, with the energy rating only mentioned by one household.

The EU Framework 7 funded project 'Barriers and opportunities to changing consumer behaviour at EU level' (BARENERGY) carried out between 2008 and 2010, conducted a series of focus groups with consumers in 6 European countries. One of the most striking findings here was that consumers often automatically equate 'brand' with 'efficiency' rather than framing the purchase of an appliance in relation to its efficiency rating. It is postulated, therefore, that the brand of an

appliance is often the most accurate marker vis-a-vis other characteristics which are also important to consumers (longevity, reliability etc.). In this study sample, and to a lesser extent, factors of space/size, advice from friends, offers and consumer advice reports were also significant.

Table 3: Considerations taken into account when buying a new appliance

Household	Main considerations when buying a new appliance
1 (Single a)	"I look to the energy rating first – preferably A triple rated. Cost and brand name are also important – [Brand X] seems to be better than most"
2 (Single b)	"When I buy something, 1) it has to fit into the available space, 2) cost, 3) efficiency and how long it is likely to last, 4) take advice from friends, 5) look to see what is on offer, and 6) I might read a Which report (but not often)"
3 (Family a)	"The cost and its longevity are the main considerations"
4 (Family b)	"1) Its purpose, 2) cost, reliability and longevity. The brand name is the least important consideration. We have gone for appliances that suited our needs".
5 (Family c)	"Main considerations are its purpose, brand name and reliability followed by cost and longevity"

When specifically asked to explain how a product's 'energy efficiency' rates in comparison to other issues that they identified, the responses indicated that whilst some of the participants rated it as the *most* important factor, others wanted to balance this with cost whilst another household rated it less important than purpose/ brand name/reliability/longevity.

One household cited size of washing machine, and its drum, as the primary factor of significance (see Table 4). When considered in the context of the environmental attitude responses (Section 2.1) it is interesting to note that even households characteristic of the most 'pro-environmental' mindsets' placed energy efficiency below other purchasing considerations.

Table 4: The relative importance of energy efficiency when buying a new appliance

Household	Importance of energy efficiency
1 (Single a)	Very important as stated above in previous question
2 (Single b)	Would try to choose an energy efficient one, partly for cost saving reasons
3 (Family a)	Has to be balanced out with cost as well
4 (Family b)	Certainly take it into account. Our washing machine was our latest appliance – but we bought it primarily for a bigger drum and its speed. The fridge-freezer is efficient and was bought with this in mind
5 (Family c)	This is of equal importance to cost and longevity but not as important as purpose/brand name/reliability

When asked whether they were aware of and used the current energy labelling system - one participant had a "feeling that you should choose A or B rated appliances, but that's all I know", while another described himself as only slightly aware, asking "is it standardised?".

Similarly, there was no consensus about whether current energy rating practices are relevant to consumer choices. One householder thought that running costs, rather than energy ratings, should be labelled; another agreed with the principle of current rating practice but said that a lot of people bought appliances on appearance. Other responses to this question are contained in the interview extracts below:

"Yes, I am aware of energy labels, but they should indicate cost levels of running the appliance, rather than green to red, so you would know how much it costs to run per year."(Household 1)

"I personally am aware, but don't think people in general take much notice." (Household 3)

"…I feel that with a lot of people appliance are bought on looks…however, if it's a dishwasher that is hidden behind a cupboard door, the looks aren't so important and therefore the efficiency rating could become more salient." (Household 4)

In relation to the importance of turning down or switching off domestic appliances fully (rather than leaving on standby) most of the households stated that they have the habit of turning off at least some of their appliances fully at night. The appliances turned off varied, however, usually to suit the habits of the household.

"I try to turn what I can off fully – other than the computer which is my life (the screen goes off fully but I leave the hard drive on standby – too much time and hassle to keep powering it up). TV can't be fully switched off, so I need to get a special plug for that so it goes off fully automatically when it's switched off." (Household 1)

"Yes, except for TV because switch under bookcase." (Household 2)

"Do it a lot because I read somewhere about phone chargers using energy when in standby mode. Do turn following off fully: TV, mobile phone chargers, laptops. Broadband has to be left on. We don't argue about it – it's common practice in our house." (Household 3)

"Turn computer, wi-fi and TV off fully." (Household 4)

"Turn off PC and TV each night out of habit and for safety/environmental reasons. We all agree on this. The dishwasher/tumble dryer/washing machine are not on standby when not in use anyway." (Household 5)

As the interview extracts above reflect, TVs, broadband and computers are most often left on standby, and, as far as this study sample is concerned, kitchen and washing appliances are not left on standby when not in use. The interview extracts also suggest that participants, in general, were more likely to engage in pro-environmental 'standby practices' (e.g. switching off mobile phone chargers) than adopting habits and choices such as purchase/use of energy efficient appliances and reduced travel patterns, which potentially have far greater magnitudes of energy and carbon saving potential. Again, this demonstrates the tenuous relationship that can often exist between attitudes and people's actual behaviours.

Participants were asked if they had ever considered not buying or having a product because they were aware that it was energy intensive or environmentally damaging. Their responses highlight the fact that consumers buy, or do not buy, products for a variety of reasons, including assessments of their damage to the environment. For instance, one householder said that "a product wouldn't be advertised as environmentally damaging in the first place if it was". Another claimed that "I wouldn't buy something if it was environmentally damaging". One household admitted to avoiding buying certain household cleaning products "for this reason", while another said that it only bought products it "needs", and that if it needed it and it was not energy efficient, it would still have to have it.

When asked if they would consider it reasonable if companies themselves stopped producing energy intensive products for the market (i.e. rather than the primary onus being on consumers to change purchasing habits), most considered that the emphasis for preventing a market in energy intensive products should rest on both consumers and producers, for example:

> *"It has to be a bit of both, but consumer led… consumers need to change their habits. I don't fully support new light bulbs, e.g. waste disposal and some models don't fit with recessed lighting fittings, etc…Have to be mindful of whole life cost as well as environmental impact."* (Household 4)

> *"There should be an onus on consumers and producers."* (Household 5)

Two of the participants, however, felt that manufacturers should take the lead in stopping production of energy intensive products:

> *"Manufacturers need to take responsibility!"* (Household 1)

> *"Would help, yes, if manufacturers stopped producing energy intensive products for the market."* (Household 2)

The final part of this section queried participants on their use of three main household appliances; their washing machines, tumble dryers and dishwashers. Most householders in the sample claimed to use their washing machines on low temperature cycles (40 or even 30 degrees), fill the machine to the full and use economy buttons where available; and one delayed operation to take advantage of cheaper night-time electricity rates.

The results indicate that less expensive non-bio detergent brands are favoured. Families tend to use the machine every day with a small amount of hand washing carried out for delicate items (Table 5). Participant practices relating to the use of dishwashers and tumble dryers are presented in Table 6 and Table 7.

Table 5: participant responses to the question ‘how do you use your washing machine?’

Household	Washing machine practice/habits
1 (Single a)	Try to cut washes down to a couple of times a week and only wash at 40 degrees. Split washes up and try to wait until I have a full load, although with my disability I sometimes have to do smaller loads. Usually put on overnight so I use the night time rate on electricity use.
2 (Single b)	Wash once or twice a week – always make sure it’s full. Use half load button if absolutely necessary (if I need something quickly). Use non-bio detergents because of skin sensitivity. Use a brand that is cheap and works. Always wash at 40 degrees. Do a certain amount of hand washing.
3 (Family a)	Only make a wash when full. Tend to go on 40 degree cool cycle. Stick with [Premium Brand] as it seems to clean best. Have used [Premium Brand] concentrated – but too expensive with a family.
4 (Family b)	Only one of the cycles will go down to 30 degrees, and we use this a lot. All other cycles only go down to 40 degrees, which we use for towels. Use every day. Doesn’t have an economy button. Always fill machine to full. Go for non-bio (reaction to daughter’s skin) but mainly go for what is on offer.
5 (Family c)	6 loads a week – normally all done on a Saturday. Different cycles are used for different types of wash loads. We use non-bio detergent – best available deal and also use a de-scaler. We always use the energy saving button. We already wash at low temperatures (occasionally high for linens).

Responses relating to use of the dishwasher seem to reveal a lack of trust in lower temperature cycles. Use of cheaper detergents (or those that can be purchased ‘in bulk’ thus lowering the unit price) was a common theme. The use of an ‘eco cycle’ (on models that have this feature) varied among the participating households, as the comments in Table 6 demonstrate.

Table 6: participant responses to the question ‘tell me about the way you use your dishwasher?’

Household	Dishwasher practice/habits
1 (Single a)	Use it on demand – i.e. only when full. Stick to the same cycle – normally the hottest as the plates etc. have been in there a long time before the load is full. Use [Premium Brand] detergent as it seems to be most reasonable and buy in bulk. Think it has an energy saving button but always switch it on at night (to benefit from lower energy tariff). Would be encouraged to use lower energy cycles I suppose if I did more washes, but that would defeat the object: “I always wait for a full load otherwise I would use the eco button”.
2 (Single b)	Use it once a month – bought it because of a family visit. Don’t put really dirty things in (wash them by hand) use the normal wash cycle. Use cheapest detergent I can get ([Supermarket] own normally). Don’t think it has an energy saving button. In terms of using lower temperature cycles I don’t think it would be hygienic and not sure you can lower the temperature anyway.
3 (Family a)	Use it 3-4 times a week. Use economy cycle. Use [Premium Brand] tablets or [Premium Brand] gel. Energy saving button is used. Lower temperatures would not be practical.
4 (Family b)	Run it overnight, every night. Might change if more people here. Normally use 50 degree setting but occasionally 65 if very greasy. Use [Premium Brand] or whatever is on offer. No energy saving button. Would use lower energy cycle if it cleaned the contents properly. Occasionally use lower temperature cycle.
5 (Family c)	Try not to use it until full – then around five times a week. Always use economy cycle 40-50 degrees. Every so often wife uses ‘normal’ wash. [Brand] tablets currently used. Always use on energy saving mode – sometimes give an extra rinse beforehand for heavily soiled plates. Cost of bills and environmental concerns caused us to switch to lower temperature cycles about a year ago.

In terms of tumble dryer practice and habits, for those who have tumble dryers, use is generally seasonal or based on clemency of weather capable of drying clothes (Table 7). There is a general trend towards speed and convenience of drying rather than the possibilities for saving energy. One participant pointed out that their machine only had one setting thus making energy saving options for tumble dryer use more difficult.

Table 7: participant responses to the question 'could you tell me about the way you use your tumble dryer?'

Household	Tumble dryer practice/habits
1 (Single a)	Not applicable
2 (Single b)	Not applicable
3 (Family a)	Use 3 times a week. Not used at all in the summer. Fill it to the maximum. "Go by what label says on clothes". "Only has medium-high setting and time dials". "Only use it mid Oct to Feb/March (other than in bad weather during Summer)". "Would rather have it on high temperature for 30 minutes than on low for an hour".
4 (Family b)	"Don't use it daily but when I use it I will do two loads on that day". "Current tumble dryer is very basic – just has a timer 20-30 minutes". Occasional use in summer when raining. No energy saving button. Lower temperature cycles not relevant for our machine but if you could work out how long it takes to dry particular items could possibly be more accurate at setting the drying time.
5 (Family c)	Use 6 times full loads on a Saturday. One cycle every two days for remainder of week. 'Cupboard dry' and 'mixed fabric' settings mainly used – normally check if dry before end of cycle. In the summer just use it occasionally – weather dependent. Machine doesn't have an energy saving button. It would not be practical to use lower temperature cycles.

2.2 Results from the monitored electricity consumption data

The 3 or 4 major appliances in each household were monitored for three phases: Phases 1 (January), 1b (mid February to mid March) and Phase 2 (April). The replacement of the appliances with more efficient models was conducted over a period of time, either during phase 1b or between phase 1b and phase 2.

The following tables and figures identify the relevant phases and the periods over which data were measured or averaged. Fuller datasheets for appliance electricity use for each household and phase are contained in Appendix 4.

2.2a Appliance usage

The usage of each appliance type varied considerably between households. Tables 8a and 8b show the number of cycles per week for each appliance and per occupant. In all cases the family households used the appliances more frequently than the individual ones - but the single occupancy households used their washing machines more frequently per person. Note that occupancy here includes both adults and children.

The number of dishwasher uses per person per week varied from 0.4 to 1.89 for singles, and from 0.69 to 1.59 for families; and for washing machines, from 1.93 to 4.12 for singles and from 1.21 and 1.7 for families. For families the number of uses per occupant for tumble dryers varied from 0.99 to 1.58 per week.

Table 8a: Cycles per week - whole household
Old appliances, average across all phases

Household	Occupants	Dishwasher	Washing m/c	Tumble dryer
1	1	1.89	4.12	
2	1	0.40	1.93	
3	5	3.46	6.03	4.95
4	5	7.97	7.93	6.53
5	3	3.26	5.09	4.75

Table 8b: Cycles per week – per occupant
Old appliances, average across all phases

Household	Occupants	Dishwasher	Washing m/c	Tumble dryer
1	1	1.89	4.12	
2	1	0.40	1.93	
3	5	0.69	1.21	0.99
4	5	1.59	1.59	1.31
5	3	1.09	1.70	1.58

2.2b Effect of household occupancy on electricity use

Table 9 shows the average electricity use per day for the original appliances, normalised by the number of occupants in each household (adults and children are counted alike).

Table 9: Consumption per day (kWh) - per person
Old appliances, average across all phases

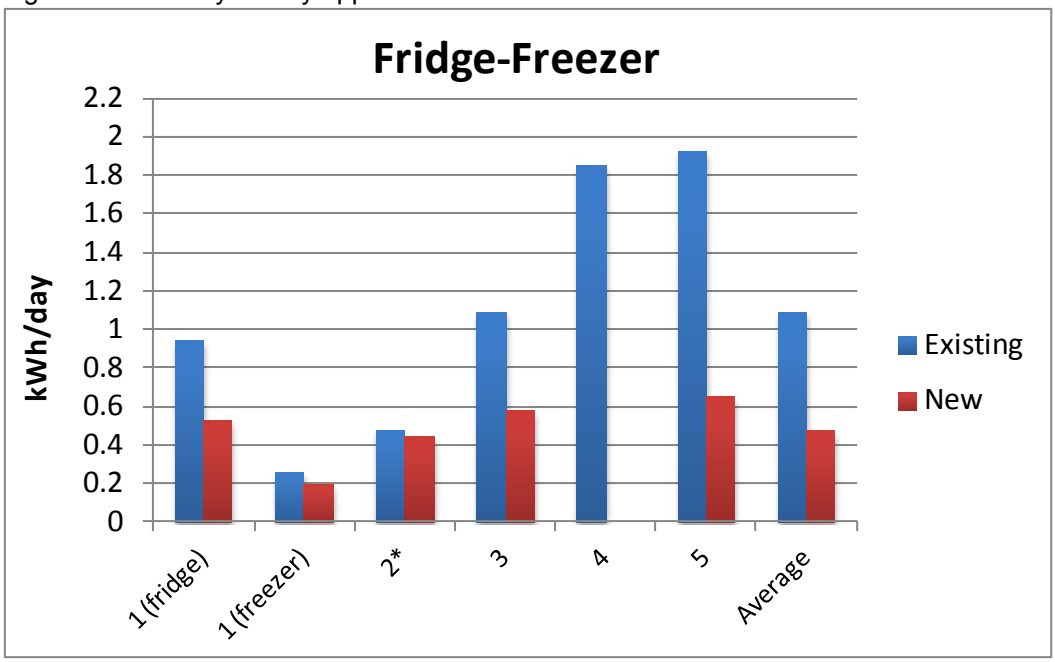
Household	Occupants	Fridge	Freezer	Fridge-freezer	Dish-washer	Washing m/c	Tumble dryer	Total
1	1	0.94	0.26		0.42	0.38		0.80
2	1			0.50	0.08	0.25		0.83
3	5			0.20	0.11	0.12	0.26	0.70
4	5			0.37	0.21	0.21	0.29	1.09
5	3			0.63	0.18	0.28	0.33	1.43

This table takes into account the energy efficiency as well as the usage of the appliances and again reflects very considerable differences in energy consumption.

2.2c Appliance electricity use

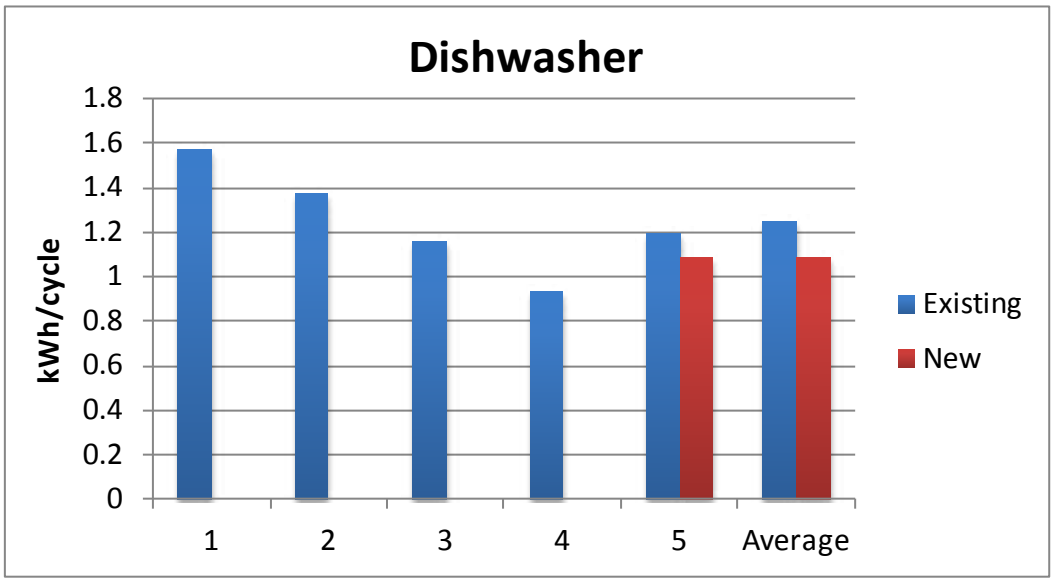
The figures below show the mean electricity use per day (for cold appliances) and per cycle (for washing and laundry appliances). The red bars represent the new replacement appliances. It is clear that significant reductions are brought about with the new appliances, as indicated by the lower height of the red bars.

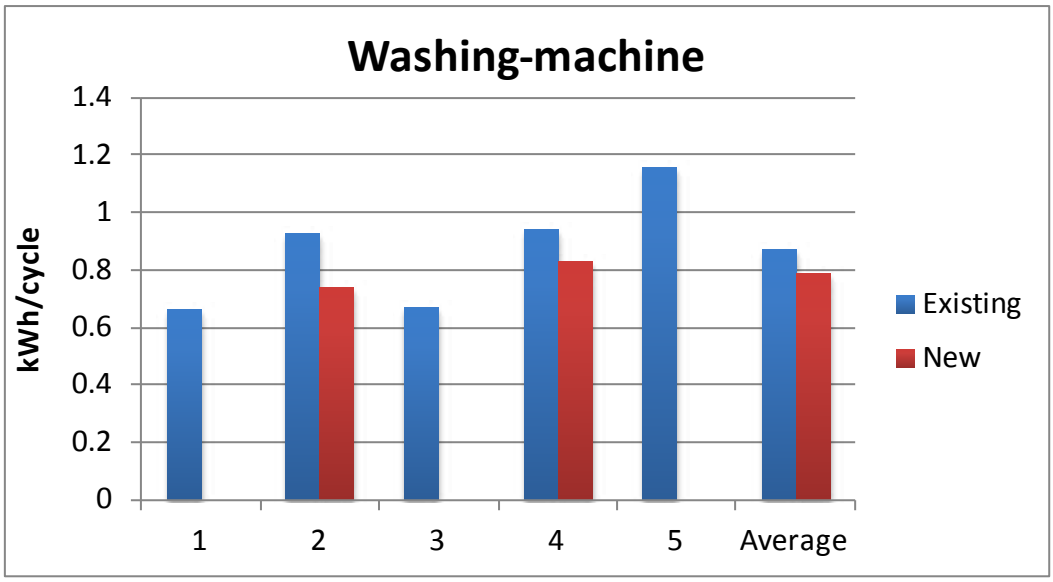
Figure 4: Electricity use by appliance and household

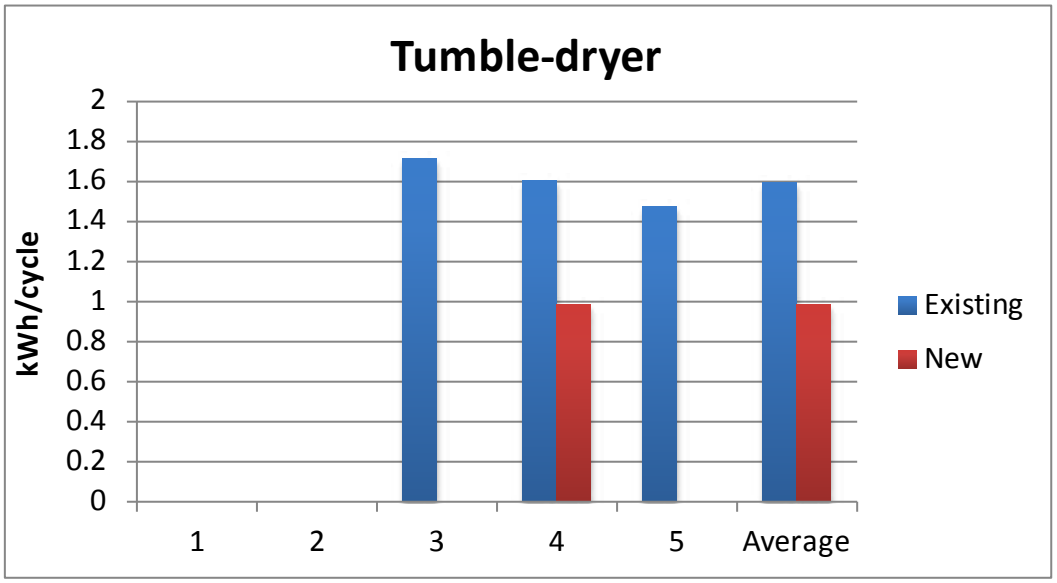


Note: households 2-5 have combined fridge-freezers and household 1 has separate fridge and freezer

Note: for household 2, it was discovered that the freezer compartment of the new fridge-freezer was left ajar for much of the final monitoring phase, due to some residual packing material having not been removed. This may explain the limited improvement in performance.







Tables 10 and 11 show the same electricity use data for the original and replacement appliances. Table 12 shows the percentage reduction in electricity use achieved through appliance replacement.

Table 10: Electricity use per day or per cycle (kWh); old appliances
Average across all phases

Household	Fridge	Freezer	Fridge-freezer	Dish-washer	Wash m/c	Tumble dryer
1	0.94	0.26		1.57	0.66	
2			0.48	1.37	0.93	
3			1.09	1.16	0.67	1.71
4			1.85	0.93	0.94	1.60
5			1.92	1.19	1.16	1.47

Table 11: Electricity use per day or per cycle (kWh); new appliances
Average across all phases

Household	Fridge	Freezer	Fridge-freezer	Dish-washer	Wash m/c	Tumble dryer
1	0.53	0.20				
2			0.45		0.74	
3			0.58			
4					0.83	0.98
5			0.65	1.09		

Table 12: Improvement in electricity use from new appliances
Average across all phases

Household	Fridge	Freezer	Fridge-freezer	Dish-washer	Wash m/c	Tumble dryer
1	43%	23%				
2			6%		21%	
3			47%			
4					12%	39%
5			66%	8%		

Note: for household 2, it was discovered that the freezer compartment of the new fridge-freezer was left ajar for much of the final monitoring phase, due to some residual packing material having not been removed. This may explain the limited reduction in energy usage.

In all instances of appliance replacement, savings in energy use were achieved with no evident changes to how the appliances were used, demonstrating that replacing an old with a new energy efficient machine does (unsurprisingly) yield energy savings of itself.

The savings by type of appliance were:

- fridge-freezer replacement typically yielded savings of 47% to 66% (excepting the malfunctioning Household 2 unit, see note above)
- the separate fridge and freezer replacements in Household 1 each yielded significant savings, with an aggregate saving for combined freezing and refrigeration services of 39%
- dishwashers and washing machines saved between 8% and 21%
- the tumble dryer replacement also yielded high savings (39%): the figures for tumble dryer energy use *per cycle* are not reliable, as in practice people use tumble dryers in a variety of ways, interrupting cycles to add or remove items, and restarting with extended drying time if items are not found to be dry enough. However the 39% reduction above reflects a comparison of overall energy use for tumble drying before and after replacement, and is thus a reliable indicator.

2.2d Energy saving practices

As described in section 1.2c, a set of changes in practice were requested of four of the households, reflecting energy saving behaviours that they reported they had not tried. Household 1 was not asked to make any changes in practices.

Table 13 shows the results of the implementation of these energy saving practices in the households. Each of the other households was asked to try a change affecting two or three of their appliances. However, from the data collected it is not possible to make a comparison of the effect of changes for several of these as the households were not asked to record the details of their practices in sufficient detail.

The results for those practices that could be assessed do, nevertheless, indicate strong reductions in energy use.

Table 13: Energy saving practices: 18th to 25th April
Shaded cells indicate the appliance affected was a new replacement

	Dishwasher			Washing m/c		
Household	Average kWh/cycle	Low temp detergent & low temp kWh/cycle	Reduction %	Average kWh/cycle	Low temp detergent & low temp kWh/cycle	Reduction %
1						
2				0.74	0.48	35%
3	1.25	1.02	19%	0.82	0.34	59%
4	0.87	0.58	34%			
5						

For dishwashing, Household 4 tried two washes using a 35deg.C setting with Premium Brand tablets. This resulted in 34% lower electricity use than their usual 50deg.C setting. However they noted that the loads did not wash as well.

Household 3 (18 month old dishwasher) tried a 45deg.C 'Fastwash' using Premium Brand tablets for five washes. This used 19% less electricity than their usual 55deg.C 'Ecowash', with satisfactory results.

For clothes washing, Household 2 tried one wash at 30deg.C with a Premium Brand non-bio in their new, replacement machine. This used 35% less electricity than their usual setting. Similarly, throughout Phase 2 Household 3 (5yo) tried using a 30deg.C 'Everyday' wash, which saved 59% compared to their claimed usual 40deg.C 'Everyday' setting.

The shaded cells in Table 13 indicate where the practice changes were implemented with appliances that had been replaced. Due to the small sample size it is not possible to draw clear conclusions;

however it is evident that for Household 2, even though a new A+ washing machine was in use, a further reduction in electricity use of 35% could be achieved through a change in user practice. Although the evidence base is slim, this implies a cumulative saving from appliance replacement plus behaviour change of 48%.

2.3 Supplementary qualitative data

It was suggested at the beginning of the study that there was a good overall level of awareness in all of the households in relation to energy efficiency, particularly regarding the importance of cost. However, as the study unfolded, it was apparent that this knowledge does not always equate to behaviour. For instance, whilst some of the participants washed their clothes at lower temperatures, there was variable knowledge on energy labels, and many of them do not, apparently, look at the energy labels on appliances. All of the participants felt that they had gained something from their participation in the project and had taken different things from the experience:

> *"The monitoring process in particular has made a big difference to the ways in which we use energy"* (Household 4).

> *"I was already aware [of energy] but the questionnaire made me think more than anything else. It has not really changed anything as I was doing most of the things suggested in the first place. My solar panels have been the things making the most difference I think. Everyone should have solar panels I think, with batteries to store the power"* (Household 2)

This participant argued that the study had influenced him to continue to improve his energy use:

> *"I behave completely differently when my wife is not here. I might wear the same shirt for several days in a row for instance. I behave differently as a consumer where I might wear the same clothes for longer so that you don't do so much washing or ironing for instance"* (Household 5).

The presence of a dog was pointed out as adding to the electricity consumption of one of the single occupant houses:

> *"…you have done this thinking that there is one person living here, but having a dog is like having an extra person – in terms of washing his bed regularly etc."* (Household 1)

This may have some validity as this single person household scored highest for energy consumption across all appliances on a per person basis.

In relation to the new appliances which had been installed in the household, one of the participants pointed out:

> *"I have enjoyed the experience because I would like to be a better energy consumer. The new appliances have been great for us and they have shown how more modern appliances can make a difference to energy consumption"* (Household 5)

He went on to say that both new appliances (i.e. fridge-freezer and dishwasher) had been "a great success…actual usage and space dimensions have been great as well as functionality."

This participant in Household 2 made the point that her age meant that she often struggled with new technology in general and that this had been the case with the new appliances that had been installed:

> *"I found it difficult to get to grips with the technology [new washing machine]."* (Household 2).

The two single occupancy participants highlighted certain practical issues that can influence the extent to which behavioural practice changes are, or are not, feasible. For instance one of these participants has disabilities and this serves to limit some of the behaviours which might be undertaken by other people, and the other one is elderly:

> *"As a person with disabilities and requiring walking sticks I cannot carry heavier loads which will be the case if I use a slower spin."*
>
> *"I find it difficult to adapt to new things at my time of life – it's the same with my computer."*

As the extracts above highlight, some circumstances mean that changes in behaviour can be difficult and that there may be a need for more technologically driven solutions. Other 'single occupant' issues raised included:

> *"I live on my own so I can't wait for a full load…"*
>
> *"I never mix "whites" with "coloureds" so my wash loads will be smaller"*
>
> *"Specialist brands of detergent are so much more expensive and I can't always afford them unless they are on special offer…"*
>
> *"I use specialist brands on heavily soiled items. The cheaper brands cope very well for lightly soiled clothing"*
>
> *"I always use my washing machine overnight to save on running costs as I have a "white meter" [off peak tariff]*

3. CONCLUSIONS AND POST-STUDY REFLECTIONS

3.1 Conclusions

Whilst all of the participants considered themselves to be 'green' and energy conscious - and indeed three had recently had solar panels installed - in practice their actual energy usage and routines leave significant scope for further efficiency savings. The analysis reveals that the highest household energy use per person for washing-machines and dishwashers was between double and treble that of the most energy efficient.

Energy-efficiency was a not a top priority when buying appliances - and understanding and attention paid to energy labelling was limited. In normal use participating households had rarely, if ever, tried the lowest temperature settings for their wet appliances. When challenged with trying a variety of potential energy-saving measures - such as untangling, and/or pre-sorting, washing before using the tumble dryer - convenience of not doing so for some participants overcame their desire to save energy or money. For one participant who did undertake these suggested changes to tumble dryer practice, the efficiency benefits (both in relation to drying time and energy usage) became unmistakably evident.

As noted above the participants best fitted the '1. Positive Greens' and '5. Concerned Participants' categories as set out by Defra in 2008. The DEFRA framework (p8) revealed that 'segments 1, 2 and 3 offer the most potential in terms of their ability to act, … Segment 5's willingness to act is informed by their concerns about others' actions". This small study suggests that in practice these groups' self-perception of their action on reducing their energy consumption is considerably ahead of their actual actions and willingness to act in certain areas of appliance use.

In practice and in all cases substantial energy savings could be achieved: in the case of cold appliances and the tumble dryer predominantly by switching to newer more energy efficient models; in the wet appliances predominantly by reducing the temperature of the wash, but also by using newer technologies.

Whilst the cold appliance and tumble dryer savings only required a purchase with little further effort; behavioural changes were also necessary for the 'wet' appliances.

The 'test week', when participants were asked to carry out a range of new energy-efficient practices, demonstrated that some of the perceived barriers to behaviour change could be quite easily overcome with limited effort; and give rise to results that exceeded the expectations of some participants.

The potential for considerable savings through behavioural and practice-oriented changes to the daily use of appliances appear not always to have been fully appreciated. A range of relatively 'simple' measures with less

potential energy-saving impact (such as switching off mobile phone chargers at the wall overnight) were, however, routinely followed - reiterating the potential for additional savings through the adoption of further habitual changes, e.g. turning down the temperature of the wash.

The new appliances offer substantial energy savings with the existing state of technology. There seems however to be a disconnect between this technology and consumer behaviour, which is likely to be due in part to cultural factors - as other countries such as Germany have a much larger purchase level of high specification, energy-saving appliances. Clearly we would need a much larger sampling framework which might include international comparison and longitudinal inquiry to further substantiate this finding.

Disconnect between consumer behaviour and technology can probably most profitably be addressed by a mixture of public education by government agencies; clearer demonstrations on how to save energy and money from manufacturers and retailers; and a financial mechanism to encourage the take up of appliances with a proven energy saving.

This represents a substantial opportunity to save money, electricity and greenhouse gas emissions.

3.2 Post-study reflections and policy recommendations

From a research perspective, the overall impression of conducting this programme of work is generally positive. It proved: very successful in relation to participant engagement; fruitful in respect of monitoring data collected; and insightful with regard to the potential for energy efficiency improvements involving both appliance and behavioural changes. There are, however, elements of the approach taken which would inevitably be modified (given the benefit of hindsight) in future programmes designed to build on the evidence base established through the present study.

Installation, maintenance and data downloading from energy monitoring equipment require specialist knowledge; and failures in equipment and software do occur, necessitating regular testing. It is therefore recommended to employ specialist assistance and to use a robust web-based interface for data collection as far as possible. Second, we propose that any extended future study makes allowance for further support to cover the engagement with households, including scheduling of visits. Every household presents different circumstances and challenges and this variety requires significant time and resource to manage. It is postulated that this may also help to mitigate the influence of real-life practicalities in implementation as noted above.

In terms of the design of a future study it would be beneficial to incorporate the following:

- An extended study sample representing a broader range of 'baseline' environmental awareness (i.e. covering the full range of segments described in the Defra 2008 model);
- Splitting this larger sample into 'control' and 'treatment' subgroups in order to test more completely the interface between technology and (changed) behaviour;
- Increasing the duration of the study in order to shed light on the durability of savings enabled through behavioural and technology-oriented changes;
- Increasing the breadth and reach of the study to identify how these issues are addressed by different cultures and how best practices can be transferred.

The principal policy recommendations are:

1. Energy labelling to be far more visible on all communications on brochures, webpages and instore;
2. Clearer information relating the energy rating of new appliances to the cost saving potential;
3. Clearer requirements for manufacturers to provide explicit information to consumers on the most energy-efficient use of their new appliances;
4. A reinvigorated communication programme focusing on behaviour change, coupled with new technology;
5. Encouragement of further research to explore more fully the nature of the restricting and factors is also recommended;
6. A mechanism to encourage consumers to trade-up old (especially) cold appliances for new high efficiency replacements.

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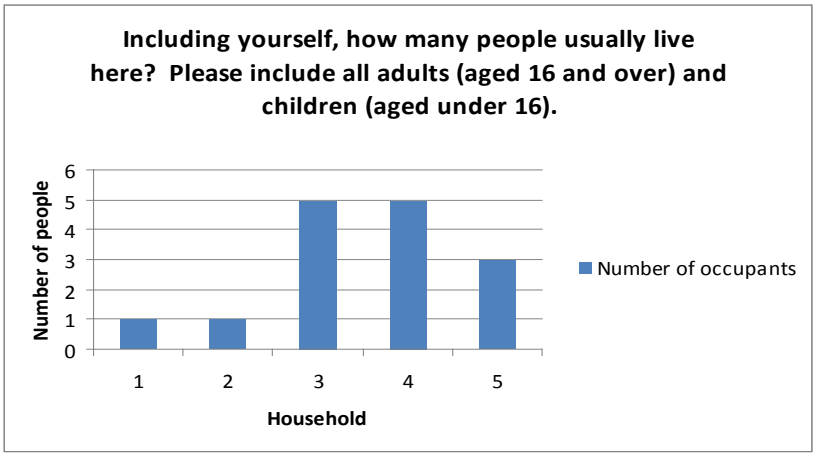
Appendix 1: Household and respondent characteristics

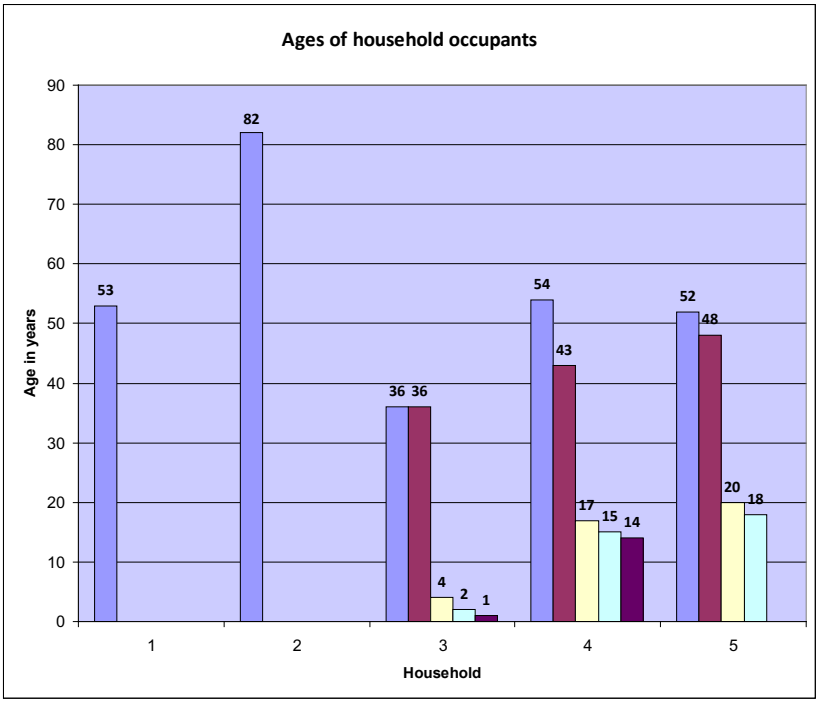
Type and age of properties

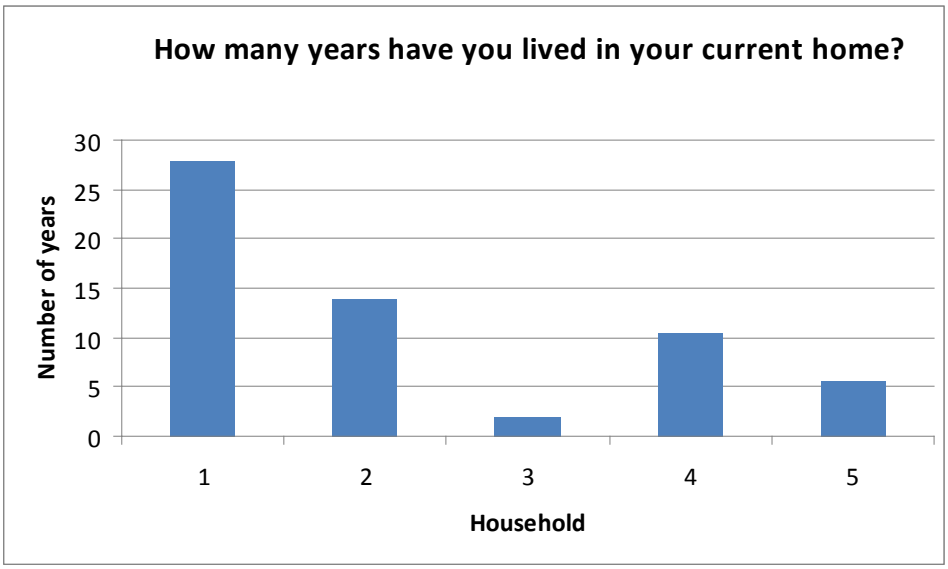
	Type of property	Date property built
Household 1	Detached bungalow	1953
Household 2	Detached dormer bungalow	1948
Household 3	Detached House	1960
Household 4	Detached House	1970
Household 5	Detached House	1950

Gender of respondent(s)

	Male	Female
Household 1		1
Household 2		1
Household 3		1
Household 4	1	1
Household 5	1	







What is the working status of adults in the household?	
Household	Working status
1	Medically retired
2	Retired
3	1 full-time paid work; 1 not in paid employment
4	1 full-time paid work; 1 part-time paid work
5	2 full-time paid work; 1 still at school; 1 in full time higher education

The two households with children, and the household with a single occupant of working age, are all buying their houses with mortgages. One house of four adults has "other" accommodation status (clergy). The house belonging to the eldest adult is owned outright.

Appendix 2: Initial site visit and appliance use/practices questionnaire

1. Household and respondent characteristics

1. Code gender of respondent(s)
Male
Female

2. Including yourself, how many people usually live here? Please include all adults (aged 16 and over) and children (aged under 16).

Enter number

3. Please could you tell me the age of each person on their last birthday?

Enter age of each person
Refused

4. What is the working status of adults in the household?
Full-time paid work (30+ hours per week)
Part-time paid work (8-29 hours per week)
Part-time paid work (under 8 hours per week)
Retired
Still at school
In full time higher education
Unemployed (seeking work)
Not in paid employment (not seeking work)
Refused

5. Which of these best describes your home?
Detached house
Semi-detached house
Terraced house
Bungalow
Flat (in a block of flats)
Flat (in a house)
Maisonette
Other (specify)
Don't know
Refused

6. Which of these best describes how you occupy your accommodation?
Own it outright
Buying with a mortgage
Pay part rent part mortgage (shared ownership)
Rented
Other
Don't know
Refused

7. Do you know roughly when your home was built?
1929 or earlier
1930-1965
1966-1994
1995 or later
Don't know
Refused

8. How long have you lived in your current home?
Up to 1 year
More than 1 year, up to 2 years
More than 2 years, up to 5 years
More than 5 years, up to 10 years
More than 10 years, up to 20 years
More than 20 years
Don't know
Refused

2. Environmental and energy behaviour

We are now going to discuss some of the issues involved with energy use in the home and what you understand by this in terms of your everyday practices

1. What are some of the key issues that determine your energy use in the home with regard to both home heating and more general electricity use? Are decisions based for instance on:
- Cost;
- Environment;
- Efficiency;
- Warmth;
- Convenience;
- Habits.

2. Have you ever tried to adopt more efficient heating/electricity practices? For instance have you insulated your home/bought solar panels/changed to green electricity?
- When?
- What did you do?
- Why did you do it?
- Why did you not do it?

3. What sort of circumstances, if any, would make you consider changing your practices to more efficient ways of heating your home and in relation to other forms of domestic energy use?
- For instance, if you were moving home, would you consider it then?
- Can you imagine any other situations in which you would be likely to make changes?

4. I am now going to read out some changes that people might make to their lifestyles. For each one tell me which answer on the card applies to you *personally* at the moment. Remember there are no right or wrong answers – we're just interested in what you *personally* do at the moment, *not* what you think you should or shouldn't be doing.

1. Turning down the thermostat (by 1 degree or more)
2. Putting on an extra layer rather than turn up heating
3. Washing clothes at 40 degrees or less
4. Waste less food
5. Recycle more
6. Making an effort to cut down on water usage at home
7. Buying energy efficient ('A' rated or better) appliances
8. Cutting down on the use of hot water at home
9. Use a car less
10. Walk or cycle more

[HAND RESPONDENT SHOWCARD 1]

SHOWCARD 1

Answer Options

I don't really want to do this
I haven't really thought about doing this
I've thought about doing this, but probably won't do it
I'm thinking about doing this
I'm already doing this, but I probably won't manage to keep it up
I'm already doing this and intend to keep it up
I've tried doing this, but I've given up
I haven't heard of this
Don't know
Not applicable

3. Environmental and energy attitudes

Before we move on to ask you about household appliances, here are a couple of questions about your own thoughts on issues related to energy and the environment

1. How much if anything would you say you know about the following terms?

Climate change
Global warming
Carbon footprint
CO2 (carbon dioxide) emissions
Biodiversity

[HAND RESPONDENT SHOWCARD 2]

SHOWCARD 2

Answer Options

A lot
A fair amount
Just a little
Nothing – have only heard of the name
Nothing – have never heard of it
Don't know

2. How much do you agree or disagree with these statements?

1. I don't really give much thought to saving energy in my home
2. I find it hard to change my habits to be more environmentally-friendly
3. It would embarrass me if my friends thought my lifestyle was purposefully environmentally friendly
4. It's not worth Britain trying to combat climate change, because other countries will just cancel out what we do
5. The effects of climate change are too far in the future to really worry me
6. It's not worth me doing things to help the environment if others don't do the same
7. It's only worth doing environmentally-friendly things if they save you money
8. *Any changes I make to help the environment need to fit in with my lifestyle*
9. I need more information on what I could do to be more environmentally friendly
10. I would be prepared to pay more for environmentally-friendly products
11. I often talk to friends and family about the things they can do to help the environment
12. The environment is a low priority compared to other things in my life
13. If government did more to tackle climate change, I'd do more too
14. I don't believe my everyday behaviour and lifestyle contribute to climate change

[HAND RESPONDENT SHOWCARD 3]

SHOWCARD 3

Answer Options

Strongly agree
Tend to agree
Neither agree nor disagree
Tend to disagree
Strongly disagree
Don't Know

4. Household appliances

1. What are the main considerations that you take into account when purchasing a new electrical appliance? For instance:

- Purpose;
- Brand;
- Cost;
- Status;
- Renewal

2. How does a product's 'energy efficiency' rate in comparison to these?

3. Are you aware of the current energy labelling system? How do you think current energy rating practices on appliances could be made more relevant to consumers?

4. Is the current energy labelling system a help, a hindrance or irrelevant in your opinion?

5. Do you consider it important to turn down or switch off domestic appliances fully (rather than leaving on standby)?

- If you do, which appliances and when?
- Why did you do it?
- Do other members of your household do the same thing? Is it something that you ever discuss or argue about in your house?

6. Have you ever considered not buying or having a product if it was energy intensive/environmentally damaging? Why not?

7. Would you consider it reasonable if companies themselves stopped producing energy intensive products for the market in the first place or should the onus be on consumers to change purchasing habits?

8. Could tell me about the way you use your washing machine/dishwasher/tumble dryer in relation to:

- Daily/weekly practice;
- Different cycles used for different types of wash loads?
- Particular brands of detergent used;
- Does the machine has an energy saving button/cycle and if so how much this is used?
- What would encourage the use of lower temperature cycles?

Mid-Point Survey Questions

Washing machine

Description of practice	Do his always	Do this sometimes	Tried and rejected	Not tried	Not applicable
A half load usually uses more than half the energy of a full load – ensure that you use full loads.					
Washing at 30C can cut energy costs by 50%+ - use it for all but the most soiled loads					
Some specialist detergents are more effective at lower temperatures – use them					
A slower spin saves energy and reduces creasing and reduces the energy required when ironing – use a slower spin when you are drying outside					
A fast spin uses less energy to dry clothes than a tumble-dryer – use fast spin before tumble-drying					
If lights are on then the machine is using electricity – turn off completely when not in use					

Dishwasher

Description of practice	Do this always	Do this sometimes	Tried and rejected	Not tried	Not applicable
A half load usually uses more than half the energy of a full load – ensure that you use full loads.					
A fully-loaded dishwasher uses less water and energy than washing dishes by hand – save up your dishes to fill the dishwasher completely					
Washing at no more than 50 or 55°C can save a lot of energy — use the lowest appropriate temperature settings					
Some specialist detergents are more effective at lower temperatures – use them					
Energy saving cycles take longer but use less energy – use them					

Dishwasher manufacturers advise how to load their machines to optimize water and energy use – load according to the manufacturer's plan					
If lights are on then the machine is using electricity – turn off completely when not in use					

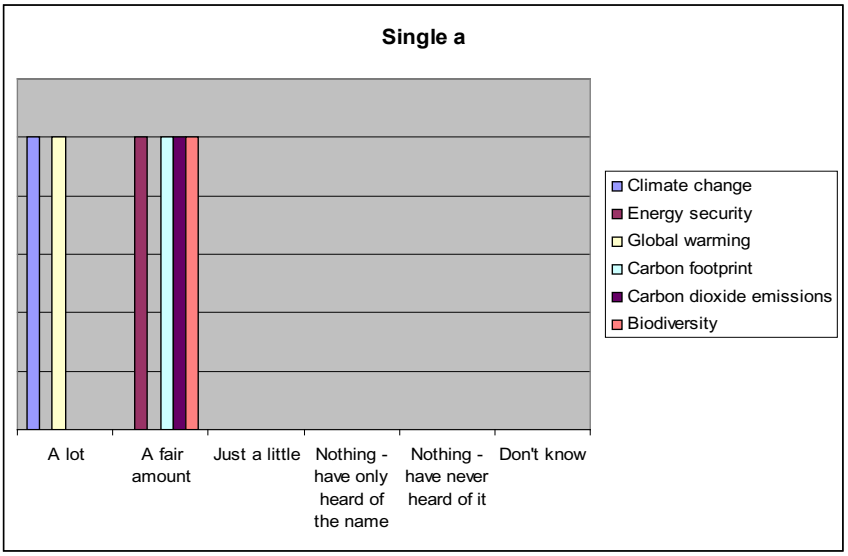
Tumble dryer

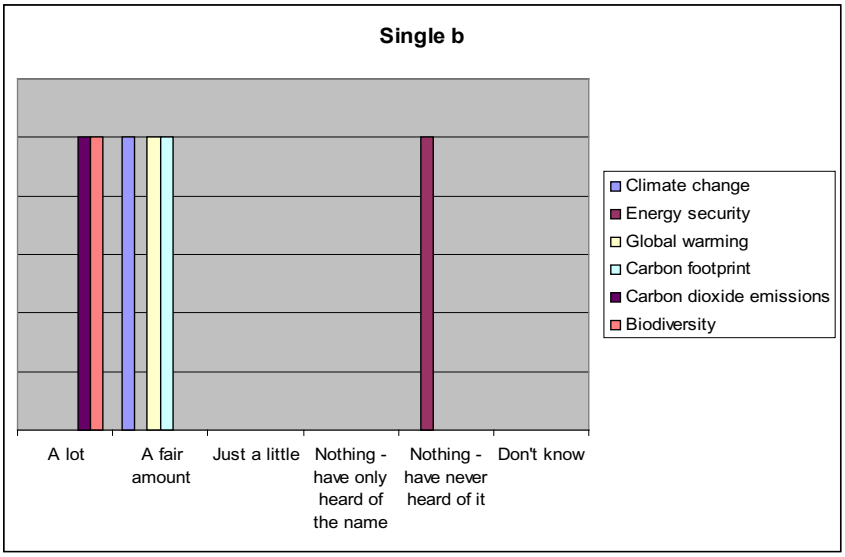
Description of practice	Do this always	Do this sometimes	Tried and rejected	Not tried	Not applicable
Compacted fabrics will take longer to dry - when loading the dryer, untangle clothes and bedding					
Overloading can use more energy, cause undue wear and tear on the machine, and increase the time spent ironing to get the wrinkles out – ensure that the load weight complies with manufacturer advice					
Putting clothes that still feel wet at the end of the wash back in on a high spin cycle, this uses less energy than tumble drying – don't put very wet items in the tumble dryer					
Sorting your laundry by fabric type and using the appropriate heat setting for each will reduce average drying time, save energy and make your clothes last longer – sort laundry and use the appropriate settings					
Blocked filters impede the airflow and cause the machine to use more energy and take longer to dry the items – regularly clean the lint filters					
– regularly clean or vacuum the filter cavity					
If you have a vented dryer a blocked vent hose will likewise put more pressure on the motor and reduce efficiency – check and clear vent hose regularly					
Hang or fold clothes up straight away after drying them so they will need less ironing					
If lights are on then the machine is using electricity – turn off completely when not in use					
Dry outside, when the weather permits					

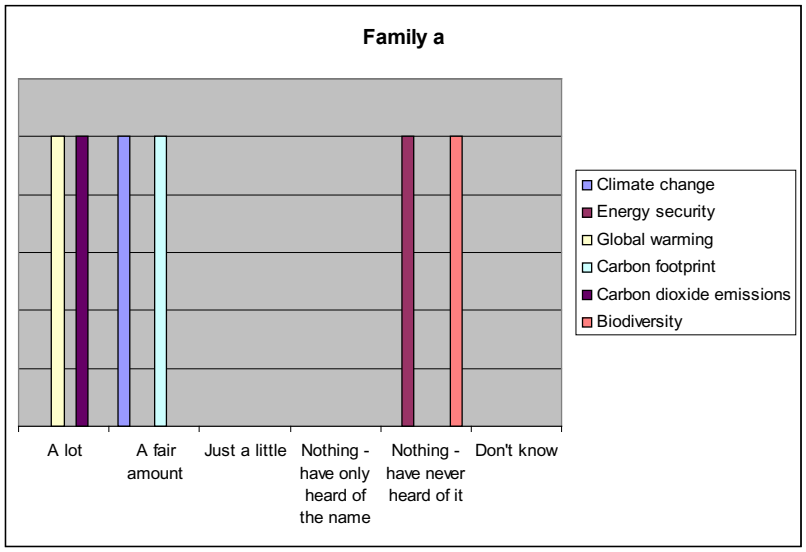
Fridge/fridge-freezer

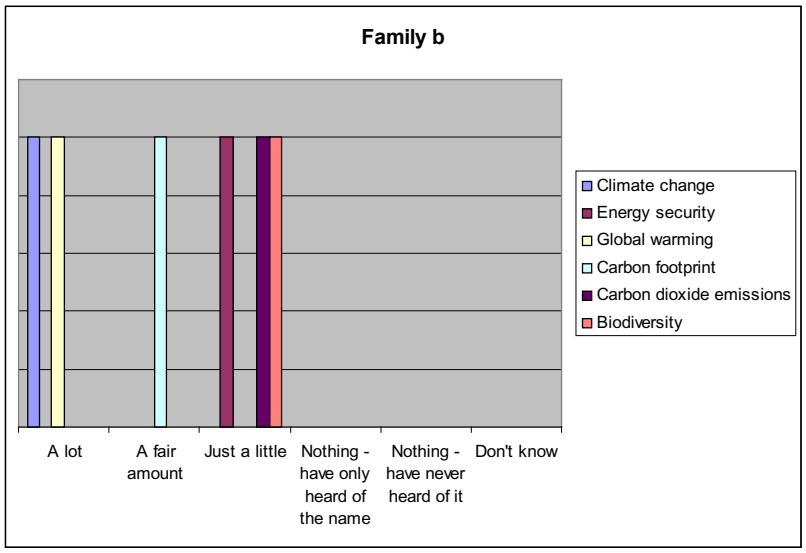
Description of practice	Do this always	Do this sometimes	Tried and rejected	Not tried	Not applicable
Fridges and freezers are less efficient in cold places – avoid putting them in the garage or outside					
Fridges and freezers are also less efficient in hot places – avoid siting them next to a cooker or radiator, or in direct sunlight.					
Air must circulate for the appliance to operate efficiently – avoid overloading					
Fridge units have dedicated areas for foods that require different levels of cooling – use the as the manufacturer advises					
Nearly empty, or unnecessary, food packaging takes up space and makes the fridge/freezer less efficient – do not freeze nearly empty packages					
Putting warm items in the fridge/ freezer may cause other items partially to defrost and wastes energy - leave warm items to cool before putting them inside					
Fridges/freezers have variable temperature controls to suit different needs – adjust the temperature controls to the appropriate temperature for your needs, check manufacturer's recommendations for food safety					
Some fridge/freezers have eco-settings for added economy – check and use eco setting					
Opening the fridge/freezer door, or leaving it open, warms up the inside requiring more energy to cool it again - avoid leaving the door open					
Defrost food in the fridge overnight rather than microwaving it.					
Freeze your leftovers, or eat them the next day					
Check what you have in the fridge and freezer before you go shopping. Wasted food is a big contributor towards carbon dioxide emissions					

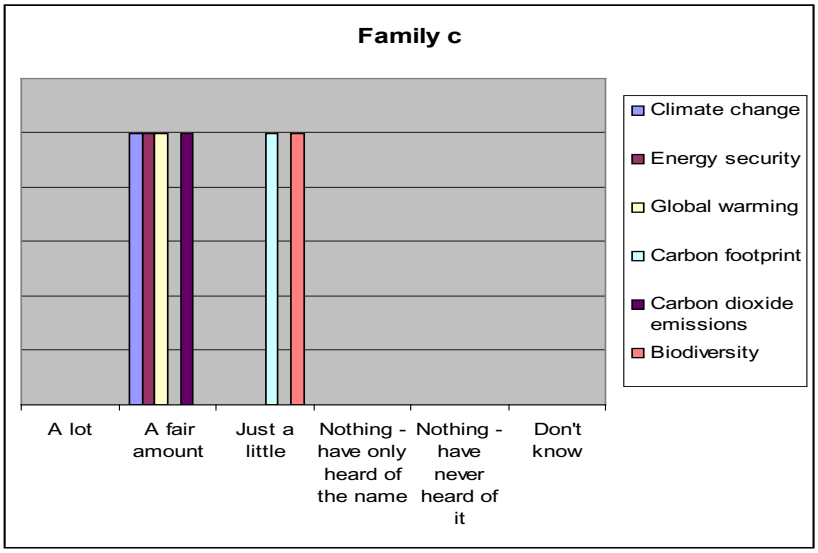
Appendix 3: Degree of stated knowledge by household





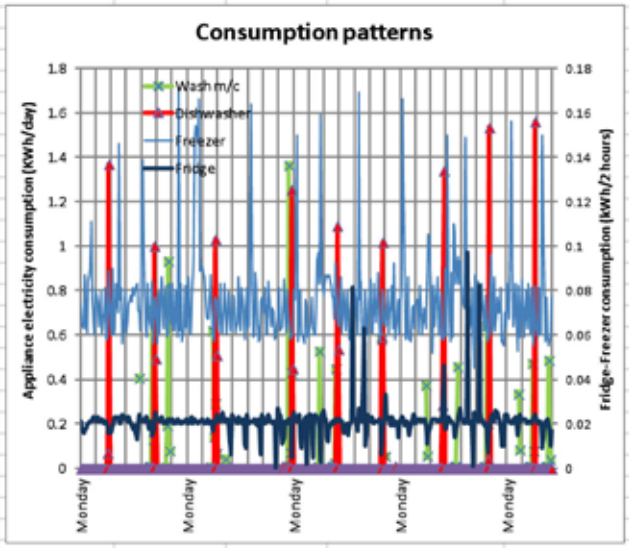

Family a
Climate change
Energy security
Global warming
Carbon footprint
Carbon dioxide emissions
Biodiversity
A lot
A fair amount
Just a little
Nothing - have only heard of the name
Nothing - have never heard of it
Don't know

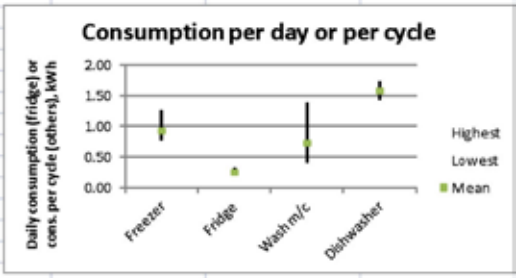

Family b
Climate change
Energy security
Global warming
Carbon footprint
Carbon dioxide emissions
Biodiversity
A lot
A fair amount
Just a little
Nothing - have only heard of the name
Nothing - have never heard of it
Don't know

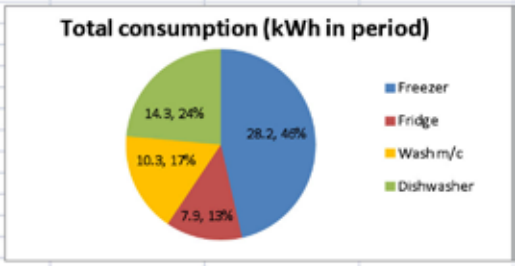

Family c
Climate change
Energy security
Global warming
Carbon footprint
Carbon dioxide emissions
Biodiversity
A lot
A fair amount
Just a little
Nothing - have only heard of the name
Nothing - have never heard of it
Don't know

Appendix 4: Datasheets for monitored energy consumption

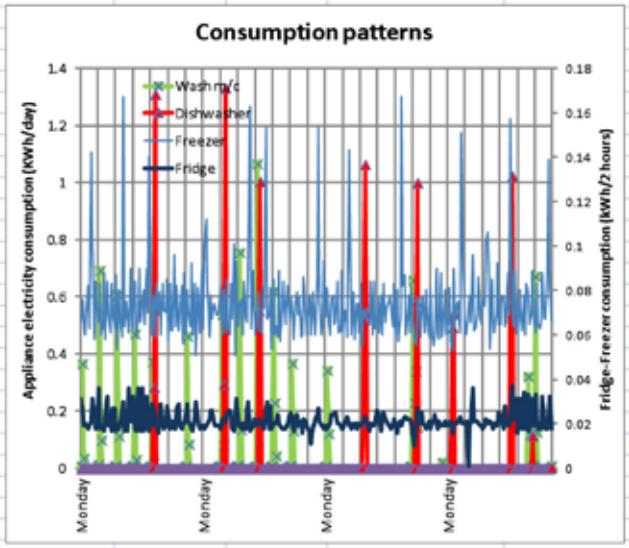
Household	Period: start	end		Freezer	Fridge	Wash m/c	Dishwasher
House 1	02-Jan-12	01-Feb-12	Cycles/week			3.27	2.10
			Average consumption/ day or per cycle (kWh)	0.94	0.26	0.74	1.59

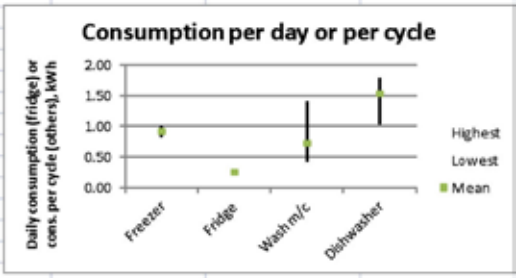


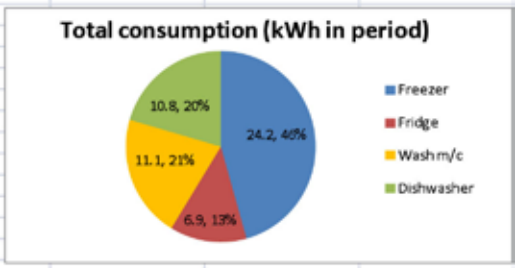




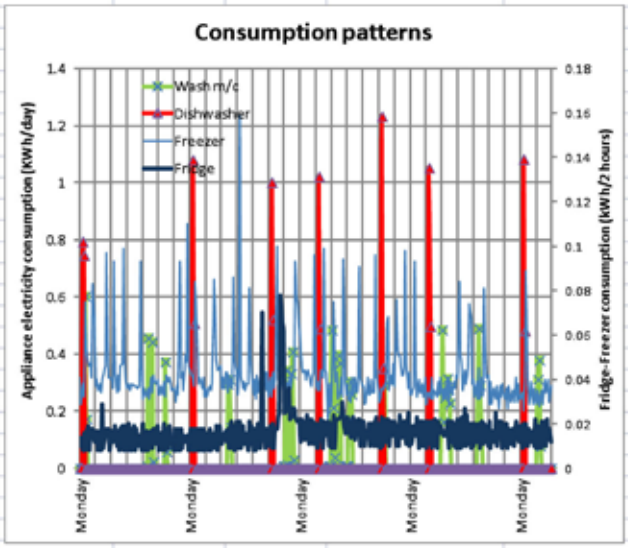
Household	Period: start	end		Freezer	Fridge	Wash m/c	Dishwasher
House 1	15-Feb-12	12-Mar-12	Cycles/week			4.04	1.88
			Average consumption/ day or per cycle (kWh)	0.93	0.27	0.74	1.55

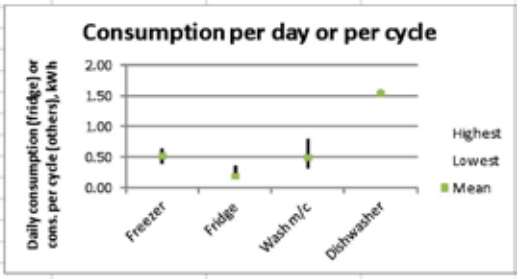


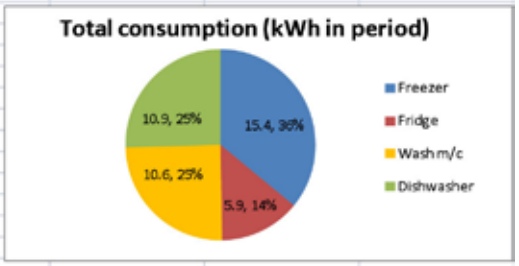




Household	Period: start	end		Freezer	Fridge	Wash m/c	Dishwasher
House 1	27-Mar-12	26-Apr-12	Cycles/week			5.07	1.69
			Average consumption/ day or per cycle (kWh)	0.53	0.20	0.51	1.56



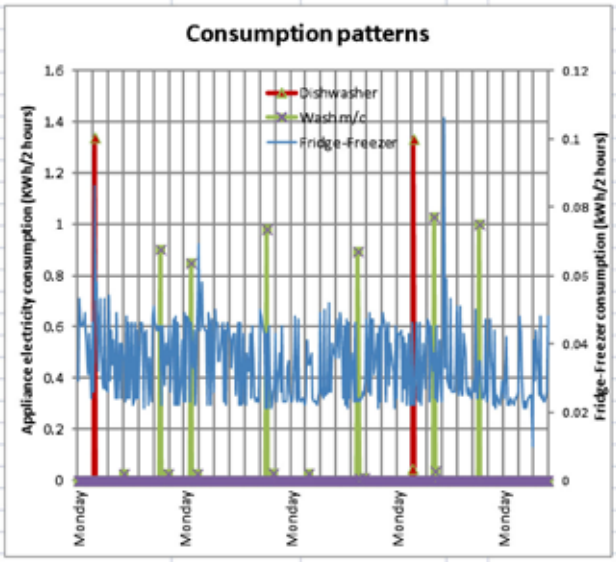


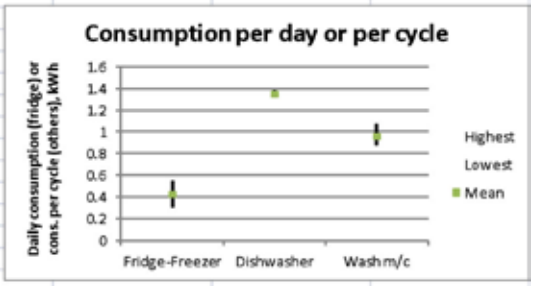


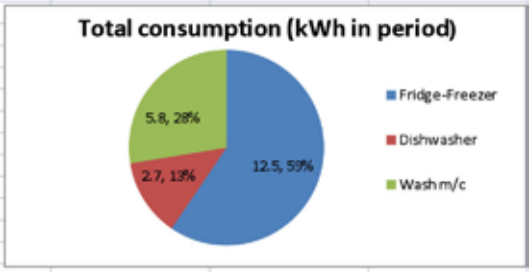
New fridge installed 13th March. New freezer installed 20th March. (Both before start of this phase)

Household	Period: start	end
House 2	02-Jan-12	31-Jan-12

	Fridge-Freezer	Dishwasher	Wash m/c
Cycles/week		0.48	1.45
Average consumption/ day or per cycle (kWh)	0.43	1.36	0.97

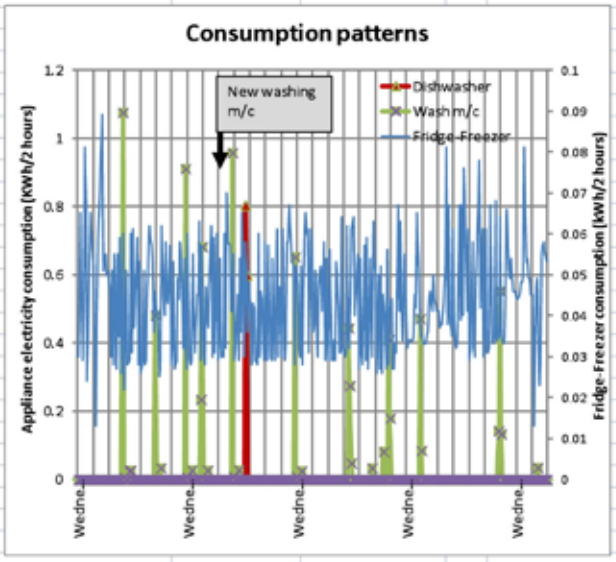


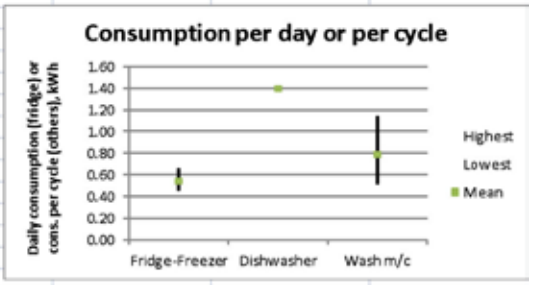


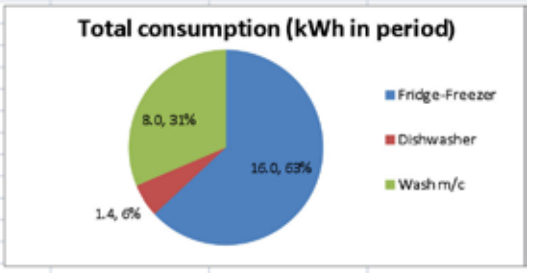


Household	Period: start	end
House 2	15-Feb-12	15-Mar-12

	Fridge-Freezer	Dishwasher	Wash m/c
Cycles/week		0.24	2.41
Average consumption/ day or per cycle (kWh)	0.55	1.41	0.80
Avg cons/ day or per cycle - old appliance			0.89
Avg cons/ day or per cycle - new appliance			0.74



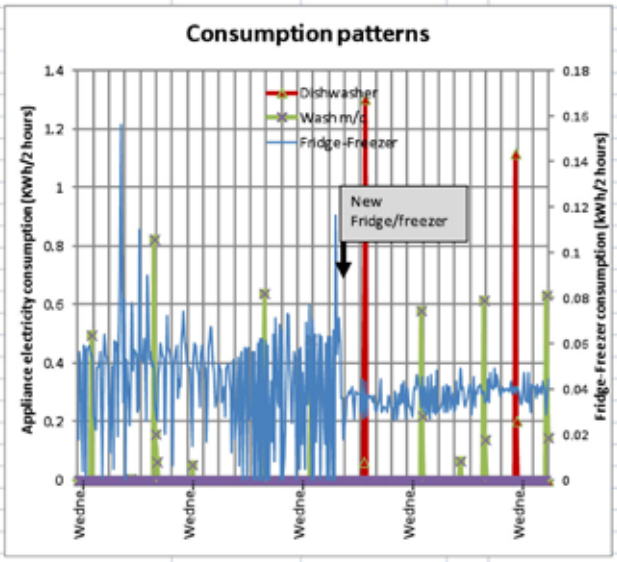


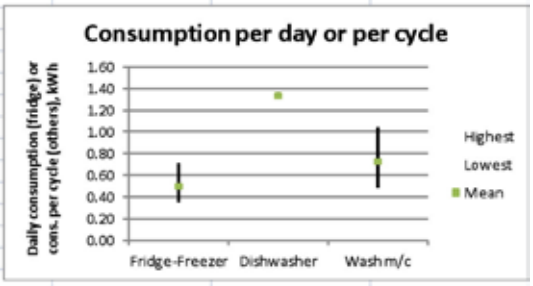


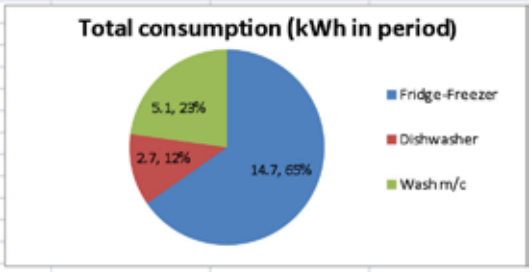
New washing machine on 23rd February

Household	Period: start	end
House 2	04-Apr-12	03-May-12

	Fridge-Freezer	Dishwasher	Wash m/c
Cycles/week		0.48	1.69
Average consumption/ day or per cycle (kWh)	0.508	1.34	0.74
Avg cons/ day or per cycle - old appliance	0.509		
Avg cons/ day or per cycle - new appliance	0.454		

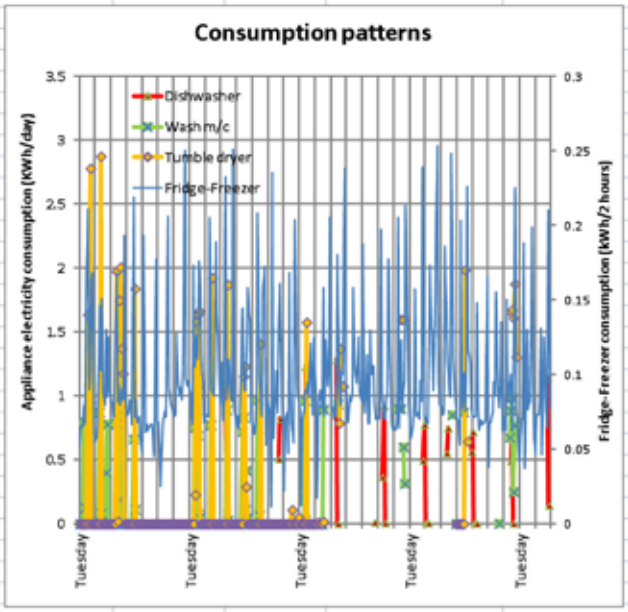


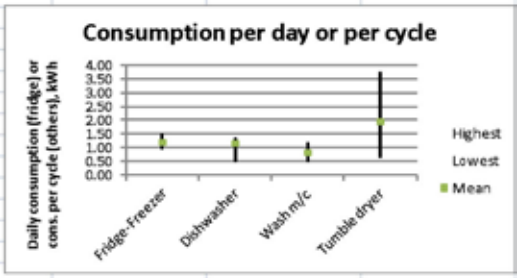


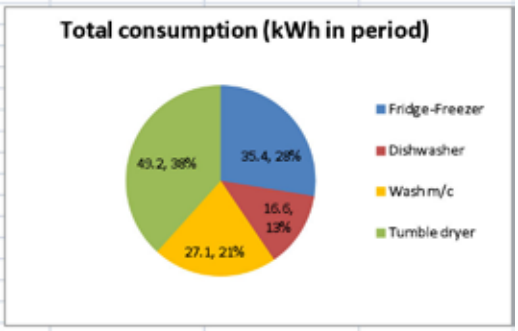


Fridge-Freezer installed week starting 23rd April

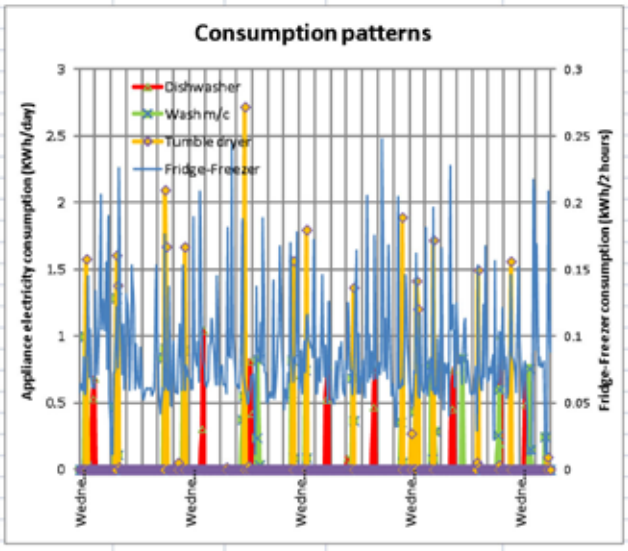
Household	Period: start	end		Fridge-Freezer	Dishwasher	Wash m/c	Tumble dryer
House 3	03-Jan-12	01-Feb-12	Cycles/week		3.38	7.72	6.03
			Average consumption/ day or per cycle (kWh)	1.22	1.19	0.85	1.97

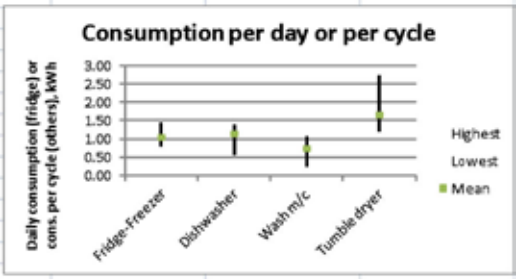


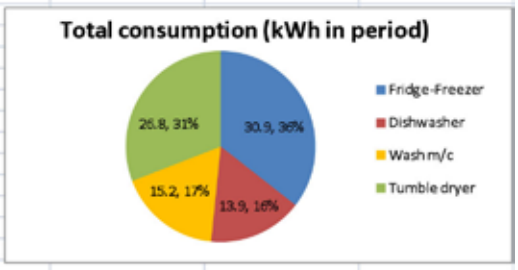




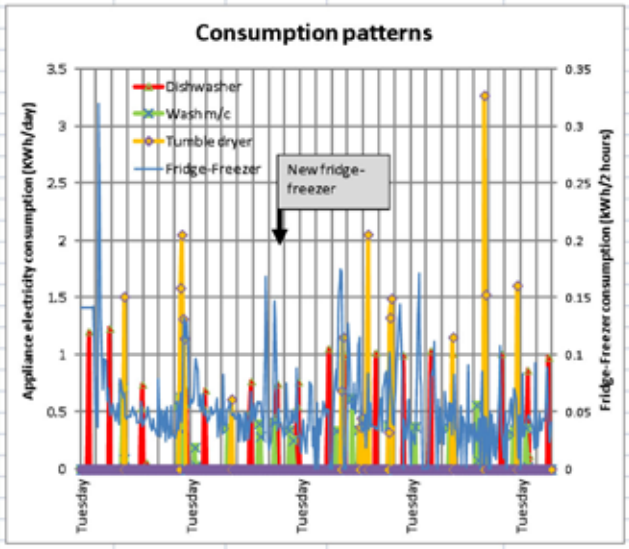
Household	Period: start	end		Fridge-Freezer	Dishwasher	Wash m/c	Tumble dryer
House 3	15-Feb-12	15-Mar-12	Cycles/week		2.90	4.83	3.86
			Average consumption/ day or per cycle (kWh)	1.06	1.16	0.76	1.68

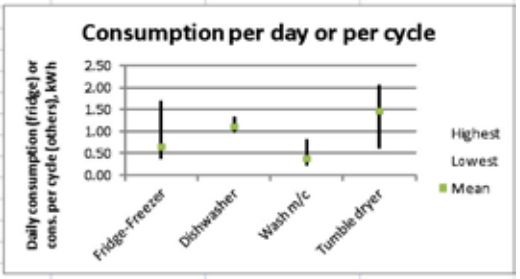


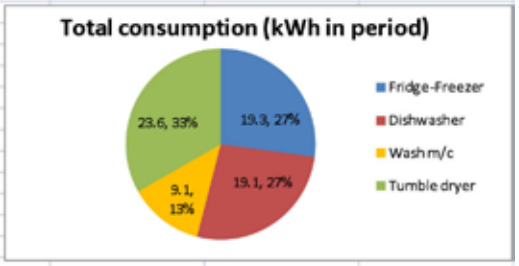




House 3	03-Apr-12	02-May-12	Cycles/week		4.10	5.55	3.86
			Average consumption/ day or per cycle (kWh)	0.67	1.12	0.39	1.48
			Avg cons/ day or per cycle - old appliance	0.76			
			Avg cons/ day or per cycle - new appliance	0.58			



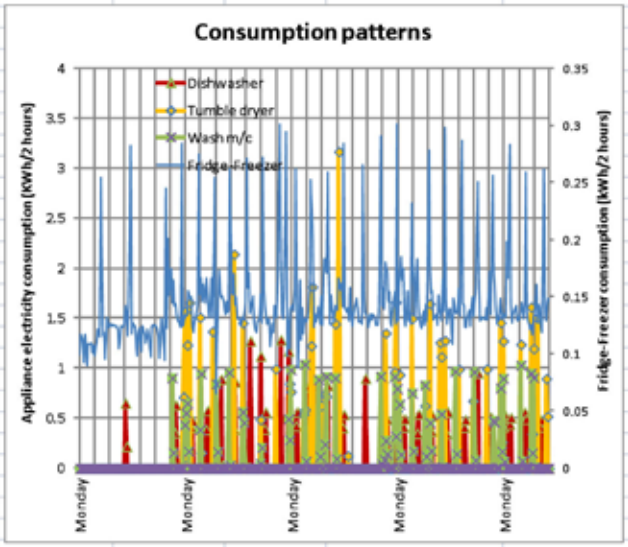


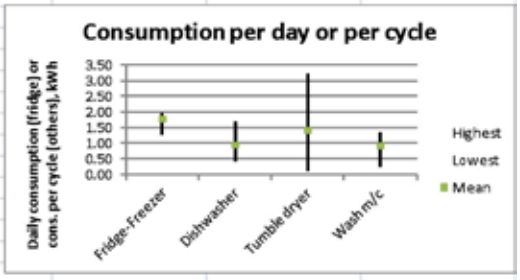


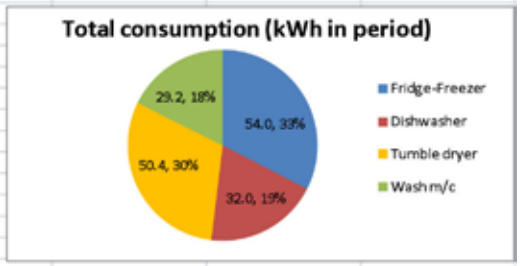
New Fridge installed on 3rd April. New Fridge-Freezer installed on 14th April

Household	Period: start	end
House 4	02-Jan-12	01-Feb-12

	Fridge-Freezer	Dishwasher	Tumble dryer	Wash m/c
Cycles/week		7.70	8.17	7.23
Average consumption/ day or per cycle (kWh)	1.80	0.97	1.44	0.94

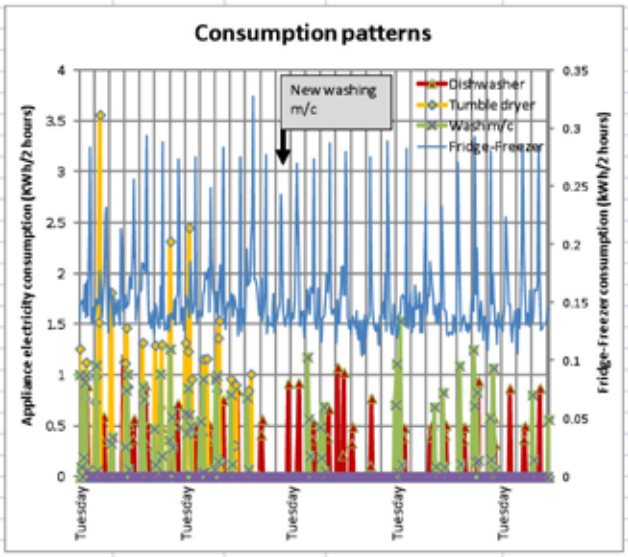


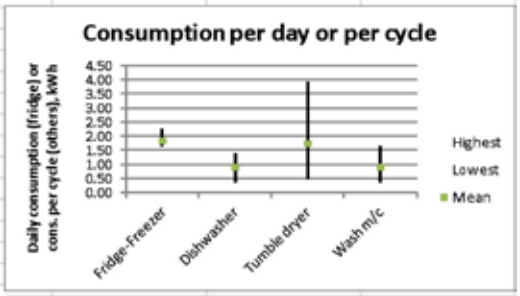


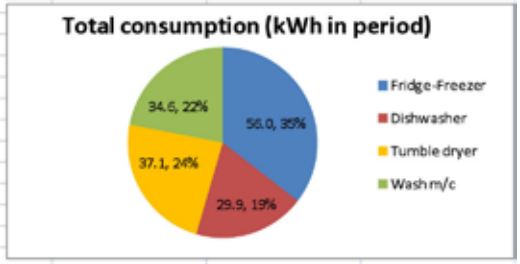


Household	Period: start	end
House 4	15-Feb-12	15-Mar-12

	Fridge-Freezer	Dishwasher	Tumble dryer	Wash m/c
Cycles/week		7.47	4.90	8.63
Average consumption/ day or per cycle (kWh)	1.87	0.93	1.77	0.93
Avg cons/ day or per cycle - old appliance				0.94
Avg cons/ day or per cycle - new appliance				0.93

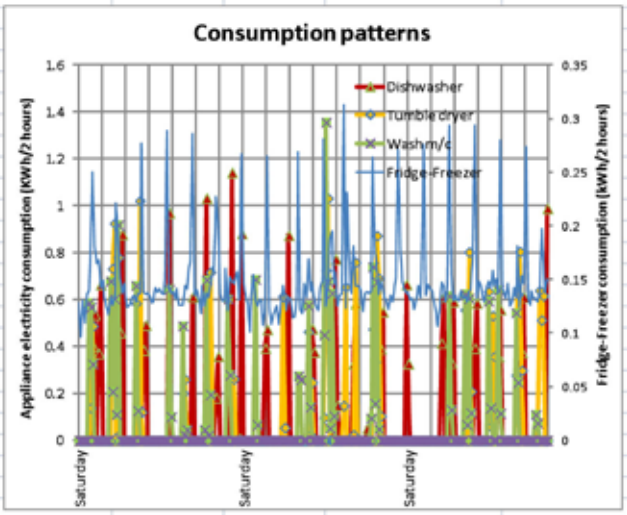


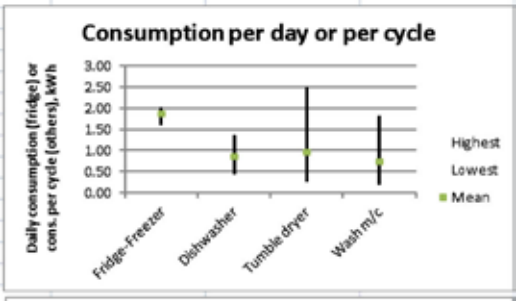


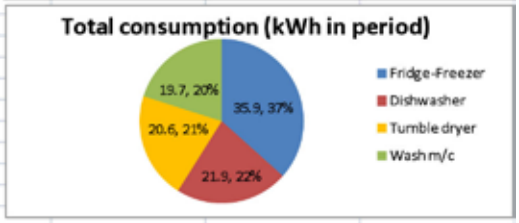


Tumble dryer monitor seems to have stopped working after 25th Feb
Washing machine installed 27th February

Household	Period: start	end		Fridge-Freezer	Dishwasher	Tumble dryer	Wash m/c
House 4	14-Apr-12	03-May-12	Cycles/week		9.21	7.74	9.58
			Average consumption/ day or per cycle (kWh)	1.89	0.87	0.98	0.76



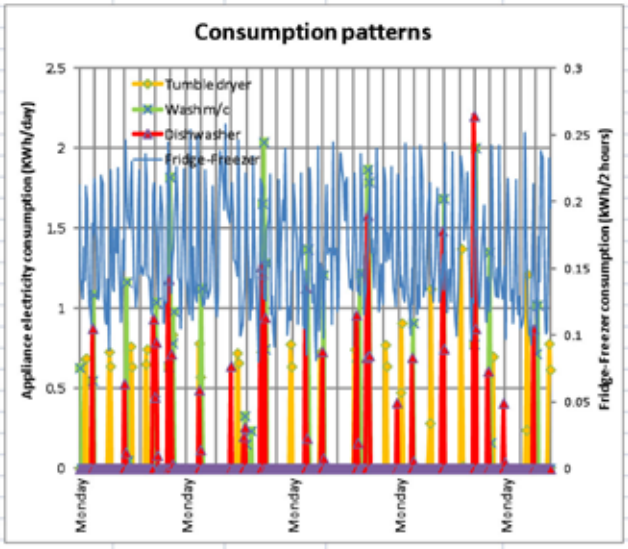


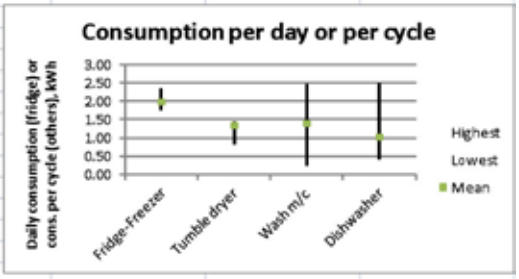


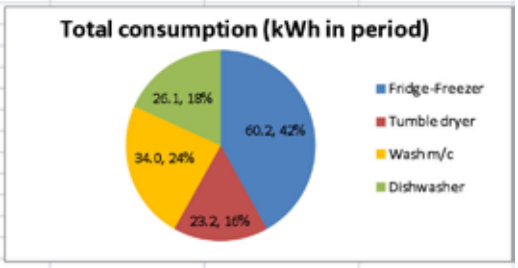
Appliance monitors not recording 4th April to 13th April

New tumble dryer installed week of 11th March (before this phase)

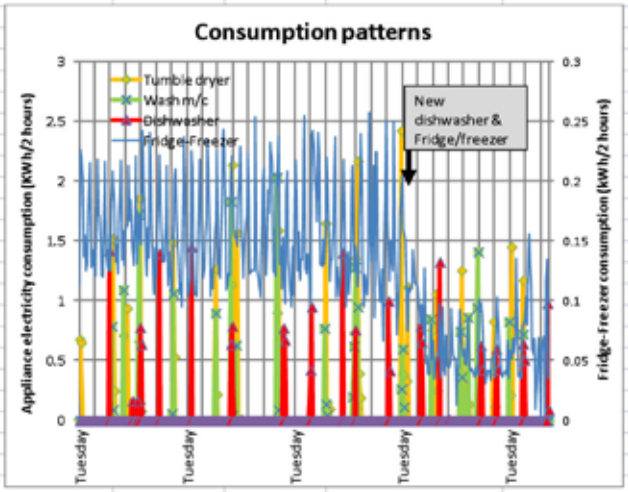
Household	Period: start	end		Fridge-Freezer	Tumble dryer	Wash m/c	Dishwasher
House 5	02-Jan-12	01-Feb-12	Cycles/week		3.97	5.60	5.83
			Average consumption/ day or per cycle (kWh)	2.01	1.36	1.42	1.05

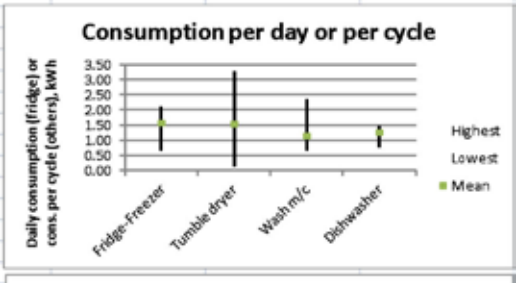


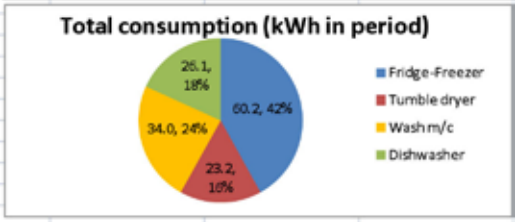




Household	Period: start	end		Fridge-Freezer	Tumble dryer	Wash m/c	Dishwasher
House 5	15-Feb-12	15-Mar-12	Cycles/week		5.55	4.59	3.86
			Average consumption/ day or per cycle (kWh)	1.60	1.56	1.17	1.28
			Avg cons/ day or per cycle - old appliance	1.798			1.360
			Avg cons/ day or per cycle - new appliance	0.710			1.050







Dishwasher installed 9th March; Fridge-freezer installed 9th March

Household	Period: start	end		Fridge-Freezer	Tumble dryer	Wash m/c	Dishwasher
House 5	28-Mar-12	26-Apr-12	Cycles/week		3.38	5.07	2.90
			Average consumption/ day or per cycle (kWh)	0.64	1.49	0.90	1.11