Department of Energy & Climate Change

Domestic energy use study: to understand why comparable households use different amounts of energy

Final report

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Credits

This report was written by David Fell and Geoff King of Brook Lyndhurst. The research team comprised Geoff King and David Fell of Brook Lyndhurst; Annie Austin of Brook Lyndhurst and Manchester University; Phil Downing of Icaro Consulting; and Sue Clegg of Qualquest. Recruitment services were provided by Criteria Fieldwork Ltd.

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Executive Summary

Background

Domestic gas consumption in the UK can vary dramatically between households. The top ten per cent of gas users consume as least four times as much gas as the bottom ten per cent.

Quantitative modelling – based on the property, household income and tenure – has so far been able to explain less than 40% of this variation.[1] In order to begin to understand the unexplained portion, this qualitative research has explored the day-to-day lives of the people that live in those houses so as to build a rich, people-centred picture of how energy is actually consumed.

Seventy households participated in the research, all of whom lived in 3-bedroom, semi-detached properties in suburban locations. Half the sample was identified at the beginning of the study as being 'High' gas users and half as 'Low' gas users, defined as being in the top or bottom decile.

The research comprised a programme of semi-structured interviews conducted in participants' homes, involving house-tours and a variety of exercises designed to allow the research to explore everyday life in each home. This was followed by an easy-to-complete diary exercise over an eight week period; unobtrusive temperature monitoring; and follow-up interviews.

Drawing on data gathered throughout the study – including energy performance certificates (EPC) evidence, Annual Energy Statements, gas bills and meter readings – the final review of households classified 28 as High and 25 as Low gas users. Analysis of the differences between these otherwise comparable groups forms the mainstay of the research findings.

The research reveals wide and in many cases intriguing variations in behaviours that have consequences for gas consumption. However, it did not appear that High and Low gas users had *particular* behaviours that made them easy to identify as High or Low. Instead, each High or Low gas user tends to have a cluster of very ordinary behaviours that *happen* to culminate in high or low gas use. There are, it seems, many different ways to be a High or Low gas user.

Findings

The behaviours in question can be clustered under three broad headings:

- temperature management – how people manage the temperature in their homes and their awareness of the energy implications of their actions;
- people in the home – who is in the home, and when, and what they are doing;
- physical properties of the home – the particular physical environment in which people live.

Temperature management

Very few households fully understood their heating systems. All were, however, able to control their heating systems to make their homes *feel* comfortable. Interviewees displayed distinct and different ways of achieving this. Some tinkered endlessly with settings; others touched their heating controls rarely if ever.

[1] DECC (2012) National Energy Efficiency Data Framework. Annex E, Table A 3.1.

High households may prefer to live in warmer homes. Of the 19 properties where temperatures were recorded, 5 turned out to be High and 7 Low. Although caution should be exercised given the small number of households, on average, temperatures were higher in High households compared to Low households. Rooms in High households peaked at temperatures an average of 2-4^{o}C higher than rooms in Low households.

Interviewees frequently did not have a precise sense of the temperature to which the thermostat was set. Thermostats, when adjusted, were often set within temperature *ranges* rather than to specific temperatures. Thermostats were typically in halls, further reducing the connection between the thermostat and the subjective experience of warmth or cold in (say) the living room.

Participants were not aware how much gas they used, either in absolute terms or in relation to others. Most estimated their use was 'about average'. Paying by direct debit, fluctuating energy prices, variations in how cold the winter is and changing household circumstances appeared to cloud people's understanding of how much energy they used.

The amount of energy used by space heating, relative to other energy uses in the home, was underestimated by most participants. Energy efficiency was almost unanimously seen as a good idea, particularly to save money, but few people seemed to be attempting to reduce gas consumption and were far more focused on saving electricity.

People in the home

The composition of the household influenced how heat was used. The presence of young children led to particular consideration of house temperatures and people taking relatively unusual steps to manage the temperature. Occupants with health issues (including chronic conditions such as back pain, or whilst recovering from injury or surgery) or with elderly visitors reported keeping their homes warmer to alleviate stiff joints or because visitors felt the cold.

Patterns of house use were reflected in winter heating hours, so households that were empty more often heated the house for fewer hours a day. 'High' households tended to be empty on fewer occasions than 'Low' households. Showering and bathing habits varied considerably between individuals and households. High households tended to take more long showers than Low households.

Participants in High households tended to have lived in their homes for longer compared to those in Low households. Participants who had been in their homes for longer tended to have undertaken large-scale modifications to their homes in the early years of residency; and it was large-scale rather than more cosmetic modifications that were most likely to have included energy efficiency measures. As a result, households that had been in their homes for longer tended to have older and potentially less effective energy efficiency measures in place.

Physical properties of the home

Although the households recruited to the research were recruited principally on the basis of the comparability of their houses, there were nevertheless some differences. Not all three-bedroom, semi-detached houses are the same. Virtually all the properties in the research had been modified or improved with extensions, conservatories, conversions and/or open plan spaces.

These modifications have the potential to affect the thermal properties of a home, but have not been included in existing quantitative modelling of domestic energy consumption.[2]

High households also lived in properties that had lower energy efficiency ratings on average than the Low households. These physical differences were enough to explain, on the basis of estimates from EPCs, an average of £250 variation in bills between High and Low households. In fact, the difference in average bills between the High and Low households in this study was £860. The physical characteristics of properties were therefore able to explain less than a third of the actual difference observed.

Among participants, insulation and double glazing were considered 'normal' parts of home improvement. That is to say, when participants had had extensions built, or lofts converted, double-glazed windows and efficient insulation were considered to be normal features of the extension. Home improvements that consisted solely of insulation or the installation of double glazing were, by contrast, rare.

Conclusions and implications

Households that use dramatically more gas than average – the High gas users – appear to have occupants who simply prefer a warmer home; who are at home for more of the time than average; who are keen on taking long showers; and who happen to live in relatively inefficient properties. These factors, however, are not sufficient fully to explain their consumption of gas.

There is a long list of additional factors – ranging from whether the main living room faces south, to whether someone in the house is unwell, to how often people bathe – that can also be associated with being a High gas user. However, and crucially, these additional factors can also be associated with being a *Low* gas user. That is to say, among all the factors and behaviours that characterise a household, a Low user typically has some that are more typical of a High user; and a High user typically has some that are more characteristic of a Low user. A High (or a Low) gas user is not, it appears, a household with a particular *overall* attitude that marks them out as High or Low; it appears, instead, to be a household that has a range of ordinary in-home behaviours that *happen* to culminate in a particular level of gas use.

Easy targeting of High users would not, therefore, seem straightforward at this time. Instead, a focus on individual behaviours – such as switching from baths to showers, or adopting more efficient heating management practices – would be more appropriate. The research suggests that virtually all households have the potential to reduce their gas consumption, because these behaviours are widely distributed across households.

Awareness of gas usage appears, on the basis of this research, to be low. The research suggests that most households believe they are already using their heating as little as possible, and may perceive any suggestion that they reduce their usage as a threat to their comfort. In addition, householders do not appear presently to connect the idea of 'efficiency' with their use of their home heating systems. DECC should consider how best to address these challenges so as to meet its goal of maximising energy efficiency this decade.

[2] DECC (2012) National Energy Efficiency Data Framework. Annex E, Table A 3.1

Contents

1. Introduction

English residents, living in seemingly identical homes, use very different amounts of gas. Why is this?

The Department of Energy and Climate Change (DECC) has priorities to save energy and drive action on climate change. Domestic homes use over 40% of UK energy and are responsible for 25% of the country's CO_2 emissions[3]. DECC is therefore trying to reduce domestic energy use and has a Carbon Plan to reduce emissions from buildings to zero by 2050. For this to be achievable, DECC is focusing on maximising energy efficiency this decade (2010-2020).

In 2011, 60% of energy at home was used for space heating and 15% for hot water[4]. A significant majority of this energy consumption was in the form of gas – 85% of UK homes have gas central heating[5]. However, households use very different amounts of gas and modelling by DECC has found that less than 40% of the variation in gas consumption can be explained by the size, age and type of property, as well as household income and tenure[6].

If DECC's goal of maximising energy efficiency in the present decade is to be achieved, it will be necessary to reduce domestic gas consumption; and, in order to do this without relying solely on price it will be necessary to understand more fully why gas consumption varies so much between apparently comparable households. Only with a fuller understanding will it be possible to develop the appropriate support and interventions to enable households to reduce their energy consumption.

Against this background, Brook Lyndhurst undertook qualitative research in order to explore and improve understanding of factors that might explain the 60% of variation in consumption not yet captured by DECC's models. The overall purpose of the research was to build up a rich, 'people-centred' picture of how and why households use energy in the ways that they do and, in particular, why **apparently comparable homes consume such different amounts of gas**.

Fieldwork for the research was conducted between March and June of 2012. Section 2 of this report explains the methods used during the fieldwork and the rationale for those methods. The findings from the research are set out in Section 3 (which presents evidence on general energy behaviours revealed by the research) and Section 4 (which focuses specifically on differences between households identified as 'high' gas users and those identified as 'low' gas users).

Section 5, finally, presents the research team's analysis, conclusions, assessment of implications and suggestions for action and further research. Detailed material (covering research materials, detailed findings and so forth) is available in a separate volume of appendices.

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[3] DECC, 2011. The Carbon Plan: Delivering our low carbon future. http://www.decc.gov.uk/assets/decc/11/tackling-climate-change/carbon-plan/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf

[4] DECC, 2012. Energy consumption in the United Kingdom: 2012. http://www.decc.gov.uk/assets/decc/11/stats/publications/energy-consumption/2323-domestic-energy-consumption-factsheet.pdf

[5] DECC, 2011. Great Britain's housing energy factfile. http://www.decc.gov.uk/assets/decc/11/stats/climate-change/3224-great-britains-housing-energy-fact-file-2011.pdf

[6] DECC (2012) National Energy Efficiency Data Framework. Annex E, Table A 3.1.

2. Research design

Is something extraordinary going on in the homes of families that use a great deal more gas, or a great deal less gas, than average?

DECC's modelling reveals that less than 40% of observed variation in gas consumption can be explained by physical factors of the property (size, type and age), household income and tenure.[7] The remainder must be something to do with how the people inside the homes are living.

Drawing upon relevant literature[8] and Brook Lyndhurst's own recent research experience[9], the research hypothesised that energy, and in particular gas, is not used *directly* by householders. Rather, householders consume the *services provided by gas* – notably space heating and water heating – and gas is consumed as a result. The key to understanding gas consumption in the home is therefore to understand how and why people live in their homes the way that they do. In turn, the key to understanding *variation* in gas consumption is to understand the different ways in which people live.

Three perspectives were identified to frame the research:

- the psychology of 'home' – the attributes of 'home', in particular the services it provides in terms of comfort and security (e.g. do householders, in seeking 'comfort', prefer their home to be warm or cool?)
- the lifestyles of householders – the pattern of day-to-day life, the distribution of decision-making within the household etc (e.g. if household members are generally out during the day then they might be expected to consume less energy compared to a household where one or more family members are generally at home for much of the time)
- practices in the home – the particular day-to-day habits and skills of householders (e.g. some householders might be more adept at using their central heating system and may consequently use less energy)

In order to investigate these issues, an in-depth, qualitative approach was adopted. This entailed working with a sample of **70 households**, over a period of several months. The research involved a range of techniques, including interviews, observations, diaries and temperature monitoring.

[7] DECC (2012) National Energy Efficiency Data Framework. Annex E, Table A 3.1.

[8] A standalone literature review, or a Rapid Evidence Assessment, was not conducted as part of this research. Instead, both DECC and Brook Lyndhurst drew upon their respective experiences in the domain of domestic energy consumption and behaviours to devise the approach to the research. Key to the approach was the school of thinking best described as the 'sociology of everyday life', within which the historical contribution of Henri Lefebvre and the contemporary contributions from Elizabeth Shove (University of Lancaster) and Daniel Miller (University College London) are especially important.

[9] Brook Lyndhurst has undertaken qualitative research, and explored the potential for more sustainable practices, across a range of everyday behaviours, including: sustainable energy in the home (Defra); catalyst behaviours (Defra); and food waste behaviours (Wrap).

2.1 Specifying the sample

DECC's statistical analyses[10] have investigated how household energy consumption varies with physical differences in the size, age and type of property as well as household income and tenure type (rented, owner-occupied, council or social housing):

- Consumption of both electricity and gas rises with the size of a property and household income.
- Owner-occupied properties consume more electricity and gas than rented properties.
- Newer properties consume less gas than older properties, whereas electricity consumption remains roughly constant.
- Some types of property consume more electricity and gas than others, for instance, detached properties consume more than purpose-built flats.
- There are also regional variations. Less electricity is consumed in northern England than the rest of the country. There is less regional variation in gas consumption once the data has been temperature corrected.

The intention of this qualitative research was to explore why, among **comparable households**, some households use dramatically more gas than average, and some households use dramatically less. Key to the selection of households for inclusion in the research, therefore, was to ensure, as far as possible, that households were indeed comparable with one another.

With this in mind, the sample consisted of 70 households[11] all of which lived in three-bedroom semi-detached houses. This housing type was selected as it is the most common in the UK, and is known to have a large variation in gas use[12]. All participants also owned their own homes, all had gas central heating and all households were located in similar suburban, residential areas[13]. The locations chosen for the research were Manchester (including Stockport and Prestwich), St Albans, Croydon, Reading, Newbury and west London (Uxbridge and Richmond). These suburban locations were chosen further to minimise any variation in gas use that might arise from non-behavioural factors (e.g. homes in highly urban environments might be affected by heat-island effects).

Other factors were also included in shaping the sample. The recruiters were instructed to recruit at least 12 participants with an annual household income over £60,000, and 12 with an annual household income of under £15,000. (Other things being equal, higher income households consume more gas than lower income households – though it should be noted that there are dramatic variations in gas consumption *within* any given income band, and the highest gas users in low income groups consume more gas than the lowest consumers in the higher income bands.) Similarly, as it is known that newer properties consume less gas than older properties, the objective was to recruit at least 12 participants with houses built before 1920 and 12

[10] DECC, 2011. National Energy Efficiency Data Framework: Report on the development of the data-framework and initial analysis. http://www.decc.gov.uk/assets/decc/11/stats/energy/energy-efficiency/2078-need-data-framework-report.pdf

[11] The sample was agreed between DECC and Brook Lyndhurst as being of sufficient size for qualitative research of this kind, within the envelope of the available resources. Without the participation of these households the research would not have been possible, and thanks are due to those householders.

[12] Ad hoc analysis of the Domestic National Energy Efficiency Data Framework undertaken for this project.

[13] Note that the English Housing Survey (2010) shows that around 90% of owner-occupiers have gas central heating.

participants with houses built after 1980. The table below shows the characteristics taken into consideration in the recruitment process, and the achieved sample sizes:[14]

Figure 1 - Recruitment criteria and outcomes

Characteristic	Recruitment achieved (70 households)[15]	Final High/Low allocation (53 households)
Age	Aged 59 or under – 54 Aged 60 or over – 16	Aged 59 or under – 41 Aged 60 or over – 12
Family status[16]	Single and have no children – 5 Married/co-habiting, no children, <55 years of age – 13 Have at least one child under 18 – 28 (of which 12 had at least one child under 5) Single empty nester/no children – 7 Married/co-habiting empty nesters, no children, >55 years of age - 17	Single and have no children – 4 Married/co-habiting, no children, <55 years of age – 12 Have at least one child under 18 – 22 (of which 9 had at least one child under 5) Single empty nester/no children – 7 Married/co-habiting empty nesters, no children, >55 years of age – 8
Income	Up to £14,999 – 16 £15k-£60k - 37 Over £60,000 – 17	Up to £14,999 – 13 £15k-£60k – 26 Over £60,000 – 14
Age of house	Built before 1920 – 12 Built 1920-1980 - 48 Built after 1980 – 10	Built before 1920 – 9 Built 1920-1980 - 37 Built after 1980 – 7

A number of other factors not captured by DECC's modelling to date were identified by DECC and Brook Lyndhurst as being of potential significance in explaining variation in gas consumption (e.g. presence or otherwise of a conservatory, presence or otherwise of pets, presence or otherwise of babies/young children, and so forth). The recruitment process was designed to ensure that the sample included the presence of households enabling these various factors to be explored. Appendix A provides full details of these factors and the numbers of households in the sample to which each factor applied.

[14] Targets for these various criteria were derived from the known distributions for 3-bedroomed semi-detached houses, as set out in the English Housing Survey (2010).

[15] It is noteworthy that there was an over-recruitment of women to the research (55 female, 15 male). This is perhaps because both the recruitment and the fieldwork were primarily conducted in the daytime, and it is more often women that are at home in the day. This was accounted for during the research by the use of research materials which very explicitly asked about the attitudes and behaviours of other household members.

[16] These numbers were chosen as broadly reflective of the demographics of the occupants of three-bedroom semi-detached houses based on the 2010 English Housing Survey available at: http://www.communities.gov.uk/publications/corporate/statistics/ehs200910householdreport.

The most crucial element of the sample, however, was to have half the sample identified as high gas users and half as low gas users. Since the households in the sample were in many other respects comparable, any differences revealed by the research between high and low gas users (in terms of the lifestyles, practices and concepts of home referred to above) could be inferred as being implicated in explaining the differences in gas consumption.

These high and low gas users were defined by being in the top or bottom 10% (decile) of households according to their annual gas consumption. Data from the National Energy Efficiency Database (NEED)[17] was used to identify the thresholds (for three-bedroom semi-detached houses with gas central heating) for these deciles, for three income bands (more than £60,000, £15,000-60,000 and less than £15,000). That is, 'High' and 'Low' users were not simply defined in terms of an overall average but with respect to the consumption for others in their income band living in three-bedroom semi-detached houses.

2.1.1 Confirming the Highs and the Lows

Potential research participants were required, during the recruitment process, to provide evidence (gas bills) to confirm their level of consumption, and were categorised as either 'High' or 'Low' or rejected from inclusion in the study.

Although gas bills had been used for recruitment in previous qualitative research exercises, the degree of precision required for the present study was unusual. Thus, whilst it was possible to specify the annual gas bill of a household deemed (for a given income level) to be in the top or bottom decile, it has to be acknowledged that other factors – the household's energy contract, the time period to which the bill applied, and so on – meant that there was room for two types of error: some householders that, on the basis of the bill shown at the point of recruitment appeared to be 'High' or 'Low' may, in fact, not be so; and some householders rejected for inclusion may, in fact, have been High or Low households.

Several types of data, gathered during the research, were used, once data collection was complete, to revisit and revise the classification into High or Low user. These were:

- gas use during the course of the study (as recorded by householders during the diary phase)
- gas readings at the start and end of the study (readings at the end were collected by researchers during the second interview)
- evidence from an Annual Energy Statement, where available
- gas bills presented at the point of recruitment
- gas bills presented at the second interview

At the end of this process 53 of the 70 households were confirmed as High or Low: 28 High users and 25 Low users.

These 28 high users and 25 low users were broadly comparable, in the sense that they had all met the same stringent recruitment specification for the sample. Comparison between results for High and Low was therefore considered a legitimate and effective means of analysing the differences between comparable households.

[17] DECC, 2011. National Energy Efficiency Data Framework: Report on the development of the data-framework and initial analysis. http://www.decc.gov.uk/assets/decc/11/stats/energy/energy-efficiency/2078-need-data-framework-report.pdf

As an additional exercise, however, specific and more precisely comparable pairs of households were identified from within the High and Low users. This process – households were matched in terms of their age, their socio-economic group, their income, their family status and the age of their home – enabled the generation of 17 pairs of households where the degree of comparability is particularly high. The ambition was to further minimise any observed variation in gas use occurring as a result of factors already known to DECC, and to reveal new factors that seemed to be causing variation in use. Section 3 of this report describes findings that applied to all 70 participants; while Section 4 presents the findings from examining the 28 high, 25 low and 17 pairs of high and low participants in particular.

Given all this, 'Highs' and 'Lows' can be conceptualised as households that, at the time of the research, and over the period of several months prior to the research, consumed an amount of gas either *markedly higher* or *markedly lower* than might otherwise have been expected for a household of their type. Analysis of the behaviours (both observed and reported) and attitudes of these households provides a powerful basis for exploring in-home energy behaviours in general and, most especially, for beginning to explore and explain why some households use so much more or much less gas than other, comparable households.

2.2 Methodology

Given the broad hypothesis – that gas consumption is not a *direct* behaviour but occurs as a result of a range of other, ordinary in-home behaviours – the research method was focused on everyday home life *in general* rather than 'energy behaviours' in particular.

Such a focus implied, first and foremost, that the research needed to be conducted in a fashion that enabled the research team to gather information from householders in the most naturalistic setting possible. It also increased the importance of establishing a good rapport with research participants: not only was the research scheduled to last a period of a few months but research participants were being asked to share quite extensive details of their normal, private, everyday life. This is, obviously, a potentially intrusive undertaking, and only by establishing an effective rapport was it possible to gather the kind of evidence required.

A three phased method was used:

- **Phase 1 - programme of two hour in-home, in-depth interviews:** Interviews were conducted with the individual who had been recruited. Where a partner or other household member was available and willing to participate, they were included in the discussions. The interviews used a mix of carefully designed prompts, including diagrams and activities; took place in interviewees' homes in March and April 2012 (that is, still within the winter heating period); and included a 'guided tour' of each home. The topic guide used is presented in the appendix to this main report.

  The interviews were centred on normal everyday lifestyles, comfort and use of the home. Participants were not explicitly informed about the focus on energy consumption, in part because the focus of the research was on their lifestyles etc, and also to minimise the risk of any changes in (energy-relevant) behaviour by participants that might be caused by the research process itself.

- **Phase 2 - diaries and energy monitoring:** Following the in-depth interviews, the recruited householders kept diaries for eight weeks, writing once a week online[18] about what had been happening in their home. The diary – an example of which is included in the appendix to the main report – was used to collect a range of information each week (focused on understanding lifestyles, comfort and use of the home) as well as a gas meter reading each week. All 70 research participants completed the diaries; 66 of these provided useable gas meter data.

  Also during the diary phase, twenty householders gave consent for Thermochron® iButtons®[19] to be placed in their homes. These iButtons (about the same size as a shirt button) were left unobtrusively in three rooms in each household – one identified as warm, one as cool, and a third room the temperature of which was considered interesting by the householder (perhaps because it was used regularly, or was frequently occupied by a household member with an idiosyncratic temperature preference) – and recorded the temperature once every hour for 10 weeks[20].

- **Phase 3 – final programme of one hour in-depth interviews:** Interviews were conducted with the recruited householder; i.e. the same individual as had participated in the first interview and who had been responsible for completing the diary. It proved impossible to conduct interviews with two of these individuals and, as a result, full results were achieved for 68 of the 70. The interviews were conducted on the basis of a topic guide developed specifically for this final stage of fieldwork (a copy is presented in the appendix) and took place in homes two to three months after the first interview. Interviewees were asked more directly about their gas use, heating, and energy consumption; and a variety of additional data were gathered for each household, principally to fill any gaps identified from the phase 1 interviews and to explore issues raised either by the diary results or by the research team's interim analyses. Photos were taken of participants, their homes, and their boilers[21]. Interviewees were also given the option of having their property assessed for an Energy Performance Certificate (EPC): ten participants already had EPCs, and 38 further assessments were completed[22].

2.3 Interpretation and use of qualitative data

Qualitative research can be an extremely valuable tool in circumstances where, for example, there is a paucity of quantitative data, or where more needs to be understood about a situation before quantitative data is gathered.

[18] Those less comfortable using the internet (eight out of 70) were sent paper diaries to complete, along with pre-paid envelopes.
[19] DS1921G Thermochron iButtons. More information on this technology: http://www.maximintegrated.com/datasheet/index.mvp/id/4023
[20] Illustrative iButton data is presented in Appendix F. The full data, together with a range of other data gathered during the research, has been separately submitted to DECC. Full details are set out in the Introduction to the Appendices.
[21] These research materials are kept confidential to preserve the anonymity of research participants.
[22] Of the 60 households that did not have EPCs at the time of interview, 48 agreed to have an assessment. Of the dozen not agreeing, most declined the offer because, they said, it would be 'a hassle'. Having agreed to an assessment, a further ten dropped out, mainly by means of persistently postponing an appointment or by 'changing their mind' when the assessor rang to book an appointment.

The present work has been conducted in accordance with the Cabinet Office guide to good practice.[23] Thus, despite the relatively large number of research participants, there are few numeric results presented in the findings. All references to 'households' should be taken to mean 'the households that participated in the study': the findings are not statistically 'representative' and may not be generalizable either to the population as a whole or to other groups within the population; but they present a powerful picture of energy-relevant behaviours and attitudes in England in 2012.

[23] Spencer L., Ritchie J., Lewis J. and Dillon L. (2003) Quality in Qualitative Evaluation: A framework for assessing research evidence. National Centre for Social Research, Government Chief Social Researcher's Office, Cabinet Office. London.

3. Main findings: how and why households use energy in the way that they do

Householders display a very wide range of behaviours that affect their gas consumption; and, for these householders, all of these behaviours are 'ordinary'.

The findings from this research are presented in two sections. In this first section, the concentration is upon general findings: results from the research that throw general light upon how householders behave in their homes and the consequences for gas consumption. In the following section, the focus is more specifically on the results that shed light on the differences, and the reasons for those differences, between High and Low households.

The findings are presented against the three perspectives used to frame the research and introduced in Section 2, plus a fourth theme "Physical properties of the home":

- **conceptualisation of the home** – in particular what people mean by 'comfort' and how it (might) affect energy behaviours;
- **temperature management** – how people manage the temperature in their homes and their awareness of the energy implications of their actions;
- **people in the home and their lifestyles** – who is in the home, and when, and what they are doing;
- **physical properties of the home** – the particular physical environment in which people live[24].

For each of these themes, the report distinguishes between factors identified during the research that have a clear impact (positively or negatively) on gas consumption; and factors that had been expected to have an impact but did not, in fact, appear to do so, or which are of more general interest.

3.1 Conceptualisation of home

At the outset of the research, it had been considered possible that householders would have different notions of 'home' and of what it means to be comfortable whilst at home. This could, potentially, be very important to understanding gas use, given the hypothesis that householders behave in ways that *indirectly* cause gas to be used rather than having behaviours that use gas directly. If there were different ideas of what constituted a comfortable home, and if temperature was a key component of 'comfort', then this could be important in explaining variations in gas use.

[24] Although the physical properties of the home have been previously been researched and modelled by DECC, they are included here for two particular reasons: firstly, it became clear during the research that a wide range of superficially minor variations in the physical properties (minor in the sense that they may not always be included in large scale quantitative analyses of housing) were having an effect on energy consumption; and, secondly, that the interaction between lifestyles/practices/skills and the physical properties of any given home was also potentially important in explaining observed variation.

In the event, this turned out not to be the case. Although there appeared to be marked variation in the actual temperature that householders considered comfortable, there was no variation in the extent to which comfort itself was a goal.

3.1.1 Key finding(s) relevant to gas use

It is not the case that some people make a big effort to make their home comfortable while others are less concerned. **All participants made an effort to make their home comfortable**, both in terms of aesthetics and in terms of temperature.

Being 'house proud' was more likely to have direct consequences for aesthetics and tidiness in the home than heating.

What was perceived as a comfortable temperature (and indeed a comfortable home) did differ considerably among participants (see section 3.3.1 below). In addition, there was a sense amongst some participants, particularly (though not exclusively) retirees, that they had **earned the right to live how they wanted to** and any suggestion of using less gas was seen as contrary to this.

3.1.2 Other (potentially) useful findings

The majority of householders described their **home as some sort of refuge** – a place of escape, safety, comfort. Only a handful saw the house they occupied as a place to store their things while they did things outside of the home, or as a stepping stone en route to somewhere bigger/better. Furthermore, no differences in energy consumption could be discerned between the two types of conceptualisation.

Interviewees who had lived in their houses for long periods of time reported having done '**major' work to their homes soon after they moved in** and/or in the early years living there. More recent movers reported that, when moving into a new house, they had made attempts to redesign the house to make it to their taste and to suit their needs. There were suggestions that, beyond these early years, renovations and work on the home thereafter tends to be more incremental.

Virtually all participants reported that they thought **energy efficiency was 'a good idea'**, with the majority citing personal benefits (i.e. financial savings) as being the reason. Energy efficiency was, however, conceptualised by most participants as being concerned with electricity (turning off lights, turning appliances off stand-by etc) rather than using less gas (turning down TRVs in unused rooms, matching the times the boiler is on to the times the home is occupied etc).

3.2 Temperature management

Although there was little or no variation in the idea that the home should be 'comfortable', householders in the study showed a much wider variety of behaviours in terms of the techniques they used to control the temperature in their homes. The behaviours associated with temperature management, and with the consequences of that management for gas use, were not generally 'top of mind' for householders in the study. Instead, behaviours appeared largely habitual; and some issues that might be considered important from the perspective of enabling or encouraging householders to reduce gas use, were simply out of sight and out of mind.

3.2.1 Key finding(s) relevant to gas use

Virtually **all the householders** in the study reported that they **were able to operate their heating system** so as to keep their house as they wanted it. Some householders identified features of their heating system that had, at some point, been a source of minor frustration or annoyance; and few householders in the study had a confident understanding of how their heating system actually worked. This lack of understanding appeared not to be, however, a barrier to them having effective control over the system.

Techniques for controlling the temperature of the house seemed generally to have been inherited from previous homes or family members without too much consideration of whether there was an alternative or more efficient way of doing it. **Householders went through a period of experimenting with the heating system in their home when they first moved in**[25]; and, once they had found a way of making the system meet their needs, it was generally not reflected upon by participants.

There was a minority who were confident that the thermostat would maintain the temperature of the house appropriately and left it alone: including some who 'left it alone' because they were not quite sure how it worked; and a **majority that altered the thermostat as and when they felt the need to do so**. Those who left their thermostat alone were more likely to leave their heating on permanently in winter, expecting that the boiler would only 'click on' if the house dropped below a certain temperature.

Some householders relied entirely upon changing the thermostat to meet their in-home comfort requirements; some households relied entirely upon the boiler controls. **The majority adopted a more mixed approach**, with boiler timings setting the broad parameters for the operation of the heating (and water) system, and a mix of manual over-rides (of both thermostat and boiler settings) being used to meet day-to-day needs. This pattern appeared to persist both when the boiler was being used for heating and water, and when it was being used for heating alone.

In households with male/female couples, participants tended to report that boiler settings and timing control panels were more likely to be the domain of the male, while the thermostat was more likely to be adjusted by the female or other family members.

Many interviewees were unaware of the temperature their thermostat was set to. Rather than having a specific temperature at which they wished to have their home, households appeared to have a target temperature range and they set the thermostat within that range (e.g.

[25] It is worth noting that the heating system in any given house was highly idiosyncratic: the precise configuration of boiler, thermostat, radiators, house orientation and so on is (close to) unique for any given house, so it is not something where previously learned lessons can be easily transferred.

between 15°C and 20°C, or between 18°C and 22°C). Specific temperatures were used only for specific purposes (e.g. “turn down to 15°C over night” or “turn up to 25°C for 30 minutes to boost heating”).

People use Thermostatic Radiator Values (TRVs) in many different ways. 46 of the 70 participants had TRVs for at least some of their radiators; and, among these, patterns of use vary widely, ranging from “all on maximum, all of the time” to individuals who appear to tinker frequently with radiator settings. As with thermostats/boilers, participants reported a pattern of use that suits the times they are in the home and what they are up to when at home, without regard to efficiency or cost, and there appeared to be **no relationship between the use of TRVs and overall gas consumption**.

The majority of participants measured their gas use in terms of money rather than kilowatt hours.[26] The majority of participants also paid for their gas via monthly direct debits and reported that, as a result, t**hey did not really have a clear sense either of how much gas they used** or how their gas use varied from one month to another. Participants also noted that they may end up in credit or debit at the end of the year and this made it even more difficult to relate the monthly direct debit charge to their actual gas consumption. Many participants suggested that changes in the price of gas (especially in recent years) meant that they were unable to compare how much they have used compared to previous bills.

On top of this, people’s knowledge and understanding of bills was generally low, with households unsure how often their direct debit was altered, or being only aware of the lump sum they were paying for gas and electricity.

While interviewees mentioned that they turned appliances off standby, or filled the kettle with only the amount of water they required, **there was no equivalent for gas use**. A lot of participants seemed to think that they were using just about the minimum in any case, by turning the heating off in summer and having it on a timer in winter. This may also be because participants saw gas use as essential compared to many other appliances (such as lights, phone chargers etc) and in continuous use in a way that appliances were not.

Many interviewees stated that they were not prepared to sit in their homes and get cold, and so as long as they could afford to pay for their heating, they did not consider their gas use to be ‘a problem’. As a result, **few reported making active efforts to reduce their consumption**. In cases where there were active attempts to use less, saving money was the primary driver cited. Those householders who reported having made attempts to reduce their consumption had used a variety of methods, including using secondary heaters instead of central heating, turning off radiators in unused (or less frequently used) rooms and wearing additional clothes. No householder reported having simply reduced the thermostat temperature. It was not clear whether the efforts being made by these householders were temporary or whether they might in due course become habits; however, respondents gave the impression that, having previously enjoyed a particular standard of ‘comfort’, they would attempt to return to it as soon as the opportunity arose.

3.2.2 Other (potentially) useful findings

When asked what they think uses most energy in the home, only around half of the participants interviewed put heating and/or hot water among the top three. **Space heating is**

[26] Note that a kWh of electricity costs about three times a kWh of gas at the time of writing.

underestimated as a use of energy. There was certainly not a wide or deep understanding of the amount of energy that heating requires, relative to other energy uses in the household. Some householders reported that they thought heating used less energy because it was only on for six months of the year.

Participants were asked how they thought their gas use compared to others in similar properties across the country. Participants had few, if any, 'reference' points, either in terms of the public generally, people living in similar homes to themselves or even family and friends. **There was a strong tendency for all households to assume that their gas consumption was about average**.

Virtually all the households in the sample were observed to have sofas or armchairs (or other furniture) **positioned against radiators**. This appeared mainly to be as a result of the size and shape of furniture relative to the available walls, and the fact that it is difficult to move the radiators.

3.3 People in the home

The three-bedroomed, semi-detached properties in the sample contained a mix of household types: young single occupants, new and mature families, retired people. Their patterns of use of the home – in particular, how often they were at home, and for how long – had an impact on their use of heating and, as a result, their consumption of gas. However, the differences in gas consumption between houses that were often empty and those that were always full were less pronounced than had been expected: whilst most households had the heating on for 'core hours' (the morning and evening periods), many properties were occupied during the day without the central heating on.

Perhaps the most significant factor that varied between households, however, was the fact that some people 'feel the cold' more than others.

3.3.1 Key finding(s) relevant to gas use

A majority of interviewees mentioned, unprompted, that they either 'feel the cold' or that they don't; and they made these reports with considerable confidence. These **subjectively-specified notions appeared to have a direct effect on temperature expectations of, and temperature management within, the home**. Those who 'feel the cold' endeavoured to have their home at a temperature that keeps them warm.

However, since the sensation of 'feel the cold' is entirely subjective, in households with multiple occupants there was often a difference in the extent to which individuals 'felt the cold'. In these cases, **the temperature in the home was a negotiated outcome**: there were very few (multi-person) households where all occupants had the same temperature preferences. As a result, household dynamics – who is in, and when; who is 'in charge'; and so on – were an important factor in dictating the temperature to which the thermostat was set.

In sample households with adult male/female couples, women were more likely than men to have temperature requirements/preferences (feeling either hot or, more frequently, 'the cold') that dictated management of the thermostat (i.e. that **women were more likely** either **to set the thermostat**, or the thermostat was set by others to meet the women's needs).

There was also an awareness of others in their family or household 'feeling the cold'; and this, too, was reported with confidence by participants.

Parents of babies and young toddlers went to great lengths to get the temperature 'right' in the home. This was certainly the case in the room in which the child sleeps, where the temperature was sometimes indicated by a digital display on a baby monitor. It was less clear, however, what was meant by the 'right' temperature, with most parents having the belief that their home needed to be warmer and others believing that it should be cooler. This led to behaviours that are infrequently seen in other households, such as altering TRVs or leaving heating on overnight.

Some homes were made warmer to alleviate certain illnesses and disabilities, or because ill or disabled people were more likely to feel cold. People with bad backs, or those who undertook activities leading to stiff joints (e.g. gardening) also reported having the house warmer or taking (more frequent) baths to ease the stiffness.

Among participating households, **those that were regularly or typically unoccupied in the daytime tended to have their heating set to come on for fewer hours a day** than houses with people spending more time at home. However, the relationship was not straightforward.

For example, among households that were often occupied during the day, particularly older and/or retired households, the central heating was often not set by a timer to come on during the day: many people in these age groups had lifestyles that meant they were not sure whether they would be in or not on any particular day. The heating was therefore 'off', and ad hoc methods (turning the heating on, or the thermostat up, for a short burst; or using a secondary heater; or occupying the 'warm room' in the house) were used to maintain comfort.

Conversely, in households where the house was more typically empty during the day, there were invariably occasions (working at home; a child off sick from school; etc) where the house was indeed occupied. Again, the timer tended not to be adjusted, and manual over-ride of the heating system (and/or other ad hoc temperature management methods) came into play.

As a result, the difference in gas consumption between houses that were largely unoccupied during the day and those that were (or appeared) always occupied was more muted than might have been expected.

Late in the evening after the heating had gone off, however, **interviewees reported that they tended not to override the timer**, instead finding alternative ways of staying warm (such as blankets, or going to watch TV in bed). Participants reported rarely leaving their heating on overnight, except for exceptionally cold winter nights, though several interviewees did regularly use things like hot water bottles and blankets in winter.

The eight week monitoring period and interviews **revealed large differences in showering and bathing habits**. One household, for instance, reported having an average of over 30 baths a week for the eight weeks (equivalent to an average of just over one bath per person per day), while a dozen households had not had a single bath. Some people reported having very quick showers, while one household reported that all 28 showers in a particular week – each of the two adults in the household having had two showers every day – had lasted over 10 minutes.

In terms of awareness, there seemed to be a greater awareness of hot water use when there was some risk of running out of hot water as opposed to being instantly available through a combi boiler.

3.3.2 Other (potentially) useful findings

Older children and teenagers often spent more time in upstairs bedrooms than in downstairs living areas. As a result, more rooms tended to be in use than might otherwise be the case. However, there was little to suggest that heating of houses changed to reflect this: upstairs rooms in homes without children were often heated anyway, even in houses where these were 'spare' rooms.

The frequency with which interviewees welcomed others into the home varied significantly, but there were **few reports of people altering the heating to take visits into account**. The exceptions to this were when babies and very young children visited, or when an elderly relative that is known to 'feel the cold' visited. For larger gatherings, interviewees reported that sometimes the house was warmer with more people anyway, so additional heating was not required.

There was no relationship, among the households in this study, between the amount of hot water people used and their use of their heating systems. People who used a lot of hot water did not necessarily use a lot of space heating; and vice versa.

There was considerable variation among participating households in terms of **how much laundry was done**. Households with more people tended to use the washing machine more frequently than households with fewer people; households with more active lifestyles (involving sport, for example) tended to do the laundry more often; and there was some suggestion that some households had higher expectations of cleanliness and/or freshness and that these households, too, did more laundry.

Most people claimed to dry clothes outside when the weather was good enough. Given the inclement weather in the summer months of 2012, however, it was often the case that alternative methods had been used. Despite considerable acknowledgement amongst interviewees that tumble dryers used a lot of energy, these had been used frequently when the weather had not been good or if clothes were needed quickly. For others, clothes horses (or airers) were used in the house or clothing was put on radiators. Only on rare occasions did participants say that they had used extra heating or opened windows to dry clothes.

Some householders reported that, on occasions, they would put on **additional layers of clothing** (or use e.g. a foot warmer) if it was cold. It appeared that these occasions were either when the external temperature was exceptionally cold; or, more frequently, when the house was occupied outside of the normal hours of operation of the heating system (see above). There were few, if any, indications that changing clothes was a normal or habitual behaviour to modify personal temperature during the usual hours of operation of the heating system; tinkering with the thermostat was a much more frequent response.

3.4 Physical properties of the home

It became clear during the research that a wide range of superficially minor variations in the physical properties (minor in the sense that they may not always be included in large scale quantitative analyses of housing) were having an effect on energy consumption. It also became apparent that the interaction between householders' lifestyles/practices/skills and the physical properties of any given home was also potentially important in explaining observed variation in gas consumption.

As a result, and despite the fact that 'physical properties of the home' was not one of the three themes used to shape the methodology for the research, a number of potentially important findings are presented here.

3.4.1 Key finding(s) relevant to gas use

The majority of the three-bedroomed semi-detached properties in this study had been **modified and extended significantly** from when they were first constructed. Modifications included loft and garage conversions, added conservatories, and the creation of large open plan spaces downstairs. It appeared highly likely that, as a result, more energy was being consumed to heat them than might otherwise have been the case.

In the sample of houses for this study, floor area ranged from 63m^2 to 139m^2. Clearly, larger homes are, other things being equal, more likely to have more people in them and will require more energy to heat; and this appeared to be the case in this study. (NB: The use of the word 'appeared' is both deliberate and important. There are many factors causing gas use to be either higher or lower, and some of the larger homes in this study used less gas than some of the smaller homes. This is discussed in depth in Section 4.)

The SAP annual efficiency rating of boilers in the study ranged from 90% to 65%[27]. Some boilers had been in the homes for almost 30 years, some for under a year. The star ratings in the EPCs showed households with anywhere between 1 and 4 stars for efficiency of their walls, roofs, and windows. Participants in the research that received EPCs also had between 1 and 5 stars for their heating controls, hot water, and lighting. Overall, properties ranged from an energy efficiency rating of 42 (E), to 73 (C). These physical variations, along with the differences in floor area, cannot account for all the observed variation in gas consumption between households. As Section 4.3 explains in more detail, together they may have accounted for about a third of the variation seen.

Many interviewees had conservatories in their homes. Conservatories varied in size and design but **households invariably reported that the conservatory had a temperature implication for downstairs areas**. In summer, conservatories acted as heat traps, warming connected rooms. In winter, some conservatories were still in use as they would still capture heat on sunny days or could be heated sufficiently, while others were not used and shut off from the rest of the house[28].

Interviewees were asked why they felt that warmer rooms were warm, and why cooler rooms were cool. One of the most common reasons given for explaining a room's temperature was **whether it was exposed to sunlight for several hours**, or not. Interviewees were not necessarily able to state which compass direction the house was facing, but were able to report which hours of the day particular rooms would get sunlight through the windows. If respondents' preferred rooms were naturally warm, they were less likely to use the heating system to ensure their preferred location was 'comfortable'. Many respondents heated their home to ensure that the room(s) they most frequently occupy were comfortable, with the consequence that, for some households, other rooms were heated to an *un*comfortably high temperature.

[27] These were calculated by looking up boilers in the SAP boiler efficiency database at: http://www.boilers.org.uk/ .
[28] Of the 57 iButtons retrieved from participants' households, only one was placed in a conservatory - but it recorded by far the biggest variations from the mean room temperature (see Appendix F for more iButton data).

In most homes **the thermostat was in the hall**[29]. Being, typically, a cooler place (draughty; less likely to have a radiator; doors in frequent use etc) this seemed to contribute to a disconnect between the temperature on the thermostat and the 'required' temperature: householders were tinkering with the thermostat in the hall, but the temperature they were attempting to control was that in e.g. the living room.

3.4.2 Other (potentially) useful findings

Where houses had been extended or rooms rebuilt completely, the new rooms were insulated. When glazing was replaced it tended to be with double glazing. These were not major decisions for people and were viewed as **normal components of upgrading a house**, with the side effect being cost savings and/or warmer homes. There were a few instances where cavity wall or loft insulation had been installed on their own, either because it had been offered for free or at a discount. Interestingly, a few of these households with insulation recently installed reported that it had made rooms too warm (which some participants addressed by opening their windows). No one with insulation installed spontaneously mentioned a resulting reduction in their gas bills; and, when asked directly, no-one was able to quantify any savings in gas bills that they might have made.

[29] No participants reported having been responsible for deciding on the location of their wall-mounted thermostat.

4. Main findings: high and low gas use

There are some households that used dramatically more gas – the High users – and some that use dramatically less gas – the Low users – than average. What are their distinctive characteristics?

In Section 3, this report set out a range of ordinary in-home behaviours and factors that emerged from the research as being relevant to all the households in the study. For some of those factors, such as the way in which people used their thermostat, there was no immediate link to whether people used more or less gas as a result; but the issue is clearly of use in understanding how people use gas in their homes, and ought therefore to be borne in mind when considering how to design support and interventions to enable or encourage people to use less gas.

For other factors, such as the frequency with which people have baths or showers, it is obvious that in two otherwise identical households, the one in which people use more hot water will use more gas than the one in which they use less. Variation in behaviour is, in these instances, clearly linked to variation in gas consumption.

For the factors discussed in Section 3, however, the research found no particular pattern or link to the overall classification of households into High or Low (see methodology section for a discussion of this classification). A number of households – for example – had lots of baths, and some of these households were 'High' and some were 'Low'.

This section of the report presents findings for those factors and behaviours for which a distinctive High/Low divide was discovered. The analysis and interpretation of the findings – from both this and the preceding section – are presented in the final Section 5.

NB: a variety of data are presented in this section. All of these findings are based on small numbers of observations. They are not statistics, and should not be taken as in any sense representative of the wider population.

As explained in Section 3.1, although there was some variation in how people conceptualised their home, this variation appeared to have no impact on variations in gas use. The sub-sections of Section 4 thus proceed as in Section 3, with the 'conceptualisation' sub-section omitted.

4.1 Temperature management

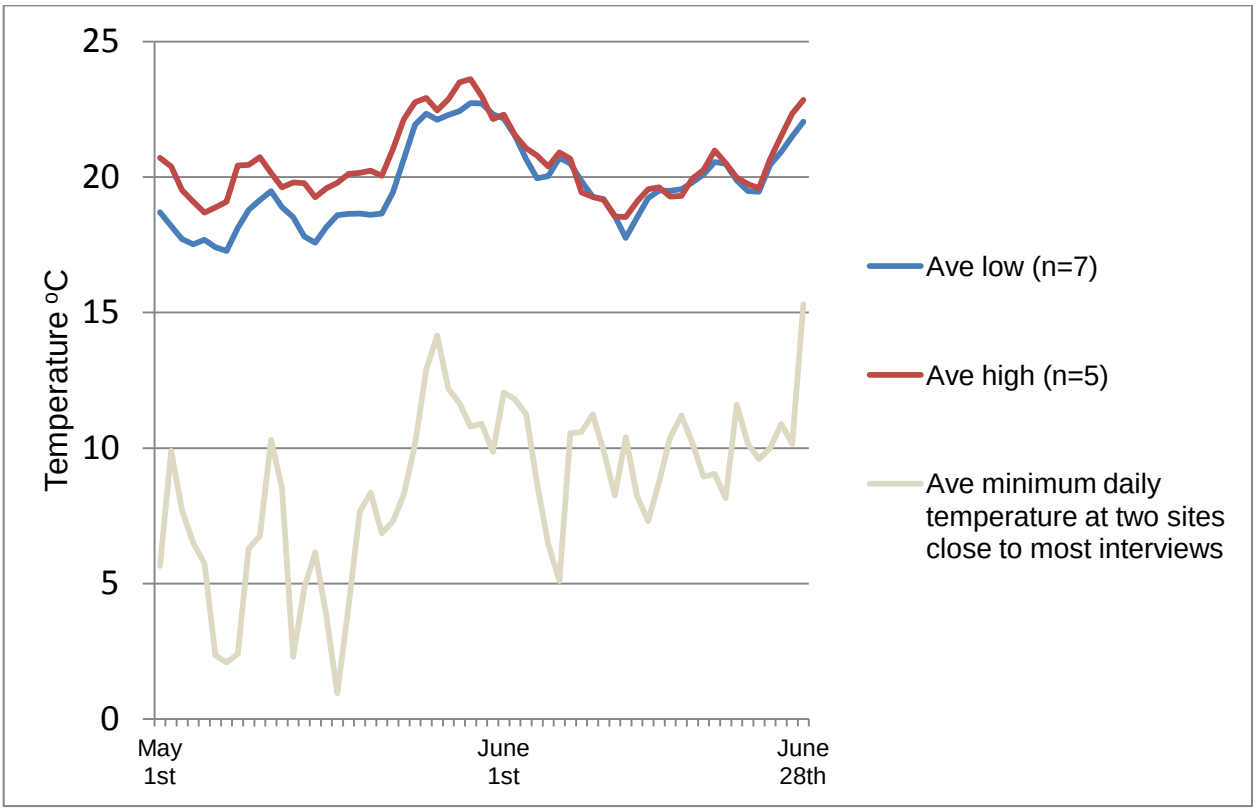
iButtons were left in 20 properties during the course of the study. They measured the temperature on an hourly basis for eight weeks in three rooms in each property. Of the twenty, five were left in (what turned out to be) High households and seven in (what turned out to be) Low households.

There was a **consistent pattern of difference between these two groups**[30]. In most cases, the minimum temperature, the mean temperature and the maximum temperature recorded in rooms in High households were higher than those for Low households. Of particular note is that average maximum temperatures in the High households were between 2°C and 4°C higher than in Low households (see Appendix F).

Figure 2, below, shows a daily average of the room temperatures recorded by the iButtons in High and Low gas users' houses. From the diary entries it is known that many participants had their heating on until at least the end of May 2012 (at which point there was a period of particularly warm weather). The graph below suggests that before May, when daily minimum temperatures were lower[31] (and the heating is on), higher gas users, on average, heat their houses to warmer temperatures than lower gas users. In June, when daily minimum temperatures were milder, there was little or no difference between the internal temperatures of high and low gas using households.

Given the energy required to achieve these temperature differences, it suggests that **High users preferred a higher temperature, and were thus using more energy to heat their homes**. The opposite, for Low users, also applied.

Figure 2 – iButton data for high and low gas users, May-June[32], 2012



Although this sample is very small, and clearly this issue needs further investigation, the pattern is sufficiently consistent to be noteworthy. In the previous section it was suggested that "feeling

[30] On average. Some of the individual households within the High group had average room temperatures lower than a couple in the Low group. See Appendix F for more detailed iButton data.
[31] The information for weather stations near two of the fieldwork areas was purchased from the Met Office.
[32] This time period was dictated by the timing of the fieldwork for the study.

the cold" appears to be a key variable: no householder wants their home to feel 'cold'; but no-one is able to translate their subjective sense of an acceptable temperature into an actual objective temperature measure. It may simply be – it was suggested – that **some people's preferred temperature is higher than for others** and that, as result, **people who prefer to be in warm homes** (other things being equal) **use more gas**.

Since, in many other respects, the paired High/Low households were indistinguishable, the temperature evidence appears to support this hypothesis.

In terms of other energy management behaviours – notably hours of use of the heating system; observed and reported thermostat settings; reported and observed knowledge or awareness of gas use; or in claimed radiator management – whilst there were differences in behaviours across the sample as a whole, there were no marked differences in the patterns of behaviour between High and Low users.

4.2 People in the home

Few features of how people live in their homes showed a distinctive difference between High and Low gas users:

- Length of residency – participants in High households tended to have been in their homes for longer (an average of 17 years) compared to those in Low households (10 years)
- Presence in the home – High households were empty on fewer occasions than Low households
- Long showers – High households tended to take more long showers (an average of 2.8 per week that last ten minutes or more) than Low households (1.6 per week)

Taking more, longer showers is likely to have an impact on overall gas use. However, around half of both High and Low households have 'power showers' or electric showers, thus reducing the likely impact of this behavioural difference on gas consumption.

Being in the home, too, has an impact on gas consumption (although, as discussed in Section 3.3, the difference is muted by a variety of factors). The fact that **High households tend to be at home more often than Low households** would therefore seem important.

The potential importance of the rather marked difference in length of residency is less clear: it could, perhaps, indicate that those who have been in their homes longer, having done major works to their home longer ago (see the earlier finding that participants reported tending to undertake major projects on their home in the early years of occupancy), now occupy homes in which the standards of insulation are lower, so their homes are less energy efficient.

4.3 Physical properties of the home

On average the physical characteristics of properties classified as High meant they required more energy to provide the same energy service as those classified as Low. For example, the High properties were larger than the Low, 110 m^2 as compared with 87m^2, and had more radiators, an average of ten as compared with eight.

However, the energy performance certificates (EPCs) show that these differences were not sufficient to explain all the variation in energy demand. On average, EPCs showed that the High

households were less efficient than the Low properties, with an average EPC rating of 63 as compared with 57. These predicted that High households would spend an average of about £980 on 22,000 kWh of gas per year as compared with £730 on 16,500 kWh for the Low households. [33]

However, this difference of £250 predicted by the physical differences between properties was in fact far lower than the difference of £860 in their actual bills. This suggests that around a third of the difference between Highs and Lows in this study occurred as a result of physical differences between the properties, and two thirds as a result of behavioural factors.

[33] At a 2011 price of 4.43p per kWh of gas.

5. Analysis, conclusions and suggestions for action

5.1 Analysis

Reviewing both the general findings and the findings that are specific to the High/Low categories, our analysis has two main components.

The first component is to note that the factors identified as being able specifically to *distinguish* the High and Low gas users are insufficient to *explain* the difference between High and Low. Whilst a third of the difference in gas consumption between High and Low can be explained in terms of the physical differences between properties, it seems unlikely that the remainder can be explained solely in terms of temperature preferences (section 4.1), taking long showers and being at home a little longer (section 4.2).

The second component of our analysis is to group explanations into four different levels (summarised in figure 3):

1. How and why people used gas at home in the ways that they do
2. Why people used different amounts of gas at home
3. Why households used exceptionally high or low amounts of gas
4. Aspects that could have affected gas use, but appeared not to in this study

Our interpretation of this analysis is that the categories ‘High’ and ‘Low’ gas users need to be thought about in a very particular way.

It is worth recalling, initially, that the factors listed in part 2 of figure 3 do not merely show variation among the households that participated in the research; they show a variation that does not align with the High/Low categories. That is to say, for example, there are households that have very high numbers of baths (compared to the average) but are not Highs; there are small houses that are not Lows; there are households with babies that are not Highs; and so on.

Even for the factors listed in part 3, where the link to High and Low is strong, it is still possible to elude the categorisation: some households that are empty for much of the working week still manage to be Highs; while some households that are almost always occupied are still, on occasion, Lows.

Figure 3 – What affected gas consumption in this study[34]

1 How and why people used gas at home in the ways that they did

People used gas to get a 'service': comfort, cleanliness, relaxation and so on.

Amongst these, people used most gas to get comfortable.

People were unaware of how much gas they used. They thought energy efficiency was a good idea, but focused much more on saving electricity than gas.

People used gas to manage temperatures in untidy, inefficient yet effective ways: e.g. thermostats in halls were used to warm the (other) places people liked to be, turned until they clicked to switch heating on/off and set warmer than desired to heat homes quickly.

2 Why people used different amounts of gas at home

Gas services were used in particular ways by/for particular occupants: e.g. parents used TRVs to keep babies (safe and) warm; elderly and injured used heat and hot water to relieve pain in achy joints.

Different people preferred to use the same services in different ways: e.g. people who 'felt the cold' used more heating to get comfortable.

Properties varied in ways that national statistics do not capture but do affect energy use: e.g. home improvements (roof extensions, garage conversions, conservatories) caused larger areas to be heated; people used less heat when sunshine warmed places they wanted to occupy.

3 Why households used exceptionally high or low amounts of gas

People who used a lot of gas for one service (e.g. heating for comfort) did not use a lot for another (e.g. hot water for cleanliness).

Quite ordinary choices underlay exceptional gas use: e.g. spending more time at home, preferring higher temperatures or longer showers and doing renovations when occupants first moved home[35].

4 Aspects that could have affected gas use, but appeared not to in this study[36]

Attitudes or values were not simply related to gas use: those who hated waste, or valued the environment did *not* appear to use exceptionally little gas (and vice versa).[37]

Heating homes for pets

Increasing ventilation to remove cigarette smoke

Turning on heating and opening windows to dry laundry (e.g. on wet winter days)

Having more occupants (e.g. older/teenage children, guests)

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[34] This table excludes property size, age, type; household income and tenure as these are already included in DECC's models.
[35] It may be that recent renovations improve energy efficiency more than older renovations.
[36] This report focuses on aspects that do affect gas use, so many of these do not appear elsewhere.
[37] Respondents were invited, during the diary phase, to answer a series of questions based on Schwartz's circumplex (see Schwartz, S.H. (2006) Basic human values: Theory, measurement and applications) so as explore whether respondents' values related to their gas consumption (or related behaviours). Interim analysis was inconclusive.

In fact, reviewing the 53 cases that we were able to classify as either High or Low, we found virtually no stable mechanism by which an individual household 'became' a High or a Low. In almost every case there was a unique or near unique set of factors that *culminated* in them being a High or Low gas using household.

- One Low using household, for example, is an older couple in the large home in which they raised their children; they have turned off radiators in some of the spare rooms, but leave a number on 'just in case' a child or grandchild comes to stay. The house – and, more importantly, the main living area – faces south, and the double-glazed windows mean that, especially in early autumn and late spring, the house 'feels' warm, so they don't need to turn the heating on. Both the man and the woman like the house to be about the same temperature, so the thermostat is rarely touched. The house is normally empty during the day time, and if one or other of the couple is at home they tend to use the convection heater that they keep in the living room. They prefer baths to showers.
- Another Low user, by contrast, is a young couple in a much smaller house. Their income is constrained, so they are very conscious of the cost of gas. The heating system – which they know almost nothing about, it having 'worked' since they moved in a couple of years ago – happens to be relatively efficient, and they try not to have it switched on more than absolutely necessary. There are TRVs in most rooms, but they don't really understand how they work and just leave them alone. They shower rather than bath. The house has relatively small windows and is relatively new, so it is well-insulated. The man is currently unemployed, so the house is rarely empty; but he tries to avoid using the heating un-necessarily, preferring to wear a jumper indoors, or to use the portable heater that his mum gave him.
- In a High user household, also comprising an older couple in a large home in which they raised their children, the male enjoys being able to walk around wearing a t-shirt whenever he feels like it. He has worked hard all his life and being able to enjoy a few luxuries is – he says – something he's entitled to. His favourite room (he is semi-retired, and is often at home in the mornings) faces north east, and he often over-rides the heating timer to ensure the whole house is nice and warm so that he does not get cold on his way to make a cup of coffee. He hates baths and always showers; so, too, does his wife. She is very house proud, and the various modifications to the house over the years have been her idea. The open-plan living area means that they 'need' to keep all the other rooms in the house warm otherwise they get a draught.
- Still another household, another High, happens to live in a particularly poorly insulated older house. The boiler, too, is rather old, and despite the fact that, as young parents, they are money conscious and try not to be too wasteful, they barely notice the direct debits for gas every month: there are many other things to be worrying about. The main room faces south, but they rarely seem to spend time sitting still, certainly during daylight hours, so it makes little difference to them. The woman in the home 'feels the cold' and is perpetually nudging the thermostat up a little; the man feels that this is wasteful and is perpetually nudging it down again. They haven't changed the timings on the boiler since they moved in.

As these pen portraits illustrate – and this research has generated seventy such stories – householders are simply getting on with life – and a combination of *some* of the things they do, and the house that they happen to live in, culminates in a particular level of gas usage.

This leads us to the view that being a ‘High’ or a ‘Low’ is not the outcome of some broad lifestyle choice, or a value-set based on profligacy or frugality. Rather, in the context of variations in the energy efficiency characteristics of individual houses that are sometimes obvious and sometimes subtle, it is the outcome of a messy assembly of perfectly ordinary behaviours, only some of which are conspicuous in terms of their gas use. Identifying a ‘High’ or a ‘Low’ on the basis of their behaviours and/or attitudes would therefore not appear to be a straightforward task; and, similarly, isolating those behaviours most closely associated with High or Low gas use is also potentially fraught with difficulty.

5.2 Conclusions

This research exercise began with a small number of broad hypotheses, notable among which was the idea that people don’t consume energy, they instead consume the services delivered by energy. To understand energy, and in particular gas consumption, it would be necessary to try to understand the services that people sought while in their homes.

Comfort, the research confirms, is indeed the principal service people expect from being in their home; and this appears not to vary between people of different ages, social classes or working status. Everyone (if our sample is anything to go by) irrespective of how often or for how long they are in their home, wants to be comfortable when they are there – and having one’s home the ‘right’ temperature appears to be central to the idea of it being comfortable.

The notion of the ‘right’ temperature appears to be highly individualised. Most people we spoke with during this research either identified themselves as someone who ‘feels the cold’ or their partner as someone who ‘feels the cold’ or someone else in the household as someone who ‘feels the cold’. Different people appear to have a different, subjective notion of what ‘comfort’ means in temperature terms. We were not able to test this formally as part of this exploratory qualitative research, but the findings from a small number of homes in which we were able to leave temperature monitoring equipment suggested that there is indeed a temperature differential between households that use a lot of gas and those that use a little: some people, it seems, simply like it to be warmer than others, and they use more gas as a result.

Most of the people in our research do not really understand how their heating system works; and most, it would seem, do not really care. The boiler is not a high profile ‘statement’ good in their home. What they care about is that it works – which means, they care that it makes their home the temperature that they want, when they want it. None of the people in our research were familiar with their new home’s heating system when they moved in, so they had tinkered and played with it until they had figured out how to make it work the way they wanted.

And what they wanted from it was shaped by who they were, and how many people were in their home, and who liked it ‘warm’ and who liked it ‘cool’, and when the children got home from school and whether anyone was at home sick and how often the spare room was used… and they sometimes adjusted the radiators and they sometimes adjusted the boiler but most of the time they simply moved the thermostat up a little or down a little, within an ill-thought through temperature range, mainly to make sure that everyone in the house was, as far as possible within the constraints of domestic negotiation, comfortable.

Most of the people in our study did not know how much gas or energy they used as a result; and many could not easily even say how much it actually cost. They knew that gas had become more expensive (though it was not clear whether they had simply heard this on television or had actually noticed their bill, because most of them paid for their gas by direct debit and an almost

invisible amount of money simply disappeared from their bank account each month) and most of them suggested that 'saving money' was the main reason they would have for trying to reduce their gas consumption; but few, in fact, had actually attempted to do this; and among those that had, or who had installed insulation in the belief that it would save them money, none of the people in this research exercise were able to state, or even hint, at how much money they had actually saved.

What was very clear, however, is that there are indeed some households, living in broadly comparable houses, that consume a very great deal more gas than other households. Our detailed investigation of the reasons for this difference produced, from one perspective, a rather unsatisfactory answer: which is that there are many different ways to be a High gas user, and many different ways to be a Low gas user. Discovering that a particular household has a particular high- or low-gas-using behaviour, or happens to live in a house that increases or decreases their gas consumption, is no indication of what their overall gas consumption might be.

In a further complication, it seems likely that classification as 'High' or 'Low' is unlikely to be stable over time, since many of the variables can change.

The consequences of all this would appear to be relatively few in number:

- Virtually all the households in this research study were undertaking at least one 'high gas using' behaviour – implying that in virtually all households, even the 'Lows', there is the potential to reduce gas consumption.
- Awareness of gas use is very low, and the link to 'energy efficiency' is rarely made. Some form of awareness raising would appear to be a pre-requisite to any more substantive efforts to enable and/or encourage householders to reduce their gas consumption.
- Any education or awareness-raising in this area would need, this research suggests, to be done very carefully. Households are not, after all, consuming gas, they are pursuing comfort, and any attempts to encourage them to reduce gas use could be interpreted as a request to sacrifice their comfort.
- In situations where householders have attempted to reduce their gas consumption, they stated that saving money was their principle motivation. Future efforts could probably continue to use a financial argument as the basis for action, and may not even need to be specific about how much money householders might save: none of the householders in this research knew how much they had saved as a result either of insulation measures they had undertaken or of more 'behavioural' steps they had taken to try to use less gas.
- The number of behaviours/factors that appear to have an effect on gas use, and which also appear amenable to change in the short term is, it appears on the basis of this research, relatively small. Subjective temperature preferences, the presence or otherwise of children and the overall energy efficiency of one's home – for example – are all somewhat immutable in the short term. Furthermore, variables such as the thermostat temperature, the hours of operation of the heating system and the number of baths taken – behaviours with respect to which could, in principle, be changed very quickly – appear to be entrenched habits that are deeply connected to notions of comfort such that any change would be experienced as a 'sacrifice' to be resisted.

Although we identified a range of behaviours that appeared not to have particular implications for more or less gas use (part 1of figure 3) it is possible that more refined and/or detailed and/or quantitative research and analysis might reveal important patterns that have eluded this initial, exploratory research. It might be, for example, that the widespread habit of operating the thermostat within temperature ranges is linked, via a particular typology of heating system management techniques, to higher or lower gas use. Care should therefore be taken in interpreting these results: things could, in fact, be even more complicated than this research suggests.

5.3 Suggestions for action

On the basis of our conclusions, and in light of the research findings as a whole, we have identified a number of areas where action or intervention appears most likely to have the potential in the short term (i.e. within the current decade) to influence gas-related behaviours and to enable householders to reduce their gas consumption. It is worth acknowledging the fact, however, that many of the factors identified in this research as having an influence over in-home energy behaviours are not easily amenable to policy (or other) intervention.

- The low salience of gas means that work will be required to establish the idea that it is important to include gas within the idea of energy efficiency. Although 'understanding' is not always or necessarily a pre-requisite to action, it would seem that many people are already trying to be energy efficient in their own homes – but they are doing so solely with respect to electricity usage. Expanding the realm of a current behaviour (or suite of behaviours) would seem likely, in our view, to be a more effective way forward than attempting to introduce a behaviour (or set of behaviours) around gas that is perceived as entirely new.
- Understanding how and why people use gas as they do is key to designing interventions that successfully increase energy efficiency. Even current advice, such as reducing the temperature of the thermostat by a couple of degrees[38], may be too far removed from the realities of how many people control their heating (which often involves frequent adjustments to the thermostat within broad temperature bands). Instead, offering tips and guidance on how to remain comfortable in your home, but to do so in a way that 'saves money', could be more fruitful.
- Mechanisms for highlighting and/or explaining norms or benchmarks could be helpful: "Many people [like you] have homes that are just as warm as yours, but by doing a, b and c they are paying 20% less for their gas each year!"
- A significant opportunity exists to highlight not merely the cost savings associated with measures intended to reduce gas consumption, but to present those savings in more accessible ways (for example, as is the case with pension funds, where future benefits are illustrated under different interest rate scenarios).
- The roll out of smart meters, and the awareness raising and marketing that will both precede and be an integral part of the roll out, may provide an opportunity to raise awareness of gas efficiency issues more generally and, in particular, to present 'ordinary' tips and techniques for staying comfortable while spending less.

[38] See for example, http://www.ukpower.co.uk/energy_expert/top_10_ways_to_reduce_your_energy_usage.

- In terms of targeting, it is already clear that larger and/or wealthier households use more gas than smaller/poorer households. Beyond this, however, the results from this research suggest that there may be merit in segmenting behaviours rather than people. That is to say, the 'multiple ways to be a High or a Low' could be used as the basis for identifying a more manageable number of broad types of behavioural cluster[39] (within any given housing and/or socio-economic group) that could further refine the targeting of messages and/or other interventions.

5.4 Suggestions for further research

In light of this research, the research team has identified a range of further research that could usefully be undertaken, either to deepen understanding of the in-home behaviours that influence gas consumption; to move from the present qualitative understanding towards more quantitative understanding; or to support the kinds of actions and interventions suggested above:

- There is scope for the development of a typology of in-home energy management practices. Using the data gathered for this present study, plus – potentially – additional similar research, a typology of such behaviours could more accurately inform interventions aimed at helping householders adopt more efficient in-home practices.

- It may be valuable to further research the issue of subjective temperature preferences. There were hints in the research that age and gender could be important. In any case, a fuller understanding of 'I feel the cold' could help to understand how best to assure householders that they can maintain their 'comfort' whilst also reducing their gas use.

- Although the frequency of bathing and washing did not emerge as a definitive indicator of High or Low gas use, it is clear that there is considerable variation in washing practices, with significant implications for the amount of hot water used in English households. There is therefore scope for further research into issues of health, cleanliness and hygiene that might shed light on this issue.

- It may be useful to explore the findings from this research via other lenses, perhaps by means of other samples. Whilst owner occupied, three bedroomed, semi-detached properties are the most common type of property, they only account for 35% of UK households. Also, whilst absolute (or full) household income is straightforward to collect and is used widely by Government in poverty and fuel poverty indicators, *disposable* income is potentially a better measure of household purchasing power and a sample based on disposable income may give a more nuanced insight into the detailed relationship between household incomes and the costs of energy.

- When asked why they had taken measures to reduce their gas consumption, householders in this research invariably mentioned 'saving money'. None, however, was able to explain how much money they had actually saved. It may be that merely the generic possibility of saving money, rather than a measure of the actual money saved, may be a sufficient motivation for action; or it may be that there is a non-linear relationship between the size of

[39] Of the kind illustrated in the pen portraits in section 5.1

prospective savings and the likelihood of action (it might be that relatively small sums of money may be sufficient to trigger action, in some circumstances; or that disproportionately large sums may be required). There were also hints from the research that householders who paid for their gas with key cards were more aware of the costs of their gas (and their gas usage) than other households. Research (potentially action-based, experimental research) could throw useful light on these issues.

- Nevertheless, we would suggest that initial small scale quantitative work (probably involving attitudinal and/or behavioural survey work) could explore the variables identified as 'in play' by this research (see figure 3, above), and it would be appropriate to conduct preliminary multi-variate analysis (or similar) with a view to further narrowing the field of enquiry.

- Finally, there may be scope for some segmentation modelling; and, in our view, this is most likely to prove fruitful if, within the broad parameters set by household-type and socio-economic group, such modelling explored clusters of behaviours that might be associated with different levels of gas usage. Such a segmentation – which could build on the multi-variate analysis described above – could prove to be an exceptionally valuable tool in targeting the kind of interventions just discussed and which are likely to be essential if energy efficiency – and, in particular, gas efficiency – is to improve in the hoped-for fashion in the next decade.

Department of Energy & Climate Change
3 Whitehall Place
London SW1A 2AW
www.decc.gov.uk

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