Powering the Nation

Household electricity-using habits revealed

energy saving trust®

DEPARTMENT OF ENERGY & CLIMATE CHANGE

defra
Department for Environment Food and Rural Affairs

About the Energy Saving Trust

The Energy Saving Trust gives impartial, accurate and independent advice to communities and households on how to reduce carbon emissions, how to use water more sustainably and how to save money on energy bills.

We work in partnership with government, local authorities, third sector organisations and businesses. Our activities include:

- delivering or managing government programmes
- testing microgeneration technology
- certification and assurance for businesses and consumer goods
- developing models and tools

The Energy Saving Trust is a social enterprise with charitable status.

The Energy Saving Trust was formed in 1992.

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Executive Summary

In 2010, the Department for Environment, Food and Rural Affairs (Defra), the Department of Energy and Climate Change (DECC) and the Energy Saving Trust jointly commissioned an ambitious, ground-breaking study designed to uncover the actual, day-to-day, minute-by-minute, electricity consumption habits of the nation.

Until now a survey of this magnitude, complexity and depth had been considered unviable. This was because of the technical challenges inherent in monitoring, the cost of such an ambitious project, and the social challenge of recruiting an appropriately sized, nationally representative mix of willing householders who could be relied upon to stay the course of such a study. In spite of these issues it has long been recognised that in order to deliver the most impactful and appropriate policies it is crucial to have an accurate understanding of how people consume energy in their homes.

This project has overcome each one of those challenges. It provides us with the richest insights ever produced in the UK into how people interact with the electrical products that power their lives. It sweeps away entrenched, outmoded assumptions about the how, the why and the when of appliance use. It allows us to update our models to paint a thoroughly modern, accurate, 21st-century picture of what is actually happening inside people's homes. Most importantly, it lays bare the magnitude of the task required to ensure UK citizens reduce their energy use and contribute to the emergence of a low-carbon future.

There are a number of (mostly unwelcome) surprises uncovered by the study.

Domestic background standby consumption is much higher than previously estimated. On average, our study households spent between £50 and £86[1] a year on their appliances in a standby, or 'non-active', state. This compares with an observed, average annual electricity bill for all households monitored[2] of around £530. Consequently, we see that total standby consumption[3] can amount to nine to 16 per cent of domestic power demand. This is significantly higher than the current five to ten per cent estimated/modelled for domestic standby power[4].

The observed energy demand of the single-person households monitored is a revelation. The old adage 'two can live as cheaply as one' is particularly true when it comes to electricity use. The monitored one-person households used as much, and sometimes more, energy as typical families on particular appliances. In particular, for cooking and laundry we observed the power demand of lone dwellers matching or exceeding those of average family units.

The implications of this finding, with over 29 per cent of all UK households currently single-person dwellings[5] in 2010, are troubling from a future energy demand perspective, particularly if the trend towards increasing numbers of lone households continues.

The UK really is a nation of television watchers. Instead of the previously assumed figure of almost five hours of typical daily TV viewing[6], our study shows this is more likely to top six hours a day. To put it another way, this is an additional 400 hours of viewing per household a year, equating to over 10 billion extra hours nationwide. This will cost the nation, on average, an extra £205 million a year in total.

We also love to keep our clothes clean. We run, on average, 5.5 washes a week, similar to the previous estimated average of five[7]. Households with a tumble dryer will dry 81 per cent of their wash cycles using dryers rather than utilising outdoor washing lines or other non-powered forms of drying. If households own a washing machine and a tumble dryer, then the price of laundering their clothes typically costs them £80 per year, not including the cost of detergents and fabric softeners.

We consume much more energy on keeping our crockery, glasses and cutlery clean than we do on our clothes. Households with dishwashers use on average nearly double the amount of electricity on this appliance than they do on washing machines[8].

The average annual electricity consumption in our test households was ten per cent higher than the UK national average[9], costing the average household in this study an extra £50[10]. And, intriguingly, these higher figures were from a group of householders whose stated attitudes regarding being careful of energy use in the home were, on average, a whole ten per cent higher than the national average.

These findings are just a taster of the wide range of insights that have been unearthed by the study. This summary report aims to give you a flavour of what has been discovered and to whet your appetite to delve in to the full report to discover more.

This study will prove invaluable over the coming years. It will help researchers and policy makers to get under the skin of the nation's energy-using habits. This research will allow government to form new policies that will fundamentally change the way people think of, and use, the electricity consumed in their homes. Not only do we need people to use less power, we also need them to use power differently and at different times, altering their behaviour to reduce the 'peak load' demands on the grid. This will become even more crucial when we have a greater contribution of decentralised and renewable power in the electricity mix in the next decade as well as the need to increase the amount of electricity available to power the next generation of electric vehicles.

As a result of this ground-breaking work, we now have the data and the evidence to get to grips with how people consume electricity in their homes. The next stage in this journey is to develop strategies and programmes that inform, educate and inspire people to take up the challenge of becoming 'energy-smart' in their everyday lives.

1. Introduction

Domestic energy use[11] in the UK accounts for over a quarter of the total CO_2 emissions of the country. We need accurate, up-to-date evidence of how, why, and when people use energy in their homes to ensure that the residential sector plays its part in helping to achieve the government's goals: a 34 per cent reduction in greenhouse gas emissions by 2020; 50 per cent by the mid-2020s; and the ambitious 80 per cent reduction by 2050. We need evidence to assess the potential for the UK's households to lower their energy usage, discover where the potential for big savings lie, help people save money on energy bills and lead more environmentally friendly lifestyles; but ideally without a material reduction in their comfort or perceived quality of life.

Although previous studies, both in the UK and abroad, have investigated the variety of appliances people own and how they typically use them, they tended to be both small in scale and limited in scope[12]. Generally, they focused on one electrical product group and were monitored over a relatively short timescale. The ideal study of household electricity consumption would monitor all electrically powered products in a home simultaneously and over a long enough timescale to gain evidence-based insights into typical habits and behaviours over the changing seasons.

Such a study would be invaluable for updating existing assumptions and data, which are used in models to forecast the impact of policy interventions on domestic energy usage and bills. Until now, comprehensive, whole-house electricity studies of this type have been achieved only in Sweden and France[13].

In 2010, Defra, DECC and the Energy Saving Trust jointly commissioned such an in-depth, whole-house study to cover the electricity usage of a representative sample of English owner-occupier homes.

The Household Electricity Use Study monitored a total of 251 owner-occupier households across England from 2010 to 2011. Twenty-six of these households were monitored for a full year; the remaining 225 were monitored for the duration of one month on a rolling basis throughout the trial.

The study had four broad objectives at the outset:

1. To identify and catalogue the range and quantity of electrically powered appliances, products and gadgets found in the typical home.
2. To understand their frequency and patterns of usage; in particular, their impact on peak electricity demand.
3. To monitor total electricity consumption of the home as well as individually monitoring the majority of appliances in the household.
4. To collect 'user habit' data when using a range of appliances through the use of diaries.

The study began in the spring/summer of 2010, with the initial recruitment of owner-occupier households across England for the year-long monitoring. The recruitment

1. Average minimum standby was measured at 343 kWh, costing approx. £50 annually if this minimum average is taken to be a constant background standby consumption, average maximum yearly standby consumption was 591 kWh costing a maximum of £86 (if in standby 20/7) using an average electricity price (2011/12) of 14.5 pence per KWh.
2. The study found the total average annual electricity demand for all dwellings monitored in the survey (excluding electrically heated homes) to be 3,638 kWh.
3. Including both background standby, typically unavoidable electricity use inherent in a number of household products and avoidable standby consumption, e.g. turning products and gadgets off at the switch.
4. Source: BNXS36: Estimated UK standby electricity consumption in 2006.
5. ONS figures for household make-up, Social Trends 41 7.5 million single households c.f. 25.3 total households in 2010.
6. MTP BNCE TV02: Televisions (TVs) Reference Scenario (2009) puts average primary TV daily watching at 4.8 hours.
7. MTP Briefing note BNW01 2009 Key inputs, 260 cycles per year in 2007.
8. Washing machine annual consumption is166 kWh, and dishwasher annual consumption is 296 kWh.
9. Currently averaged at 3,300 kWh per household per year for the UK. The study's average consumption was 3,638: **http://www.ofgem.gov.uk/Markets/RetMkts/Compl/Consumption/Pages/ConsumptionReview.aspx**
10. Using a 14.5 pence/kWh average cost for electricity in 2011/12.
11. This includes domestic heating, lighting, and powering appliances.
12. How trends in appliances affect domestic CO_2 emissions: a review of home and garden appliances. Technical Annex April 2010 (DECC publication).
13. The Swedish study monitored 400 homes in 2008; the French study, in 2007, monitored 100 homes over one year.

partner was asked to select a suitable range of householders to match, as closely as possible, the typical English socio-economic mix. Recruitment took place, in equal numbers, in the North, the Midlands and the South[14].

The Consumer Voice[15] database, run by Mori, was used for recruitment. The final make-up of the monitored households showed a good correlation when compared with the English national average in terms of 'life-stage', which is the criterion picked to construct representative quotas. Life-stage is an indicator of the composition of a household, taking into consideration the number of people in a household and their ages.

It is important to note that all the figures shown in this report are representative of owner-occupier[16] households only, rather than the entire English population. Approximately 69 per cent of all UK households were owner-occupiers in 2008[17]. It proved too difficult a task to recruit tenants to the study due to the challenges relating to gaining consent from landlords and the more frequent turnover of tenants in rented properties. However, even with this restriction a good demographic mix was achieved that matched the overall population profile of England.

Initial recruitment involved recruiting the 26 households that would be monitored for a full year, as well as the first tranche of the monthly sub-sets. Subsequently, recruitment was carried out on a rolling monthly basis throughout the 12-month period of the study. Two hundred and fifty-one households completed the study. As this is the first study of its type in the UK it was difficult to predict the rate of drop-out. It was assumed that it would be relatively high due to the effort involved and the level of intrusiveness perceived by the householders. To compensate for this, over-recruitment was undertaken. A total of 412 households were recruited throughout the year, with an initial goal of 240 households to be retained to ensure the study's findings would be robust.

Each participant was required to complete an attitudinal survey that covered issues such as their views and beliefs on the environment, their use of energy, and their attitudes to climate change. Questions taken from the Defra 'Framework for pro-environmental behaviours'[18] were also used to segment the participants into one of seven 'clusters'. Results from an earlier government-run attitudinal study could then be used to compare the participants' responses. It must be noted that, as the study[19] recruited owner-occupiers only, the results cannot be wholly correlated with other national generally representative samples that will typically include private and social tenants too. Instead, the study is a broad comparison with the national average.

In addition, the participants were asked to keep diaries in which they recorded their use of the main appliances in their homes. These diary entries, when matched with the electricity consumption data collected, do much to complete the picture of both total use and the patterns of consumption within typical households.

When questioned on attitudes to energy saving in the home, the results from the study households were broadly comparable to the national average. Around 86 per cent of the sample households agreed that they 'think about saving energy in the home', with just one in ten saying they did not; compared with 76 per cent and 14 per cent respectively for the national average.

The electrical product audit, carried out at the beginning of the monitoring period, gives fascinating insight into the number and range of products typically found in English homes. Table 1 shows the distribution of households with the total number of products they owned at the time of monitoring.

Number of appliances in households / percentage owning them		Average number of appliances owned	Minimum number of appliances owned	Maximum number of appliances
1 - 30	24%	41	13	85
31 - 40	29%			
41 - 50	26%			
51+	21%			

Table 1. Number of electrical appliances owned in the study households (excluding lighting)

The average number of electrical products (not including lighting) owned by the study households was 41. This fits well with earlier estimates of the number of items owned by modern households[20]. (Note that the average 1970s' home had about a dozen electrical appliances.) The maximum number of electrical items found in any single household was 85 products and the minimum number of products a modest thirteen. The highest percentage of households, nearly a third at 29 per cent, owned between 30 and 40 products; although one in five households owned 50-plus items.

More detail on the recruitment, attitudinal survey and monitoring processes undertaken for this project can be found in the Appendix.

The remainder of the report outlines a selective sample of the headline findings from the study, which paints a very detailed picture of how our modern daily lives are powered. It shows the minutiae of how and when people use their appliances, as well as providing an exhaustive audit of which 'mod cons' 21st-century households typically contain. This short report can give only a flavour of the breadth and depth of the data collected. The complete report, detailing all the findings, can be downloaded from the Defra and DECC websites[21]. In addition, there is a comprehensive database containing all data points and links to diary entries which is being made freely available for further research and study. These two resources combined will provide the domestic energy researchers with a rich seam of data and insights for years to come.

2. Overall electricity study findings

Total electricity use for each of the households was measured over the month of monitoring, or the full year in the case of 26 homes. The monthly figures were then annualised with an adjustment to compensate for whether they were monitored in the winter or summer[22].

The overall results are shown in Table 2, broken down by each house type. The final figure shows a weighted average for all dwellings in the study. These figures exclude the contribution of primary electric heating systems: there were nine homes that contained primary electric heating in our study, 3.5 per cent of the sample total; this compares with a national level of around 8–9 per cent of homes that are electrically heated.

Dwelling type	Annual consumption (kWh/year)
Terraced house – mid-terrace	2,779
Terraced house – end-terrace	3,442
Terraced house – small up to 70m2	2,894
Terraced house – med/large over 70m2	4,399
Semi-detached house	3,847
Detached house	4,153
Bungalow	3,866
Flat	2,829
Weighted average of all households	**3,638**

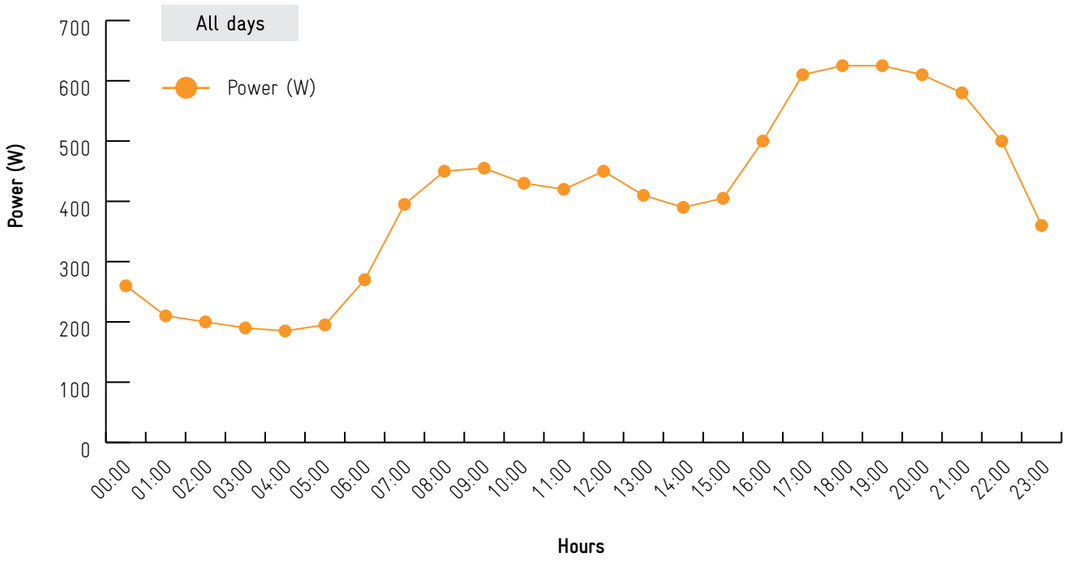
Table 2. Annualised average electricity consumption (kWh/year) excluding primary electric heating

The typical average domestic electricity annual consumption value currently used in the UK is 3,300 kWh/year[23]. This investigation shows that the study households were using 3,638 kWh/year, on average, which is ten per cent higher than the official average consumption figure. Average per capita consumption for the study was seen to be 2,012[24], kWh/person/year compared with 1,375 kWh/person/year nationally[25]. This is an interesting finding, given that the sample households have self-declared, on average, that they are more aware and interested in 'energy saving in the home' than the average UK household[26] (86 per cent versus 76 per cent respectively). The fact that this study included only owner-occupiers must be kept in mind here.

Daily peaks in hourly demand for electricity occur, unsurprisingly, at breakfast time and from about five until

14. Recruitment was not intended to reflect the national profile, but instead aimed for an equal split between the three regions to allow for comparisons to be made between them.
15. The Consumer Voice database contains details of respondents to Ipsos Mori's Capibus surveys. Capibus is a nationally and regionally representative sample of 2000 British adults surveyed weekly.
16. Those households that own their homes outright or have bought them with a mortgage.
17. ONS Social Trends 41: 2011 Edition, Chapter10: Housing.
18. Defra Framework for pro-environmental behaviours: **http://archive.defra.gov.uk/evidence/social/behaviour**
19. Defra 2009, public attitudes and behaviours towards the environment – tracker survey **http://www.defra.gov.uk/statistics/files/report-attitudes-behaviuors2009.pdf**
20. *Rise of the Machines*, a 2006 Energy Saving Trust publication on energy using products, calculated that the typical modern home would own around 40–50 appliances.
21. http://www.decc.gov.uk/en/content/cms/about/science/activities/reductions/reductions.aspx
22. Some appliance electricity use is seasonal, hence for the monthly households, depending on whether they were monitored in winter or summer, their monthly usage was adjusted by a factor to project their usage over one year. The factor was calculated on the annual data taken from the households monitored for the full year.
23. This figure, produced by Ofgem and based on meter point data, is a median figure; this means that it removes the long tail of a small number of very high users of electricity, and hence can be thought of as being more representative of typical household consumption. **http://www.ofgem.gov.uk/Markets/RetMkts/Compl/Consumption/Pages/ConsumptionReview.aspx**
24. This per capita number was calculated on the average number of people in a study dwelling. If the total electricity demand were divided by the national average number of people in a dwelling then the per capita consumption would be 1,515 (3,638/2.4 = 1,515 kWh).
25. 3,300 kWh divided by 2.4 = 1,375
26. 86 per cent self-reported that they often 'thought about energy saving in the home', compared with 76 per cent in a national survey; only one in ten said they were not interested in energy saving, compared with 14 per cent nationally.

Figure 1. Daily profile for electricity use in all test households (excluding electric heating)



ten in the evening. What is surprising, however, is the relatively high baseline demand for power throughout the night (1 a.m. to 5 a.m.). This hovers around 175–200 watts value all household types monitored, regardless of make-up, size of household or life-stage. Figure 1 shows the average 24-hour demand curve for all households monitored.

The power demand of different main appliance types, e.g. cold, wet cooking, lighting etc., are shown in Table 3. This shows their relative contributions to total electricity use (without electric heating[27]).

A direct comparison cannot be made with the official figures for domestic electricity consumption from Energy Consumption in the UK (ECUK) (a government publication which, amongst a wide range of statistics, gives an annual indication of the energy consumption of the main domestic products) as our Household Study figures include a number of products that could not be definitively placed in any one of the six main product groups. This has resulted in a group of products collectively known as 'Other'. These products include the small electrical items such as hair styling products, toothbrushes, shavers etc., and other products that are only occasionally used and that did not

Appliance type	Contribution to electricity consumption demand (percentage)
Cold appliances	16.2
Cooking	13.8
Lighting	15.4
CE	14.4
ICT	6.1
Wet appliances	13.6
Other	3.7
Not Known	9.7
Water heating	7.1

Table 3. Percentage contributions to domestic power demand in the study households (excluding electric heating)

27. This includes both primary electric heating systems and secondary heating devices.

produce an identifiable electric signature in the data. The 'Other' category accounts for nearly four per cent of total electricity demand.

There was some power consumption that could not be positively identified from the analysis: this contribution is collectively called 'Unknown'. It includes portable products that are charged through external power supply units, such as mobile phones, tablet computers, MP3 players, handheld games consoles etc. This accounts for nearly 10 per cent of total electricity use.

It is clear, however, that the traditional six main domestic appliance sectors – cold, wet, cooking, lighting, consumer electronics and computing – make up approximately 80 per cent of the total electricity used in a typical study household. So we can uplift these values for the six main sectors in our test households by a quarter (to total 100 per cent) to give us an approximate comparison with the main six domestic product sector figures used in 'Energy Consumption in the UK', (see Table 4).

Appliance type	Contribution to 2010 domestic power use by main 6 appliance sectors (ECUK 2011)[28]	Uplifted figures for test households (%)
Cold	17	20.5
Lighting	17	19.3
Cooking	16	17.3
Wet	17	17
CE	25	18
ICT	8	7.6
Total	**100**	**99.7**

Table 4. A comparison of the main six domestic appliance sectors contribution to domestic demand. ECUK figures for 2010 versus study household results uplifted to 100 per cent[29]

The surprise here is the smaller contribution of consumer electronics compared with the figures in ECUK. Entertainment products fall from first to third place. However, if combined with the ICT sector, which is increasingly the case with the continuing convergence of these product types, these two sectors make up 25 per cent of the total. Refrigeration and lighting make a bigger contribution overall than was recorded in 2010 by ECUK, thereby returning cold products to the number one spot of the highest consumption product group. Lighting comes in second. The wet sector and computing products match very closely the ECUK percentage contribution figures. Cooking is slightly higher than estimated.

In summary, we can see that the study households are generally higher-than-average users of electricity, and this extra consumption is costing them around £50 more than the typical UK household in electricity bills.

Since the sample households are generally more aware and careful of energy use in the home than the national average (by ten per cent), this higher usage is puzzling. It warrants further investigation into the attitudes and behaviours of householders generally and, ideally, a review and re-run of the national survey to ascertain how attitudes may have changed since the last survey.

The breakdown of where electricity demand comes from offers some surprises. Consumer electronic devices do not seem to be increasing their 'market share' of electricity consumption at the rate previously estimated, although it must be noted that the products in this grouping do not include any externally powered devices such as MP3 players, mobile communications and handheld gaming. (These are included in the 'Unknown' group.) However, if you aggregate consumer electronics with computing products, which some argue is the way forward given the convergence of products in these markets, then the combined CE/ICT sector will account for around one quarter of electricity consumption. Refrigeration and lighting are still the highest consuming product groups.

The next chapter explores each of these sectors in turn and attempts to throw light on these findings.

3. Through the keyhole: a room-by-room breakdown of power use

3.1 Kitchen

Refrigeration products

The traditional stalwarts of the kitchen, the so-called 'cold' appliances – fridges, fridge-freezers, upright and chest freezers – have historically been the largest single consumers of electricity in the home[30]. Due to their nature,

28. Energy consumption in the UK (ECUK) gives an annual indication of the total consumption of electricity used by the six main domestic energy-using product sectors. These values are then used to indicate the relative percentage contribution to electricity use in the home excluding electric heating.

29. Rounding errors account for the slight undercounting of this total.

30. Not including electrical heating systems.

they are essentially 'on' 24/7 of their lifetimes. Modern advances in technology, coupled with the success of the EU energy label, have seen this power demand per unit drop in recent decades. This study has identified the following average annual energy demand for the cold appliances monitored in all households (Table 5).

Cold appliance	Annual kWh usage	Running cost per year (£)
Refrigerator	162	23.50
Fridge-freezer	427	62.00
Upright freezer	327	47.50
Chest freezer	362	52.50

Table 5. Typical yearly running costs for monitored cold appliances for monitored households

The study found that cold appliances accounted for 16 per cent of the total electricity used in products for the households monitored. It is the highest of the six main household appliance sectors; the ECUK 2010 data placed cold appliances in joint second[31] after consumer electronics.

The most commonly owned appliance in the kitchen was the fridge-freezer, which was owned by 57 per cent of households in the study. Ten per cent of the total sample owned three separate cold appliances, and 3.5 per cent owned four types. The average number of cold appliances per household was 1.7 units. From this we estimate that an average household bill for keeping food and drink cold is around £79 per year.

Cooking appliances and products

Electricity consumption for cooking is seasonally affected, which is no surprise. More cooking is done in the winter than in the summer. This category included oven, hob, cooker, microwave, kettle, deep fat fryer and toaster.

The total average electricity consumption by cooking appliances in all households was 460 kWh. The range for the study was 429–505 kWh. This costs the average household £66 a year, over a relatively narrow range of £62–72.

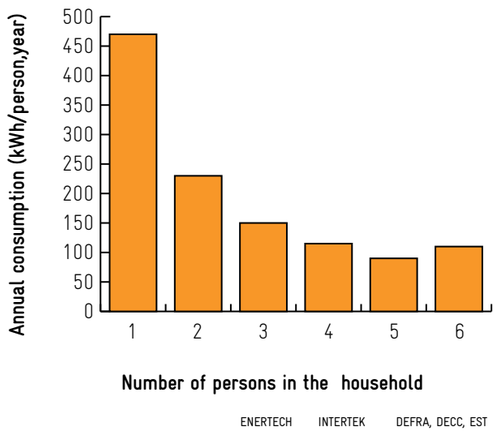
Recent trends have seen the rise of the electric oven in households: 70 per cent of ovens are predicted to be electrically powered in 2020. Gas hobs still dominate. By 2020 they are expected to hold 60 per cent of the market share[32].

Cooking appliance	Annual kWh usage	Running cost per year (£)
Oven (without hob)	290	42
Hob	226	33
Cooker with electric cook top	317	46
Microwave	56	8
Electric Kettle	167	24

Table 6. Annual usage and running costs for main electrical cooking appliances

It is interesting to note the relative efficiency of cooking for multiple people compared with smaller households units. Figure 2 shows the average electricity consumption per person depending on the size of the family unit.

Figure 2. Annual consumption for cooking per person per family unit size



This figure shows clearly the relative efficiency of cooking for larger groups. A three- or four-person household consumes roughly the same amount of energy through cooking activities as an individual. This finding has potentially unwelcome consequences for future energy demand, due to the recent trend of more single-person households in the UK. In 2000, seven million people lived alone in the UK: by 2010, this had risen to 7.5 million[33].

Other kitchen appliances

The data for all other kitchen-related appliances monitored during the study are listed below. They are not major consumers of electricity compared with the main kitchen activities of cooling things down and heating things up.

All other kitchen appliances monitored accounted for only 242 kWh a year, a maximum of £35 if a household owned and used all of the products shown in Table 7. This is the equivalent to the annual energy consumption of an electric hob.

Kitchen appliance	Average consumption (kWh/year)	Average running cost (£/year)
Bottle warmer	27.2	4.00
Bread maker	23.6	3.42
Coffee machine	31.8	4.6
Extractor hood	11.7	1.7
Food mixer	0.5	.07
Food steamer	52.7	7.60
Fryer	52.0	7.54
Grill	12.8	1.86
Toaster	21.9	3.18
Yoghurt maker	8.0	1.16

Table 7. Other smaller kitchen appliance usage data

Total annual cost of cooling and cooking

From the preceding figures, we estimate that a typical kitchen in this study is responsible for £150–185 of the typical annual electricity bill.

3.2 Laundry/utility room

In this area of the home we find laundry, dishwashing and cleaning products. Households will tend to own a washing machine, a washing machine plus tumble dryer or a washer-dryer. Lack of space is usually the main reason for ownership of a washer-dryer: they are generally considered to be not as effective as separate laundry appliances.

Washing machines and dryers

The average annual consumption of a washing machine was seen to be 166kWh with a total of 284 cycles, at an average of 5.5 cycles per week. However, this ranged from fewer than one to 22 cycles a week across the sample; indeed, one participant was seen to use it 1,200 times in one year. That's three washes every day of the year.

The daily maximum peak for washing machine use was seen to be between 8 and 10 o'clock in the morning.

The average annual consumption for clothes dryers, typically tumble dryers, was 394 kWh, and the average number of cycles was 260 a year. The report analysed each household for the number of washes that were followed by a tumble drying cycle and found that this occurred in approximately 80 per cent of cases. This is higher than estimated in Market Transformation Programme's (MTP) current models (60 per cent[34]). This could be an indication that people are not fully utilising any outdoor space they may have available to dry their laundry in the warmer, drier months.

In total, the average household with a washing machine plus tumble dryer spends around £81 a year keeping their clothes clean. If they only own a washing machine this cost falls to £24 per annum.

A washer-dryer uses, on average, 243 kWh of electricity a year and the average number of cycles was observed to be nearly one each day. In this case, the cycle may be a wash only, a wash/dry cycle or simply a drying-only cycle. The research was unable to tell the difference between the cycle options. A typical household with a washer dryer was seen to spend around £35 on washing and drying each year.

From the householders' diary entries it was found that around half of all washes were performed at 40˚C; just over a quarter (26 per cent) were washed at 30˚C; another 15 per cent were done at 50/60˚C and only two per cent at 90+˚C.

Nearly two thirds of washes (64 per cent) were claimed to have been 'full washes'[35], with 16 per cent at half load. There were instances of single garments being washed, but these were relatively rare occurrences.

The big surprise in this area is the difference in the various households' washing habits and frequency of cycles. The single-person household (non-pensioner) had a higher number of cycles and average annual energy consumption than the 'household with children' category (300 versus 284 respectively). The household type 'multiple with no dependents' is by far the highest group for laundry activities. This could be because households made up of house-sharers may not combine washing in the same way a family unit would. The breakdown of usage by household type is shown in Table 8.

31. With lighting and wet appliances.

32. *The Elephant in the Living Room*, EST publication 2011.

33. Social Trends 41 Households and Families 2011.

34. MTP Briefing note BNW01: Combined laundry: Govt standards evidence base 2009, reviewed 2010.

35. The definition of 'full load' and 'half load' were left to the householders to decide, so there may be a variation in what individuals perceive to be full or half loads.

Household type	Washing machine use (kWh/yr)	Clothes dryers use (kWh/yr)	Total kWh/yr for households with washers and dryers
Single pensioner	144	344	488
Single non-pensioner	173	332	505
Multiple pensioner	111	287	398
Household with children	170	342	512
Multiple household with no dependents	178	497	675

Table 8. Total energy demand needed for washing and drying laundry

The breakdown of 'per person' wash cycles shows that two-person households have an annualised consumption similar to that of one-person households. As with the cooking results, it adds to the evidence that two people can live as cheaply as one.

Dishwashers

Dishwashers were present in 45 per cent of the households monitored; this is a higher ownership level than the average national ownership figures for this appliance, which in 2009 was 36 per cent (according to MTP estimates[36]).

The annualised average usage across all households in the study was 294 kWh, at a cost of £42 per year. The average number of cycles was 254 a year, or 4.9 a week, which tallies well with earlier estimates that put the average at 4.7 cycles a week (246 cycles a year). This is nearly double the electricity used, on average, for keeping clothes clean.

There were no surprises here in terms of which households used their dishwashers the most. Multiple households and families topped the table; single households used them less. It was seen that a two-person household uses only an extra 50 kWh a year compared with a single-person household (300 versus 250 kWh respectively). Table 9 shows the annual consumption per household type.

Household type	Annual dishwasher consumption (kWh/yr)
Single pensioner	230
Single non-pensioner	265
Multiple pensioner	250
Household with children	313
Multiple household with no dependents	315

Table 9. Dishwasher power consumption per household type

Other utility room appliances

Other appliances often found in a utility room include irons, vacuum cleaners, and trouser presses. Table 10 shows the annual consumption monitored for these items.

Utility appliance	Average consumption (kWh/year)	Average cost (£/year)
Iron	31	4.50
Vacuum cleaner	18	2.60
Trouser press	12	1.70

Table 10. Other utility room appliances and their annual running costs

The monitored households containing a washing machine, tumble drier, dishwasher, iron and vacuum will spend approximately £130 on cleaning in a year. On the other side of the spectrum, households with a washing machine alone, iron, vacuum cleaner, but with no dishwasher[37] will spend a modest £32 on electricity to keep their clothes and the home clean.

3.3 Lounge

In the lounge we find the entertainment hub. Ninety-eight per cent of all UK homes own at least one TV. Only one household out of our sample did not own a TV. Over 500 TVs of various types were monitored, an average of two TV sets per household. Current MTP figures put the average ownership at 2.3 sets.

36. MTP BNW DW01 9.4 million dishwashers in 2009.

37. The cost of washing dishes will be included in the gas bill in the case of no dishwasher.

CE product	Number of products	Ownership (percentage study households)
TV sets (all types)	515	99.6%
Set-top box	187	75%
Complex set-top box Box	25	10%
DVD (all types)	192	76%
Games console (all types)	95	38%

Table 11. Consumer Electronic product ownership levels

No seasonality of use was found with consumer electronic products, so the monthly figures were not corrected for seasonality. The main peak time of use, in all cases, is between eight and ten in the evening.

The overall average consumption of electricity in these products was observed to be 553 kWh a year. This equates to £80 a year spent on powering entertainment. The range of average consumption levels in different households for consumer electronic products was wide, from 441 to 630 kWh. The highest consumption was in multi-person households with no dependents; the lowest consumption was in multi-pensioner households.

The hourly usage pattern of the night-time power demand for consumer electronics is interesting. From one a.m. to seven a.m. an average background consumption of 20-30 watts was observed. It is unlikely this is predominately due to active night-time usage: instead, it can be attributed to 'stand-by' power consumption. This consumption was lowest for pensioner households (i.e. nearer 20 watts) and highest for multiple households and family units.

Examining the annual power consumption of TV technologies in use in the households we see the following average cost figures. The plasma screens included in this study typically cost more than five times a year to run (although the proportion of plasma screens monitored was low) than the old style CRTs monitored.

TV technology	Annual consumption (kWh)	Annual running cost (£)
CRT - traditional	118	17
LCD – flat screen	199	29
Plasma – flat screen	658	95

Table 12. Observed annual running costs of different TV technologies

The proportion of time that TVs were on 'stand-by' state depended, to a large extent, upon the technology type. CRT TVs had a standby rate of 11 per cent; LCD 8.7 per cent; and plasma screens a much smaller 0.4 per cent. The number of hours spent watching TV varied by technology type too, but not so markedly. CRT TVs were in 'on mode' for 17.4 per cent; LCD TVs for 22.9 per cent and Plasma screens for 23.3 per cent.

Average TV watching was observed to be six hours a day. This is a surprise given that existing models and current assumptions put the figure at about 4.8 hours for the primary TV set (according to MTP figures[38]).

Other consumer electronic gadgets play a lesser role in terms of power use in the home. Table 13 shows the observed annual power consumption of a number of the devices monitored in the study.

Consumer Electronics product	Annual usage (kWh)	Running cost rounded(£)
Aerial	24.5	4
AV receiver[39]	1025.8	149
CD player	34.7	5
DVD recorder	96.8	14
Wii	40.0	6
Games console	47.6	7
PS3	67.7	9
Xbox 360	56.6	8
Hi fi	107	15
Radio	35	5
Set top box	115.2	17
Complex set-top box	148	21
TV + DVD + set-top box	462	67
VCR	48.3	7
Home cinema (sound amplifier)	54.5	8

Table 13. Typical observed usage figures for CE equipment

The surprise here is the range of energy demand required to power the entertainment products in the test households, from the relatively modest to a total bill into the hundreds. Existing models and calculations have consumer electronic products responsible for approximately 25 per cent of household electricity consumption. Our study shows entertainment products making up a lower than expected contribution. However, some 'externally powered' (i.e. mobile) products or gadgets were not captured under this

38. MTP BNCE TV02: Televisions (TVs) Government Standards Evidence Base 2009: Reference Scenario v1.1 2010 last reviewed.

39. These were found in only one study household, so these values should be read with care. AV receivers are part of a 'Home cinema' system.

sector in the study. The electricity demand for them is included in the 'Unknown' category. This will account for a portion of this shortfall compared with previously published figures.

It is clear from the research that the money spent on powering consumer electronic products in a home is primarily dependent on the technologies owned. If we take two extremes of CE product ownership, and apply the usage figures observed in this study, we see the following range of energy costs:

- Households with a typical CRT TV, a set-top box, DVD recorder, a radio and hi-fi could expect to spend approximately £68 a year on entertainment.
- Households with a home cinema system consisting of a plasma TV, AV receiver, sound amplifier, complex set-top box, games console, DVD recorder, aerial, hi-fi and radio could expect to pay £300+ for their entertainment.

3.4 Home computing

We now take a turn down the landing and visit the study, or 'home office' as it is now more commonly called. Here we find desktop computers, laptops, modems, printers, scanners and monitors. This equipment's use is not seasonal, so no adjustments were made to the observed monthly consumption for seasonal variation.

Instead of analysing the individual components or products, the analysis has been carried out on a group of products consisting of a computer, monitor and printer, and a modem/ADSL box.

Table 14 shows the list of the most common products and the number monitored.

Computing product	Number monitored	Ownership (percentage study households)
Laptop	174	69
Desktop	106	42
Router	139	55
Monitor	103	41
Printer	113	45
Multifunctional printer	14	6
Modem	12	5

Table 14. Ownership of most common computer related products

Ownership levels of computing equipment are in line with the published figures of 77 per cent ownership of home computers (both laptop and desktop) in 2010[40]. Internet connection is calculated to have a 73 per cent penetration in UK households[41]; hence the study figures are reported as lower than the national average.

Table 15 shows the average consumption and yearly running cost of the bundle of computer equipment described previously, across all households studied.

Household type	Average consumption (kWh)	Annual running cost rounded (£)
Single pensioner	137	20
Single non-pensioner	201	29
Multiple pensioner	258	37
Household with children	241	35
Multiple-person household non-dependents	267	39
All households	240	35

Table 15. Average consumption of computer products across the households

An average cost of £35 was seen overall for all households observed. For a single person the average consumption was seen to be 207 kWh; for a two or more person household this figure drops to a range of 60 to 130 kWh per person.

Table 16 gives the individual usage for the main components of a typical home-based computer system. We can see clearly the larger amount of energy required to power a desktop computer than a laptop. A desktop computer uses almost six times the power of a laptop.

Computing appliance	Average consumption (kWh)	Annual running cost rounded (£)
Desktop	166	24
laptop	29	4
Fax/printer	160	23
Modem	62	9
monitor	42	6
Multifunctional printer	26	4
Printer	21	3
Router	58	8
Scanner	20	3

Table 16. Energy demand and running costs for typical home computer products

40. ONS percentage of households with consumer durables 2010 **http://www.ons.gov.uk/ons/rel/family-spending/family-spending/family-spending-2011-edition/sum-consumer-durables-nugget.html**

41. ONS again **http://www.ons.gov.uk/ons/rel/family-spending/family-spending/family-spending-2011-edition/sum-consumer-durables-nugget.html**

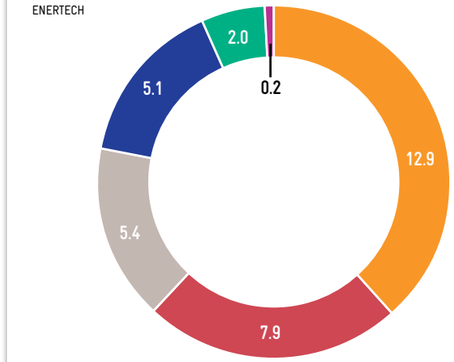


Figure 3. Average number of light sources per type of light bulb technology

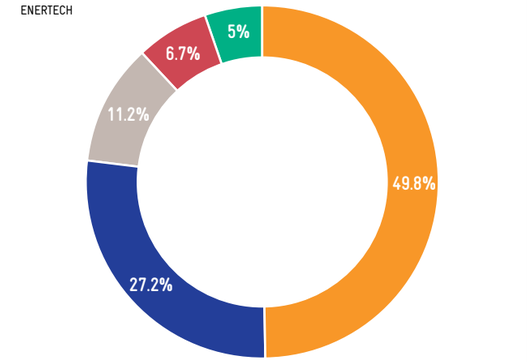


Figure 4. The breakdown of lighting technologies in the study households by share of installed wattage

On average, £35 is spent on powering computing equipment and, depending on the type of products owned, there was a range of £25 to £60 for those households.

3.5 Other electricity use throughout the home

We've looked at the main rooms in the home where electrical items are commonly found. Now we turn to the other sources of electricity consumption that are used either throughout the house or are portable and hence can be used anywhere. In this category we examine lighting, standby power, and small portable devices that are used periodically.

Lighting

Lighting, traditionally, has been one of the highest consuming product groups in the home and, naturally, it is found in every room of the house. On average, each home had around 34 lights.

Recently, the EU-wide ban on most incandescent lighting coupled with the reduction in cost, and recent subsidised promotion[42], of compact fluorescent bulbs (CFLs), alongside new technologies such as LED lighting, has meant that lighting is reducing its overall impact on domestic electricity use.

The percentage share of the different lighting technologies in terms of total installed bulbs and wattage observed in the study households are shown in Figures 3 and 4.

Old-fashioned incandescent bulbs still account for most of the total overall lighting (nearly 40 per cent of all light bulbs installed) and are responsible for half of the total observed installed wattage in the homes. The relatively low level of CFL bulbs – around 24 per cent – is a surprise. The remainder of the technologies are halogens (31 per cent) and fluorescents (six per cent). Very little LED lighting was observed in the mix. This might help to explain the higher-than-expected contribution of lighting to the overall power consumption patterns in the study.

42. EEC2 and CERT – government-run subsidies.

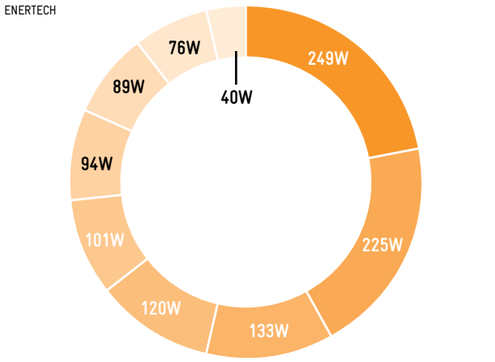


Figure 5. Distribution of lighting around the typical home

The distribution of lighting throughout the home does not reveal many surprises. The biggest lighting demands arise from the kitchen and lounge (see Figure 5)

For all households monitored the average electricity demand for lighting was observed to be 537 kWh a year, costing the average household £77 a year in lighting bills (at a range of £60–84).

There is not a huge variation in lighting demand across the different household types, although the single-person households, yet again, rate higher than the multiple-person households. There is a 33 per cent extra spend on lighting in the single pensioner's home as opposed to a multiple-pensioner household. Table 17 shows the variation in demand.

Household type	Av lighting consumption (kWh)	Running costs rounded (£)
Single pensioner	548	79
Single non-pensioner	581	84
Multiple pensioner	413	60
Household with children	477	69
Multiple no dependents	548	79
All households	537	78

Table 17. Energy demand and running costs for typical home computer products

In all cases, the peak demand for lighting occurred between 9 and 11 at night, and ranged from 130 to 200 watts per household, although lighting demand was observed all through the night. Due to the methods of monitoring it was not possible to pinpoint the location of the night-time lighting sources.

Other miscellaneous products

The range and number of electrical products found in people's homes is extensive – see the main report for a full listing of all products monitored during this study. A list of the products that could be individually monitored, with their annual usage and running costs, can be seen in Table 18. Care must be taken in the use of some of this data, however, as in some cases the quantity of products monitored is small.

Appliance	Number observed	Annual usage rounded (KWh)	Running cost rounded (£)
Air conditioners	1	42	6
Aquarium	15	278	40
Baby monitor	1	9	1
Clock radio	3	20	3
Cordless phone	3	25	4
Dehumidifier	3	525	76
Door bell	5	52	6
Electric blanket	6	14	2
Electric chair	1	13	2
Fan	17	46	7
Hair dryer	89	20	3
Hair straightener	34	4	1
House alarm	14	67	10
Massage bed	2	215	31
Paper shredder	4	2.3	0.04
Picture frame	1	15	2
Pond pump	6	218	32
Sewing machine	9	7	1
Steriliser	5	43	6
Vivarium (reptile tank)	4	56	8

Table 18. Miscellaneous electrical products present in the study households – usage and running costs

It's good news for users of hair styling products: drying and styling of hair costs, on average, only a fiver a year. But keepers of fish spend a relatively large amount to keep their pets oxygenated and healthy.

Households with damp issues would do well to look into getting the problem fixed permanently, as it costs £70 a year to keep a dehumidifier running.

Baby care doesn't seem to be costing the earth either, with less than £10 spent on sterilising and monitoring, and another £4 spent on bottle warming.

Standby power

Standby power consumption, mainly associated with consumer electronic products and computing, has been observed in a much wider range of products than is generally acknowledged.

'Standby' mode definitions can vary in what they include and exclude; it is important to state what is contained in any standby mode discussion in the context of this study.

'Standby mode' is the mode in which an appliance is neither switched off, nor is in full-on mode. This mode groups together all the standby and energy management modes that exist in a single appliance. Depending on the appliance, it might include 'idle', 'energy saving', 'doze', 'standby', 'delay start' or 'suspended' modes.

Consumer electronics and computer products were monitored continually with special software that could tease out of the wattmeter data the standby power and rate.

Two types of standby power were measured: a minimum average value of standby and a maximum average standby power consumption. Details of how these two were measured can be found in the full report.

Standby type	Wattage (W)	Annual use (kWh)[43]	Annual running costs rounded (£)
Minimum average	47	343	50
Maximum average	81	591	86

Table 19. Average standby figures for all households studied

Given that the average power bill for the average home in the study was approximately £530, we can see that standby power demand could account for 9–16 per cent of a household's power bill. This is higher than the current view that standby power makes up 5–10 per cent of a typical household's electricity bill.

4. The make-up of a typical household's electricity bill

We have completed our tour of the typical home monitored in this study and we have seen how an electricity bill can be broken down into energy spend in the various rooms and typical domestic functions of a home. Now that we have a better picture of the energy demand of different activities, we can now take a look at how the typical electricity bill breaks down. If we take the typical bill for a home as observed in this study, £530 a year at current prices, we can see the following contributions from the various product sectors.

Room/product	Function	Running cost £ (typical range)
Kitchen	Cooking and cooling	150 - 185
Utility	Washing and cleaning	32 - 130
Living room	Entertainment	70 - 300
Home office/ study	Computing / telephony	25 - 60
Lighting	light	60 - 84
miscellaneous	general	10 – 100[44]
Total		347 - 859

Table 20. A breakdown of the running costs of appliances in the home

43. These figures are maximum standby figures if that level of standby consumption was present 20 hours a day, seven days a week (20 hours to take into account other power modes). Due to the nature of the monitoring, and the quantity and complexity of unpicking each appliance's power-use pattern, we cannot at this point ascertain exactly for how long the standby consumption is present. These current figures should be seen as a best estimate until further research can be carried out.

44. These two figures present a lowest and highest case scenario for our study households: a typical household would be somewhere in-between these two figures, depending on the number, and the nature, of the appliances they own.

5. Conclusions

This study is ground-breaking with regard to the insight it gives to energy efficiency and demand-side experts on how people use electricity in their homes. A number of particularly interesting and unexpected findings have been unearthed that will require further analysis and investigation. One of the most surprising is the relatively high use of appliances by single-person households compared with multiple-person dwellings and families.

There are other mostly unwelcome surprises uncovered by the study. Domestic background standby consumption is higher than previously estimated. On average, our study households spent £50–86[45] a year on their appliances in a 'non-active' state. This compares with an observed, average annual electricity bill for all households monitored[46] of £530. Total standby consumption can potentially be 16 per cent of domestic power demand. This is significantly higher than the current five to ten per cent estimated/modelled for domestic standby power.

It can now be stated, with a level of confidence, that the old adage 'two can live as cheaply as one' is particularly true when it comes to electricity use, as the monitored one-person households were seen to be using as much, and sometimes more, energy on particular appliances as typical families. In particular, in the activities of cooking and laundry we observed the power demand of lone dwellers matching or exceeding those of average family units.

The implications of this finding are troubling from a future energy demand perspective. More than 29 per cent of all UK households were single-person dwellers[47] in 2010; there was an upward trend over the last decade for increasing numbers of lone households (7 million people living alone in 2000 increasing to 7.5 million by 2010).

We really are a nation of TV watchers. Instead of the previously assumed figure of almost five hours of typical daily TV viewing[48], our study shows this is more likely to top six hours per day; or, put another way, an additional 400 hours of viewing per household per year. This costs the nation, on average, an extra £205 million a year in total.

We also love to keep our clothes clean; we run, on average, 5.5 washes a week, similar to the previous estimated average of five. If we own a tumble dryer, then we dry 80 per cent of our washes using dryers rather than utilising outdoor washing lines or other non-powered methods. If households own both a washing machine and tumble dryer then the price of laundering their clothes typically costs £80 per year; not including the cost of detergents and fabric softeners.

Worryingly, the average annual electricity consumption in our test households was ten per cent higher than the UK national average[49], costing the average household in this study an extra £50[50]. There were also large variations between the highest and lowest users in the same category of home and family unit. Curiously, these higher than average electricity-use figures were from a group of householders whose stated attitudes on the careful use of energy in the home was, on average, a whole ten per cent higher than the national average.

In conclusion, this report has provided answers for many of the questions domestic energy professionals and researchers have been asking for decades. However, the findings also open up another set of intriguing questions that only more in-depth analysis of the vast quantity of data the study has collected will answer. For this reason, it is planned that the complete database (fully anonymised) will be made freely available to researchers to enable this rich and unique source of data to be examined and analysed in a much greater depth.

45. Average minimum standby was measured at 343 kWh costing £50; average maximum yearly standby consumption was 591 kWh, costing £86 using a 20/7 calculation with an average electricity price (2011) of 14.5 pence per kWh.

46. The study found the total average annual electricity demand for all dwellings monitored in the survey to be 3,638 kWh.

47. ONS figures for household make-up, Social Trends 41 7.5 million single households. Cf 25.3 total households in 2010.

48. MTP BNCE TV02: Televisions (TVs) Reference Scenario (2009) puts average primary TV daily watching at 4.8 hours.

49. Currently averaged at 3,300 kWh per household per year for the UK. The study's average consumption was 3,867; however, this included nine electrically heated homes out of 251 surveyed, or 3.5 per cent of total homes. **http://www.ofgem.gov.uk/Markets/RetMkts/Compl/Consumption/Pages/ConsumptionReview.aspx**

50. Using a 14.5pence/kWh average cost for electricity in 2011.

Appendix: The English Household Electricity-Use Study 2010/11

A large-scale, in-depth household electricity-use study is unprecedented in the UK; nothing of this magnitude or ambition has been attempted before. Similar studies took place in Sweden in 2008, where 400 households were studied over 12 months; and in France where a series of studies monitored 100 homes for a year in 2007.

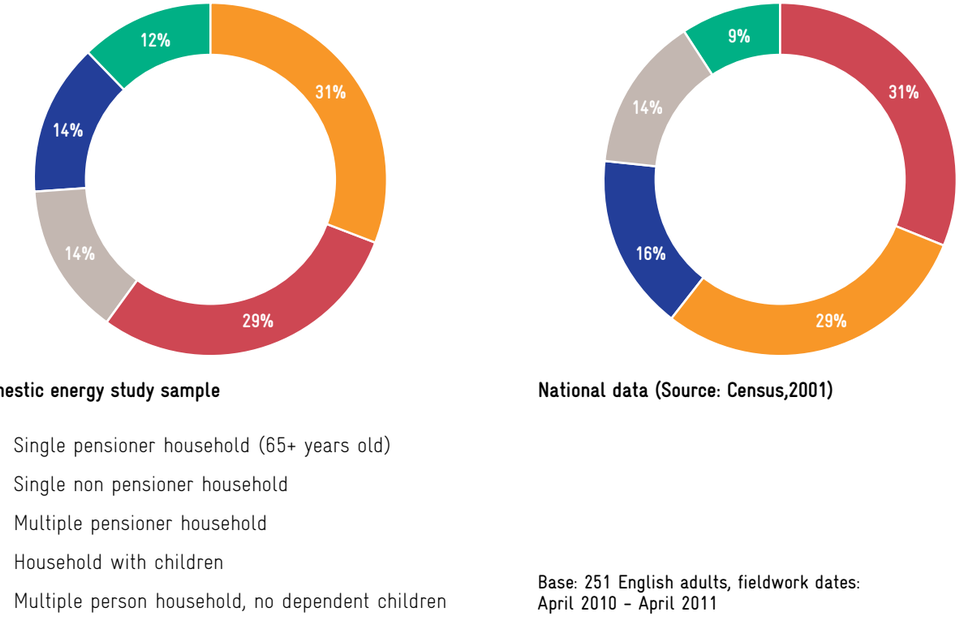
There are three critical reasons for the dearth of previous work in this area. First, they are expensive to run; second, they are technically challenging to undertake; third, it is difficult to recruit and, crucially, retain the households over the entire monitoring period to ensure the findings are representative, statistically viable and robust.

Recent advances in the sophistication and reliability of monitoring equipment has meant that such longitudinal studies, literally collecting and storing millions of pieces of data per household, are now possible. The monitoring equipment utilised in this study was robustly tested in both the Swedish and French studies and proven to be both durable and reliable. This greatly reduced the technical barrier to implementation. The budget required for this type of research is relatively high and typically prohibitive for most single agencies, but the coming together of three interested parties in DECC, Defra and the Energy Saving Trust, pooling their research budgets, enabled the study to be commissioned. The third barrier, the appropriate and representative level of recruitment and retention of the households, was overcome through a carefully judged level of initial over-recruitment of households to anticipate a high dropout rate. In fact, the study achieved a slightly higher completion rate than was initially forecast.

The study had four, broad, main objectives at the outset:

1. to identify the range and quantity of electrically powered appliances, products and gadgets found in the typical home
2. to understand their frequency and patterns of usage; in particular, their impact on peak electricity demand
3. to monitor the total electricity consumption of the home as well as individually monitoring most appliances in the household
4. to collect user habits data when using some types of electrically powered appliances through use of diaries

Figure A1. Mix of 'life-stages' of the study households compared with the national average



Recruitment of the households

The study began in spring/summer 2010, with the initial recruitment of owner-occupier households across England for the year-long monitoring. The recruitment partner selected a suitable range of householders that matched, as closely as possible, the typical socio-economic mix of English owner-occupiers. Recruitment took place, in equal numbers, in the North, the Midlands and the South[51].

The Consumer Voice[52] database, run by Mori, was used for recruitment. Figure A1 shows the final make-up of the monitored households compared with the English national average in terms of 'life-stage' (the criterion picked to construct representative quotas). Life-stage is an indicator of the composition of a household, taking into consideration the number of people in a household and their ages. It can be seen that a good correlation with the national average was achieved in the final study sample.

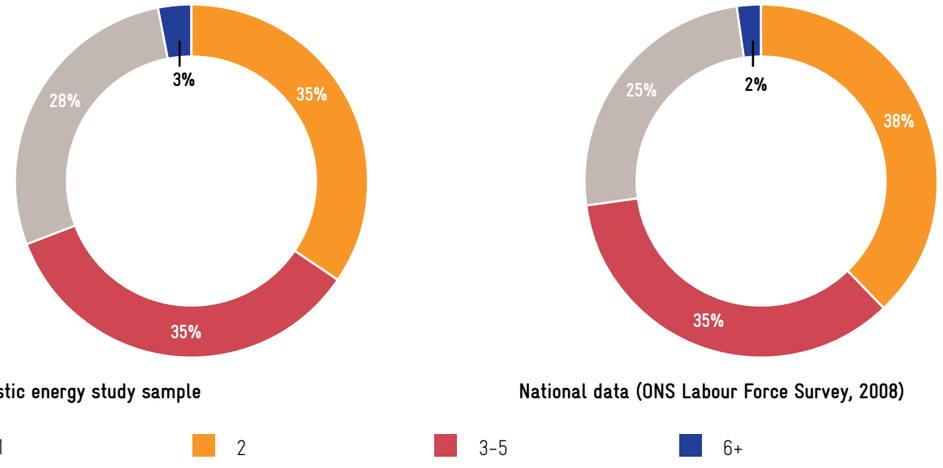
The 'life-stage' categorisation helps to identify the household in terms of age and circumstance. There are five categories:

- Single pensioner household (65+ years)
- Single non-pensioner household (<65 years)
- Multi-pensioner household
- Household with children
- Multi-person household, with no dependent children

Another close correlation was achieved in the make-up of household numbers, i.e. relative number of single households, couples, and family units chosen compared with the national average (Figure A2).

It is important to note that the figures shown for the study households are representative of owner-occupier[53] households only, rather than the entire English population. Approximately 69 per cent of all UK households were owner-occupiers in 2008[54]. It proved too difficult a task to recruit tenants to the study due to challenges relating to appropriate consent from landlords and more frequent turnover of tenants in rented properties. However, even with this restriction a good demographic mix was achieved that matched the overall population profile of England. Below, shown in Figure A3, the social grade[55] classification scheme, typically known as the ABC1 rating, for the study sample is again compared against the national average.

Figure A2. The number of people in study households compared with national average



Base: 251 English adults, fieldwork dates: April 2010 – April 2011

Initial recruitment involved signing up the 26 households that would be monitored for a full year, as well as the first tranche of the monthly sub-set. Subsequently, recruitment was carried out on a rolling monthly basis throughout the 12-month period of the study. Two hundred and fifty-one households completed the study. As this is a first study of its type in the UK it was difficult to predict the rate of drop-out; it was assumed it would be relatively high due to the effort involved and the level of intrusiveness perceived by the householders. To compensate for this, over-recruitment was undertaken. A total of 412 households were recruited throughout the year, and 240 households were retained to ensure the study's findings would be valid.

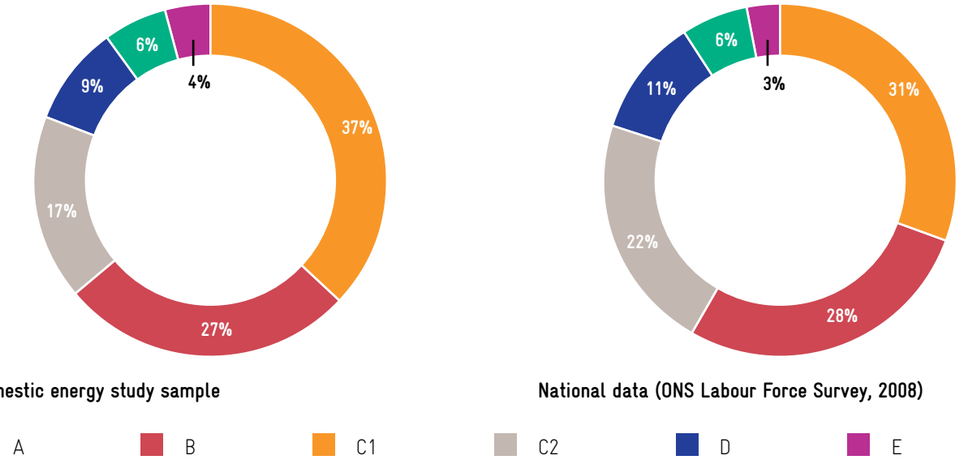
The study requirements

For the home-owners taking part in the study there was a prerequisite to agree to a number of requirements before recruitment was finalised:

- An initial visit from qualified electricians to survey the home for electrical items and to fit the data loggers and other necessary equipment to the home's electrical circuits.
- Completing an attitudinal survey covering questions on their views towards the environment, climate change and energy use within the home.
- A visit from a Domestic Energy Assessor to ascertain the Energy Performance Certificate rating of the home, which was then supplied to the householder for reference.
- Agreeing to keep a usage diary of their main appliance (habits and routines).
- For the households that were being studied for the full year: an extra three visits from the electricians were required, through the winter months, to download data from the loggers when the data was collected on a two-minute interval[56] (the rest of the year was monitored at ten-minute intervals).
- A final visit from the electricians to remove the kit from the property.

Due to the fairly onerous and intrusive nature inherent in such a study, the somewhat high drop-out rate of 39 per cent was observed overall. The year-long households' drop-out rate (38 per cent) was slightly lower than the monthly households (43 per cent).

Figure A3. The social grade of the study households compared with national average



Base: 251 English adults, fieldwork dates: April 2010 – April 2011

51. Recruitment was intended to reflect the national profile, but instead aimed for an equal split between the three regions to allow for comparisons to me made between them.
52. The Consumer Voice database contains details of respondents to Ipsos Mori's Capibus surveys. Capibus is a nationally and regionally representative sample of 2,000 British adults surveyed weekly.
53. Those households that own their homes outright or have bought them with a mortgage.
54. ONS Social Trends 41: 2011 Edition Chapter10: Housing.
55. Social grade is the classification scheme based on occupation of the Chief Income Earner (CIE). There are six categories – A,B,C1,C2,D,E ranging from high managerial (A) through to state pensioners and unemployed (E).
56. To monitor in more detail usage over peak periods in the winter season.

The sample set also excluded households that had any form of renewable energy generation on-site, as the incoming locally generated electricity could interfere with the monitoring equipment. Renewable energy technologies include wind turbines, PV installations, biomass boilers and heat pumps.

Attitudinal Survey

All participants were required to complete an attitudinal survey. The survey covered issues such as householders' views and beliefs on the environment, their use of energy and their attitudes towards climate change generally. Questions taken from the Defra framework for pro-environmental behaviours[57] were also used in order to segment the participants into one of seven 'clusters'. Results from an earlier government-run attitudinal study[58] could then be compared with the participants' responses. It must be noted that, as the study only recruited owner-occupiers, the results cannot be wholly correlated with other national representative samples that will typically include private and social tenants. Instead, the comparison is used to look broadly at how the study sample compares to the national average.

Figure A4 shows how the final sample of the householders' attitudes on environmental issues compare to the original study, carried out nationally, in 2008. The biggest differences are seen in the proportion of 'positive greens' and 'cautious participants' who represent the lowest and highest drop-out rates respectively. The final make-up of study households had an over-representation of 'positive greens' and an under-representation of 'cautious participants' compared with the national average.

The over representation of the 'positive green' category – the most pro-environmental category in the Defra framework – should be kept in mind when reviewing the results. This over-representation does not seem to have materially influenced opinions and attitudes to the environmental issues investigated in the survey. Figure A5 shows the responses to a general question regarding efforts to be environmentally friendly.

When questioned about attitudes to energy saving in the home, the results from the study households were broadly comparable to the national average. Around 86 per cent of the sample households agreed that they think about saving energy in the home, with just one in ten saying they did not; this compares with 76 per cent and 14 per cent respectively for the national average.

The survey findings generally have a 94 per cent confidence level. This means that the results taken from our sample set would come in within six per cent of any findings if we had sampled the whole population.

From these findings, we conclude that the household survey participants were broadly in line with the environmental attitudes of the nation as a whole[59], but there is a tendency to be more environmentally aware and there is a stated eagerness to engage in more pro-environment actions than the general population.

Household monitoring

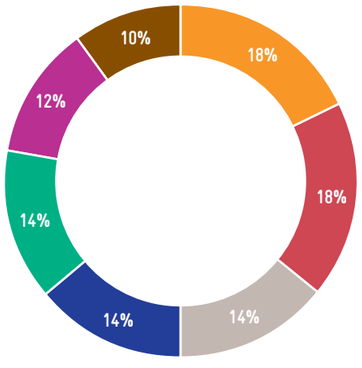
All study households were monitored for total electricity use, in addition to individual monitoring of all accessible electrical items identified in the home, outhouses and garages connected to the property.

Any product with an accessible plug was monitored with a wattmeter[60] placed between the plug and the socket. Other appliances, typically those 'wired in', such as cooking appliances, water heaters and other electrical heating systems, could be monitored through the 'metering unit' of the house. A Multivoies[61] system was installed in the consumer unit to monitor these items.

The aim of the study was to individually monitor as many individual household products as feasible, with a physical maximum number of appliances of 80–90.

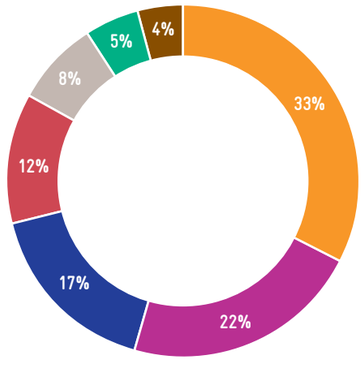
The electrical product audit, carried out at the beginning of the monitoring period, resulted in fascinating insights into the number and range of products typically found in English homes. Table A1 shows the distribution of households with the total number of products they owned at the time of monitoring.

Figure A4. Percentage of study households falling into the 7 Defra pro environment framework categories versus national average in 2008



National data (Defra pro-environmental behaviours, 2008)

- Cautious Participant
- Concerned Consumer
- Honestly Disengaged
- Positive Green

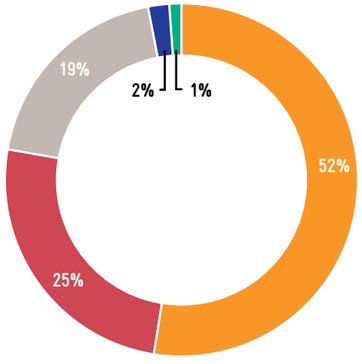


Domestic energy study final sample

- Sideline Supporter
- Stalled Starter
- Waste Watcher

Base: 251 English adults, fieldwork dates: April 2010 – April 2011

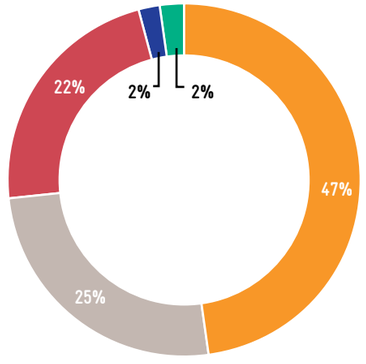
Figure A5. Survey households versus national survey on the question of being environmentally friend in their everyday lives



Domestic energy study sample

- I don't really do anything that is environmentally friendly
- I do one or two things that are environmentally friendly
- I do quite a few things that are environmentally friendly

Base: 251 English adults, fieldwork dates: April 2010 – April 2011



National data (Source: Defra, 2009)

- I'm environmentally friendly in most things I do
- I'm environmentally friendly in everything I do

Base: 2,009 English adults

57. Defra Framework for pro-environmental behaviours: **http://archive.defra.gov.uk/evidence/social/behaviour**

58. Defra 2009, public attitudes and behaviours towards the environment – tracker survey **http://www.defra.gov.uk/statistics/files/report-attitudes-behaviours2009.pdf**

59. The original Defra attitudes survey was carried out in 2008; opinions may have changed since then.

60. The serial Wattmeter was developing by the monitoring company to measure active energy and voltage for single-phase appliances with a power rating <3kW.

61. A Multivoies system measures a large number of channels of power consumption and energy in electrical distribution boards.

Number of appliances in households / percentage owning them		Average number of appliances owned	Minimum number of appliances owned	Maximum number of appliances
1 - 30	24%	41	13	85
31 - 40	29%			
41 - 50	26%			
51+	21%			

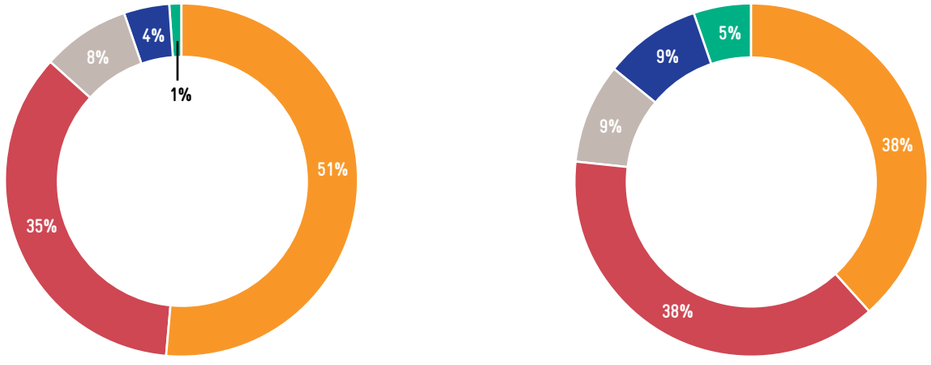
Table A1. Number of electrical appliances owned in the study households

The average number of electrical products owned by the study households is 41. This fits well with earlier estimates of the number of items owned by modern households[62] and can be compared with the average 1970s' home, which owned about a dozen or so electrical appliances. The maximum number of electrical items found in any single household was 85 products; and the minimum number of products a modest 13. The highest percentage of households, nearly a third at 29 per cent, owned between 30 and 40 products; although one in five households owned 50-plus items.

As much information as possible was logged for each product (available at the time of the audit). If the item had an energy rating then this was noted, alongside make, model and year of purchase, if known. Photographs were taken of each product to ensure the accuracy of the record and for ease of any subsequent rechecking of the data.

Generally, the appliances were monitored at ten-minute intervals throughout the surveillance period. However, the 26 households that were studied for a whole calendar year were additionally monitored at two-minute intervals throughout the winter to help pinpoint periods of peak usage; at all other times they were recorded at ten-minute intervals. Consequently, through the winter, the study's electricians made three additional bi-monthly visits to the households to collect data and free-up memory space in the recording devices. This also gave the electricians additional opportunities to update and add to the appliance audit if new products had been purchased in the intervening time.

Figure A6. Attitudes to saving energy in the home compared with national average



Base: 251 English adults, fieldwork dates: April 2010 – April 2011

Base: 2,009 English adults

Energy Performance Certificates

Each survey household received an Energy Performance Certificate (EPC) assessment as part of the requirement for participation. This is the same certificate issued when people buy, sell or rent properties. The EPC covers: dwelling age; heating type; total area and other pertinent factors such as double glazing and insulation measures. This is part of an inspection process known as the Standard Assessment Procedure, commonly referred to as SAP[63], a government approved survey tool.

The average EPC rating for the homes surveyed was 58.9[64]: this was the actual RdSAP figure obtained from the survey.

This compares to an average SAP rating obtained through the latest English Housing Survey[65] 2009 of 53 for all properties, and 51.3 for owner-occupied housing, in England. The conclusion is that the sample households have generally more thermally efficient homes than the national average. We would not expect this to have any significant bearing on the use of electricity for non-heating purposes.

62. *Rise of the Machines*, a 2006 EST publication on energy using products, calculated that the typical modern home would own around 40-50 appliances.

63. The actual procedure used is the 'reduced dataset standard assessment procedure', or RdSAP, which is a subset of the full SAP process.

64. There was a change in RdSAP methodology half way through the study, from RdSAP 2005 to RdSAP 2009. This had an influence on the results.

65. The Housing Stock Report 2009 surveyed 16,000+ properties between April 2008 and March 2010.

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