Programme Area: Smart Systems and Heat

Project: Consumer Response and Behaviour

Title: Primary Consumer Research (Phase 1) Report

Abstract:

This report was prepared for the ETI by the consortium that delivered the project in 2013 and whose contents may be out of date and may not represent current thinking. This report aims to map the range and diversity of heat energy needs and behaviour of domestic consumers in the UK. Drawing on a multi-faceted project of primary consumer research, it also presents an emerging framework (depicted in Figure 1) for understanding why consumers behave as they do, and how and why these needs and behaviours vary across the population The report has a wealth of information, and readers may find the following sections of particular interest;
• The Executive Summary which provides insight into the key findings of the research
• Figure 1 the Explanatory Framework
• The Case Studies in Appendix 1 which have been used to understand and describe the framework

Context:

The delivery of consumer energy requirements is a key focus of the Smart Systems and Heat Programme. The Consumer Response and Behavior Project will identify consumer requirements and predict consumer response to Smart Energy System proposals, providing a consumer focus for the other Work Areas. This project involved thousands of respondents providing insight into consumer requirements for heat and energy services, both now and in the future. Particular focus was given to identifying the behaviour that leads people to consume energy - in particular heat and hot water. This £3m project was led by PRP Architects, experts in the built environment. It involved a consortium of academia and industry - UCL Energy Institute, Frontier Economics, The Technology Partnership, The Peabody Trust, National Centre for Social Research and Hitachi Europe.

Smart Systems and Heat (SSH) Technology Programme

Work Area 5: Consumer Response and Behaviour

WP5.4: Primary Consumer Research (Phase 1)

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Contents

Executive summary

This study was conducted as part of the Consumer Response and Behaviour project, within Work Area 5 of the Smart Systems and Heat (SSH) Programme of the Energy Technologies Institute (ETI). Fundamental to any new approach to domestic energy is an understanding of the needs that consumers meet (or seek to meet) through energy use, and the behaviours and technologies through which they currently address those needs. If these are not well understood, the design of smart energy solutions (SES) risks failure – as consumers will dislike solutions that do not meet their needs, and so be less likely to adopt them or use them appropriately. The Consumer Response and Behaviour project provides an essential basis in this consumer perspective.

This report aims to map the range and diversity of heat energy needs and behaviour of domestic consumers in the UK. Drawing on a multi-faceted project of primary consumer research, it also presents an emerging framework (depicted in Figure 1) for understanding why consumers behave as they do, and how and why these needs and behaviours vary across the population.
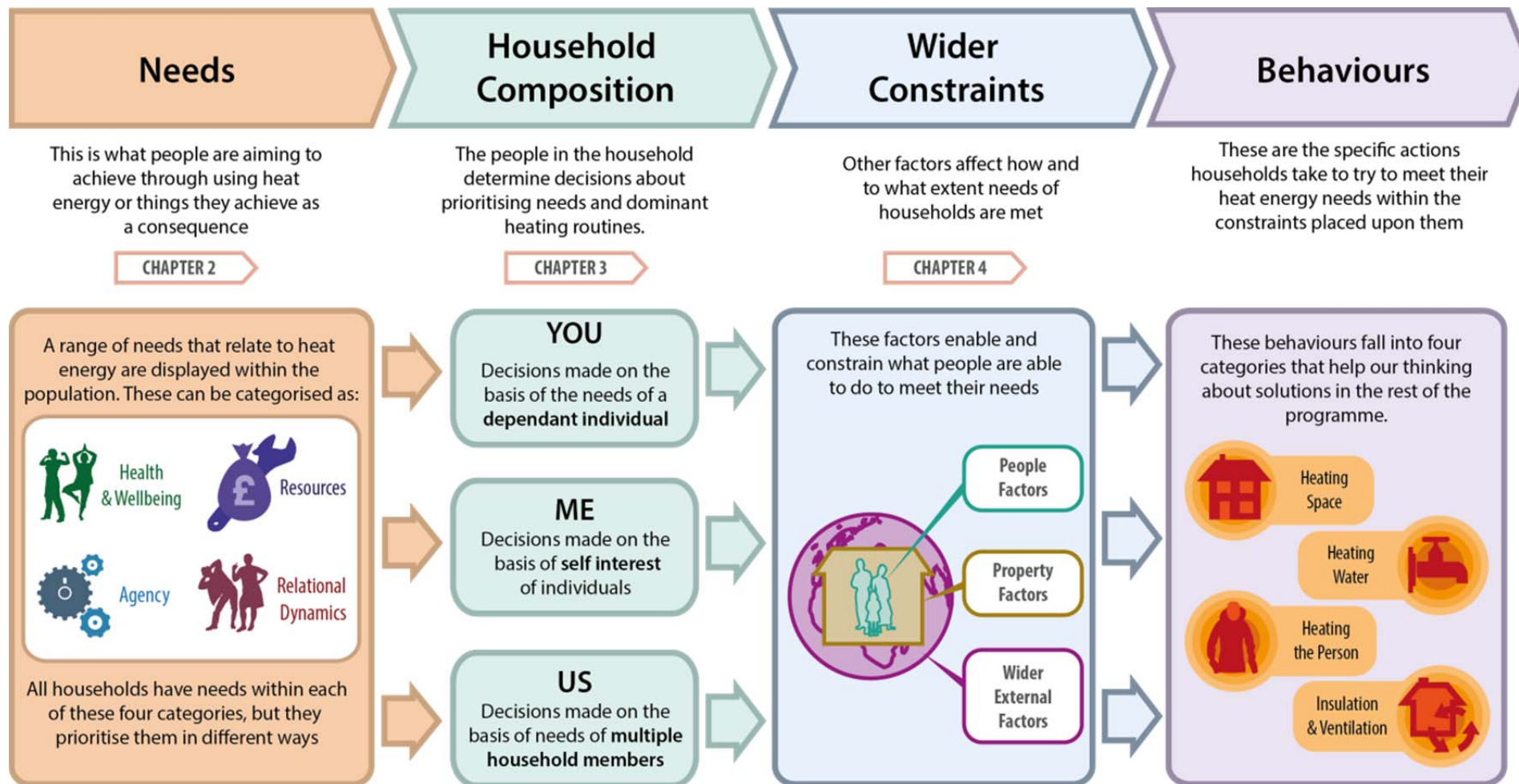
Figure 1. Overview of explanatory framework

This study represents one of the first systematic attempts to understand heat energy behaviour in terms of what people are trying to achieve. For the purposes of this report, therefore, we have adopted a broad definition of needs. Heat energy needs are understood here as what people are aiming to achieve through using heat energy or things they achieve as a consequence of using heat energy. We recognise that there is variation in how the concept of needs is understood in different disciplines and have deliberately avoided adopting a narrow view of needs. Instead we feel it is most helpful to start with this broad, non-academic understanding as an initial lens to understand heat energy behaviour.

Because our definition is broad, it incorporates a wide range of needs, from those that are objectively "essential for life" to preferences based on individual perceived requirements or values. Needs may also be addressed as high level "purposes" for a home (e.g. having a healthy, comfortable life, maintaining cleanliness, or caring for a family) or as relating to very specific targets, such as aiming to control mould or damp or drying clothes.

The report begins by presenting a new thematic categorisation of needs that people seek to meet through the use of heat energy. This categorisation has emerged from our research with a diverse sample of the general public. The final categories are the result of an analytical process where needs that are similar are grouped together and given an appropriate label. Our aim here is to make it easier to comprehend the full diversity and complexity of needs that exist within the general population and select categories that help us understand why households have different priorities. The four categories of needs are as follows.

- *Health and wellbeing*: A diverse and significant category of needs described as fundamental by participants. Broadly, the needs in this category relate to specific health concerns (e.g. having a hot bath to ease arthritic pain) or general wellbeing, which spanned comfort (e.g. using a blanket to feel cosy while watching TV, or having the heating on to be able to walk around in the comfort of shorts and a t-shirt in the home), keeping clean (e.g. having a shower, as it is seen as more hygienic than a bath), relaxation and invigoration (e.g. having a shower to wake up, or a bath to relax and unwind), avoiding harm (e.g. keeping windows closed to avoid children falling out, or intruders entering), and ambience and aesthetics (e.g. lighting a fire to enjoy the glow).

- *Resources*: Resource-related needs related to finances (e.g. going out for a long walk to warm up rather than turning the heating on, to save on energy costs), waste (e.g. wearing an extra layer of clothing, rather than turning up the heating, to avoid unnecessary use of energy) and property maintenance (e.g. heating empty rooms to avoid damp and mould, or leaving the heating on a low setting to avoid the risk of burst pipes). Finance-related needs tended to be driven by the desire to save money. In contrast, avoiding waste (although it resulted in similar strategies) was driven more generally by the principle of being efficient with energy use, with cost savings being a welcome consequence rather than the main driver of behaviour.

- *Agency*: This is a term that has different meanings in different contexts, but in this categorisation, agency refers to the capacity and willingness of a person to act independently and make choices. This includes both purposeful, goal-directed behaviour and unconscious, involuntary behaviour. Needs considered under agency include control (e.g. using TRVs and/or timers to feel in control of energy use), routine and habit (e.g. adjusting the timer to align with household routines, or using a hot water bottle in summer out of habit) and convenience (e.g. saving time by using radiators or tumble dryers to dry clothes, or having the heating on at all times or controlled by a timer to avoid the effort of thinking about it). All of these relate to a desire to be actively in control of heat energy use within the home and the effort people are willing to put in, often to meet personal or household requirements and preferences.

- *Relational dynamics*: This category of needs focuses on the social relationship between the individual or household and others, including the wider world. These needs operate at various levels: self-image and social acceptance (e.g. keeping the home at a high temperature to ensure children are warm at all times, because this is part of being a 'good mother'); social interactions with household members and guests (e.g. turning the heating up before guests visit to avoid being seen as 'tight', or lighting a fire to serve as a focal point for social interactions); social interactions beyond the home (e.g. having a shower to be hygienic, to aid social acceptance in the workplace); and the wider implications of energy use. The last point relates to the link between domestic

energy consumption and its potential impact on the wider community, society or environment. In many ways, this is a 'hidden' need, not featuring in discussions or showing itself in behaviour. Nevertheless, the reasons why it was generally not salient to different groups of people are important, and these are explored within the report.

Of these categories, health and well-being and resources appear to be more fundamental and tangible and, as categories, very intuitive. Agency and relational dynamics have been more difficult to define and demand further exploration. The Consumer Response and Behaviour programme will continue to refine the categories of needs, in particular to provide clearer implications for possible smart energy solutions.

When describing these categories in more detail, Chapter 2 identifies a wide range of ways in which each of the needs feature in participants' accounts, while linking these to a range of behaviours (which are considered in terms of space heating, water heating, heating the person, ventilation and insulation) and technologies through which they address the needs.

Table 2 provides an illustrative representation of needs and behaviours in interaction. As the table shows, a given need may be met through a range of behaviours and technologies, while a given behaviour might be used to meet a range of needs.

Behaviours / Needs	Heat space	Heat water	Heat the person	Ventilation & insulation
Health & Wellbeing	E.g. Keeping the heat on to avoid damp for health and aesthetic reasons	E.g. Having a shower, rather than bath, to invigorate oneself and aid productivity	E.g. Using a hot water bottle or heat pack to lift mood during illness	E.g. Keeping windows closed to avoid children falling out
Resources	E.g. Turning off central heating while using the oven to cook to save money and avoid waste	E.g. Using boiled water from pans heated over the stove or in kettles rather than re-heating storage heaters, to save money	E.g. Exercising or wearing an extra layer of clothing, rather than turning the heat on/up	E.g. Use of extract fans to reduce moisture levels and prevent damp or mould
Agency	E.g. Having the heating set on a timer, to avoid the effort of thinking about it	E.g. Having showers rather than baths because these are quicker	E.g. Walking around in shorts with the heat on high, rather than wearing layers of clothes in the home, because this creates a sense of choice and control	E.g. Sleeping with the bedroom window open at night, because that is what s/he did as a child
Relational Dynamics	E.g. Turning the heat up before guests arrive, to avoid appearing 'tight'	E.g. Using the hot tub to socialise with guests	E.g. Using an electric blanket or extra blanket at night, when a partner prefers a cooler bedroom	E.g. Installing efficiency measures such as insulation to retain heat, as justification for keeping the heat on all the time in a busy family

Table 2. Needs and behaviours in interaction

To some extent, all households display needs in each of these four categories and all could potentially have an influence on behaviour. However, in practice, the influence they have over behaviour varies among households, as described in Chapter 3. This is because different households prioritise needs in different ways, in response to factors that are particular to their circumstances. These factors include the presence of a dependant in the household, household unity (that is, the extent to which the household operates and perceives itself as a unit) and the complexity of household routines.

Based on which of these factors are in operation, any given household can be classified as one of three 'types', each characterised by a distinct combination and prioritisation of the four needs categories. This is useful in aiming to identify the reasons for different types of behaviour, both between different types of households or within the same household at different times (of the day or year). The typology defines the typical way households make decisions and determine their routine patterns of heat energy behaviour:

- *YOU* – decisions made on the basis of the needs of a dependent individual;
- *US* – decisions made on the basis of needs of multiple household members*;*
- *ME* – decisions made on the basis of the self-interest of individuals.

The typology serves to illustrate high-level patterns of behaviour and makes it easier to understand the complexity of household needs and behaviour. It can take into account the social dynamics and negotiation that inevitably influence decision-making, and give insight into how the needs of multiple individuals play out at the household level, and the patterns of behaviour and energy use that arise from this. The typology also enables us to connect needs to patterns of behaviour, and can account for transition and change: a household does not necessarily belong to a fixed type; it can vary by time of day, year or life, depending on, for example, who is at home, and the changing characteristics and needs of the people who make up the household.

However, the typology does not explain every specific element of behaviour within a given household. Chapter 4 describes another set of factors that comes into play at this point, to further constrain and/or enable what people can actually do to meet their needs and the extent to which they are able to meet those needs. These are cross-cutting factors that could potentially affect any household, relating to people (e.g. personal preference, knowledge and beliefs); the property (e.g. energy system and property characteristics, tenure, and finances); and the wider external environment (e.g. regulations, energy prices and weather). These additional factors should be seen as complementary to the household-level typology, together creating a broader explanatory framework.

To sum up, all households have needs from each of our four categories, yet who is in the household determines which needs are most important. A range of wider characteristics of that household then constrain how it can behave to meet these needs. Our understanding of this is currently best illustrated through the explanatory framework (see Figure 1) which represents this multi-staged process, whereby each stage further focuses and refines decision-making and behaviour. In practice, of course, decision-making and behaviour do not take place in such a staged way and individuals are not necessarily conscious of a process. However, the value of the framework is that:

- it provides an addition to the literature on understanding heat energy behaviour by taking needs as its starting point;
- it helps our understanding of different behaviours and decision-making in different households;
- while still taking into account wider constraining factors; and
- mapping an existing technical categorisation of behaviour back onto what people are actually trying to achieve, to try to bridge the gap between a needs-based understanding and building- or technically-based model.

It can also be used by other work packages to identify where efforts should be focused, to design and implement smart energy systems in a way that is informed by a detailed understanding of the needs and priorities of different types of household.

The framework we have developed here is a work in progress. It is not a predictive model or a definitive explanatory account. It is a means of summarising and synthesising current findings, and will be tested, refined and enriched through the second phase of primary consumer research, through both qualitative and quantitative components, and the incorporation of further findings from the Consumer Response and Behaviour literature review.

1. Introduction

This report maps the heat energy needs and behaviour of a sample of domestic consumers in the UK. Drawing on a multi-faceted project of primary consumer research, it also presents an emerging framework for understanding why consumers behave as they do and how and why these needs and behaviours vary across the population.

1.1 Background and context

This study was conducted as part of the Consumer Response and Behaviour project, which is Work Area 5 (WA5), within the Smart Systems and Heat (SSH) Programme of the Energy Technologies Institute (ETI). The ETI commissioned the SSH programme in 2012, with the objective of informing the design, development and demonstration of a cost effective, smart energy system suitable for future roll-out within the UK.

Consumer Response and Behaviour aims to develop an understanding of consumer behaviour and provide insights into consumer needs in an energy systems context. Thus, while the SSH Programme as a whole is largely technological, Consumer Response and Behaviour provides an essential basis in the consumer perspective. Future energy systems will deploy new technologies and business models and will potentially feature a much greater degree of consumer involvement in the provision and management of energy-based services during the period to 2050. It is therefore important to develop a clear understanding of consumer requirements and preferences, and build these into the design features of consumer-focused products, in this context.

This particular study formed Work Package (WP) 5.4 of the Consumer Response and Behaviour project. WP5.4 is a primary consumer research programme, using a range of complementary techniques, aimed at understanding consumer needs and behaviour in relation to domestic energy usage, and how these vary between different groups in the population.

WP5.4 builds on the work carried out in other Work Packages and, along with the literature review carried out as part of WP5.1, our findings provide the building blocks for a number of other pieces of work within Consumer Response and Behaviour. These include these four WPs in particular.

- **WP5.5** – Informing *solution scenarios,* by providing a diverse set of representative characters or personas with different solution requirements.

- **WP5.6** – Informing *the model*, by providing evidence to refine the categories of behaviour and needs to be used in the model.

- **WP5.7** – Helping to inform the design of *survey instruments* by providing clusters of need and typical patterns of behaviour to test/quantify; the phrasing of question items; and how to design and pitch consumer-facing materials for qualitative testing of smart energy solutions.

- **WP5.8** – Drawing out a clear set of implications for *solution characteristics*.

1.2 Study aims and starting points

Work Package 5.4 aims to answer the first four of the 10 research questions that Work Area 5 aimed to address.

- RQ1. What needs do consumers want to meet, that involve energy use? *(Mapping consumer need)*

- RQ2. What do people currently do that uses energy? *(Mapping consumer behaviour)*

- RQ3. Why do consumers exhibit particular energy-using behaviours? *(Explaining behaviour)*

- RQ4.How do consumer needs, behaviour, motivation and rationale vary across the population? *(Describing variation across groups)*

The evidence presented within the report is structured and interpreted with the specific aim of answering these questions. The ordering of the research questions, whereby an understanding of

consumer needs takes precedence, reflects the starting point of this study, and the Work Area it forms a part of.

As noted above, this Work Area is focused on the consumer. It is chiefly interested in what people do and why they do it. At the centre of this is a hypothesis that what people do in relation to heat energy in the home is in some way related to a set of needs. This marks something of a departure from other research with the aim of informing the technical design of smart heating systems. Much of our current understanding of what drives behaviour in relation to heat energy takes the physical characteristics of the property as its starting point. The rationale for this is understandable: the characteristics of the property (age, size, type of heating system and insulation, for example) set the boundaries of what is possible for people trying to heat, cool and ventilate their home.

Despite the intuitive and pragmatic basis for starting with the physical characteristics of the property, the research presented here takes a different starting point. What we want to understand is not only what constrains and enables behaviour *when* people engage in heat energy behaviour, but the underlying goals and motivations that drive and structure their behaviour, routines and habits. Both are important; but to design smart energy solutions (SES) that are holistic and sustainable it will be crucial to understand the basic and more complex human needs we have for heat energy, not just how we currently interact with it. This forms the rationale for the overall design of Work Area 5. Without this understanding of consumer requirements at the heart of solutions design, it is possible that solutions may be technically sound but not meet the complex needs of different types of household.

In order to do this, we have adopted a broad definition of needs, from those that are objectively "essential for life" to preferences based on individual perceived needs or values. Needs may be addressed as high level "purposes" for a home (e.g. having a healthy, comfortable life, maintaining cleanliness, or caring for a family) or very specific targets, such as how much of the home is heated or the specific temperatures required. The categorisation of needs we present here adopts an intermediate level (e.g. comfort, health, safety, productivity) that easily supports connections between needs, behaviours and energy systems, but is also sufficiently high level to facilitate connection to purposes. This level of categorisation formed our starting point with research participants, and our methods allowed them to further focus or refine what is specifically meant by needs.

A more detailed account of the way needs, as well as behaviours, are understood within this report, and within the wider Consumer Response and Behaviour project, is provided in Chapter 2.

1.3 Overview of method

To address the research questions, we initially adopted an exploratory qualitative approach that could allow us to understand the range and diversity of people's needs and behaviours, and provide useful insight into how consumers conceptualised these issues and the language they used to discuss them. This section describes a number of methodological challenges to meeting the research objectives and briefly outlines the methods used. A full description of the method will be provided in a separate Technical Appendix.

There were three key components to the research design:
- *half-day qualitative workshops*, which harnessed group interactions to access a breadth of experiences and views in a short space of time;
- *in-home individual interviews* with householders which added case-study depth to the emerging understanding of energy behaviours and needs;
- *in-home energy monitoring and data-led interviews*, geared at bridging the gap between reported and actual behaviours;
- *longitudinal study design*: to allow for insight into seasonal transitions in needs and behaviours (the findings from this will begin to emerge out of the next stage of research).

Table 3 summarises the key components of the study design, which are discussed in the next sub-sections.

Method	Achieved sample	Approach
Qualitative workshops	4 workshops 153 individuals 32 group discussions	Group interaction used to surface subconscious behaviours and needs Diary as pre-workshop task to stimulate critical reflection
In-home monitoring and interviews	30 households recruited from workshops Each involved in an initial in-home interview, monitoring, and a further 'data-led' interview A further 2 data-led interviews to be carried out as part of WP5.7 activities	Deeper understanding of needs and behaviours in the home context / sub-group variation In-home monitoring used to bridge gap between reported and actual behaviour Longitudinal element helps access further depth of insight
Additional in-home interviews	27 additional households	Further understanding of needs and behaviours in the home context Further insight into sub-group variation by targeting groups who might not have been engaged via the workshops

Table 3. Overview of research design

1.3.1 Qualitative workshops

Aims: Geared at generating and mapping a wide breadth of needs and behaviours across a diverse sample of consumers, and identifying priorities and inter-dependencies between needs among sub-groups.

Sample: Each workshop involved up to 40 participants. The workshop sample design hinged on four household composition categories, which were derived from the provisional consumer segmentation developed in WP5.1. These provisional segments were incorporated into the sample design for the workshops (and subsequent interviews) as in Table 4. These aspects of household composition are likely to influence heat energy behaviour (through factors such as variation in needs, routines and occupancy).

Category used for household composition primary criteria in WP5.4	
No children in the household	Adults over 60 (single, couples, sharers)
	Adults under 60 (single, couples, sharers)
Children in the household	One or more children not yet at primary school
	All children started/completed primary school

Table 4. Household composition sample criteria for WP5.4

Additional sample criteria included achieving a mix of urban/rural location, whether the home had district heating or was off the gas grid, tenure, property type and social grade. A full overview of the workshop sample design is included in the Technical Appendix. Participants were recruited through a professional recruitment agency, which used on-street and door-to-door recruitment strategies to achieve target sample quotas.

Approach: Four half-day workshops were carried out in four locations across England with different levels of urbanicity and different socio-economic characteristics. Each workshop comprised a morning and an afternoon 'break-out' session, each session involving four group discussions with up to 10 individuals in each group. Morning discussions involved a heterogeneous group of individuals, and aimed to generate and map of heat energy behaviours and needs. Afternoon sessions were segmented by household composition group, and explored sub-group priorities and interdependencies between needs. A total of 32 group discussions were carried out. Workshops included an additional session to provide information about the in-home monitoring, and to get consent for re-contact regarding further participation.

Timing: These workshops were carried out during the heating season in February and March 2013.

1.3.2   In-home monitoring and interviews

Thirty participants were recruited from the workshops, to participate in the in-home monitoring study, following the workshops. The sampling criteria for these participants mirrored those of the workshops.

This component of the study aimed to generate a deeper understanding of needs and behaviours in the home and to allow for a deeper exploration of sub-group variation than was possible through the workshops. It was also geared at bridging the gap between reported and actual behaviours, as data collected through in-home energy monitoring was used as a stimulus to prompt householders to reflect more accurately on actual behaviours. Repeat interviews added a longitudinal dimension to the study, offering the opportunity to explore seasonal variations in needs and behaviour.

Participants were involved in an initial in-home 'walk-around' interview, followed by a second 'data-led' interview that incorporated data collected through monitoring devices (note that two further 'data-led' interviews will be carried out as part of WP5.7 qualitative research activities, and are not reflected in this report).

Interview 1 ('Walk-around'): One-hour interviews in the homes of participants. Interviews involved creating floor plans of the home with participants, and a walk-around tour of the home, making use of in-situ prompts (e.g. discussing how technologies present in different rooms are used, exploring why certain windows and doors are open or shut, making reference to control settings on radiators to discuss how heat is used across the home) to stimulate deeper and more accurate reflection on heat energy needs and behaviours. Interviewers also completed an observational checklist, in which they recorded details such as the heating system, heating appliances and heating controls in the home and the settings. These initial interviews were carried out in March and April 2013.

Monitoring approach: Monitoring equipment was installed in all households, and included:

- a multi-sensor globe mounted in the corner of each room, collecting data on temperature, humidity, light and movement;
- window and door sensors attached to any external doors and most windows, to collect data on opening and closing;
- an electricity monitor installed at the meter, to collect data on electricity use;
- a plug-in carbon dioxide monitor installed in one room, the main bedroom by preference, to collect data on air quality and occupancy.

A range of factors were intended to be observable with the assistance of the monitoring equipment, including heating and occupancy patterns, ventilation behaviours, cooking and washing, and wasted energy (see Table 5). Monitoring equipment communicated wirelessly with a central hub, which in turn transmitted data periodically to a secure cloud server. Data were then downloaded and subjected to analysis and interpretation by UCL, with reference to what was already known about the household's heat energy system and use from the initial interview. A bespoke set of information was produced for each household including heating and occupancy patterns, ventilation behaviours, cooking and washing, and wasted energy.

Interview 2 ('data-led'): Data analysis produced a bespoke set of information for each household which was then shared with participants during 'data-led' interviews in narrative and graphic form.

While the research study aimed to explore the full extent to which different behaviours could be observed by the research team, the data provided an empirical basis of actual behaviour against which an individual's reported behaviour and needs could be discussed.

The set of data-led interviews that informed this report drew on data collected during April and May 2013, meaning that the bulk of homes had switched off their heating systems. A further two data-led interviews will be carried out with participating households in the 2013/14 heating season, as part of WP5.7 qualitative research activities to supplement insight about behaviours during the heating season.

Behaviour	Sensor(s) involved	Details
Heating patterns	Multi-sensors (temperature)	Time-stamped data indicated internal temperatures, allowing researchers to identify when occupants heated their homes and the extent to which different parts of the home were heated.
Occupancy patterns	All sensors in combination	Sensors indicated periods when homes (and individual rooms) were empty and when they were occupied. The sensor set-up identified the predictability of routines and occupancy of households, including sleeping patterns.
Ventilation behaviours	Window and door sensors (in combination with multi-sensors)	Window and door sensors indicated when people opened windows/doors and, in combination with the multi-sensors, gave an indication of the motivations or consequences of these events.
Cooking and washing	Multi-sensors (temperature and humidity)	Observing spikes in temperature and humidity in the kitchen and bathroom (and cross-referencing these with motion and window/door sensors) gave an indication of cooking and washing routines within the home.
Wasted energy	All sensors in combination	In assessing occupancy patterns and heating patterns, the heating of empty homes or rooms, or not heating occupied rooms, could be identified.

Table 5. In-home monitoring sensors and associated behaviours

1.3.3 Additional in-home interviews

The process of finalising the sample design for the workshops raised implications for the overall design of WP5.4. As originally designed, the sample was unlikely to include certain groups that may be of specific interest to ETI and partners. In addition, there was a desire to increase the proportion of individual interviews relative to the group-based data collection offered through the workshops, to allow for more detailed case analysis.

Accordingly, we set out to conduct up to 30 additional in-home interviews. Households were recruited, using study partners as gatekeepers to help access participants, to ensure that groups who may not be represented within the workshops were included in the overall study sample. These additional interviews included four specific groups of relevance to the study (households that were fuel-poor; time-poor with high income; single occupants; and the very elderly i.e. over 75 years) and homes with specific energy features of interest (well insulated homes or homes or with a heat pump).

Participants were sent a heat energy use diary to complete for 3-7 days before the interview, to stimulate critical reflection on their heat energy behaviours and needs. Interviews were carried out using a similar topic guide to the one used in the in-home monitoring 'walk-around' Interview 1, but with the additional inclusion of bespoke questions, tailored to the group in question. In a number of cases (for interviews in energy-efficient and heat pump homes), social researchers who were carrying out the interviews were accompanied by a co-interviewer with technical expertise, who could follow up

and explore technically-oriented avenues of discussion in greater depth. Interviews were carried out into the summer of 2013, to allow us to explore cooling as well as heating behaviours.

1.3.4 Research challenges

The research method was developed to address the research aims as outlined above and to address the following set of challenges raised by the research objectives.

- *Engaging and retaining a diverse group of participants*: While energy is a necessity, it is neither front-of-mind nor of particular interest for the majority of the population. Equally, only a small proportion of the population is engaged with the energy technologies they use. In order to achieve a balanced qualitative sample reflecting the range and diversity of views, it was important to ensure that we made efforts to make the topic engaging and inclusive to appeal not only to those already highly engaged. We addressed this through the following.
  - › *Recruitment approach*: A professional recruitment agency was enlisted to recruit participants for the workshop to meet a diverse set of quotas. These were achieved through on-street and door-to-door recruitment approaches.
  - › *Marketing and 'pitch'*: Engaging, professionally-designed and bespoke materials (information leaflet, postcard reminder and pamphlet) were produced by the research team and handed to participants at the point of recruitment, to lend legitimacy and engage interest in the study. Prospective participants were briefed on the purpose of the study, stressing that this was not market research driven by commercial interests.
  - › *Building trust and rapport to encourage ongoing participation*: The workshop was used to establish trust, provide information, and engage interest in ongoing participation in the study. Participants who remained in the study after the workshops were interviewed consistently by the same fieldworker to build rapport and trust over time.
  - › *Incentivisation*: Participants were provided with cash incentives following each point of data collection. Those individuals who participated in multiple interviews and monitoring were remunerated on the basis of a staggered incentive structure, to encourage retention.
  - › *Multiple routes to participation*: While the workshops served to engage a diverse range of participants, there were concerns that certain sub-groups of relevance to the study may not fall out naturally within the workshop sample. The additional in-home interviews outlined above were designed to include these groups using a targeted approach and working strategically and ethically through relevant gatekeepers to access participants.

- *Encouraging critical reflection on subconscious or habituated heat energy needs and behaviour, and bridging the gap between reported and actual behaviour*: Other studies have suggested a potential disconnection between reported and actual behaviour. This may be because the behaviours under study can be highly habituated, and people therefore may not be highly aware or conscious of them. This was addressed through the following.
  - › *Heat energy diary*: this was used as a pre-workshop task to stimulate critical reflection. Participants were asked to record how, why and when they used heat energy in the seven days prior to the workshop or additional interview. Diaries were used as a reference point in workshops to anchor discussions and to make the topic more accessible to the participants.
  - › *Structure of workshop discussions*: the initial discussion focused on behaviour, which was then used as an anchor to make the ensuing discussion on needs more accessible, which in turn yielded greater depth of discussion.
  - › *Harnessing the group dynamic* in the workshops to stimulate deeper reflection on behaviours and needs, through a combination of paired and whole-group activities.
  - › *Use of in-situ prompts* during in-home interviews to stimulate deeper and more accurate reflection on energy use and behaviours.
  - › *Use of objective data* collected as part of the in-home monitoring component of the study as a tool to prompt deeper and more accurate reflection during data-led interviews.

- *Unit of analysis*: Finally, a crucial question centred on how best to understand decisions relating to heat energy behaviour: the individual versus the household. We chose to focus on households rather than individuals, because there is generally only one system (and one bill) per household, and because this level of analysis can take account of the socially negotiated nature of decision-making within the home and how this impacts on overall patterns of behaviour and energy use. However, we still had to rely heavily on individuals to tell us about household patterns of behaviour and need, which has inherent limitations. To overcome these limitations to some degree, the following steps were taken.

  - The heat energy diary task was geared at attuning participants to the use of heat energy at the household level and capturing how and why this occurred.

  - Workshops and interviews encouraged individuals to talk about how and why households used heat energy in their homes, rather than focusing solely on how and why they personally used heat energy. During discussions, attention was focused on drawing out the social dynamics and negotiation entailed in heat energy use.

  - Where possible during in-home interviews, joint interviews were carried out that involved other family members in addition to the primary participant.

Given the challenges raised by the research objectives, we carried out a pilot research study to test various options for the important parts of the method. The final research method was developed after this. The details of this pilot study are reported in the separate Technical Appendix.

1.4 Chapter outline

The remainder of this report describes the combined findings of the study in more detail, presenting an emerging framework for understanding why consumers behave as they do and how and why these needs and behaviours vary across the population. Chapter 3 begins by providing a descriptive map of consumer needs, linking these to a range of behaviours and uses of technology. Chapter 4 then introduces a typology of household decision-making, defining the characteristics of each decision-making type and describing the various household compositions. For each type we outline how needs are prioritised and identify their typical patterns of behaviour. In Chapter 5, we then bring together a range of case illustrations to show in detail how needs and decision-making – and a wide range of influencing factors – explain behaviour in the context of different households. In the concluding chapter, we draw out a high-level summary of substantive and methodological insights and lessons learned, and identify implications and priority areas for further research and activity within Consumer Response and Behaviour and the SSH programme.

2.   Documenting consumer needs and associated behaviours

Fundamental to the design of any new approach to providing energy for domestic consumers is an understanding of the needs those consumers are meeting (or seeking to meet) through energy use, and the behaviours and technologies through which they currently address those needs. If these are not well understood, the design may fail to meet consumers' needs or conflict with how consumers wish to behave. This chapter focuses on documenting the wide range of needs that people seek to meet through energy use, linking these to the similarly wide range of behaviours and technologies through which these needs are addressed.

2.1 Defining and categorising needs and behaviours

There are various ways in which heat energy needs and behaviours may be defined and categorised. For the purposes of this study, we have adopted a pragmatic approach, whereby the selected dimensions for analysis are those that have the greatest bearing on SES.

2.1.1 Needs

This study represents one of the first systematic attempts to understand heat energy behaviour in terms of what consumers are trying to achieve. For the purposes of this report, therefore, we have adopted a broad definition of needs. Heat energy needs are understood here as what people are aiming to achieve through using heat energy, or as things they achieve as a consequence of using heat energy. We recognise that there is variation in how the concept of needs is understood in different disciplines and have deliberately avoided adopting a narrow view of needs. Instead we feel it is most helpful to start with this broad, non-academic understanding as an initial lens to understand heat energy behaviour.

Because our definition is broad, it incorporates a wide range of needs from those that are objectively "essential for life" to preferences based on individual perceived requirements or values. Needs may also be addressed as high level "purposes" for a home (e.g. having a healthy, comfortable life, maintaining cleanliness, or caring for a family) or as relating to very specific targets, such as aiming to control mould or damp or drying clothes.

Needs, and associated behaviours, are discussed in this chapter under four primary categories: health and well-being; resources; agency; and relational dynamics (see Figure 6). This categorisation has emerged from our research with a diverse sample of the general public. The final categories are the result of an analytical process where needs that are similar are grouped together and given an appropriate label. Our aim here is to make it easier to comprehend the full diversity and complexity of needs that exist within the general population and select categories that help us understand why households have different priorities. In this respect, the categories and the meanings attached to each are rooted in consumer understandings and frames of reference.
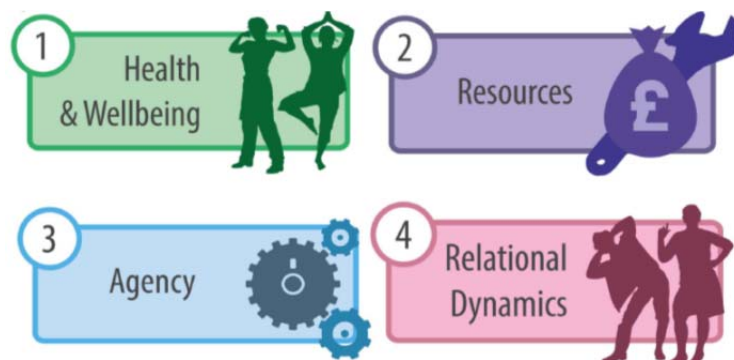
Figure 6. Categorisation of needs

We also identified the following cross-cutting dimensions that featured in participants' accounts, which operate within and/or cut across the substantive categories outlined above.

- *Fundamental vs. peripheral*: The study aims included a focus on how needs are prioritised. Our analysis of workshop discussions and interview data revealed a priority order between needs, whereby some needs feature as fundamental, and others in more peripheral terms. Our analysis suggested that needs are prioritised differently by different households, and the priority attached to a given need affects how and to what extent that need drives behaviour. Needs that are considered fundamental appear to drive high level patterns of heat energy behaviour and use within a household. More peripheral needs are pursued once fundamental needs have been met, and are met through specific behaviours that do not compromise meeting fundamental needs. Sometimes, priorities become observable only (or particularly) when there is a limit on the resources available to meet the needs (e.g. in cases of fuel poverty where people go to extraordinary lengths to meet their comfort needs and keep costs down despite it being very inconvenient).

- *Personal vs. social*: Needs might relate to a person's own individual needs, or alternatively to the needs of others or social norms and expectations. Needs may be directly those of the person taking the decision that results in heat energy use, decided by negotiation, or decided on behalf of someone else. In this sense, needs and the way in which they are prioritised are socially complex, depending on who is dominant in the decision-making, the needs of specific individuals and/or care responsibilities.

- *Functional vs. symbolic:* The categorisation includes both "functional" needs, such as comfort and health, and more "symbolic" needs relating to identity and social relationships. Certain needs might have elements of both: for example, participants spoke about keeping clean as serving the functional purpose of hygiene, and also in terms of social acceptability.

- *Conscious vs. unconscious*: A need exists whether or not a person is aware of either the need itself or the contingent energy use. In some cases, the role of heat energy may be distant in people's minds from the need itself (e.g. a window may be kept closed to shut out the noise rather than to keep in heat, or a fire lit for aesthetic effect and to facilitate social interaction rather than to warm a room). Some needs may be so fundamental that they are taken as a given, and may therefore not be front of mind, while others may become apparent only in their absence.

- *Avoidance vs. seeking*: Participants spoke about their needs in terms of ones they actively seek (e.g. comfort or health) or, in other instances, in terms of avoidance (e.g. avoiding waste or harm).

While the discussion on needs below is ordered in terms of the substantive categories (i.e. health and well-being, resources, agency and relational dynamics), we give consideration to and draw out of these cross-cutting dimensions where relevant.

2.1.2 Behaviours

As in the case of needs, there are various lenses through which we can look to understand heat energy behaviours and the use of technology. We have taken a pragmatic approach whereby the selected dimensions for analysis are those that have the greatest bearing on SES. The key issues for SES depend on the *domain* and, within the domain, issues relating to *technology and control*, and *frequency* of behaviour.

We give consideration to the *four domains*: space heating; heating water; heating the person; and ventilation and insulation.

Space heating

Space heating involved the use of a range of heating sources, which can be further categorised as primary and secondary heating sources (see Table 7). This distinction is not a technical one, but is drawn from the discussions with participants. Primary sources refer to those that are relied on as a key source of heat for the majority of the time and secondary sources are those which are used either to supplement ('top-up') or as a substitute for primary heating sources. Consequently, the means of heating identified within each of these categories are not mutually exclusive. When used as a supplement, secondary heating sources were used to warm spaces while waiting for primary sources to have effect, and/or when participants did not have confidence in the ability of the main heating

systems to warm the home sufficiently. Secondary sources were also used to top up or substitute primary sources as a means to be more cost or energy efficient. While primary sources were typically purpose-built, dedicated technology (with some exceptions, e.g. one individual who heats his home with a camper-van cooker), secondary heating sources included more reference to 'makeshift' use of technologies that are not primarily designed as space heating (e.g. tumble dryer or oven). Space heating was sometimes sourced distantly: for example, some participants kept internal doors open to allow hot air to be distributed to other rooms, or higher floors in the home and, in some apartment blocks, some individuals relied primarily on the heat from surrounding apartments to heat their home ('heat scavenging'). Space heating sources may be used for a range of purposes beyond keeping the home warm, for example, radiators may be used to dry clothes, and gas fires may be used to make a room feel cosy.

Primary sources	Secondary sources
• Gas central heating (with and without timer and thermostat; includes pre-paid) • Storage heaters • District/communal heating • Electric heaters (with and without Economy 7) • Oil system • Wood burner • Underfloor heating • Gas fires • Cooker	• Wood burner • Electric and halogen heaters • Fires (coal, gas, open) • Underfloor heating • Solar panels • Clothes drying devices (e.g. 'clothes buddy' with electric fan) • Tumble dryer • Cooker/oven • Artificial heating devices (e.g. LCD fire)

Table 7. Primary and secondary sources of space heating

Heating water

Hot water behaviours included the use of showers and baths, hot tubs, hot water bottles, kettles, and cleaning the home and possessions (e.g. dishwashers, washing machines, and dishwashing). Participants did not always spontaneously or explicitly associate or see hot water as heat energy. This may be, in part, because there is less direct association of related behaviours with thermal comfort or 'keeping warm'. Rather, as will become apparent in the analysis below, other needs such as health, keeping the person, home and possessions clean, and relaxation and invigoration, seem to be most salient. Perhaps linked with the above, there was little mention of actively controlling hot water in the way people mentioned control over space heating. Compared with space heating, participants described less diversity and complexity in related behaviours. Therefore, less explicit attention is given to hot water use in this report than the other domains. In the next phase of the qualitative primary consumer research we aim to explore hot water use in more detail to ensure that our understanding of hot water as less complex and salient is an accurate one.

Heating the person

Behaviours included the use of warm clothing, blankets and heated items (such as hot water bottles, heat packs and heated teddies), consuming hot food and drinks, gaining heat from other living things (such as partners or pets), and using physical activity to keep warm. These practices were used as a means of 'topping up' or as a substitute for more 'high tech' solutions. Again, they were not always directed primarily at simply 'keeping warm' (i.e. at a comfortable temperature), but also at being comfortable and cosy (i.e. creating the right temperature and 'mood'), or as a means of negotiating a harmonious social dynamic in a home where individuals have different temperature preferences. They were also sometimes used as a resource-efficient heating solution, to save money and avoid waste.

Ventilation and insulation

These are grouped together as both relate to the retention or loss of heat in efforts to keep warm (or cool). This is an area where people appear to be most aware of inefficiencies, but unsure of the best approach to address these, particularly in relation to avoiding damp and condensation. Discussions about ventilation behaviours focused primarily on window and door opening/closing. Other technologies included extract fans, underfloor ventilation, window vents, and dehumidifiers. Insulation

behaviours included loft insulation, cavity wall insulation, double and triple glazed windows, wall-to-wall carpeting, replacing wooden doors with PVC doors to exclude draughts, draught excluders on windows and doors, and use of curtains. 'Makeshift' technologies were also evident, such as building shelves above or using aluminium foil behind radiators to direct heat back into rooms, or using cling film to cover open vents.

Within these four domains, as has already been suggested above, behaviours may be further understood in terms of these two factors.

- *Technology and control:* Technologies and the means of controlling heat energy use range from high tech to low tech; purpose-built to DIY or 'makeshift' solutions or 'workarounds'; and may include long-term investments or short-term solutions. Additionally, technologies may be used in combination, to 'top up', or as a substitute. People may seek to control their energy use through technology in different ways: for example, people spoke of heating the home manually or automatically, and using alternatively a centralised approach (heating the entire home equally) or a room-by-room ('zoning') approach to control. Some of the purposes behind these different strategies are considered at various points in this report.

- *Frequency* is another key dimension for understanding consumer behaviour: whether the behaviour is frequent (more-or-less daily), occasional (perhaps only once during a person's occupation of a home) or infrequent (between these two). These affect the amount of time and thinking that a consumer needs to give to the behaviour (e.g. whether it is a habit or an extensively researched investment), the required resources (money, time and space) and technology (e.g. a light switch or a new boiler), and who is in control of making the choices (e.g. an individual adjusting a thermostat or a household deciding to install micro-generation). Frequency therefore influences the kind of interaction the consumer would need to have with an SES and how it should be presented to the consumer in order to illustrate its compatibility with their needs.

We should note here that managing overheating (in winter) and cooling behaviour (in summer) are given only superficial attention in this report, as there was not sufficient time to subject the evidence to systematic, in-depth analysis. The relevant data will be analysed and used to inform WP5.7 phase 2 primary consumer research outputs.

2.1.3 Needs and behaviours in interaction

The distinction between needs and behaviours is not always clear, particularly when attempting to understand behaviours in human-centred, goal-oriented terms, which is essential in the context of consumer-centred design of SES. Within this report, we have selected to use consumer needs as a starting point, and to map behaviours in terms of the needs with which they are associated.

To help structure thinking, however, we have provided a matrix (Table 8) that overlays the four overarching categories of need (health and well-being, resources, agency and relational dynamics) against domains of behaviour (space heating; water heating; heating the person; ventilation and insulation) to enable the reader to think about behaviour and needs in a complex, interactive and integrated manner, which is more reflective of the way they exist in practice. Note that this matrix should be considered as an illustrative, rather than an exhaustive, representation of needs and behaviours in interaction, and as presenting material selectively rather than systematically.

As the table shows, a given need may be met through a range of behaviours and technologies, while a given behaviour might be used to meet a range of needs.

		Behaviours[1]			
		Heat space	**Heat water**	**Heat the person**	**Lose heat (ventilation) and retain heat (insulation)**
Needs	**1. Health and well-being** *1.1 Health* *1.2 Comfort* *1.3 Keeping clean* *1.4 Relaxation and invigoration* *1.5 Avoiding harm* *1.6 Ambience and aesthetics*	Keeping the heat on to avoid damp for health and aesthetic reasons (1.1, 1.6) Keeping the home cool to address a specific health condition, e.g. prevent a child with febrile convulsions having a fit (1.1) Lighting a fire to relax and unwind in front of (1.4) Adjusting timers to avoid being woken up by the sound of the heating system turning on (1.4) Adjusting the thermostat to aid productivity when working at home (1.4)	Showers seen as more hygienic way to keep clean than baths. (1.3) Washing clothes at a high temperature to kill bacteria. (1.3) Having hot baths and showers to manage health conditions, e.g. arthritis, backache, muscle injury. (1.1) Having a bath to relax at the end of the day, and carve out time away from the family (1.1) Having a shower, rather than bath, to invigorate oneself and aid productivity (1.4)	Using a hot water bottle or heat pack to lift mood during illness, or take mind off it (1.1, 1.2) Doing physical activity to warm up and aid productivity (1.4) Using a heat pack for comfort (1.2)	Ensuring home is well ventilated and fresh air circulates to *prevent ill-health*, physically or mentally, e.g. chest infections or claustrophobia (1.1) Keeping windows closed and draughts excluded to prevent asthma attacks (1.1) Leaving the window open to aid sleep and to avoid waking too early. (1.4) Keeping windows closed to avoid children falling out (1.5) Use of extract fans and cooker hoods to remove cooking smells (1.6)
	2. Resources *2.1 Finances* *2.2 Waste* *2.3 Property maintenance*	Turning off central heating while using the oven to cook (2.1, 2.2) Ensuring the heating patterns are aligned with patterns of occupancy (2.1, 2.2) Use of 'zoning', e.g. heating and occupying one room until bedtime (2.1) Using portable heaters instead of heating the whole house (2.1) Using portable electric heater rather than gas central heating, because electricity seen as cheaper than gas (2.1) Heating empty rooms to avoid damp and mould (2.3)	Using boiled water from pans heated over the stove or in kettles rather than re-heating storage heaters, to save money (2.1) Washing clothes at off-peak times (2.1) Spending limited time in the shower or using timers (2.1) Getting children to share one bath (2.1, 2.2)	Wearing an extra layer of clothing, rather than turning the heat on/up (2.1, 2.2) Exercise to keep warm, rather than turning heat on (2.1)	Installing cavity wall insulation, helped by a council grant (2.3) Keeping window open instead of using extract fan, to save costs (2.3) Use of extract fans to reduce moisture levels (2.3) Leaving the heat on a low setting to avoid the risk of burst pipes (2.3) Use of dehumidifiers to reduce damp (2.3) Tumble drying clothes before placing on radiators, to limit condensation (2.3) Avoiding loft insulation, as it is thought to damage roof struts (2.3)

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[1] Numbers used in the examples provided correspond to numbering in the 'needs' column.

		Behaviours[1]			
		Heat space	**Heat water**	**Heat the person**	**Lose heat (ventilation) and retain heat (insulation)**
Needs	**3. Agency** *3.1 Convenience* *3.2 Control* *3.3 Routine & Habit*	Saving time by using radiators or tumble dryers to dry clothes quickly (3.1) Having the heating set on a timer, to avoid the effort of thinking about it (3.1) Using tumble dryer to heat a room more quickly than a radiator (3.1) Avoiding the hassle of installing underfloor heating, even if perceived as a more effective and efficient solution (3.1) Using a thermostat because this is seen as easier to use than a timer (3.1) Setting weekend timer differently from weekday because of being home more and different schedules (3.3)	Having showers rather than baths because these are quicker (3.1) Getting children to bathe together as a time-saving device (3.1) Using a hot water bottle out of habit, even in summer, after using it routinely to keep warm (3.3)	Taking off a layer of clothing rather than adjusting the thermostat to save on effort (3.1) Walking around in shorts (and turning up the heat) rather than wearing layers of clothes in the home, because this creates a sense of choice and being in control (3.2)	Using extract fans in kitchens to remove smells more easily than opening a window, and making kitchens damp free and therefore easier to clean (3.1) Using the extract fan in the bathroom out of habit, but 'not knowing why' (3.3) Sleeping with the bedroom window open at night, because that is what s/he did as a child (3.3)
	4. Relational dynamics *4.1 Self-image and social acceptance* *4.2 Social interactions with household members* *4.3 Social interactions with guests* *4.4 Social interactions beyond the home* *4.5 Wider implications of energy use*	Keeping the heating at a high temperature, because that is part of being a good mother (4.1) Turning the heat up before guests arrive, to avoid appearing 'tight' (4.3) Having the heat on constantly, rather than engaging with timer, to cater to the needs of a busy family with conflicting routines (4.2) Using radiator to dry clothes because drying clothes on balcony looks 'trashy' with clothes flying about (4.4)	Having a bath or shower to be hygienic, to aid social acceptance in situations such as the workplace (4.4) Using the hot tub to socialise with guests (4.3) Having showers rather than baths to save water (4.5)	Using an electric blanket or extra blanket at night, when a partner prefers a cooler bedroom (4.2)	Installing efficiency measures such as insulation to retain heat, as justification for keeping the heat on all the time in a busy family (4.2) Keeping mould at bay, through ventilation behaviours, to keep up appearances (4.3, 4.4)

Table 8. Matrix of needs and behaviours

The remaining sections of this chapter discuss the range of ways in which each of the needs featured in participants' accounts, while linking these to the range of behaviours and technologies through which they are addressed. Where a motive is stated for a behaviour, this refers to what the participants said and does not imply that the behaviour would necessarily achieve its stated purpose.

2.2 Health and well-being

This is a diverse category of needs, described as fundamental by participants. It may be that these needs are so fundamental in some instances that they are taken as a given – e.g. keeping warm and comfortable and keeping self and family healthy – such that they do not appear to drive specific behaviours but they set behavioural patterns. For example, if a household is faced with two choices around how to heat their home, these needs may not drive their decision as both options will have to meet these needs.

Broadly, the needs in this category relate to specific health concerns or general well-being. They include:

- health;
- comfort;
- keeping clean;
- relaxation and invigoration;
- avoiding harm;
- ambiance and aesthetics.

2.2.1 Health

People reported engaging in a wide range of behaviours in the interest of meeting needs relating to physical and mental health. However, we did not achieve a detailed understanding of mental health, which was therefore beyond the scope of this analysis.

This need encompassed physical and mental health, and related to participants themselves, other members of the household, or guests in the home. Certain groups featured particularly in discussions around health-related needs and behaviours, including infants and young children, people with specific health conditions, and the elderly. Pets also featured in some participants' references to health-related needs and behaviours. Health-related needs and behaviours featured in three key ways, relating to maintaining health or preventing ill-health, management of specific health conditions, and the management of specific life stages.

Maintaining health or preventing ill-health related to both children and adults, and centred on both physical and mental health. Participants sometimes had specific health conditions in mind (e.g. lung problems, muscle stiffness, blood pressure issues, cot deaths and pneumonia). Other times, participants spoke in general terms of maintaining good health. This involved a range of behaviours, including the following.

- Having the temperature at a certain level. This varied depending on participants and the sub-groups they were referring to (e.g. young people, babies and the elderly). Some participants advocated having their homes at a constant temperature, others a high temperature (e.g. to keep a newborn warm) and others still felt that a low temperature was preferable (e.g. to avoid air being too dry).
- Sterilising baby equipment (e.g. using hot water to sterilise baby bottles).
- Ensuring fresh air circulates in the home to address the issue of damp but also to address a general sense of fresh air being good for you (e.g. helps prevent chest infections or is good for the baby). Removing and/or avoiding the build-up of condensation and mould through a variety of means, such as opening windows, drying windows with towel, using anti-mould paint, and keeping the heating on. Ventilation behaviour was also mentioned in relation to specific mental health conditions (e.g. opening a window to stop feeling claustrophobic or to stop panic attacks).

Managing specific health conditions involved a range of behaviours geared at managing both chronic and intermittent physical health conditions (asthma, diabetes, febrile convulsions, backache, sinus issues, physical disability) and mental health issues (depression and Seasonal Affective Disorder). Examples are having hot baths or showers to manage arthritis or backache; keeping windows open at night to address sinus problems or headaches, or keeping windows closed to prevent asthma attacks;

keeping the heating on for a child who has a long-term illness and finds it difficult to keep warm, or keeping the home cool to meet the needs of a sick child.

> *"When [child] was getting hot and he had a temperature, I used to check him quite often like if he had tonsillitis. Kids are always ill. He'd basically be wearing nothing in the house asleep in the middle of October when it's snowing outside with patio doors wide open just trying to get his fever down. We've also got the air conditioning because of that. We don't use it that much though...In the summer but I'd rather get, no, you know, in the winter, you can get natural coldness in."*

Participants also acknowledged that the *management of different life stages* necessitated changes in behaviours. These three particular life stages were mentioned.

- *Pregnancy*. Participants mentioned changes in routine behaviours (for example, having the heating on for longer periods, and/or at a higher temperature) to ensure safety of mother and child.

- *Babies and young children*. These were held to be more vulnerable than adults and so needed extra care and attention. This translated into various specific heating and ventilation behaviours. For example, one grandparent always put the heating on when young grandchildren visited as he felt they could not articulate their heating needs.

- *Old age*. There was general acknowledgement that as individuals got older they started to become less active and more susceptible to health conditions. As such, they tended to need the heating on more often and/or warmer – although one participant lowered her heating levels as she went through menopause. A participant also mentioned leaving the heating on for an ageing dog.

2.2.2 Comfort

Comfort was one of the most diverse sets of needs discussed by participants, encompassing a wide range of meanings and associations for participants. It had both physiological and psychological dimensions, and was closely related to needs considered later, including the drive for freedom, control, independence and convenience within the home (2.4).

> *"[I] don't want to be red hot…but I don't, you don't want to be cold either …Comfortable means I can walk around in shorts and a tee shirt. Rather than wearing a jumper…I just, I work outside, I wear a jumper, coat, all that sort of stuff. I don't want to be like that in house. I don't like to have too many layers on … When I work outside, I don't have a choice, I have to accept whatever temperature it is. In summer, it can be red hot and I don't like that and in winter, it can be minus, I don't like that…I don't think it gives me a sense of control. It just give, it just, I have, I have the choice. My choice is to be as warm as I feel comfortable with [in my home]. It's like, that's why I do it."*

Physical comfort related to achieving thermal comfort – being neither too hot not too cold – and was not purely about keeping warm. Physical comfort was seen as important to being able to 'get on with life', unhampered by concerns about heating.

> *"A stable and comfortable [temperature], which nobody finds it too hot or it's not too cold… If it was winter and it was too cold then it's not comfortable. If it's too hot, it's not comfortable; something which is right in the middle, ambient temperature or whatever you want to call it…Well, then you can get on with your day-to-day life without…worrying about this, that, or it's too hot one minute. Oh no, it's too cold."*

For participants, temperatures associated with physical comfort could vary across individuals according to a range of factors: current activity levels, gender and age in particular. For example, some participants mentioned wanting their homes heated to a higher temperature when inactive (e.g. when watching TV or working at their computer, some people mentioned wearing an extra layer of clothing or wanting the home to be a couple of degrees warmer), and preferred lower temperatures when active within the home (e.g. exercising or doing housework). There was a perception among some that men are 'naturally' warmer than women (although some held the view that men simply put up appearances of not needing heat to appear 'manly'), and that the elderly and infants are particularly prone to feeling the cold, and therefore needed more warmth to be comfortable (this was separate from health-related needs).

Comfort was also linked with *general psychological well-being and mood*. People spoke of using a range of behaviours to stimulate a positive mood, to help them feel better when unwell (e.g. using hot water bottles and space heating to lift mood during illness) and more generally supporting general happiness.

"You'll not wanna be uncomfortable in your own home, you know? Yeah, I think that being uncomfortable would make you grumpy and not, you know, and not happy and I think if you're warm, you're, you're happy, you know? If you were sat there shivering, worrying about everything, you know, you wouldn't be happy. And if you're not happy, you know, that, lots of things can lead on from there, you know?"

"Heat is part of comfort and happiness, you know."

People sometimes spoke of deriving comfort and happiness from warmth due to positive associations. For example, one participant mentioned that feeling warm is like being on holiday and lifts her spirits, while another associated warmth with childhood, and feeling cosy and 'safe' inside when the doors and windows were closed.

2.2.3 Keeping clean

Keeping clean was closely related to hygiene and health, and also to needs, considered later, such as social acceptance (see Section 2.5).

Keeping oneself clean relates to being hygienic but also to conforming to norms around socially acceptable standard of cleanliness (e.g. taking a shower because cleanliness was expected within the workplace, or society in general). Personal hygiene-related behaviours involving hot water use included bathing, showering, and washing hands.

Keeping other household members clean (including pets). This was particularly in reference to keeping children clean and healthy (both young children and teenagers) but sometimes also pets (e.g. ensuring young child who is going through potty training has regular baths, or having a super-deluxe dog shower to keep pets clean).

Keeping the home clean related to keeping aspects of the home environment clean and hygienic, including clothing, belongings, and physical structure of the home. Associated behaviours included cleaning and drying clothes, mopping floors, washing dishes, and cleaning windows. This also related to keeping pests at bay. For example, insulation was used as a means to deter rodents (e.g. foam filler to stop mice) and clothes were washed at higher temperatures, and/or dried outdoors to combat germs or bacteria.

"We've got automatic washing machines and drying machines. But we always put our clothes on the line outside because there's nothing better than the wind blowing it for fresh air … and the ozone and the natural sunlight to sterilise and sanitise and make clothes smell better. I mean, you know, we're in 2013 but there's nothing better than fresh air for drying your clothes rather than the, rather than an electric drying machine."

2.2.4 Relaxation and invigoration

Feeling rested and relaxed at home was important to participants. Achieving general relaxation was linked with the use of both space heating (for example, lighting a fire to unwind in front of, or turning up the heat to have the house warm enough to avoid wearing layers of clothing) as well as ventilation.

"It [opening windows when it's too hot and stuffy] just makes it more comfortable, doesn't it?...Yeah, you're more relaxed, you feel more um at peace…Yeah, if it's too hot you're not going to be comfortable. You're going to feel agitated."

Relaxation also featured particularly in relation to hot water use (particularly bathing). Participants tended to describe using baths to relax, and showers to wake themselves up. For example, baths were taken by some participants at the end of a hard day to relax, or simply as a means of carving time out away from the children and family to unwind in the company of a book or glass of wine. In this respect, bathing was seen as a 'luxury' by some.

More specifically, some participants mentioned *aiding sleep* as a goal for various behaviours. This was referred to in relation to helping participants or family members fall asleep (e.g. as part of children's bedtime routines to calm them down before bed); to aid sleep during the night (this was particularly linked with ventilation-related behaviours, such as leaving the bedroom window open even at times or in homes where leaving windows open was not routine behaviour more generally) and to prevent waking up too early. Here, reference was made by some participants to adjusting timers, particularly at weekends, so that participants were not woken up too early by the noise of the heating

system turning on, and in one case a participant mentioned keeping the young child's bedroom colder in the early mornings in order to encourage the child to stay in bed. Or, in one case, a participant explained that his wife does not like to sleep with the windows open:

> "'Cause the birds start singing in the morning and wake her up so…"

Alternatively, people engaged in behaviours associated with the need for invigoration, sometimes associated generally with waking up, or alternatively associated with productivity.

Discussions around the use of heat in waking up tended to relate to hot water use. As noted above, showers featured in discussions about waking up. Both warm and cold showers were used by people to aid waking up, to energise themselves, and to feel fresh enough to function. This also included showering after work or during hot summer days.

Productivity related to being able to do employment-related tasks (e.g. for those who work from home), or to aid children's studies.

> "[A warm home is important] so the kids are happy and they will thrive in a good environment … if they're happy eventually they'll, they'll be studying well as well. A lot of studying happens."

Productivity also related to domestic tasks (e.g. housework) or entertainment-oriented activities (e.g. physical activity, play, entertainment) within the home:

> "Well I wouldn't be able to concentrate [if it was too hot], because I'd be constantly distracted in the fact that I feel hot, I need to do something about it. So um, you know if I'm trying to enjoy something, a movie's on and it's just too hot, you know, I'll be forced to open a window or put the fan on or something like that."

Participants had varying preferences regarding temperature, with some feeling 'sluggish' and unproductive if the heating was on, while others would go to lengths to ensure they were warm enough (e.g. not getting out of bed until home is warm enough or doing physical activity to warm up). For those participants who worked at home, having the home at an optimal temperature to facilitate the type of work involved was important; this involved varying heating levels according to how active participants were (e.g. sitting immobile at a computer may demand more heat) and, more specifically, ensuring that zones where work was taking place were warm or cool enough.

2.2.5 Avoiding harm

This section discusses how participants behaved to avoid personal harm or to safeguard their household. Key concerns that were reflected in discussions are discussed below.

Avoiding burns and scalds. Associated behaviours mentioned by participants included avoiding certain types of technology (e.g. fan heaters that can be knocked over, and open heating sources such as log or coal fires where ashes are also considered a burn hazard). Alternatively, some participants mentioned using technologies in certain ways to minimise risk, for example, ensuring that potential fire hazards were not left unattended, or were switched off at critical times (particularly when children were present and/or asleep). Participants also mentioned exercising control over hot water temperatures to avoid scalding.

Avoiding air contamination, including carbon monoxide poisoning. Associated behaviours and practices ranged from the removal of oil burners (which one participant said made the family tired), avoiding tumble dryers in homes with poor ventilation, avoiding log fires where the flue was perceived not to provide enough ventilation, and ensuring adequate ventilation when heating sources that were likely to contaminate the air were used (e.g. keeping air vents open when gas fires are used).

Avoiding falls. These related particularly to concerns about safeguarding children. Associated behaviours included keeping windows closed (and, in some cases, using fans as a substitute), to avoid the possibility of children falling from windows.

> "Yeah, these windows [are closed] because he [child] has a tendency sometimes to climb up round the windowsill … We've got some string tied around it so he can't open it or get out of it."

Security: These concerns related to a desire for privacy and protection from intruders. Associated behaviours were related largely to ventilation; for example, people closed windows before leaving

home to prevent break-ins, or closed curtains to feel they had privacy. People also guarded against unwanted intrusion of a non-human kind: some ventilation behaviours such as keeping windows closed were geared at preventing insects or animals such as foxes from entering the home.

Other concerns related to safeguarding property and belongings from potential accidents. An example of this was leaving the heating on at a constant temperature during winter months to avoid water pipes bursting. This factor is explored in greater depth in 2.3.3, where property maintenance is considered as a resource-related need.

2.2.6 Ambience and aesthetics

These needs and associated behaviours relate to the general ambience and aesthetic of the home, linked with sensory stimulation, involving look, feel, smell and sound.

Behaviours associated with the *smell of the home* were geared towards ensuring that bad smells were removed from rooms (particularly the kitchen) and pleasant scents introduced into the home. Many behaviours associated with this need related to ventilation and other attempts to improve indoor air quality, including opening windows or doors to remove smells from the kitchen and toilets, and the use of extract fans and cooker hoods to remove cooking smells.

> *"Um, yeah the kitchen [window] usually is open all the time because of cooking, even through the winter because the cooking smells and that kind of thing."*

Behaviours geared towards introducing pleasant smells into the home included the use of scented candles, drying laundry indoors to introduce nice smells in the home, and avoiding the use of tumble driers because of preferences for the smell of clothes dried outdoors. A participant also mentioned baking to create a cosy atmosphere for family, linked with the warmth and smell of cooking.

Other behaviours associated with the ambience and aesthetic of the home were related to *lighting*. Particularly important were heat sources that emitted pleasing light and could be focal points of social interaction. This included tea lights, open fires such as coal or log fires, and gas fires. These were sometimes used throughout the winter and, at other times, at specific periods such as the end of year festive season. 'Artificial' devices were also used to give an impression of heat (where no heat was actually being emitted) because they looked pleasing and as a focal point for social interaction. Examples included using the glow of electric fires without switching the heat on or LCD screens with images of open fires to meet these needs.

A final set of behaviours related to sound. This could involve avoidance behaviours, related to keeping out unpleasant noise: for example, one participant explained that they never opened the study window

> *"'cos the kids play outside the front of the house it tends to be really noisy … And double glazing does very well at shutting the, shutting the sound out."*

Others spoke of heat energy use and behaviours geared towards seeking out pleasurable sounds. For example, one participant explained that he turned on the electric heater to enjoy its soothing drone, rather than because he was cold, to aid productivity while working at home

> *"I'll sit there and do it, and even then my feet aren't particularly cold, it's I turn it on and it feels nice. I don't know if you know this, but the sound that they make is really, you know, the kind of droning noise that they make, is really pleasant. Not...I don't turn it on for the sound, but what I find is if I turn it off I miss the sound and I'll turn it back on until I get too hot, that sort of thing."*

Sometimes, participants described these behaviours as being geared more generally towards creating an environment that enabled other activities to take place. For example, keeping the bedroom window closed at night was described as a way of ensuring that it was quiet enough to sleep (see also Section 2.2.4, relating to relaxation).

2.3 Resources

Resource-related needs related to finances, waste and property maintenance.

2.3.1 Finances

Finance-related needs tended to be driven by the desire to save money. The drive to minimise heat energy costs was mentioned at times, but not exclusively, in the context of low and/or falling incomes and rising energy prices. A multitude of strategies were adopted in the interest of minimising the costs associated with heat energy use; these can be grouped into three main types.

The first set of strategies involved active minimisation of heat energy use in the home.

- *Avoidance and substitution* involved the conscious avoidance of cost-intensive technologies (e.g. avoiding use of immersion heaters or tumble dryers) and/or the uptake of more cost-effective technologies over less cost-effective ones. For example using radiators, clothes maidens or clothes lines to dry clothes rather than tumble dryers; substituting baths with showers (although there was disagreement and uncertainty relating to which represents a more efficient option); using boiled water from pans heated over the stove, or from kettles, rather than re-heating stored water; or replacing the use of central heating with other means to keep warm such as clothing, or use of a cooker to heat space. One participant mentioned that, when they did not have money for gas heating one month, they used boiled water from the residual heat of an electric cooker, letting the steam heat the house. A number of behaviours within this strategy also related to ventilation and cooling, where electric fans, air conditioners and/or extract fans were replaced with other approaches that were perceived to be less energy intensive ways of cooling and ventilating, including opening windows, wearing less clothing, and using hand-held fans.

- *Displacement* involved the displacement of domestic heat energy use to other domestic settings (e.g. people mentioned staying over at parents' homes on weekends to save on costs; having baths or showers at relatives' homes; or sending the teenage children to shower at their grandparents' home) or to non-domestic settings (e.g. showing at work or a gym to save on hot water costs at home; eating out at restaurants to save money on cooking and heating at home; going to the pub to save electricity; going to public places such as libraries or generally going out until late and/or going for long walks to save on energy use at home).

A second group of strategies identified involved *maximising or making more of existing systems or heat:* rather than simply avoiding the use of heat energy, as some of the examples above suggested, this involved making the most of existing technologies and resources. Some of these examples did not cost less, or involve less use of heat, but might have enabled people to feel they were getting better value for money for the heat they had bought.

- *Improvisation* involved 'DIY' or makeshift solutions that tended to involve non-purpose-built solutions. For example, some respondents reported using paper to fill gaps in windows, or putting "aluminum foil" on the wall behind radiators to reflect more heat into the home.

   > *"I just read it somewhere, that a lot of heat…one side the heat is coming out, the rear of the radiator the heat is going, escaping in the wall. So somebody said on the internet that if you put some foil, so I was just experimenting … I was trying to save money and I was trying to use it more efficiently."*

- *Harnessing air/heat flow,* i.e. capitalising on air flow and/or heat transfer more generally, related to structural aspects of the dwelling, or capitalising on a closed or open-plan design to alternatively retain or disperse heat. Within the home, this could involve keeping doors open to allow heat from certain rooms to flow into other rooms (e.g. from lower floors to higher floors). In apartment blocks, some individuals reported consciously relying on the heat of surrounding apartments rather than paying for their own ('heat scavenging').

- *Multi-purpose strategies* involved balancing out the costs associated with heating by using one single device or energy source to serve multiple purposes, for example, turning off central heating while using the oven to cook (and thereby using the oven to heat the home); getting children to share one bath; or using radiators to dry clothes only if they are switched on anyway.

- *Control and timing:* this involved the use of controls and strategies for controlling the use of heat, particularly space heating. This included zoning approaches (e.g. heating rooms differently across

the home to reflect occupancy; using TRVs; use of portable heating devices in occupied spaces, or using the oven for heat when in the kitchen, rather than using central heating throughout the home). It also included time and timing-related approaches such as doing washing at off-peak times when electricity is cheaper (e.g. at night); limiting time spent in showers (including use of timers); maximising time spent in baths to make the most of the hot water; heating only at times when the home is occupied; and the use of timers with minimal overriding.

A final group of strategies went a step further to save costs by introducing new technologies that could save money in the short or long term. Participants mentioned *switching fuel systems*, to take up options perceived to be cheaper (e.g. switching from gas to coal for central heating; and from coal or gas fires to log fires); the use of *ad hoc technologies* over primary heating sources to save money in the immediate present (e.g. using portable heating systems, such as electric fires or halogen fan heaters, rather than central heating, which was seen as too expensive); and also *making installations* that could save money in the long term (e.g. combi-boilers; solar panels; PVC doors to exclude draughts; cavity wall and loft insulation). In addition to switching technologies, participants also mentioned changing energy providers in the pursuit of cost savings, comparing tariffs online or using 'apps' (although, it should be noted, there were participants who were confused by the tariffs and indeed, their own bills).

There were limited examples where participants mentioned installing a technology to generate or make money, rather than to save money. When mentioned, making money was considered a welcome consequence rather than actual driver of behaviours (and an 'added bonus' on top of any savings made). Examples related to making money (e.g. installation of solar panels to make money by selling energy back to energy companies) and adding value to property (e.g. particularly where introducing energy-saving technology was expected to improve the resale value of the property).

For some people, it should be noted, other needs were prioritised above cost. Here, there was less likelihood of strategies to minimise energy use to save money. For one group of people, saving money was secondary to meeting other needs (e.g. comfort or convenience). This translated into behaviours that focused on these needs over and above costs (e.g. use of a tumble dryer to dry clothes, as it was convenient within the context of having a large family and/or busy working life) – although a saving on costs was always welcomed.

For another group, costs did represent a concern, but they were unable to curb their use of energy as other needs were fundamental and warranted prioritisation, including family commitments, health reasons or life stage (e.g. elderly people who have a more sedentary lifestyle). These individuals were driven to use energy cost-consciously, but sometimes were unable to implement strategies and therefore made savings elsewhere to compensate. This included saving on basics (such as the amount and quality of food) and on goods and services that were considered luxuries rather than necessities (e.g. going out to eat, or using taxis rather than walking or using public transport).

2.3.2 Waste

Waste also featured in people's resource-related needs and behaviours. There were a number of different attitudes towards waste, with varying levels of influence over behaviour.

For one group, *waste was considered a concern and something to be avoided*. Avoiding waste was linked to saving money, manifesting in the use of many similar strategies, but was driven more generally by the principle of being efficient with energy use than a desire for cost savings (which, when achieved, tended to be more a welcome consequence rather than a driver of behaviour).

These people attributed the importance they attached to waste avoidance to a variety of factors, including the depletion of resources and the potential impact on future living standards and on the well-being of future generations; the desire to educate or set a good example for the younger generation; and on formative experiences (for example, older participants spoke of growing up during the war at a time of shortages and rationing, and becoming accustomed to living with limited means).

> *"We tend to, we will put on extra clothing rather than whack the heating up especially because our heating, well I don't know how much it costs, I'm not that au fait with it but it feels quite wasteful … It's driven by*

finance to a degree but it's honestly more predominantly how we've both been brought up 'cause both our parents, independently of each other, were much like that, you know, you put something extra on."

For a second group, *waste was considered part and parcel of, or inseparable, from saving money*. Here, although again encompassing similar strategies as the group described above and in certain groups in Section 3.3.1, the focus was on cost efficiency rather than energy efficiency.

As with costs, there were also people for whom *waste was either not important or secondary to other needs*, and for whom waste did not factor into their behaviours. This included people who felt that the use of energy at home was an issue of personal taste and freedom (a view sometimes rationalised by the view that domestic energy use has little impact on the wider environment, or that people who did voice such concerns were misguided, or trying to cover for being 'tight'). This group also included people who held the view that certain inefficiencies were acceptable, or required acceptance (based on notions of 'acceptable' or 'conscious' inefficiencies), in the interest of meeting other needs (e.g. due to the effort of changing technology, or convenience).

A final group of participants mentioned *waste as a concern*, but faced constraints in acting on this. These included people who said they lacked: the ability to control their heating systems (e.g. homes with certain types of communal heating); confidence in their heating systems or controls; the means to replace or modify inefficient energy systems (e.g. renters in energy-inefficient properties were unable to change energy systems or make modifications such as insulation); or the knowledge or feedback on how to reduce waste.

2.3.3   Property maintenance

Property maintenance was a particular concern for home owners and long-term renters, and among those with a particular view of the home, such as the 'house-proud'. Practices related to preserving the current state of the property, which revolved around ensuring that the home was aesthetically appealing and that structural damage was avoided. Many practices related to preventing damp and removing condensation, which was associated with unsightly stains, rust on radiators, damage to wallpaper and plaster, and mould, which was itself associated with health problems and property damage.

Associated practices ranged from routine activities (e.g. patterns of heating to control damp in particular parts of the home; patterns of window opening across the home or in specific rooms prone to condensation; the use of extract fans to reduce humidity, or leaving the heating on a low setting to ensure there was no risk of burst pipes which could lead to ceilings caving in); to *ad hoc* or occasional responses which could be short-term (e.g. turning on secondary heating sources such as electric heaters in addition to a primary heating source when the damp gets particularly bad, or the occasional use of dehumidifiers) or more long-term in nature, such as replacement or installation (e.g. insulation to prevent damp). This was also factored into choices around the adoption of particular technologies; for example, people mentioned tumble-drying clothes either totally or partially before placing them on radiators, to limit condensation.

Other practices were oriented towards adding to or maintaining the value of the property. This included measures to make the home more energy efficient and/or cost effective. For example, insulation in lofts and solar panels were seen to add financial value to the homes. Conversely, mould in particular was seen to take away from the value of the property; in one case, a participant had moved away from a previous property as it had an uncontrollable mould problem.

2.4 Agency

In this categorisation, we understand agency in broad terms of the capacity of a person to act independently, and to make choices. Agency may include both purposeful, goal-directed behaviour and unconscious, involuntary behaviour. The needs considered under this heading all relate to the need to be actively in control of heat energy use within the home, often to meet personal or household requirements and preferences.

Agency may feature in the positive sense, whereby people want to be actively in control of choices relating to heat energy use. Alternatively, in some cases, agency featured in the negative, where people wanted to be removed from choices relating to heat energy use (for example, as discussed under convenience, a person may not want the hassle of changing to a more efficient heating system; or may not want to be actively involved in the control of the heating system).

This category of needs comprises three factors: convenience, control, and routine and habit. Factors considered under agency can feature both as needs or, alternatively, as constraining or enabling factors.

2.4.1 Control

This sub-category of agency relates to the need to feel in control of heat energy use at home.

Control had both a functional purpose (e.g. having the heating on when needed) and a symbolic purpose (e.g. linked with meanings attached to the home, particularly where the home is considered somewhere that a person should be in control of their own comfort and wellbeing). Freedom to make choices was an important dimension of control.

> *"Comfortable means I can walk around in shorts and a tee shirt. Rather than wearing a jumper…I just, I work outside, I wear a jumper, coat, all that sort of stuff. I don't want to be like that in house. I don't like to have too many layers on … When I work outside, I don't have a choice, I have to accept whatever temperature it is. In summer, it can be red hot and I don't like that and in winter, it can be minus, I don't like that…I don't think it gives me a sense of control. It just give, it just, I have, I have the choice. My choice is to be as warm as I feel comfortable with [in my home]. It's like, that's why I do it."*

While related to characteristics of energy systems, this need related more to the *sense of being in control*.

> *"Yeah, it was lovely [having a thermostat in previous home]. And you just like seeing it come on and… Then if it got cold it used to come on automatically. If it got hot, it used to go off. [In current property] I've got do it myself… I miss the heating from our old flat… [misses thermostat because] it's like being in control, isn't it? You can just, right, I'm cold, put it on and…"*

Control featured in two main ways. One group expressed the *desire for more control*. In this instance, discussions tended to centre around *lack* of knowledge required to control heating effectively and efficiently (e.g. not knowing how storage heaters worked so not being able to control temperatures at home; not knowing how to use timers; lack of feedback required to inform more efficient and effective use of heat energy systems), and *lack* of control over heating technologies or systems. The latter was particularly the case among those renting or with particular heating systems (storage and communal). These participants felt they lacked technologies that would give them more control of their heating through control devices (e.g. timers or thermostats if the landlord had not installed them), or more generally (e.g. not being able to determine when communal heating comes on, or regulate heat from storage heaters). More detail on this is included in Chapter 4. As this group illustrates, the need for control appears to become particularly salient when the need for comfort is not met.

However, importantly, not everyone saw greater control as desirable. Some people attributed certain behaviours to the *desire to minimise their need to control*, through active input or engagement with the heating. For example, they might vary their clothing at home rather than adjust a thermostat or timer; not use a TRV as it is perceived to be too much of an effort to "fiddle" around with; use timers as it saves thinking about putting the heating on; or, alternatively, use a thermostat as this is perceived to be easier to use than a timer (either due to ease of using the controls, or their locations). However, even where active control was not desirable, this was only on condition that the comfort needs were being met.

> "I think as regards setting temperatures and having heating on and that, I think you want it set so that you don't think about it. I think if you have to think about it it's the wrong temperature."

2.4.2 Routine and habit

Routines and habits also drove behaviours.

Households' routines heavily influence how they use heat. Routines are informed particularly by current daily household patterns of activity and occupancy. Examples of routines included those relating to space heating (e.g. having the heating switching on/off at a certain time to reflect family or individual schedules, such as before children wake up, or to fit with working patterns; or setting the thermostat to a temperature that facilitates productivity among those who work from home), hot water use (e.g. having the hot water on all day as young children are at home; having showers every morning before work to wake up; giving children baths as a part of their bedtime routines to calm them down); and ventilation (e.g. having the bedroom window open at night for fresh air).

Household routines and heating routines appeared to interact in three main ways. First, some people consciously either sought routine through their heating practices: for example, retirees sometimes actively aimed to structure their lives, and their interaction with their heating system(s) was one way of doing this. Alternatively where people had more flexible lifestyles there was a view that heating systems should adapt to this, and control systems that presupposed a fixed routine were a source of frustration. Finally, in other cases household routines simply imposed certain constraints or parameters around the heating practices, thereby influencing behaviours.

Habits are understood here as routines of behaviour that are repeated regularly and tend to occur subconsciously. Habitual behaviours can be subconscious because a person does not need to engage in self-analysis when undertaking routine tasks, and people are not always able to account for them. Habits are often the vestige of *past goal pursuit*, and can either serve or stand as obstacles to the goals people consciously set for themselves in the present. For example, one household installed an air conditioner to meet the health-related needs of a child with a particular illness; although the child has since recovered and it no longer serves its original purpose, they still routinely have the air conditioner on. Habits are important, as they allow people to focus on thing that need conscious decisions and not be "cluttered" by things that do not. Hey also draw our attention to the fact that people may be *serving both past and current needs through their current behaviours*.

Examples of habits included those relating to space heating (e.g. a participant who always puts the gas fire on when arriving home, regardless of whether it needs to be on, as learned behaviour from childhood); hot water use (e.g. a person who used to have a hot water bottle to keep warm but now has got used to it so uses one out of habit); and ventilation behaviours (e.g. someone who mentioned using an extract fan in their bathroom but did not know why). As noted, habits can be linked with formative experiences (discussed further in Chapter 4), which figured in people's behaviours in two key ways: either confirming or reacting against them. So, for example, one woman described liking to keep her children warm because her mum had kept her warm when she was very young, while another always keeps the heating on because of her experience of growing up without enough heat and having frost on the window.

2.4.3 Convenience

Convenience is a key driver for behaviour, on the basis that more fundamental needs are also met, particularly those relating to comfort and cost. For some people, this conflicted with the need to save money, resulting in tensions and negotiations in some households. These negotiations and tensions between needs are explored further in later chapters.

Saving time was mentioned particularly in relation to getting household tasks done quickly and managing household routines efficiently. Examples of behaviours included clothes drying behaviours (e.g. using tumble dryers to save time on both drying and ironing clothes; and using radiators to dry clothes more quickly than hanging on the line); cleaning behaviours involving the use of hot water (e.g. showers were mentioned as a quicker way to get clean than baths, also removing the need to clean baths, while baths were sometimes mentioned as a time-saving means by allowing children to bath together); and ventilation behaviours (e.g. extract fans in kitchens were used to remove smells more efficiently than opening a window, and also to keep kitchens damp-free and therefore easier to clean).

The desire for instant gratification also featured in the form of behaviours that granted instant access to space heating (e.g. use of tumble dryers to heat the home more quickly than a radiator; preferences for heat sources such as coal fires or ovens which offer immediate heat; pre-emptive behaviours such as setting the timer to turn the heating on in advance of arriving home, to enjoy a warm blast of air on arrival); hot water (e.g. use of immersion heaters to heat water on demand or having a combi boiler as this gives all day access to hot water); or ventilation (e.g. opening a window, or using an electric fan, to enjoy a cold blast of air).

> "The kids in the afternoon come in at quarter to four so the heating will go on at three o'clock in the winter…Because you don't want the heating to come on when you arrive in the house; you want the house to be warm before you arrive in the house. And that's the only time the heating will go on if nobody's in the house… [That's important because] Well, the temperature is comfortable before they come rather than come in a cold house."

Saving effort also factored into people's needs and behaviours. This need related to the degree of perceived effort and/or ease of use associated with particular practices and technologies, and was closely aligned to participants' confidence in and knowledge of a particular technology. In particular, the effort of *thinking* about heating and cooling their homes (for example, not wanting to have to think about heating, and therefore leaving it on all the time) was mentioned. Key sets of associated behaviours included:

- installing a new technology because it saves the need to think about heating the home (e.g. central heating system);
- removing technology that is seen to involve too much effort to maintain, such as coal fires which were considered by some as messy and involving too much effort to clean);
- avoidance or 'doing nothing' (e.g. avoiding the 'hassle' of installing new technology, such as underfloor heating, even though this may be perceived as a more effective and efficient heating solution);
- adopting day-to-day behaviours that minimised physical effort (e.g. using tumble dryers as this saved the effort of putting clothes outside) or the mental effort of thinking about use of heating in the home (e.g. leaving the heat on constantly, to avoid having to think about it).

2.5   Relational dynamics

This category of need is focused on the social relationship between the individual or household and others – including the wider world. Specifically, these needs relate to maintaining harmony with others – within the home (household members and guests) as well as beyond the home (wider community, society the world). These needs tended to be more peripheral or circumstantial than those relating to the first two categories of needs relating to health and wellbeing, and resources respectively. There was a range of ways in which this featured in people's needs and associated behaviours.

2.5.1   Self-image and social acceptance

Self-image is partly about how people want to see themselves and partly about how they want to be seen by others. It related to behaviours and usage that were oriented towards presenting the self and the home in a positive light to others. This linked with pride and self-esteem – some of this in relation to what guests or other people think but also in relation to meanings attached to various social roles (e.g. being a 'good mum' might be associated with tending constantly to the comfort of a young child, and might result in behaviours associated with achieving comfort such as keeping the heat on constantly). Self-image also related to social acceptance; this played out as part of social interaction with guests within the home, but behaviours also reflected the need to be socially accepted outside of the home (see 2.5.4).

2.5.2   Social interaction with household members

Social interaction with household members relates to the various behaviours that people engaged in to facilitate and maintain various types of social dynamics within the household. Further, in-depth consideration is given to these interactions in Chapter 3.

This need or purpose is considered within this report in separate terms from meeting the various needs of others in the home – for example, behaviours geared at tending to the comfort of a child or the health of an elderly person are considered under needs relating to health and wellbeing.

2.5.3   Social interaction with guests

Facilitating and maintaining the type and quality of social interaction with guests represented a different need, and was served by a different set of behaviours. Much of the previous sub-category (2.5.2) also applies to visiting relatives. For example, one woman turns up the heat when her mother comes to stay:

> *"Because she's old and, you know, I mean they, they've still got the heating on in their house and they need it and it, you know, but I obviously I need to look after her."*

What is distinct about the current category is the changes in needs and behaviour that occur when households have guests to visit who are not family members. Two kinds of response featured, associated with a range of rationalisations and behaviours.

Adjusting routine behaviours in relation to meet (or not meet) guests' needs. Examples of behaviours geared at meeting the needs of guests included turning the heating up before guests arrived (and then sometimes turning the heat down or off on their arrival to ensure the home did not become overly warm or stuffy); or heating areas of the home that they would not otherwise heat. Behaviours were linked in part to meeting the comfort needs of guests (e.g. not wanting guests to have to come to a cold home and feel discomfort), but also were about cultivating social acceptance and a positive self-image (e.g. avoiding appearing 'tight').

> *"[When guests come to visit]: "If you've got somebody in your home and you want them to be happy, comfortable and heat is part of comfort and happiness, you know. I wouldn't want you going your way thinking, 'God, I don't want to have to go back there again'. I don't, you know, it's, it's, it's just uncivilised."*

Some people, it should be noted, mentioned changing their behaviour in the interest of prompting (generally unwanted) guests to leave, or not stay very long.

No adjustment of routine behaviours. This was rationalised in a range of ways, including the view that guests should submit themselves to the heating choices and preferences of the home owner/resident; that as the resident they should be accepted 'as they are' by guests, or guests should simply leave if their comfort is not being met (and had little regard for the image they projected as a result) and the view that guests had no right to dictate energy behaviours as they did not pay the bills.

2.5.4   Social interactions beyond the home

Some behaviours also reflected the need to be socially accepted outside of the home. In particular, being hygienic and clean (e.g. having baths and showers and clean clothes) was framed as helping participants be accepted in social situations such as work.

2.5.5   Wider implications of energy use

This need relates to the link between domestic energy consumption and its potential impact on the wider community, society or environment. The need has been placed in the "relational dynamics" category because it represents an expansion of concerns beyond the household or immediate social network. However, it also shows through in the other three categories in specific ways, as noted below. In fact, it is in many ways a hidden need, not showing itself directly in most of the discussions or being revealed as an important influence on behaviour in most cases. Nevertheless, the reasons why it was not generally salient to different groups of people are informative. These people can be characterised as follows, according to the reasons they gave.

Those who did not acknowledge the impact of home energy use on the environment. This included participants who had not given this much thought or were not convinced that how they used energy had an impact on the environment. For example, some felt global warming would happen regardless of how they used energy at home, and were not convinced that behaviour change would make any

difference. This contrasted sharply with their views on other more 'visible' ways of helping the environment, such as recycling.

Those who acknowledged that home energy use could impact negatively on the environment, but *felt individual/household level action was futile and/or lacked cumulative effect*. This sentiment tended to be linked with the view that any measures they might introduce in their individual homes would be counteracted by the inefficiencies of others: e.g. other households; use of energy in non-domestic settings/business; use of energy at local and/or national levels by Government (e.g. keeping street lights on inefficiently); and in other, bigger countries (e.g. China, India or the USA), or in 'developing' countries.

> *"My attitude is you can do the best [for the environment] in developing countries but nobody cares about anything in the Third World country. So you, you can try your best but you're not going to change anything that way….They'll be losing it 10 times faster like in India for example."*

Those who acknowledged that domestic heat energy use could impact on the environment, but for whom *other, more proximate needs outweigh environmental ones*. For example, if participant had a family with needs for comfort and convenience, this would outweigh environmental concerns.

> *"It's just everybody's saying environment, environment, environment. But when it comes to heating it doesn't matter whatever happens to the environment, it has to be nice and warm for the kids."*

> *"The thing with heat energy is, that it's difficult for a family to save on heating, because they just need the house heated up more than a single person who is out all day. So single people might feel good about saving the environment by using less energy, but really it's just the practicalities of their lives that mean they need less energy."*

In some cases, people acknowledged the wider implications of energy use as a concern, but felt *unable to act on concerns due to constraints imposed by various factors* such as tenure (e.g. participants would like to use less hot water but landlord had not installed a shower; they would like to install more energy-efficient or cost-effective technologies but do not own property) or income/cost (according to some participants, this led them to engage in compensatory behaviours to balance their energy footprint – e.g. recycling more).

Some people acknowledged and appeared to be willing to act on environmental concerns, under certain conditions. These included, in particular, convenience (if it was made convenient and cost-effective for them to do this, for example if technology was cheap to install and they were incentivised – e.g. got tax breaks for doing so) or if behaviours simultaneously met other needs, such as saving on costs or tying in with their principle of avoiding waste (e.g. a participant installed a new, more energy efficient system, but because they wanted cheaper energy and not only for the sake of the environment).

Some participants mentioned environmental concerns, with some expressing concerns about climate change (with reference to shorter summers, floods and harsh winters). In some cases, this resulted in certain behaviours such as drying clothes outside rather than use tumble dryers, or taking showers rather than baths to save water. However, on the whole, the environment either did not figure into decision-making or did so only as a part of, or secondary to, other needs (e.g. limiting waste and costs):

> *"I do think about the environment and the affects of it, you know but I suppose at the end of the day my biggest, my biggest worry is the cost, you know and…spiralling in increasing costs if we don't, you know, if we run out of uh, you know out of gas, is it going to cost us more to, to heat us house and to cook food and, and everything else that we do you know?"*

Some people felt that consciousness around the environment was more apparent in younger generations, and was becoming more 'socially acceptable'.

> *"It's more about their carbon footprint [for young people] whereas for older generations it's about saving money: my eldest is 13 ...it's around being more energy conscious, being energy efficient, cost doesn't come into it at that level. So, everything that she does in the house that relates to the energy, it's all, 'I'm saving this, I'm doing this, I'm reducing my carbon footprint here.' Whereas for me it's, 'Yeah, and how much is that saving me?"*

> *"[Nowadays] it's more socially acceptable to want to save energy, whereas before you might have appeared tight."*

3. Explaining sub-group variation in needs and behaviours

The previous chapter has mapped the range of needs that people seek to meet through energy use, while linking these to the behaviours and technologies through which people address these. Needs and behaviours do, however, vary across the population, with implications for the requirements of SES.

To some extent, all households display needs in each of the four categories identified in the previous chapter, and all four could potentially have an influence on behaviour. However, in practice, the influence they have over behaviour varies among households. This is because needs are prioritised differently in different households, in response to factors that are particular to their circumstances.

Through analysis of data from the workshops and in-home interviews, we identified a number of factors at play that appear to determine needs that rise to the surface and are prioritised within any given household. These relate specifically to three aspects of household composition and dynamics:

- the presence of dependents;
- the unity of the household;
- the complexity of routines.

This effectively sets the parameters of household decision-making: their patterns of heat energy use and behaviours.

The *presence of a dependent individual* in the household was a significant and often overriding factor influencing how households said they prioritised different heat energy needs. A dependant is most obviously a young child, but can also refer to adults who are dependent as a result of a serious health condition or by virtue of being elderly. In these households, the needs of the dependant were paramount. As a result, the daily routines and needs of the dependant largely dictated patterns of heating behaviour and use within the household. Needs of other household members were considered but come secondary to the needs of the dependant.

A more complex set of factors determined which needs were prioritised where people in the households were more independent and active. While prioritisation in households with dependants was driven by the comfort and health needs of the dependant, a range of other needs came into play where all householders were independent and active. Which of these needs took on a higher priority was driven by the other two primary influencing factors.

Household unity was the first of these factors. This refers to the extent to which the household operates and perceives itself as a unit. Households appeared to sit along a continuum. At one end are highly integrated family units such as small families with young children, making decisions almost entirely as a unit, and couples with very similar routines, for example retired couples. At the other end of the continuum are households of isolated individuals such as group of young professionals in a house share who did not describe making decisions as a unit, but as individuals, despite a perception that this may lead to inefficiencies.

These different levels of unity affected whose needs were prioritised and how these needs were best met. Relational dynamics, such as the need for social harmony, could be a prioritised need in households that behaved as a unit. For example, one participant described how his own need for fresh air was sacrificed to maintain harmony in the home by the need to meet the requirements of other family members. Furthermore, where households sat on this continuum of unity also influenced how decisions were made to fulfil these needs. Participants described different levels of negotiation in family units and in more disparate households.

The second factor affecting the prioritisation of needs and parameters of heat energy behaviour was the *complexity of household routines*. The routines of household members were particularly influential in relation to setting heating patterns as they affected when the home was occupied and when people engaged in a range of set daily activities that required heat energy. The complexity of routines was particularly dependent upon the number of people in the household, their work status and the nature

of their work; and the extent to which individual routines shared common elements. Each of these ingredients increased the complexity of negotiation required to meet household needs or, where negotiation did not take place, these elements increased the likelihood of conflicting routines leading to inefficiencies and/or some household members' needs not being met.

Based on the specific combination of primary influencers in operation, any given household could be classified as one of three 'types'.

- *Type 1: YOU* (Decisions made on the basis of the needs of a dependent individual).
- *Type 2: US* (Decisions made on the basis of needs of multiple household members).
- *Type 3: ME* (Decisions made on the basis of self-interest of individuals).

Each type is characterised by a distinct combination and prioritisation of the needs from the four categories described in Chapter 2, and associated with particular patterns of behaviour. A household does not necessarily belong to a fixed type, however: it can vary by time of day, year or life, depending, for example, on who is home, and the changing characteristics and needs of the people who make up the household.

This is the basis of a household-level decision-making typology, which explains how the needs of potentially multiple individuals play out, and inform decision-making and behaviour, at the household level. It serves to illustrate high-level patterns of behaviour and make complex household needs and behaviour more intelligible.

The rest of this chapter identifies what defines each decision-making type and the kinds of households that they comprise. For each type we outline how needs are typically prioritised (depicted graphically as a needs 'heat map', with a priority level from high, medium and low indicated by green, amber and red respectively) and their dominant patterns of behaviour.

For the purposes of this report we have extracted 12 household case illustrations that reflect the diversity of households, properties, needs and behaviours within the overall sample. A table providing a high-level summary of each household, and full details for each case, is presented in Appendix 1. We will draw on these cases in this chapter and the next, to explore how needs are negotiated and behaviours play out in the context of different households.

3.1 Type 1: 'YOU'

In this type of household, decisions were made on the basis of the needs of a dependent individual. The more dependent these individual household members were perceived as being, the greater was the priority given to meeting their needs. Within this type we identified three further types of household.

- Households with very young children/infants.
- Households with elderly resident(s) – particularly those who are infirm or frail. This included multi-generational households and elderly couples.
- Households where at least one resident has a specific health condition.

This section describes in further detail the defining characteristics of this type of household in relation to their needs and behaviours and identifies where there is variation amongst the households within this type.

3.1.1 Needs
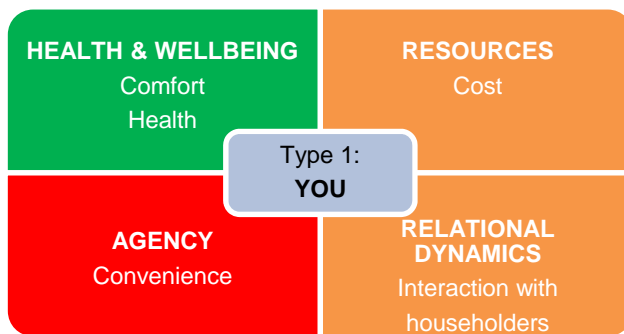
The first question in relation to how needs are prioritised in a given household is: whose needs? For this type of household, the needs of the dependant are the overriding priority. The needs of other household members are met where their needs are the same as the dependant. Where needs are in conflict, households often have to work hard to find a way to meet these needs or the needs of others are sacrificed.

Typically, the needs of the dependant relate to *health and comfort*. This is very much the crucial element of their dependency, that they are reliant on others for their health and comfort.

- Participants with *young children or infants* described the child's needs in two ways: in relation to keeping warm and clean for health reasons, but also ensuring the child was at a comfortable temperature.

- The needs of *elderly dependants* also related to health and comfort, but were described slightly differently. Older dependent people equated warmth with comfort. As a result, in comparison to households with dependent children, needs of the dependant were met in a more straightforward way as these households kept a more constant warm temperature.

- Among households with dependants with a *specific health condition*, health needs were unsurprisingly prioritised. There was less consistency in how they described these health needs as they were related to the specific condition. However, the comfort of the dependant was also an important concern for each of these households – participants described feeling an obligation to make sure the dependant was comfortable to help them manage and deal with the pain or suffering of the condition.

Other, secondary, needs were typically the needs of others in the household, apart from households with much older people where *convenience* was also important. These other needs included *keeping costs low* and *relational dynamics* (specifically, social interactions between household members) in larger households. However, these needs would not override the health and comfort needs of the dependant but would constrain behaviour in other areas. As a result, convenience was typically sacrificed, particularly among households with younger children.

For example, one single parent with two young children made a conscious decision to be out as much as possible in the winter, in order to avoid turning the heat on, and so save money on fuel bills. She ensured that her children were kept warm by taking them elsewhere – to grandparents, shopping, or local community centres – although this was not always convenient.

In some cases, other household members had needs that conflicted with those of the dependant. For example, parents described needing a room that was cooler when the heating was on. In one case, parents living with a child in a small flat would keep the kitchen cool by opening windows despite being aware of this as 'losing heat'.

Other needs considered under the category of *relational dynamics* – relating to social interactions with other householders and guests, and environmental concerns – did not feature heavily in these households, affecting behaviour very infrequently and at the margins rather than influencing routine heating behaviours and patterns of use.

3.1.2   Decision-making and typical behaviour patterns

The routines for heating space in households with young children tended to map directly onto the routine of the child. This involved ensuring the home, or at least the child's room, was warm when they woke up but not too warm while they were sleeping. It also required households to ensure they had sufficient hot water at certain times of the day for bathing.

Households with very elderly relatives and with older children or adults with a health condition described routines and household behaviour in subtly different ways, varying according to the extent of the dependency. For example, the total dependency of a very young child meant that they were accompanied for the vast majority of the time (while awake), therefore routines of parent and child were very similar. Alternatively, if the dependant required only occasional care this drove behaviour but was not as overriding. For example, one participant talked about their teenage child with severe asthma and breathing difficulties. This particular health concern did not mean that the household routine was completely driven by the routine of the dependant all the time, but the parents ensured that the temperature did not fall below a certain level at night and that the heating came on prior to the child waking up.

Within these routines, decision-making was governed by the assumed or actual inability of the dependant to tolerate any degree of discomfort. As a result, decision-making was very straightforward as there was only one factor to take into account. Despite this, even within households with young children, parents adopted different approaches to trying to meet the needs of the child, reflecting different parenting approaches. One view was that it was important to try to pre-empt the comfort needs of the child.

> "The kids are up at six o'clock in the morning but sometimes like if, if … I've had the heating off, I'll probably like if I get up in the night, I'll probably switch it on like three o'clock in the morning when I go to the loo or get a drink or something just so that it's got a bit of a warmth about the house when the kids wake up. And then if it was a day like this, I'd probably turn it off when I've taken them to school and then put it back on like just before I go to pick them up."

Alternatively, other parents were more reactive, responding to what they perceived as discomfort due to the temperature.

The unequivocal priority given to needs and the straightforward approach to decision-making led to relatively straightforward behaviours. Typically the heating was set on a timer where the heating system allowed. Timer settings were aligned directly with the routine of the dependent individuals. In the '*child-focused family'* case, for example, the central heating was set to the child's routine using a timer. The thermostat was always set fairly high, which met the perceived needs of the child when she was home. The father was often too warm and his needs were sacrificed in favour of those of the child (and expectant mother). There were, however, households that did not set a timer because systems such as storage heaters did not allow more responsive time setting. Additional top-up behaviour was also sometimes required to meet the needs and routine of the dependant.

Even for households using a timer, in addition to this routine behaviour, participants also described very active temperature control and zoning within that routine. Zoning was particularly important where other household members had different needs. Households would keep certain areas of the home very warm, targeting the needs of the dependent individual, or keep some areas cool. Top-up behaviours were also sometimes combined with pre-emptive behaviours (e.g. turning on the heat in advance of it being needed). This was particularly where systems did not allow for timers and/or manual adjustment, or where heat from the primary system was not sufficient. Where cost was a constraint, participants also described sometimes using secondary heating sources as a substitute rather than to top-up the primary heating source, to ensure that the dependant was comfortable. These systems were felt to be a more efficient way to achieve the required level of comfort.

Household decision-making around choice of heating source as well as behaviour patterns was sometimes driven by risk-averse tendencies, particularly evident amongst those with young children. For example, in one case, the householder had particular concern about the safety of gas central heating, and so chose to get storage heaters, even though these were perceived as less energy- and cost-efficient, and not always responsive enough to the child's need for warmth, resulting in further

top-up and pre-emptive behaviours, such as turning on an electric heater in the child's room. She also only opened windows that were high enough to be out of reach of children, to avoid them falling out.

In another example, in the '*high earning young family'* case, the timer was set for early morning, before the children woke up, and in the evenings when they returned from work or school. The open fire in the lounge was used rarely, because of concern over the children's safety. Top-up behaviour was more prevalent when there was a new baby in the home: an electric plug was used in the baby's room, along with extra blankets.

3.2 Type 2: 'US'

This included households with two or more occupants, where all were relatively independent but where household members were considered a unit for the purposes of making heat energy decisions. We identified three further types of households within this type.

- Families with older children or teenagers.
- Couples.
- Some single occupant households with pets (where the pet was considered an occupant).

This section describes in further detail the defining characteristics of this type of households in relation to their needs and behaviours, and identifies where there is variation amongst the households within this group.

3.2.1 Needs
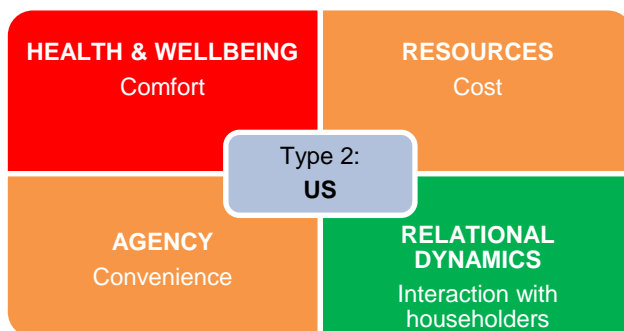
The needs of the household, as a single unit, are prioritised here. Unlike in Type 1 (YOU) households, individual householders' needs were relatively equal in priority in heating decision-making, rather than the needs of a particular individual taking precedence. Here, decisions were made on the basis of the *needs of the collective*.

This was particularly obvious when comparing households with very young children or infants with households with older children. In households with older children, who were more independent and required less attention from parents, the heat energy needs of the children had to compete on a more level playing field with the needs of others in the household and did not necessarily take precedence. In some cases, this was still through parental decision-making, though other households allowed some agency for children to be involved in the decision-making process. While the health and well-being of children certainly remained important, more divergent routines made meeting needs more complex, and fitting around a variety of weekday and weekend routine(s) became more important. Participants described needing children to be warm and comfortable enough, rather than a specific focus on their health. However, as household members were in and out at different times, these simpler needs could actually be more difficult to meet.

For this group, *comfort* remained a priority but was typically sought in the interest of maintaining household harmony, or to serve a particular set of *relational dynamics*. For this type, meeting the comfort needs of all householders was a means to an end (the end being a desired social dynamic), rather than purely an end in itself. There was also sometimes a greater focus on social interaction with those who were not household members, or providing a welcoming environment for guests.

In YOU type, needs such as cost and avoiding waste were quite peripheral; these *resource-related needs* could become core needs in some 'US' households. As a result of complex routines, properties were occupied more often than not, meaning that participants described having to heat the home continuously in the winter, particularly at weekends. As a result of this, they were very conscious of the costs of having to heat the home continually. In higher income households, some participants described themselves as resigned to leaving the heating on throughout the day. *Convenience* also featured, particularly in the context of multiple and sometimes competing requirements and routines in these households.

The need to save money or avoid waste tended to conflict with the need for convenience among this type, and it was rare for convenience to be sacrificed for resource-related needs. For the most part, it seemed that avoiding waste and cost efficiency were 'add-ons' and did not *eliminate* inefficient behaviours. The '*choice family'* household, discussed below, exemplifies this.

3.2.2 Decision-making and typical behaviour patterns

For the US type, decision-making was negotiated, but not always harmonious. We identified three dynamics in operation, which fed into different behaviours. In one, decision-making occurred *democratically*, and resulted in behaviours that found a compromise or middle-ground between the needs of all householders. In a second dynamic, decisions tended to be made *autocratically* by a dominant member of the household. This did not always serve the needs of all householders equally. Finally, decision-making could also be *conflict-ridden*, resulting in arguments (e.g. a husband and wife arguing over the temperature), inconsiderate behaviour (e.g. a teenager using all the hot water for a long shower, regardless of the needs of other householders) and sabotaging behaviours (e.g. a wife secretly putting heating on after dinner, husband and wife changing the temperature throughout the day to meet their own preferences, or a husband hiding a portable thermostat out of reach of his wife).

More generally, we identified a number of typical behaviours and strategies within these households, particularly those where the goal was achieving harmony in the home.

'Blanket solutions' (i.e. 'one size fits all', crude solutions), such as leaving the heating on constantly, was commonly the simple solution imposed by households where cost was not a constraint, as a means of implementing a heating solution that could work across the multiple, sometimes conflicting, routines of householders.

Some householders spoke of making long-term investments involving structural changes when costs and tenure were not constraints. For example, among households with older children, participants appeared to become aware that, as children get older, complex routines meant that it was difficult to heat the home in an efficient way using controls. Installing other efficiency measures such as insulation or double glazing could help to retain heat and improve the efficiency of the household if the heating had to be on constantly.

Alternatively, or in addition, and particularly where cost was a constraint, *ad hoc*, frequent engagement with technology and controls was evident. This included the use of timers, while also readily overriding these, or manual operation of heating, in a more *ad hoc* and responsive fashion, to cover a variety of routines and/or where routines were complex or unpredictable.

For example, the '*choice family'* case led busy lives and the need for convenience was key, along with ensuring the comfort of all to maintain a happy dynamic. Family members felt they worked hard and therefore had earned the right to be warm. The heating was on a timer: the timer settings were discussed and agreed upon as a family, and fitted around their daily routines. However, the timer was overridden a lot, and all householders (even the five-year-old) adjusted thermostats frequently, room by room, to cater to individual needs. For example, room temperature data for the child's bedroom indicated a stable 18 degrees, lower than the rest of the home. The participant explained that his youngest child had eczema, and the TRV in that room was switched off to ensure the room did not get too warm and aggravate the condition. TRVs in other bedrooms were adjusted by the individuals who occupied them. Data also indicated that the living room was the warmest, which the participant attributed to the TRV being set to maximum, as it is the most frequented room, and to respond to heat loss due to doors opening and closing frequently. Top-up, pre-emptive behaviours were used to

anticipate and respond to needs across multiple routines, despite ensuing inefficiencies; for example, the household turned on electric blankets ahead of going to bed, and set the timer for the heating to turn on an hour before children got home to ensure they came home to a warm house. Much of their active 'top-up' behaviour – for example, the use of plug-in heaters and convection heaters – was geared at extra comfort and cosiness, rather than a need for greater warmth per se. They were nonetheless keen to avoid waste, and had consequently installed cavity wall insulation.and experimented with different techniques (e.g. radiator foil). They also avoided solutions that they perceived to be overly costly to run (e.g. air conditioning). However, none of these measures came at the expense of convenience and comfort.

Zoning was also apparent amongst this type, and cut across approaches – allowing for individual preferences to be catered to (e.g. meeting the needs of household members with divergent temperature preferences) and for individual decision-making.

For example, the 'semi-retired couple' case prioritised their comfort above all else, and worked hard to negotiate a temperature that was comfortable for both. The husband controlled the heating system, but his wife felt the cold more than he did. Therefore, use of zoning to heat areas of the home that she occupied frequently was part of their regular heating routine. The husband also reported using zoning (turning off radiators in unused rooms) during winter, when the gas central heating was on constantly. However, temperature data for this property indicated a relatively consistent temperature across all rooms in the property. The participant expressed surprise when this was presented to him, and then accounted for it by explaining that he often forgot to turn off radiators after turning them on for a guest, and noting that he also insisted on keeping internal doors open, as he did not like to feel 'enclosed'.

The 'wealthy empty nesters' case was a retired couple with a medium income and regular, aligned routines. Similar routines meant that the heating system was set to a timer that followed the routines and was rarely interrupted. Warmth and comfort overrode any concerns about cost or waste, resulting in certain inefficient behaviours. For example, they tended to keep the heat on in rooms that were regularly unoccupied, as they wanted to avoid "a cold spot in the house ... to which warm air is drawn, you know, isn't it? Because cold air's heavy". Providing a welcoming, comfortable environment for visiting family and friends was important to this couple, reflected in pre-emptive behaviours. The participant observed that household patterns of heat energy use changed when receiving visits from grandchildren, to the extent that this would be noticeable in the monitored data we collected:

> "Now, we've got two young grandchildren up the street who come here on a very regular basis. So, with them coming here on and off on a daily basis, that the, their presence should probably show in the, in the figures. Probably show better in the winter because if they're popping in and out … we'll put the heating up if it's cold … I suppose with the baby only being, well, the little one only being three and, I don't know, they've always got colds and stuff...I'd better just keep them a little bit warmer, you know, just so that they're comfortable I think."

Household patterns of behaviour were also influenced by their pet cat; the participant was surprised to learn from the data how frequently they opened and closed the window to let the cat in and out.

3.3 Type 3: 'ME'

This included households where decision-making was made at the individual level, for and by the individual. Decision-making was relatively straightforward, as negotiation was neither sought nor required. These households contained independent and relatively active individuals and, in the case of multiple occupant households, those who did not make decisions as a household unit. We identified three types of households that fall into this category.

- Sharer households.
- Single occupant households.
- Busy professional couples or active retired couples who have relatively independent routines.

3.3.1 Needs
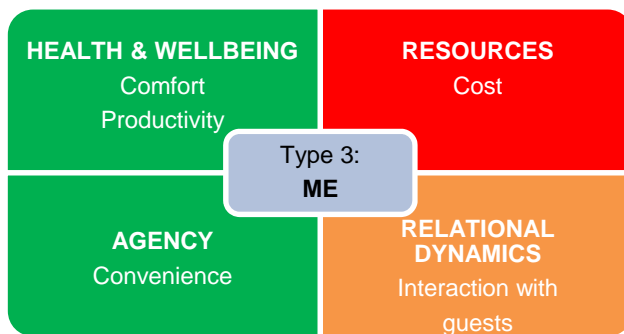
In these households, the needs of the individual were prioritised. Participants from these households described needs that were diverse, given that these were inherently individualised, but also because these households were typically able to consider needs that were peripheral to other types, such as convenience, productivity, or social interactions with guests, as decision-making was not complicated by the needs of others. While individual preference was key here, some commonalities were apparent in the priority needs among households in this type.

General comfort and 'cosiness' was emphasised over health for this type, except where specific health conditions were evident.

Productivity was also a priority for households in this type; this related to working from home (and needing warmth, particularly when inactive for long hours), needing to be warm when returning home from work in order to be productive the next day, and more generally to being active and productive during the day.

Convenience played more of a role than in other types; participants described more independent behaviour and more of a focus on the individual rather than the needs of the household as a unit. While convenience may have been overridden by other needs for the other household types, or may have been secondary, for some of these households, particularly single adult sharers, convenience was their main concern.

Resource-related needs (cost and waste) also came into play, but generally not if these meant sacrificing convenience.

Relational dynamics also featured, but – distinguishing this type from the previous type – here related primarily to interactions with guests rather than other household members.

Where household members had *specific health* conditions, this could severely override all other concerns and dominate behaviour, marking these households out from others in this type. This may also have coincided with needs for *control* – a very specific need related to the desire to have the property at a particular temperature out of a perception that this is most beneficial for health.

3.3.2 Decision-making and typical behaviours

Heating patterns and practices tended to be dependent on the routines of an individual, without reference to others. For this reason, decision-making was *the least negotiated* of the three types among these householders, and behaviours tended to be driven by individual lifestyle and routine, rather than attempting to bring in a solution that met a collective set of lifestyles and routines. What was interesting within this group was the ability to transition into a more negotiated position when the needs of others came into play – illustrated, for example, when guests came to visit in some of the examples below.

Behaviour was far more diverse and less predictable than the other two types, and this diversity is best illustrated through specific case study examples. The first three illustrate some of the more common sets of needs that drive behaviours within this type (comfort, convenience, productivity,

social interaction with guests) while the final case study illustrates how specific health conditions may become overriding.

The '*adult single sharers*' household comprised four single adults living in a flat-share, all of whom were high earners and worked full time. Household routines were transient, and none of the household members had fixed routines outside of standard working hours. Individuals were likely to be out on random evenings and for long periods of time at the weekends. There appeared to be little negotiation over the heating system, which was on a timer and overridden by all occupants to meet individual needs on a day-to-day basis, to accommodate work schedules (including working from home, on certain occasions, for some occupants) and social lives. Resource-related needs such as cost and waste appeared to be superseded by the need for convenience: the desire to have the home at a comfortable temperature when occupied, combined with highly variable schedules and occupancy patterns, led householders to choose the more convenient option of keeping the heating on at all times, and having hot water on demand, despite inefficiencies (e.g. home often heated when unoccupied). The bathroom window was left open (even when heating was on) or alternatively closed (even when high humidity levels indicating showering) for days at a time. The participant revealed that this was because it was kept open with a chopstick, which made it difficult to open and close, and therefore easier to leave open or closed for long periods.

In the '*high-earning busy couple*' household, both occupants worked full time. The primary participant usually worked long hours from home, in the living area, while his wife usually worked abroad for several weeks or months at a time. In this household, needs centred on providing a comfortable and productive working space for the primary participant. When his wife was present, the dynamic shifted, and more negotiation took place, as they had very different temperature preferences. They enjoyed entertaining guests, and had regular visitors once a month, who might stay overnight. When both householders were away for work, family members (usually an aunt and uncle) stayed over, particularly on weekends, meaning the flat was usually occupied.

A different illustration was provided by the '*social single*' household, (a single occupant with regular routines). Although she was retired, she maintained an active lifestyle, and her heating patterns and practices were organised around her regular visits to the gym and the pub (both important social activities for her), and the two days she looked after her grandchildren at her daughter's home. This meant that a constant proportion of her energy use was displaced from her home to other settings. Although she had a constant supply of heating through a communal system, and cost was not a concern because she paid a fixed weekly fee, she did not believe in wasting energy 'just for the sake of it' while her home was unoccupied. She lived alone, and kept the flat at a temperature that suited her personal preference. However, she did turn the heating off when her grandchildren visited, as it was too hot for their liking. Opportunities to socialise were important to this participant; she spent a lot of time in the kitchen during the day as it faced a public square, where she sat and smoked, and socialised with neighbours as they passed by. She kept the kitchen window open all the time that she was at home because the flat was consistently too warm, and to let out the smoke.

The '*limited mobility*' household included a single occupant with complex needs relating to a physical health condition. This case marked a break from the more common concerns, relating to productivity and social interactions, discussed in relation to other households that fall within this type.

The occupant attributed many of his behaviours to health- and comfort-related needs and, linked with these, the need for control. Temperature data collected from the property suggested that it was higher than average, likely due to solar gains and particularities of the communal heating system – which was problematic for the occupant, who suffered from overheating due to the medication he took. The data indicated that his bedroom was the coolest room in the house, which was deliberate on his part, as he spent the majority of the day in this room. He used black-out curtains as he preferred a dark room to a bright room (corroborated by the monitoring data, which indicated low luminance), and used fans and opened the window to cool down when he took his medication. He found the cool blast of air they provided more suited to helping cool down his body temperature, in addition to keeping the thermostat on low.

"There's um, a thermostat on the end of each radiator.... And me bedroom, well I usually leave it on low, one, because all the tablets I take, it causes masses sweating. So…even though the heating is on, I've still got the fan going, or the heating's off but the fan is still going … I use the fan to cool me down, not cool the bedroom down."

The bathroom sensors indicated higher vapour pressure excesses in this room than in the rest of the home: this is likely due to the fact that he tended to dry his clothes there (this was day-to-day behaviour, as he had to wash clothes regularly for reasons related to his medical condition). He also kept the radiator in the bathroom on the highest setting, to counteract the cold air coming in from the window, and to ensure that clothes dried quickly. Although he lived alone, the occupant had personal assistants who were regularly in the flat on a day to day basis, and who occasionally stayed overnight if his health conditions were aggravated. Zoning was used as a way to ensure that the spaces he occupied were suited to his needs, and he allowed visitors to regulate the areas they occupied according to their individual preferences.

3.4 Summing up: Typology features and limitations

The value of this decision-making typology is that it offers the following.

- *A household-level account*: this typology can take into account the social dynamics and negotiation that inevitably influence decision-making, and give insight into how the needs of multiple individuals play out at the household level, and the patterns of behaviour and energy use that arise from this.

- *A needs-driven account*: while centred on decision-making types, these decisions are driven by household needs: each decision-making type is driven by a different prioritisation of the four needs and has a different way of prioritising individual householders' needs.

- *Links needs to behaviours*: the model enables us to connect needs to patterns of behaviour, a critical component of the research aims.

- *Dynamic response*: the typology can account for transition and change – allowing for households to move between categories across the life-course (e.g. as an infant grows up and becomes more independent, a household could move from 'YOU' to 'US') as well as day-to-day (e.g. a household might move from 'ME' to 'US' if guests arrive, and social interactions with guests are a salient need).

While this typology can account for typical *patterns* of behaviour that may feature in a given household, specific behaviours are influenced by additional factors, discussed in the next chapter. These additional factors should be seen as a complement to the household-level typology, together creating a broader explanatory framework.

4. Understanding specific behaviours in context

Having described how needs and household composition broadly configure patterns of decision-making and behaviour, this chapter introduces a range of other factors that constrain and enable what people can actually do in practice. While the typology outlined in the previous chapter is the foundation for understanding and explaining heat energy behaviour, it is not the final piece of the jigsaw. Households may have an 'ideal' approach to heating their home but, in practice, decision-making and behaviour are typically complex and unpredictable. A diverse range of other factors enable or constrain the possible behaviours through which priority needs can be met, as well as triggering breaks in routines or atypical behaviour.

We identified three sets of these enabling and constraining factors: **People factors** relate to the circumstances or characteristics of an individual or multiple individuals in the household. **Property factors** relate to the physical nature of the home including the heating system and other building services. Another set of **wider external factors** includes regulatory requirements, energy prices and the weather.
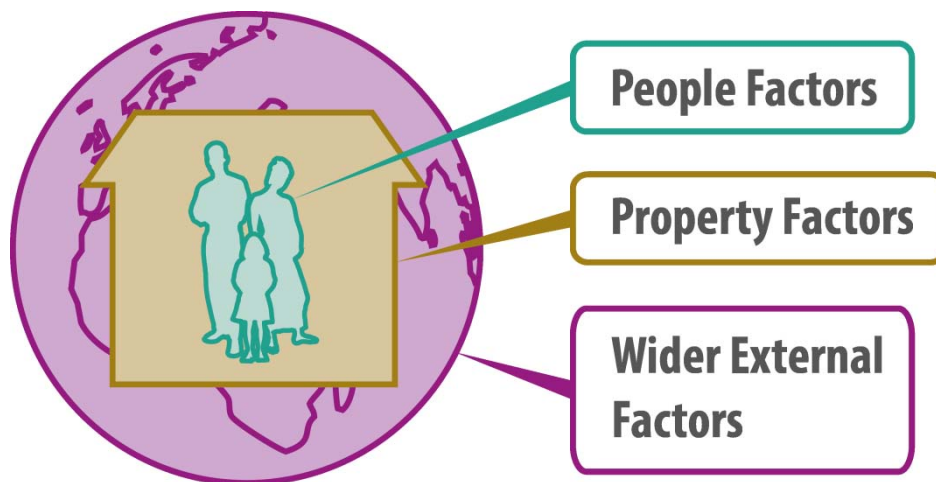

Figure 9. Enabling and constraining factors

In addition to describing each factor in turn it is important to show how these factors interact in the context of the households they affect. This can best be done through the case illustrations from our sample of households, referred to in text and in text boxes in the following sections.

4.1 People factors

People factors relate to the circumstances or characteristics of an individual or multiple individuals in the household. As demonstrated by our typology of decision-making, households are made up of individuals whose circumstances and characteristics might come into conflict. These people factors therefore play out differently in different households. Participants described and displayed five sets of factors here.

- Personal preferences
- Values and attitudes
- Knowledge and beliefs
- Tenure and income
- Meaning of home

People's *personal preferences* were a prominent factor influencing behaviour. These preferences were developed through a range of formative experiences and learned behaviours that had become habitual.

Formative experiences were identified by participants who described their experiences of home as a child or previous properties they had lived in as influencing their temperature preferences in different ways. Growing up in a warm home led people to keep temperatures warm in their own home to evoke childhood memories or because they equated warmth with comfort and protection. Alternatively experiences of a cold home could mean people preferred a cooler temperature or reacted against this experience in the way they heated their own home.

> **A cosy or cold childhood**
>
> The **high-earning couple** were both brought up in a warm home and were keen to recreate this atmosphere. However, this was constrained by the suitability of their *heating system*. They were unable to keep the home as warm as they would like when it was occupied owing to their heating system being unresponsive.
>
> The **semi-retired working couple** felt differently and thought that this represented generational differences. They were used to cold homes when they were younger and would just put a jumper if they were cold, though they were sure their children would not do the same.

"I think when you come in from the cold, you don't want to come into a cold house, you - you like to come in, get a bit of comfort when you come in and be nice and warm … I think because I grew up like that, with, you know, ice on the inside of the house and mould again, no I wouldn't, I wouldn't go back to that."

Acute examples of formative experiences were described by participants who grew up in, or had lived large parts of their life in, other countries and climates. People spoke of heat preferences being dependent on these factors in some cases, with those from warmer climates saying they heated to higher temperatures, wore more layers of clothing and felt the cold more. For example, one participant mentioned keeping her home very warm because she had originally lived in warmer climates, in the Congo and Nigeria.

Participants also described a range of *learned behaviours* that had become habitual. These related in large part to opening windows at night or when people returned to the home. It could be difficult for participants to explain exactly why they engaged in this kind of habitual behaviour.

> *"…[opening the window] it's probably a mental thing but if I know the window is closed I don't sleep very well…even if I just get up and push it even only an inch at least I know it's open and I can settle off. I've always slept in a room with a window open, being a little boy and I know that 'cause my mum used to tell me."*

In other cases, participants were unaware that they kept the window open at certain times. One participant did not think that she opened the living room window at all, which was the case typically, but the monitoring data revealed that it was open during the day while the heating was also on.

> *"...because I was cleaning…'cause you get warm. I open the window."*

These behaviours often typically met short-term needs that were not necessarily a priority, such as fresh air or ambience, but they did not influence core patterns of heating behaviour. Furthermore, where personal preferences clashed, negotiation was required, for example during the night where people slept in the same room.

> *"So I sleep on the window side, because I like to be in a warm bed in a cold room, whereas my wife just likes to be really, really warm. If she slept near the window then she'd be too cold. So she's on her side, and she's got another one of these heated blankets underneath her side of the bed, whereas I've got the window open a crack to let cool air in so that I won't get really, really hot."*

Some participants voiced awareness that habitualised behaviours could lead to inefficiencies.

> *"I think if you're not careful you can just sort of, it can become really sort of habit forming and you tend to sort of rely on it and in actual fact we would normally have the heating set to maybe come on to say 20 degrees in the morning; well hang on a minute, you know, it's 19 degrees anyway so why are we bothering to pump it up that extra one degree, do you know what I mean?"*

The second set of factors influencing behaviour was holding particular *values or attitudes*. While values tend to be stable over long periods of time and across different contexts and behaviours, and so form more deeply held needs, attitudes tend to be more behaviour- and context-specific. For some participants, the principle of avoiding waste, discussed in Chapter 2 as a need, was described as influencing some specific behaviours rather than overall routines. Notably, this included closing

windows and doors to keep heat in a particular room and using TRVs to keep the heating off in unoccupied rooms.

There was also a view amongst some participants that they had earned a certain level of comfort, and while they would not waste heat energy they would not go without.

> *"I feel like I'm working during the week and it's nice just to, without being wasteful or without, you know, without being silly it's nice just to feel comfortable in your own home."*

> *"I'm getting too long in the tooth to be sitting around freezing, you know, I don't smoke, I don't drink to excess, I don't drive a BMW but I do like to be able to sit around in shirt sleeves."*

The qualitative workshops also provided a wealth of data on *knowledge and beliefs,* the third set of people factors identified. These related to how well informed people felt they were to heat their own home effectively as well as beliefs about how to do this (picked up from a range of sources), which in some cases led to specific behaviours or 'workarounds' to meet household needs in complicated ways. In the workshops people described turning to hot drinks when the weather was cold or in some cases alcohol to keep warm – though it was noted in some cases that this was merely a perception of warmth.

Other beliefs were formed by participants who described receiving and, in some cases, acting upon advice and guidance from friends, family and more formal sources. For example, participants described using information on effective use of boiler controls that they had received from the energy supplier. One participant mentioned that they had installed reflective foil behind a few radiators, after receiving it as part of an energy saving campaign. Health care professionals also provided advice in relation to specific to health conditions and remaining healthy while pregnant. One participant described how she had opened the window of the room of her recently born child on advice from a midwife. Participants also described a range of less formal sources of information that had affected their behaviour. A seemingly common cause of confusion is about the most efficient way to heat the home in cold weather. Participants expressed uncertainty around whether turning the heating on and off as needed was more efficient than keeping it constantly at a low temperature. Some questioned whether it was more cost-effective to heat only occupied rooms (and turn off radiators in unoccupied rooms), or whether they paid the same for central heating when it was switched on regardless of the number of rooms heated. There was frustration at the lack of authoritative guidance on this.

The fourth set of people factors related to *tenure and income*. While these may appear to be two different things, in practice the way tenure and household income enabled or constrained behaviour consistently overlapped. In reality it was difficult to understand the influence of both these things in isolation, and tenure appeared to be driven largely by income (though other factors were of course influential too). Tenure and income had practical implications and also affected the relationship people had with, and the *meaning they attached to*, the home. Firstly, it affected the extent to which participants were able to replace or improve heating systems or certain property characteristics. How this worked in practice, however, was not straightforward. Those who owned their own homes and had a higher income or better access to capital were able to embark on some of the renovations or installations described in Chapter 2. For families with complex routines, improving the efficiency through structural changes was sometimes seen as a long-term solution to meeting complex needs.

> **Mixed experiences of renters**
>
> The **Social Single** lives in a modern socially rented block with a heating system that consistently meets her needs – if anything, cooling is her only concern. Other social renters follow the advice of housing providers to keep windows open to remove condensation and avoid worsening damp.
>
> Private renters can face similar problems with landlords. The **Child-Focused Family** has poor insulation and some radiators that don't work. Even when the heating is on they feel they are losing warmth. They resort to putting the heating on more often and using the fire, particularly with a second child on the way, to protect the health of both mother and unborn child.

Private and social renters were more restricted in the options open to them. Private renters on a higher income were concerned about this where they did not see their current property as a long-term

home. They also found it difficult to convince landlords to improve properties in relation to heat energy. In particular, participants spoke about landlords trying to find cheap and short-cut solutions to problems like damp. A family with a small child had to keep the windows open even when the heating was on and felt frustrated that they were losing money.

> *"[Do you have the heating on too?] Yeah and the windows open, I have to. That's what the housing [association] have told me to do…Why should I put the heating on and open windows?"*

Renters in older, poorly insulated properties and on low incomes faced the most restrictive arrangement. This was because their tenure meant that moving home was not entirely within their control, but neither was improving the energy efficiency of their home or the responsiveness of their heating system. Households on a low income and with a poorly performing system were forced to adopt a range of secondary heating behaviours, such as extensive heating of the person or using fan heaters to keep warm in very cold weather. However, it was also the case that social renters benefited from the requirement placed on their housing provider to ensure certain levels of efficiency and warmth.

The final people factor identified was the *meaning of home*. The way that participants described the meaning of home appeared to influence specific behaviours. While this suggests that it is, at least in part, a sub-set of attitudes, it is included as a separate factor here because it relates directly to other factors influencing behaviour, in particular tenure, which had an influence over but was separate from how participants described the meaning of home.

Two distinct meanings of home were identified. Firstly, the home served as the functional place to eat, sleep and keep warm for some participants. These households gave less consideration to the look and feel of their home. Alternatively, home was understood more symbolically by other participants as a place that represented freedom and control and as a source of comfort, belonging for self and others, and pride. For example, one participant worked as a builder, and spent much of his working life outdoors, where he had no control over the temperature. When he came home, he wanted to be in control of his environment, which he felt should meet his needs for comfort. This translated into behaviours such as having the heating on to allow him to wear shorts and a t-shirt, which he preferred over layering up with clothing (which he was forced to do when working outdoors). He also had the heating on a timer that came on before the family got home, to allow them to return to a warm home (although he liked to put the heat on by overriding the timer when he was unable to work during adverse weather). He also focused on creating a welcoming and comforting space for visitors, seeing it as 'good manners' to make guest comfortable.

4.2 Property factors

As noted in the introduction, much previous research focuses exclusively on the influence that physical characteristics of a property and heating system have on domestic heat consumption. This section of the report integrates these important factors within our broader framework.
Two broad property factors were identified that affected the behaviour of all members of the household in a similar fashion.

- Property characteristics
- Characteristics of heating systems

Participants described how a range of *property characteristics* constrained and enabled certain behaviours, reflecting the diversity of property types included in our achieved sample. Households varied in the extent to which they were able to do anything about these constraints.

First, fixed characteristics such as the age and location of the property were influential. The age of the property placed certain restrictions on what participants could do in relation to insulation, or which features they could replace. In one case, participants could not change their windows owing to the home being Grade II listed.

> *"They're not easy to open and close these windows. They're stiff and...So I'd have double-glazing to stop that [heat] from going out of there. It would be really, really good to have it to stop the sound."*

Where the property was located could also impose restrictions. For example, participants described refraining from opening windows because of noise where they lived by a road or in a city centre, or due to safety concerns where young children lived in high-rise blocks.

A second set of characteristics of the property were fixed for some participants and variable for others. Most notably, the size of a property was an issue. In particular, large (often also older) homes were described as very difficult to heat, particularly where two different structures had been joined together. Small properties also provided challenges. For example, participants described a lack of outside space as a problem for being able to dry clothes in a way that was not '*an eyesore'* or did not require them to have the heating on when they otherwise would not.

Too big, too small

In the **multi-generational household**, meeting needs would always be a challenge. But this is made more difficult by the nature of the property. It comprises two old houses joined together and operating different heating systems. The owner knowingly spends a lot of time and money engaging in inefficient, wasteful behaviour to meet needs.

The **child-focused family** would welcome some extra space to allow variation in temperature between rooms. The father is often too warm and his needs are sacrificed in favour of those of the child and expectant mother.

Where households were able to change the size of the area they heated, they made structural changes to 'zone' their heating more effectively, for example keeping part of the home that was a recent extension warm or cool to meet the distinct needs of an individual household member. One participant described, for example, how they had converted their garage to an office which they could keep cool when working at home, while leaving the heating on in the rest of the house.

"No, there is heating but the office is a cool, you can get a draft coming through the office, so if I open the office door."

Finally, there were also characteristics of the property that were not necessarily fixed, but whether householders could make changes to them depended more on 'people factors' such as cost or tenure, discussed previously, than any other restrictions. These include the property being poorly insulated, having no ventilation system or ventilation that no longer functioned properly. Where cost or tenure prevented household from replacing these systems, participants adopted a number of more *ad hoc*

solutions. For example, in the '*fuel poor single occupant'* household, the participant lived in a dilapidated local authority property that was scheduled for demolition. He put newspapers and towels in the window-frame to prevent draughts. However, it was difficult for him to open the windows, and he had to repeat the procedure if he did, so he tended not to open the windows.

The second set of property factors related to the influence of the characteristics and capability of *heating systems*. There is extensive existing research on the interaction of consumers with their heating systems; here we focus on examples from our sample of households that help explain the role of heating systems in our overarching explanatory framework. First, those off the gas grid were constrained in terms of the type of system they were able to install. Second, the systems participants did have in place varied in terms of meeting needs related to responsiveness and levels of control. Storage heaters were not always responsive enough to respond to flexibility and variety in household routines.

"If I had my choice really I wouldn't have storage heaters because they're not um, what's the word, they're not as flexible as say central heating, kind of once you've got the heat it's there. You can't turn it off, you know."

Some participants came up with strategies to make do nonetheless. For example, participants on shift work utilised a range of secondary heating solutions at different times of the day when their property was not well served by storage heaters, and to make use of the heating being on while they were out.

"Because the storage heaters do nothing at all, apart from heat up in the morning, we utilise that heat by drying the clothing. That's the only thing we can use it for, because we're both out in the mornings."

Others simply used alternative heating sources to substitute for storage heaters.

"If I just wanted a little bit of warmth for maybe an hour then maybe I would use that [electric convection heater] in the bedroom .... The storage heater would take so long to get to a decent temperature I might just use that because it's instant."

Participants suffered from a lack of control in some district heating systems, unable to turn heating on and off as required, leading to a perception that they were wasting energy. These participants complained about a lack of responsiveness in the system (and whoever was in control of adjusting the system) to their specific household needs, particularly at times when external temperatures fluctuated noticeably, feeling that decisions were out of their hands.

> *"It's really slow to react, and whoever's doing it is obviously not very quick to react either. Yeah, so we're completely at the mercy of whoever it is who's got that switch … It comes on too soon or goes off too late, and we might have something where all of a sudden it will be unseasonably warm, and then it'll get really, really cold, and they're really bad at reacting to that."*

This was typically with older systems; communal heating on newer properties did provide some level of control.

> *"…radiators are, they're your thermostats there, so you can turn that up and down, or off, as you please…in the winter when it's really cold outside, then if I'm only going shopping into town, then I will leave the heating on. It will be on in the living room, it will be on in the bathroom, those are the only two rooms where I would keep it on, for it to be warm for when I walk back in."*

To some degree, lack of control was also related to lack of knowledge and information on how to use controls and timers effectively. One participant explained that she had been given a leaflet explaining how to control the storage heaters in her home.

> *"although it does explain how to get the boost, it doesn't actually mention that clock on the wall and, and the reasons for it."*

> *"It [the heating] doesn't come on on a timer so the only thing we have on a timer is the water so the water'll come on about an hour before we get up… we're not too sure how it [the heating timer] works … [My partner] does all the timing stuff, I don't and we've decided that it's a lot easier to do it for the water than it is for the heater. It can only be one or the other; it's not clever enough to do both, so, so yeah, I can just about sort the timer out."*

4.3 Wider external factors

Participants also described how a number of factors external to them as an individual and to the household affected their behaviour. Three such factors were identified.

- Regulatory requirements
- Energy prices
- Weather

Regulatory requirements (e.g. Building Regulations and planning requirements) influenced behaviours in two ways. Firstly, regulations imposed certain standards or requirements on those renovating their homes. This typically meant that improvements were made to the energy efficiency of the home and households were more able to meet their needs. For example, one participant described a renovation that they had embarked on primarily for more space, but that had improved the insulation of parts of the house. Alternatively, regulations can also constrain behaviour. Sometimes related to the age of the property, participants described how regulations restricted the structural changes participants were able to make to meet their heat energy needs. Listed properties presented particular problems with participants explaining how they were unable to replace their windows to improve insulation or avoid problems with condensation and damp. There was also a view from some participants that the regulations governing their building had the effect that they had to keep their home within certain temperatures. Such requirements may alternatively be thought of as representing a need – a need to follow the regulations.

(Rising) *energy prices* also featured in participants' accounts. This was particularly apparent in workshop discussions. Some reported that the first thing that came to mind when we introduced the topic of heat energy was the cost of their heating bills. One participant maintained that "people are not managing, people are struggling all over the country", and people spoke of difficult choices facing their families, such as 'heat or eat'; one participant even expressed the view that people were keeping families smaller, as energy is so costly. In one workshop discussion, the consensus among the group was that they would heat 3-4 times as much if heat energy was less expensive. Tensions due to rising energy prices at a time when wages remained frozen were apparent: one person mentioned that he

hadn't noticed the cost of energy in previous times, but was now more conscious of it, with costs rising and not being matched by rises in income, while another mentioned turning off the heating earlier than in previous years because lower wages meant the household was unable to keep up with the cost of heat energy. People mentioned considering options such as insulation, and turning to price comparison websites as a response to rising energy prices.

For example, in the '*fuel poor single occupant'* household, the occupant intentionally spent time in the library and at friends' homes to keep warm, without footing the bill. He would also go out for walks to stay warm.

> *"I used to go to the library and work in there and enjoy their heating for free. Instead of staying home, turning the heating on and [eating into] my credit on my meter, then decide to go out."*

His heating behaviour and use is also illustrative: he only turned on the gas central heating as a last resort, and tended to rely on jumpers and heavy coats to keep warm. He also took showers to warm up, along with placing feet in warm water on colder evenings, and having a cup of tea. He purposely tried to stay in one room when at home, usually the bedroom, and relied on an electric blanket for extra warmth there.

Finally, the *weather* was also unsurprisingly an influencing factor. Seasonal changes in routine behaviours were apparent.

> *"In the winter I would have these doors shut so that one or two rooms that we are in, mainly live in are kept at a higher temperature I think as I said to you last time but in the summertime you don't need to worry about that, you just simply let the warm air circulate through the whole house … It's common sense I think. You don't want to dissipate your heat in the wintertime from the, what rooms that you want to keep warm; where you're working, where you're sitting. You just keep them warmer and you try to prevent heat escaping from those rooms."*

> *"We'll open the windows more frequently and keep them open longer if it gets warmer … The warmer it gets we'll just open the windows and just let the fresh air into the house … it's just reacting to the weather out there so if it's bright and sunny then we'll open them."*

Beyond the obvious responses to seasonal changes in relation to behavioural patterns, extreme cold prompted specific behaviour. Participants described responding to outside conditions sometimes to disrupt their overall heating routines, and also to change the temperature or leave heating on a little longer. There was a sense amongst participants that colder winters meant they heated their homes to a higher temperature to compensate for the cold outside.

Participants mentioned generally thinking more about, or being more conscious of, their comfort during very cold weather. Their accounts also referenced more frequent 'top-up' behaviours and use of secondary heating sources. For example, in one household, the entire family wore thermal clothing in the home in winter, even when the heating was on. Other examples included the use of electric blankets, putting feet in a bowl of warm water and having a cup of tea in particularly cold weather, and the use of a 'dry buddy' (electrical heating device designed to dry clothes quickly) as a heater for the living room on particularly cold mornings.

Some homes may be more exposed to the elements, and this might come into play in behaviours. For example, one household lived in an end-of-terrace property, and complained of feeling the cold in the kitchen in the early mornings 'especially when you get that wind blowing this way'. However, being exposed to the elements also means that the property benefits from radiant heat: the room warms up as the sun rises.

5. Conclusion

In the concluding chapter, we draw out a high-level summary of substantive and methodological insights and lessons learned, and identify priority areas for further research and activity within the Consumer Response and Behaviour project, the SSH programme and beyond.

5.1 Substantive insights

This report has documented the range and diversity of heat energy needs and behaviour of domestic consumers in the UK. Drawing on evidence collected through a multi-faceted project of primary consumer research, it has also presented an emerging explanatory framework, depicted in Figure 10, for understanding why consumers behave as they do, and how and why these needs and behaviours vary across the population.
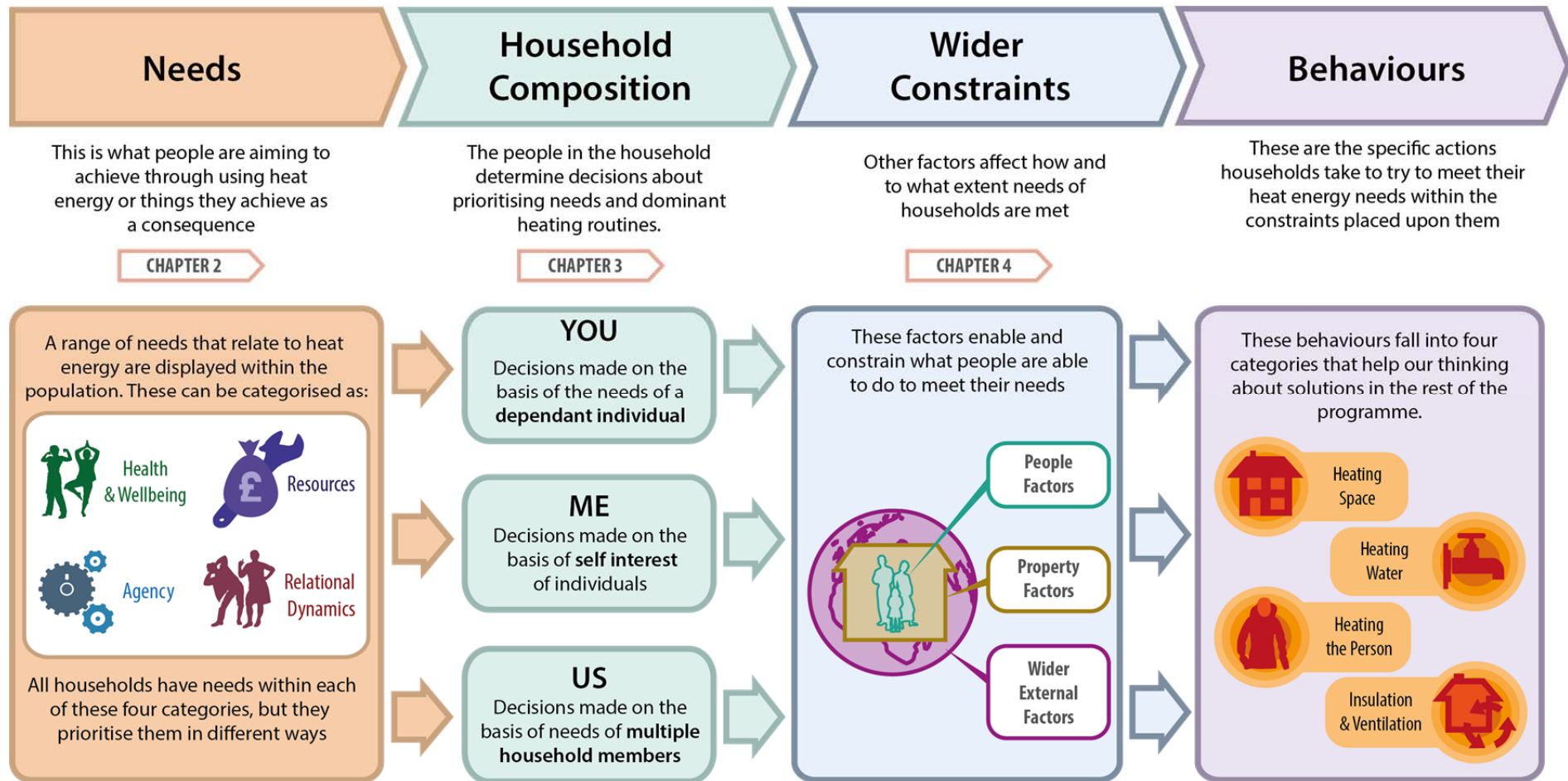
Figure 10. Overview of explanatory framework

This study represents one of the first systematic attempts to understand heat energy behaviour in terms of what consumers are trying to achieve. For the purposes of this report, therefore, we adopted a broad definition of needs. Heat energy needs are understood here as what people are aiming to achieve through using heat energy or things they achieve as a consequence of using heat energy. We recognise that there is variation in how the concept of needs is understood in different disciplines and have deliberately avoided adopting a narrow view of needs. Instead we feel it is most helpful to start with this broad, non-academic understanding as a helpful initial lens to understand heat energy behaviour.

Because our definition is broad, it incorporates a wide range of needs, from those that are objectively "essential for life" to preferences based on individual perceived requirements or values. Needs may also be addressed as high level "purposes" for a home (e.g. having a healthy, comfortable life, maintaining cleanliness, or caring for a family) or as relating to very specific targets, such as aiming to control mould or damp or drying clothes.

The report began by presenting a new thematic categorisation of needs that people seek to meet through the use of heat energy. This categorisation emerged from our research with a diverse sample of the general public. The final categories are the result of an analytical process where needs that are similar are grouped together and given an appropriate label. Our aim here is to make it easier to comprehend the full diversity and complexity of needs that exist within the general population and select categories that help us understand why households have different priorities. The four categories of needs are as follows.

- *Health and wellbeing*: A diverse category of needs described as fundamental by participants. Broadly, the needs in this category relate to specific health concerns (e.g. having a hot bath to ease arthritic pain) or general wellbeing, which spanned comfort (e.g. using a blanket to feel cosy while watching TV, or having the heating on to be able to walk around in the comfort of shorts and a t-shirt in the home), keeping clean (e.g. having a shower, as it is seen as more hygienic than a bath), relaxation and invigoration (e.g. having a shower to wake up, or a bath to relax and unwind), avoiding harm (e.g. keeping windows closed to avoid children falling out, or intruders entering), and ambience and aesthetics (e.g. lighting a fire to enjoy the glow).

- *Resources*: Resource-related needs relate to finances (e.g. going out for a long walk to warm up rather than turning the heating on to save on energy costs), waste (e.g. wearing an extra layer of clothing, rather than turning up the heating, to avoid unnecessary use of energy) and property maintenance (e.g. heating empty rooms to avoid damp and mould, or leaving the heating on a low setting to avoid the risk of burst pipes). Finance-related needs tended to be driven by the desire to save money, while avoiding waste (which resulted in similar strategies) was driven more generally by the principle of being efficient with energy use, with cost savings a welcome consequence rather than driver of behaviour.

- *Agency*: This is a term that has different meanings in different contexts, but in this categorisation, agency refers to the capacity and willingness of a person to act independently and make choices. This includes both purposeful, goal-directed behaviour and unconscious, involuntary behaviour. Needs considered under agency include control (e.g. using TRVs and/or timers to feel in control of energy use), routine and habit (e.g. adjusting the timer to align with household routines, or using a hot water bottle in summer, out of habit) and convenience (e.g. saving time by using radiators or tumble dryers to dry clothes, or having the heating on at all times or controlled by a timer, to avoid the effort of thinking about it). All of these relate to a desire to be actively in control of heat energy use within the home and the effort people are willing to put in often to meet personal or household requirements and preferences.

- *Relational dynamics*: This category of needs focuses on the social relationship between the individual or household and others, including the wider world. These needs operate at various levels: self-image and social acceptance (e.g. keeping the home at a high temperature, to ensure children are warm at all times, because this is part of being a 'good mother'); social interactions with household members and guests (e.g. turning the heating up before guests visit, to avoid being seen as 'tight', or lighting a fire to serve as a focal point for social interactions); social interactions beyond the home (e.g. having a shower to be hygienic, to aid social acceptance in the workplace); and the wider implications of energy use. The last point relates to the link between domestic energy consumption and its potential impact on the wider community, society or environment. In

many ways, this is a 'hidden' need, not featuring in discussions or showing itself in behaviour. Nevertheless, the reasons why it was generally not salient to different groups of people are important, and these are explored within the report.

Of these categories, health and well-being and resources appear to be more fundamental and tangible and, as categories, very intuitive. Agency and relational dynamics have been more difficult to define and demand further exploration. Consumer Response and Behaviour will continue to refine the categories of needs, in particular to provide clearer implications for possible solutions.

When describing these categories in more detail, Chapter 2 identified a wide range of ways in which each of the needs feature in participants' accounts, while linking these to a range of behaviours (which are considered in terms of space heating, water heating, heating the person, ventilation and insulation) and technologies through which they address the needs.

Table 11. provides an illustrative representation of needs and behaviours in interaction. As the table shows, a given need may be met through a range of behaviours and technologies, while a given behaviour might be used to meet a range of needs.

Behaviours → / Needs ↓	Heat space	Heat water	Heat the person	Ventilation & insulation
Health & Wellbeing	E.g. Keeping the heat on to avoid damp for health and aesthetic reasons	E.g. Having a shower, rather than bath, to invigorate oneself and aid productivity	E.g. Using a hot water bottle or heat pack to lift mood during illness	E.g. Keeping windows closed to avoid children falling out
Resources	E.g. Turning off central heating while using the oven to cook to save money and avoid waste	E.g. Using boiled water from pans heated over the stove or in kettles rather than re-heating storage heaters, to save money	E.g. Exercising or wearing an extra layer of clothing, rather than turning the heat on/up	E.g. Use of extract fans to reduce moisture levels and prevent damp or mould
Agency	E.g. Having the heating set on a timer, to avoid the effort of thinking about it	E.g. Having showers rather than baths because these are quicker	E.g. Walking around in shorts with the heat on high, rather than wearing layers of clothes in the home, because this creates a sense of choice and control	E.g. Sleeping with the bedroom window open at night, because that is what s/he did as a child
Relational Dynamics	E.g. Turning the heat up before guests arrive, to avoid appearing 'tight'	E.g. Using the hot tub to socialise with guests	E.g. Using an electric blanket or extra blanket at night, when a partner prefers a cooler bedroom	E.g. Installing efficiency measures such as insulation to retain heat, as justification for keeping the heat on all the time in a busy family

Table 11. Needs and behaviours in interaction

Our analysis indicated that, to some extent, all households display needs in each of these four categories and all could potentially have an influence on behaviour. However, in practice, the influence they have over behaviour varies among households, as outlined in Chapter 3. This is because different households prioritise needs in different ways, in response to factors that are particular to their circumstances. These factors include the presence of a dependant in the household, household unity (that is, the extent to which the household operates and perceives itself as a unit) and the complexity of household routines.

Based on which of these factors are in operation, any given household can be classified as one of three 'types', each characterised by a distinct combination and prioritisation of the four needs categories. This is useful for identifying the reasons for different types of behaviour, both between

different types of households or within the same household at different times (of the day or year). The typology defines the typical way households make decisions and determine their routine patterns of heat energy behaviour:

- *YOU* – decisions made on the basis of the needs of a dependent individual;
- *US* – decisions made on the basis of needs of multiple household members;
- *ME* – decisions made on the basis of the self-interest of individuals.

The typology serves to illustrate high-level patterns of behaviour and makes it easier to understand the complexity of household needs and behaviour. It can take into account the social dynamics and negotiation that inevitably influence decision-making, and give insight into how the needs of multiple individuals play out at the household level, and the patterns of behaviour and energy use that arise from this. The typology also enables us to connect needs to patterns of behaviour, and can account for transition and change: a household does not necessarily belong to a fixed type; it can vary by time of day, year or life, depending on, for example, who is at home, and the changing characteristics and needs of the people who make up the household.

However, the typology does not explain every specific element of behaviour within a given household. Chapter 4 described another set of factors that come into play at this point to further constrain or enable what people can actually do to meet their needs and the extent to which they are able to meet them. These are cross-cutting factors that could potentially affect any household, relating to people (e.g. personal preference, knowledge and beliefs); the property (e.g. energy system and property characteristics, tenure, and finances); and the wider external environment (e.g. regulations, energy prices and weather). These additional factors should be seen as complementary to the household-level typology, together creating a broader explanatory framework.

To sum up, all households have needs from each of our four categories, but who is in the household determines which needs are most important. A range of wider characteristics of that household then constrain how it can behave to meet these needs. Our understanding of this is currently best illustrated through the explanatory framework (see Figure 1) which represents this multi-staged process, whereby each stage further focuses and refines decision-making and behaviour. In practice, of course, decision-making and behaviour do not take place in such a staged way and individuals are not necessarily conscious of a process. However, the value of the framework is that:

- it provides an addition to the literature on understanding heat energy behaviour by taking needs as its starting point;
- helps our understanding of different behaviours and decision-making in different households;
- while still taking into account wider constraining factors; and
- mapping an existing technical categorisation of behaviour back on to what people are actually trying to achieve to try and bridge the gap between a needs-based understanding and building- or technical based model.

It can also be used by other work packages to identify where efforts should be focused to design and implement smart energy systems in a way that is informed by a detailed understanding of the needs and priorities of different types of household.

The framework we have developed here is a work in progress: it is not a predictive model or a definitive explanatory account. It is a means of summarising and synthesising current findings, and will be tested, refined and enriched through the second phase of primary consumer research, through both qualitative and quantitative components, and the incorporation of further findings from the Consumer Response and Behaviour literature review.

5.2 Methodological insights

The research aims presented the team with a number of challenges. Above all, we needed to be able to engage people in reflecting critically on behaviours that are highly habituated, and embedded in daily routines, and therefore are not in the front of mind. For this reason, and others, there may be a disconnection between reported and actual behaviour.

The in-home monitoring was geared towards addressing this challenge. Monitoring equipment measuring temperature, humidity, light, motion, electricity consumption, carbon dioxide, and window and external door opening was installed in 30 participating households. Data analysis produced a bespoke set of information for each household including heating and occupancy patterns, ventilation behaviours, cooking and washing, and wasted energy; this was shared with participants during 'data-led' interviews, in narrative and graphic form. While the research aimed to explore the full extent to which different behaviours could be observed by the research team, the monitoring data provided an empirical basis of actual behaviour against which an individual's reported behaviour and needs could be discussed.

Below, we consider how the in-home monitoring added value to the study, exploring the value that this added to overall insights gleaned from interviews, as well as participants' experiences of the study, and the reported impact of the study on their heat energy awareness and behaviour. We do not discuss technical aspects of the monitoring, which are to be documented separately.

5.2.1 How did the monitoring data add value?

The monitoring data added value to the insights surfaced though the study in a range of ways, including helping us to identify patterns of behaviour; use these to interrogate or confirm reported patterns of behaviour, and deepen our understanding of these patterns; identify exceptions or breaks in routine behaviour, which participants did not always mention spontaneously; surface and explore behaviours that participants may not consciously link with energy use, and therefore may not otherwise mention; and, when overlaid, the data helped to generate a more complex picture of *how different behaviours, conditions and patterns of occupancy play out in interaction*, providing a rich stimulus for deeper and more reflective discussions with participants. These points are expanded on below.

- *Interrogating reported patterns of behaviour*. The data, when available, provided a rich story of 'normal' patterns of behaviour in a given household. This provided stimulus material that could be used to corroborate reported routines, and explore inconsistencies with participants. For example, one participant reported zoning behaviour in winter (turning off radiators in unused rooms), but temperature data indicated a relatively consistent temperature across all rooms in the property. This prompted the participant to explain that he turned on radiators when visitors came to stay, and sometimes forgot to turn these off again once they had left. He also provided an alternative explanation for the data (one which supported his original account), saying that he tended to keep internal doors open, to avoid feeling 'enclosed', which might cause heat to distribute.

- *Confirming reported patterns of behaviour, and deepening understanding*. Even where data confirmed reported patterns of behaviour (which was not uncommon), the data could be used to engage the interest of participants, and encourage more prolonged and deeper reflection on these, and the needs that they serve.

- *Identifying exceptions or breaks in routine behaviour*. The monitoring data was useful in identifying and shedding light on atypical or occasional behaviour, which participants did not always mention spontaneously. For example, in a household where the master bedroom window was typically closed, the data identified occasional times when it was opened. The participant attributed this to her occasional use of an exercise treadmill on weekends, and wanting to keep the window open to avoid getting too hot. Another participant did not think that she opened the living room window at all, which was the case typically, but the monitoring data revealed that it was open during the day while the heating was also on. The participant explained that this was because she was cleaning, which got her warm, which led to her opening the window.

- *Identifying behaviours that participants may not consciously link with heat energy use*. In some cases, the role of heat energy may be distant in people's minds from the need it serves, or the behaviour through which the need is met. This may make people less likely to mention or be aware of these. For example, one participant was surprised to learn from the data how frequently he opened and closed external doors and windows to let the cat out – which prompted him to think about how much heat was lost in the process.

- When overlaid, the data could help generate a richer picture of *how different dimensions of the monitoring data play out in interaction*. This was particularly useful in helping identify inefficiencies, and using these to explore how household needs as well as other factors supported and helped

rationalise seemingly counterintuitive behaviour. For example, data that showed when the heating was on, overlaid with occupancy data, allowed for discussions about instances when the home was heated but unoccupied.

- *Zoning behaviours*. The room-by-room data enabled us to develop further insight into how and why heat is used differently across a single home, through follow-up discussions with participants. For example, one home showed variable temperature across the different rooms. The participant explained that the living room was the warmest, as it was used the most by the whole family, while the room temperature in the downstairs bedroom was the coolest, maintained at a stable 18°C to serve the needs of a child with eczema.

5.2.2 What did participants (want to) get out of the study?

Participants mentioned learning, empowerment and effecting change as key motivators and/or benefits relating to the study. Key motivators are outlined below.

- *Learning something new*: In some cases, the data drew participants' attention to habitual behaviour, helping them to learn something new or surprising about their behaviour. For example, one participant said his attention was drawn to how frequently they open and close external doors for the cat, and about overnight power consumption. Another participant was surprised to discover that temperatures remained constant even when the heating was off, given that he lived in an old building that he would not expect to retain heat. Data that surprised participants, or helped them to learn something new about their behaviour, also tended to yield insights that added value to the study, to the extent that this engaged the interest of participants, and encouraged deeper reflection.

- *Confirming existing knowledge*: Even where data corroborated what participants already knew about their behaviour, rather than telling them something new, this could still be viewed as a positive validating experience. For example, one participant felt that the data corroborated that some of the strategies he used were effective (e.g. trying to keep the child's bedroom at a constant, low temperature), while another thought that it was 'clever' that the sensors were able to capture data that mirrored her behaviour accurately, and described the process of getting feedback on her behaviour 'fun'. Where the devices corroborated behaviour, this also contributed to participants feeling assured that the devices work effectively, and that their participation was therefore worthwhile.

- Linked with the above, participants were also keen to be able to *put learning into action, and effect change*. For example, one participant wanted to be able to approach those responsible for setting the communal heating and show them 'scientific' evidence that the system was currently inefficient. Others wanted to be able to use the data to identify how and where they might be more energy-efficient, and save money, and there was mention of wanting answers to specific questions, and recommendations at the end of the study that could be implemented to this end.

5.2.3 How did the study impact on awareness and behaviour?

Participants reported raised awareness around certain specific behaviours (although in general the data tended to corroborate reported behavioural patterns and routines); raised awareness of inefficiencies, the cost of heat energy; and heightened reflection that prompted them to think about what they really need in terms of heat energy.

Despite reporting raised awareness, most participants reported no behaviour change. Those few who did mention changing behaviour tended to attribute this to the workshop discussions, rather than the experience of being monitored, indicating the possible influence of the group dynamic. For the most part, however, participants reported no behaviour change as a result of participating in the study. Reasons to which participants attributed this included the following.

- *Conscious desire not to change natural behaviour during the course of the study*. One view held by participants was that the study was aimed at exploring their 'natural' behaviour, and they had therefore made an unprompted, conscious choice not to change their normal routines, in order not to influence or compromise the outcomes of the study. Carrying on 'as normal' was also seen as important, in order to find out what they were doing in their daily life that might be 'wrong' or

inefficient. Some participants did mention that they might change their behaviour at the end of the study if the data helped them to identify ways of saving money and/or energy.

- *Other factors override influence of study*. One group felt that awareness and behaviour were governed more by outside temperature (poor weather may make participants more conscious of, and potentially change, behaviour), household needs (e.g. one participant said that although awareness was heightened, he saw no alternative to the way in which they used energy as their children's need was greater than concerns around efficiency), and characteristics of energy systems and property (e.g. one participant mentioned being more aware of inefficiencies, but having limits to what he could do differently given that they were living in an old property, off the gas grid).

- *Rapid acceptance*. Participants mentioned getting used to the monitoring devices very quickly (e.g. during the first week) and then becoming less aware or unaware of them. Participants mentioned that devices were generally unobtrusive. One participant mentioned that even visitors tended not to notice the devices, attributing this to the perception that these resembled security systems, while another noted that the devices were a 'talking point' when visitors were around. In part linked with the above, some participants did not think they were giving their behaviour enough extra thought as a result of the study to 'push' them to change behaviour.

- *No opportunity for behaviour change*. Finally, the fact that the study was carried out after the winter heating season was mentioned as a reason for lack of behaviour change. Mention was made of making changes in behaviour the following winter.

5.3 Priority areas for further research and application of the findings

This study was conducted as part of the Consumer Response and Behaviour project, within the Smart Systems and Heat (SSH) Programme of the Energy Technologies Institute (ETI). Fundamental to any new approach to domestic heat energy is an understanding of the needs that consumers meet (or seek to meet) through energy use, and the behaviours and technologies through which they currently address those needs. If these are not well understood, the design of smart energy solutions (SES) risks failure. The Consumer Response and Behaviour programme provides an essential basis for our understanding of this consumer perspective, and this study, alongside the literature review, represent the first steps toward this goal.

As noted above, the framework of understanding presented in this report is not a predictive model or a definitive explanatory account. It is a means of summarising and synthesising current findings. A key next step will be to test, refine and enrich the explanatory framework, through incorporation of findings from the Consumer Response and Behaviour literature review, and through the qualitative and quantitative components of the second phase of primary consumer research (WP 5.7, Primary Consumer Research, Phase 2), as outlined below:

- *A national survey* building on the findings of WP5.4 will enable a deeper exploration of heating needs and behaviours, their prevalence across households in Britain, and the relationships between needs and behaviour, both in general and in relation to specific areas of heating (heating space, heating water, heating the person, and ventilation and insulation). The survey will also serve to confirm further characterise and quantify the 'types' identified by the household typology, based on and defined by households' energy needs, and associated patterns of behaviour.

- *In-home interviews* will be carried out at two further intervals, during the 2013/14 heating season. These will be used to add further depth of insight into heat energy behaviours and needs during the peak of the heating season. These will be aided by the use of monitoring data, and we expect to broaden the scope of data collected to further enrich insights (e.g. data on heating use, and hot water use). The on-going nature of this element of the study will also serve to add a longitudinal element to our insights, and will provide an important opportunity to explore transition and change across the sample of households. We also intend to build a rich, consolidated understanding of a sub-set of the 30 homes in the in-home energy study, through further analysis and synthesis of social, technical, energy and environmental data, and through on-going data collection.

Another critical next step will be to interrogate and draw out the implications of the study findings for the design and uptake of smart energy solutions. The existing findings can play an illuminating role in helping to determine where efforts should be focused by other Work Packages, and in the design of SES that are responsive to consumer requirements more generally.

Specifically, the findings of this study, complemented by the Consumer Response and Behaviour literature review, provide a rich evidence base on consumer needs and behaviour that should be exploited to draw out implications for solution characteristics for Work Package 5.8, Solution Characteristics. Moreover, the rich household case studies that have been, and will continue to be developed through the WP5.7 qualitative work, can be used and developed to provide rich, contextualised illustrations of solution requirements for different households, and thereby inform the development of solution scenarios as part of Work Package 5.5, Development of Solution Scenarios.

The second phase of the primary consumer research (Work Package 5.7) will also be instrumental in this regard, and one of its primary goals will be to evaluate solution scenarios through focused consumer engagement exercises. Opportunities provided by the home monitoring study, during in-home interviews, coupled with a qualitative workshop or focus groups with consumers will be used to help develop understanding into attitudes towards characteristics of, and priorities for, possible energy solutions. The insight provided by the first phase of research will provide an important foundation for the workshop and other efforts, by informing how to design and pitch consumer facing materials for the testing of smart energy solutions.
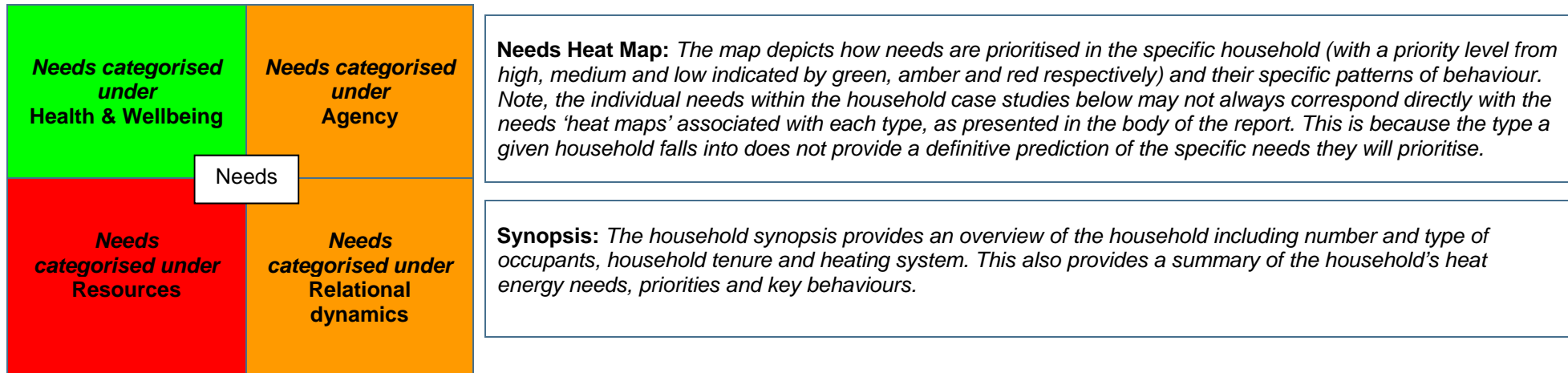
Appendix 1. Case studies

	Household label[2]	Dominant Type[3]	Needs	Influencing factors	Key behaviours
1.	Child-focused family	YOU	Health and comfort of child and expectant mother	Property characteristics	Timer set to child's routine
2.	Multi-generational	YOU / US	Comfort and health of older members; control	Property characteristics; heating system	Constant heating, zoning and top-up behaviours
3.	Limited mobility	ME	Health dominates	Visitors; health condition	Constant heating, regulated for visitors; zoning
4.	Choice family	US	Comfort; convenience; control	Income; personal preferences	Timer but overridden; top-up behaviour; zoning
5.	Semi-retired, working couple	US	Comfort; convenience	Income; property characteristics; habitual behaviour	Thermostat; extra layers; zoning
6.	Adult single sharers	ME	Convenience; control	Property characteristics; transient lifestyles	Timer but regular override
7.	Older social single	ME	Comfort; general wellbeing	System type	Little active behaviour; *ad hoc* ventilation
8.	High earning, busy couple	ME	Comfort; productivity	Property characteristics; system type	Lots of top-up heating; *ad hoc* ventilation
9.	Wealthy empty nesters	US	Ambience and mood; general wellbeing	Income; control; safety	Timer some override; *ad hoc* ventilation
10.	Fuel poor single occupant	ME	Reducing cost of energy bills; avoiding waste	Property characteristics; employment status; health condition	Lots of top-up heating; zoning; avoiding use of heating system
11.	High earning young family	YOU	Comfort of children	Property characteristics; work routines	Timer; top-up behaviour
12.	Elderly couple	ME	Comfort	Learnt behaviour	Timer; zoning

Table A.1. Summary of household case studies

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[2] These labels have been included for ease of reference, and are descriptions of particular households rather than generic types.

[3] Dominant decision-making type.

Key for case studies

Needs categorised under **Health & Wellbeing**	Needs categorised under **Agency**

Needs

Needs categorised under **Resources**	Needs categorised under **Relational dynamics**

Needs Heat Map: *The map depicts how needs are prioritised in the specific household (with a priority level from high, medium and low indicated by green, amber and red respectively) and their specific patterns of behaviour. Note, the individual needs within the household case studies below may not always correspond directly with the needs 'heat maps' associated with each type, as presented in the body of the report. This is because the type a given household falls into does not provide a definitive prediction of the specific needs they will prioritise.*

Synopsis: *The household synopsis provides an overview of the household including number and type of occupants, household tenure and heating system. This also provides a summary of the household's heat energy needs, priorities and key behaviours.*

Needs	Influencing factors	Behaviours	Meeting the need
Outlines the household's heat energy priorities and needs. This includes both fundamental and secondary needs.	*Factors that may directly or indirectly affect decision-making and subsequent behaviour.*	*Overview of the household's heat energy behaviours including use of heating system, routines, ventilation and 'top-up' behaviour.*	*Insight into whether all occupants' heat energy needs are being met sufficiently and, if not, how this negotiation is challenged or overcome.*

Child focused family (Type: YOU)

This working family with one young child currently lives in a privately rented detached property with gas central heating. Both parents are working full time and they are expecting their second child soon.

| Comfort and health	Convenience
	Needs
Cost	Social interactions with householders
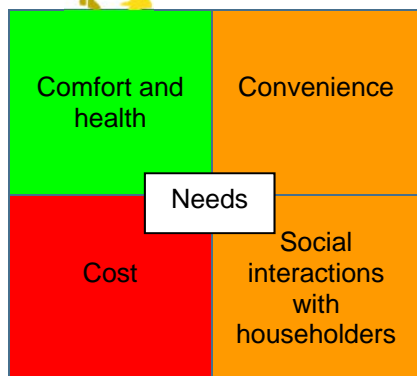
The family has regular working patterns and routines, with both parents out of the home at different times during the day and their child is at school. The parents' main priority is the health and comfort of their child and the expectant mother - heating behaviours centre on maintaining an environment to suit their needs. Sometimes this can come at the expense of one of the parent's needs; at times they feel uncomfortable when the home is warmer than their liking (to cater to the needs of the child), and this can lead to some inefficient heating energy behaviour. The home is also somewhere to socialise and they host regular friends and family gatherings. While some inefficient heat energy behaviour exists, this is felt to be an acceptable trade off to ensure their child and the expectant mother remains healthy and comfortable. The property is generally difficult to keep warm. Parents are unsure why but think that the property is poorly insulated.

Needs	Influencing factors	Behaviours	Meeting the need
Need is mainly focused on the health and wellbeing of their young child and the expectant mother. The heating system must be convenient and responsive. There remains the need to be conscious of inefficiencies due to a concern over waste, rather than cost. Ultimately this concern is sacrificed for the child's and the expectant mother's needs.	The property is poorly insulated and this has influenced some behaviours, for example, constant overriding and adjustments to the heating system during variable weather conditions. The overwhelming influencing factor for this family is the comfort and wellbeing of their child and the expectant mother.	The gas central heating system is set to a timer that is mapped closely to the child's current routine around school. This is often overridden when it is colder outside in the evenings and the family is gathered in the living room. The temperature of the thermostat is always set fairly high. The mother will also keep the gas fire on for prolonged periods during cold weather. On occasions, windows are left open at the same time as the home is being heated. Most behaviour is geared towards keeping a warm and comfortable environment for their child. Keeping curtains drawn to eliminate draughts in the child's room is part of the nightly routine. The hot water system is kept on constantly. On occasions there are issues when the hot water runs out, especially after the wife has a bath.	Negotiation exists around the child's and the expectant mother's needs. The home is kept warmer for the sake of the child and mother's health and comfort which can lead to the father feeling uncomfortable. This has resulted in some inefficient behaviours around ventilation (such as keeping windows open while the home is being heated), and keeping gas fires on for prolonged periods. Often the needs of the father are sacrificed for the child and expectant mother's needs.

Multi-generational household (Type: YOU/US)

A diverse household with nine people across three generations living together. The household has full-time, part-time and home-workers, and also an elderly relative in residence. This large-scale property has underfloor heating and a range of different living spaces.

| Comfort	Convenience
Needs	
Cost	Social interactions with householders
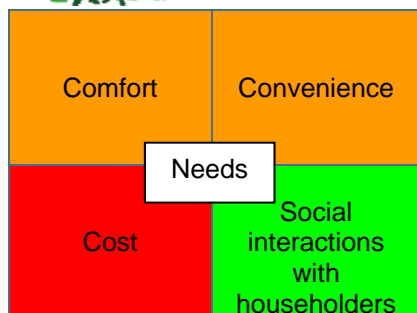
A unique household composition with complex needs and routines. The owner-occupied property has water-powered underfloor heating to the ground floor, with no installed heating system to the first floor. The property is difficult to heat due to its scale and lack of central heating system throughout. Complex needs combined with a lack of heating system to the upstairs have resulted in lots of 'top-up' behaviour, strategies and modifications to the home to try and maintain a comfortable temperature. The underfloor heating system is on constantly, with different members of the family able to control temperatures in different spaces on the ground floor. However, the system is felt to be inadequate for heating such a large space. There is a particular need to provide a comfortable environment for the older members of the family and also those who run the family business from home. Inefficient heat energy behaviour is common and there is a need to seek solutions and strategies to be less wasteful while also providing a comfortable living space and harmonious environment.

Needs	Influencing factors	Behaviours	Meeting the need
Comfort of all family members drives all behaviours. Health of elderly relative is closely linked with comfort as she spends more time in the home and is generally more likely to feel the cold. There is also a need for control; individual control is needed by family members with varying lifestyles and routines, to attempt to tackle inefficiencies. The home must also be a productive environment for work as the family business is run from there. Closely linked to comfort.	The diversity of needs due to the number of occupants is a crucial influencing factor. Built from two old cottages and then extended, there is no insulation in the property. The scale of the property creates difficulties in maintaining consistent temperatures across rooms. The underfloor heating system is also felt to be inadequate for the scale of the property. This prompts much of the 'top-up' behaviour. Due to working from home, some members of the household are less likely to be active in the home and therefore prefer certain working areas to be warmer. They find it difficult to work in cold conditions as this is distracting.	The underfloor heating system remains on constantly during the winter time. Temperatures are controlled in different 'zones' of the property by a number of thermostats. Individual control is achieved through thermostatic controls in all ground floor rooms. This controls the underfloor heating. While the heating system is generally not quick to respond, the thermostatic controls allow individuals to set preferred temperatures. Also, each upstairs room has its own electric fan heater controlled by the occupants of the room. Lots of 'top-up' behaviour is used. Electric fan heaters are used in all upstairs rooms (no central heating system on first floor). Electric blankets are also used. Behaviour is inconsistent at the household level despite individuals having routines. The hot water system is kept on constantly. There are no issues with the system and it copes well with the high demand for hot water during the mornings.	Comfort and warmth needs are met with lots of active behaviour and generally with great difficulty. Property size and renovations have a negative effect on the ability to retain heat in the property. In trying to achieve comfort, needs around efficiency are not being met. Cost is not a consideration but there is motivation not to be inefficient or wasteful. This remains challenging to overcome as lack of technical knowledge and an inadequate heating system fosters regular inefficiencies.

Limited mobility (Type: ME)

This single occupancy household has a range of complex needs related to a medical condition. Socially rented, the property boasts a communal heating system with individualised controls (TRVs on each radiator).

|	
Comfort and health	Convenience
Needs	
Cost	Social interactions with guests
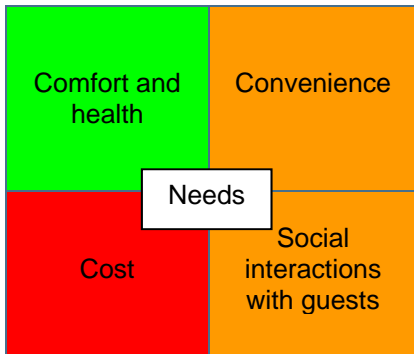
This individual has a number of health issues which influence most heat energy behaviour. In response to his medical condition, a lot of cooling behaviours (opening windows, use of fans) take place alongside the need for constant heating of the home which is adjusted throughout the day to reflect his needs. It is important that he has control over the communal heating. Use of TRVs, particularly to meet the needs of regular visitors who can control the heat in areas they occupy, is common. The heating is never turned off. Generally, the home is easy to keep warm and difficulties only arise due to varying body temperatures as a result of the individual's health condition.

Needs	Influencing factors	Behaviours	Meeting the need
Being comfortable is the main driver for behaviour. Medical conditions mean that body temperatures can vary drastically at different times of the day so having control over both ventilation options and the heating system is crucial.	Lack of mobility means that only some top-up behaviours can be employed such as use of fans and opening windows in certain rooms, while the medical condition creates a situation where body temperature can be hot, but room temperature still feels cold. Consideration of regular visitors and their comfort needs also influences behaviour. Control over the heating and ventilation is given to visitors when they are occupying particular spaces.	All behaviours are entirely dominated by health issues. Heating is always on, TRVs are used often, and windows are opened to regulate temperature. The occupant uses zoning, through the use of TRVs, to keep the temperature to his liking in the bedroom that he occupies almost constantly, while allowing frequent visitors (personal assistants) to regulate temperatures in the rooms they occupy.	Has difficulty meeting needs around comfort and wellbeing. Often unable to maintain a comfortable body temperature due to the influencing factors of ongoing medical conditions. Attempts to overcome this with lots of inefficient behaviour i.e. fans and windows are open when the heating is on.

Choice family (Type: US)

A busy household comprising a high earning couple, their two young children and a lodger. Their semi-detached home has gas central heating and all members of the household are involved in decision making.

| Comfort	Convenience
	Needs
Cost	Social interactions with householders
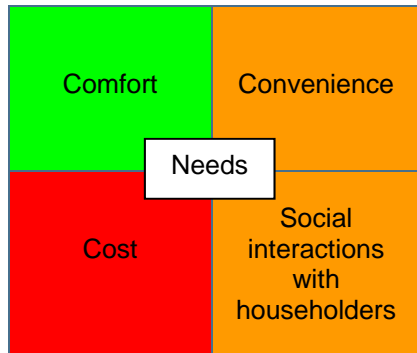
All adult members of the household work full time with busy schedules and do not want to have to think about the heating too much. Their needs are focused on convenience, comfort and maintaining a happy, ambient environment in the home. They are equally keen to avoid waste but the need to satisfy demands of the busy family overrides this, as both the timer and thermostat controls are overridden regularly, and unoccupied rooms are frequently heated. All members of the household, including the two young children (aged 2 and 5), are actively involved in controlling the main heating system. There is also a lot of active 'top-up' behaviour such as the use of electric blankets, plug in heaters and convection heaters that are usually used for comfort rather than warmth. The household has no difficulties in keeping the house warm and maintaining temperatures across the property.

Needs	Influencing factors	Behaviours	Meeting the need
Comfort of the whole household, especially the children, is the most important. Warmth is as important as being comfortable. Keen to maintain an environment where everyone is warm. Family also leads busy lives, the parents are engaged in shift work, so convenience is also important. No reported problems around keeping the home warm.	Income is an influencing factor, but cost is not the main issue. Both adults are working and feel able to live comfortably on their income, including keeping warm. Bills are not regarded as being too high. All household members are encouraged to use the heating system and 'top-ups' to satisfy individual needs. The adults believe that they work hard and therefore have earned the right to be warm, comfortable and use heat energy in the way that satisfies everyone's needs, even if it results in waste of energy.	Heating is on a timer but is overridden regularly to meet individual and family need. TRVs, electric blankets, convection heater, oil-filled heater are all used regularly to meet needs. TRVs are adjusted in a couple of rooms - bathroom and youngest child's - to avoid waste and meet health needs, respectively. Only marginal not routine behaviour relates to avoiding waste and property maintenance. The hot water system is kept on constantly as family members shower twice a day, sometimes at odd times.	Some level of negotiation exists around the need to be less wasteful. While this remains a concern, comfort and individual need is not compromised for this.

Semi-retired, working couple (Type: US)

A semi-retired couple who enjoy entertaining and providing a warm home for both themselves and guests. They own a detached property with gas central heating.
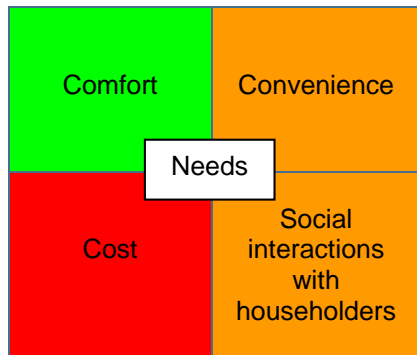
Strict routines are maintained relating to both work and social activities; the heating system is on a timer to fit into these routines. The property is well insulated and easy to heat and keep warm.

The couple's key concern is comfort and they are not worried about cost, but some habitual behaviour (e.g. putting on a jumper) means they do not override the heating controls very often, with little to no 'top-up' behaviour needed to keep comfortable. Pre-emptive behaviour is also common in this household. It is important for them to return to a warm home. They think through and plan property maintenance and will often leave the heating on when they go away for long periods of time on holiday so the pipes do not freeze.

Needs	Influencing factors	Behaviours	Meeting the need
Comfort and convenience are the main priorities for this busy couple. It is also important to them to provide a welcoming environment for visitors.	Strategies relating to heat energy from different stages of their lives have influenced their current decision-making. Habit drives much of their behaviour. Income is an influencing factor in the sense that cost is not an issue.	They keep heating on constantly during the winter season with small degree of zoning (turning valves down on radiators in unused rooms). Occasionally the temperature is adjusted by thermostat although their preference is to put on a jumper to get warmer if needed. Very little top-up behaviour; a gas fire in the lounge is used on occasions when it is particularly cold outside. Hot water is on a timer in the mornings and evenings with temperature controlled at different times of year - higher in the winter, cooler in the summer.	There is negotiation between the couple to ensure comfortable temperatures are achieved for both of them. While the male occupant usually controls the heating system (therefore satisfying general needs around comfort) his partner often still feels cold. Zoning areas where she is likely to spend most time, and keeping these areas warmer is now a regular part of routine to compensate for this.

Adult single sharers (Type: ME)

This privately rented four-bedroom home is shared by four single male occupants. The first floor flat has gas central heating. All occupants have a medium/high income.

| Comfort	Convenience
Needs	
Cost	Social interactions with householders
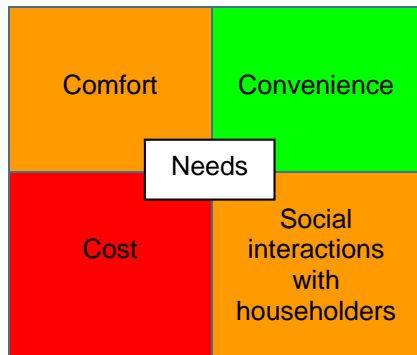
All members of this household work full time and have varying routines. The home is simple to heat and the property itself (good insulation and thick walls) keeps the heat in well. As a household they appear transient and are therefore unlikely to spend large proportions of time all together in the same space. There appears to be little to no negotiation taking place regarding the heating system; it is on a timer to come on both in the morning and evenings which is overridden by all occupants to meet individual needs. However, inefficiencies are evident as the home is often heated when no one is there and windows are regularly left open. Having a well-insulated flat means little 'top-up' behaviour is needed.

Needs	Influencing factors	Behaviours	Meeting the need
Convenience is the most important consideration for all occupants. Their transient lifestyles (busy work and social lives) mean that heating and hot water are needed on demand. Some of the occupants also work from home on occasions. Having a productive, comfortable environment to work in is also a key need. Feeling cold while working was viewed as detrimental to productivity. Ensuring individual needs are met is important in maintaining a harmonious household.	The variability of individual routines influences many behaviours, resulting in inefficiencies, such as the heating being left on when no one is at home. To ensure the home is kept at a comfortable temperature, and not knowing when the home will be occupied, it is sometimes a more convenient option to the keep the heating on all the time. The flat itself is well insulated so it means little to no top-up behaviour is needed.	A timer is used in the mornings and evenings, but constant overriding occurs. By contrast, the thermostat is hardly touched. Little top-up behaviour, but occupants are likely to put on a jumper if feeling cold along with overriding the heating system. Some inefficient behaviour is evident such as window opening in certain rooms while the heating is on.	Little negotiation between household members takes place due to occupants varying routines; they are all satisfied with adjusting the system to their individual needs. Cost is not a concern.

Older social single (Type: ME)

An active, older single occupancy household living in a socially rented flat. The house has communal heating with some individualised controls (the heating can be turned off and TRVs can be adjusted). It is easily heated, but issues arising from overheating.

| Comfort	Convenience
Cost	Social interactions with guests

Needs
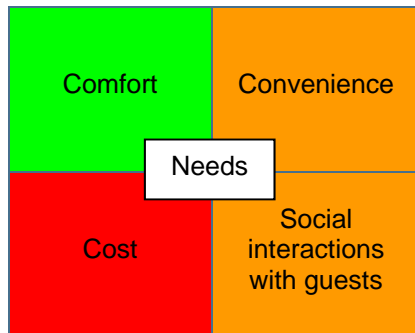
The single occupant of this household has a regular life-style pattern and social routines. There is evidence of displaced heat energy behaviours with regular visits to the gym, her daughter and grandchildren, and generally socialising outside the home. Control over the communal heating system allows her to turn the heating off when out and control TRVs. She consciously tries to avoid waste wherever possible. She will usually only adjust TRVs when visitors come or if they are feeling extremely cold. Due to the communal heating system and sometimes heating from a community centre below, overheating is a significant problem at all times of the year. The occupant often feels uncomfortably warm so lots of compensatory ventilation behaviour taking place.

Needs	Influencing factors	Behaviours	Meeting the need
Basic needs are centred on achieving thermal comfort and well-being within the home. The occupant does not want to feel uncomfortably warm; she is conscious of the role that heat energy plays in this. She would like more control over the heating system to minimise heat loss and wasted energy.	The regularity of her routine is overriding influencing factor. The communal heating system influences her behaviour in terms of controlling temperatures and ventilation. She has access to a constant supply of hot water from a central supply in the flats.	The communal heating is controlled via TRVs in ad hoc way. Temperatures are also controlled through ventilation behaviour such as leaving windows open when she is at home to try to keep cool. Windows and doors often kept open for long periods to cool the property and avoid overheating. Safety is not a concern as flat is located in a gated community. She has constant hot water from a central boiler and takes baths as she does not have a shower.	Lives by herself and has complete control over her environment. Needs are not always being met around comfort because of the difficulty of individual control of the temperature of her flat within the block. Sometimes temperatures are too high in the home due to communal heating and warmth from adjacent flats and community centre below. Overcomes this through active ventilation behaviour and controlling TRVs.

High earning, busy couple (Type: ME)

This busy high earning couple own their Grade II listed flat which has underfloor heating supplied through a communal heating system to the whole estate. They have no individualised controls over the heating system.

| Comfort | Convenience |
| Cost | Social interactions with householders |

Needs
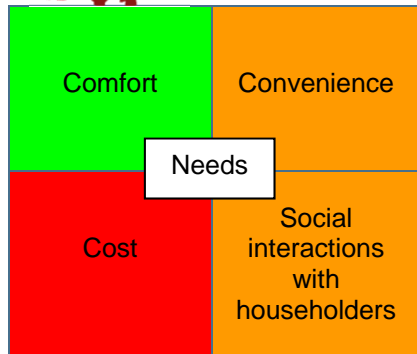
These busy professionals work full time both abroad and from home. Their priorities are comfort, warmth and productivity. They have no control over the communal heating system and their property is difficult to keep warm, so a lot of active 'top-up' and ventilation behaviour takes place. Because they have no control over the heating, it is often unnecessarily left on (for example, when they are away, or at other times when they do not require any heating). The communal heating system is so inefficient for their needs that the need for greater efficiency becomes paramount. Effective ventilation is sometimes prevented by concerns over security (fear of burglary) if the windows are left open. As the property is Grade II listed they are unable to make any changes, e.g. installing double glazing.

Needs	Influencing factors	Behaviours	Meeting the need
Thermal comfort is their biggest need. Occupants were brought up in very warm homes and do not like to wear a lot of clothing indoors; they want to achieve a similar environment to their childhood homes. As they predominately work from home a comfortable, warm environment aids productivity. They would like greater control over the system due to their variable routines and spending extended periods away from home.	The property itself is the biggest influencing factor: the inability to control the heating system results in top-up, often inefficient, behaviours; the Grade II listing restricts the potential for structural energy efficient renovations. Concern for security influences ventilation behaviours. The lifestyle and routine of occupants.	Lack of control over the underfloor communal heating system leads to the frequent opening of doors and windows. During winter, curtains are closed more regularly in the day to prevent draughts and electric plug-in heaters are used in the main living area where work takes place. Electric blankets are used in both the living area and bedrooms every day. The hot water tank is kept on constantly; hot water is used as and when needed for showers.	Needs related to comfort and control are not being met. The lack of control over the unresponsive heating system means they are unable to control temperatures as they would like and are therefore continuously using heating / cooling top-up behaviours i.e. plug-in heaters, electric blankets, curtains, fans etc. Negotiation also exists between the couple. The wife prefers it much warmer so will make use of blankets and heaters more.

Wealthy empty nesters (Type: US)

A retired couple with a medium income and regular routines. They are owner-occupiers living in a detached property with gas central heating. The property is easy to heat. Hot water is heated when the central heating is on.

| Comfort	Convenience
Needs	
Cost	Social interactions with guests
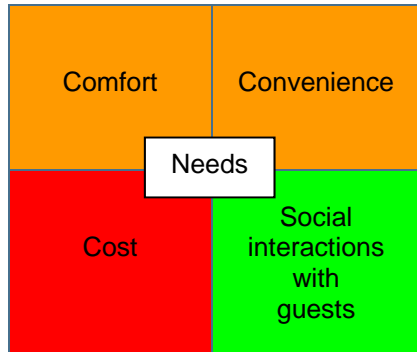
Warmth and comfort override any concerns over costs or resources hence heating rooms that are unoccupied and warming the home up before grandchildren visit. Their similar routines, due to them being both retired mean that the heating system is set to timer during waking hours and only changes when summer begins (when the system is turned off completely). Providing a welcoming, ambient environment for family and friends to spend time in is very important; this is achieved through pre-emptive behaviour and no zoning. They have some safety concerns over ventilation, due to burglaries in the area, which means they keep windows on the ground floor closed.

Needs	Influencing factors	Behaviours	Meeting the need
Ambience and aesthetics are very important when providing welcoming environment for regular friends and family visits. Important for general wellbeing to feel comfortable in the home and never to feel cold. Maintenance of property is also an important consideration. More likely to keep the heating system going continuously to avoid system breakdowns and pipes freezing in winter.	Income is an influencing factor in the sense that cost is not an issue. Ability to set the heating system to timer and therefore follow routine accordingly influences the lack of need for additional top-up behaviour. Concerns over safety in relation to ventilation somewhat influences behaviour. Ground floor windows are kept closed all the time. Security locks also make opening windows more inconvenient.	Heating and hot water are on a timer with little overriding, perhaps only on very cold or warm days. Inefficient behaviours are regular; upstairs windows will be kept open when heating is on to let fresh air in and to cool down the property as heat rises from the ground floor. Unused rooms are heated because of a fear of creating cold rooms in the house that may draw heat from other rooms. Wants to avoid interruption of heating system as much as possible.	Some evidence of challenges around control of temperatures and ventilation. Unable to leave downstairs windows open due to concern over burglary. On occasions, struggles to control temperatures. Overcomes this by overriding heating system and more ventilation behaviour in upstairs rooms. Generally have all the hot water they both need. Hot water can run out if they have baths in quick succession.

Fuel poor single occupant (Type: ME)

This single male occupant lives in a local authority rented one-bedroom property. He is currently out of work due to ongoing health conditions.
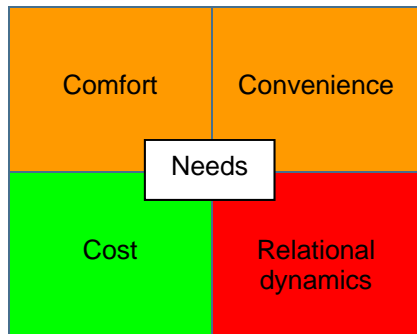
Saving money on heating bills is the main focus for this single occupant. An ongoing health condition prevents him from working therefore budgets on household bills are tight. While he has a good level of control over what he is spending (through the use of the prepaid Smart Meter system), the property itself often determines behaviour and subsequent inefficiencies. A desire to be less wasteful has seen the occupant leave the property and visit places where there is 'free' heat energy, such as the local library. Top-up behaviour such as thick coats, electric blankets and regular hot showers is part of his routine, with the main gas central heating system being turned on only as a last resort.

Needs	Influencing factors	Behaviours	Meeting the need
Need is solely focused on reducing heat energy bills and saving wherever possible. Comfort is sacrificed regularly to save money. Peripheral needs around avoiding waste and being more efficient are evident, and some behaviour is influenced by these as a result.	The property itself is the largest influencing factor. The building has been condemned for demolition and ongoing maintenance issues have not been addressed; windows are broken, there is no insulation or adequate flooring. Current employment status also influences behaviour in that cost must be minimised wherever possible, even if this sacrifices comfort. An ongoing health condition, which prevents the householder from working, also determines some behaviour especially at night time when condition is worse.	No set routine around heating system exists. Gas central heating system is only turned on as a last resort. Top-up behaviour is more prevalent; jumpers and heavy coats are worn regularly, electric blanket in the bedroom is used regularly. Showers are taken on a regular basis to keep warm, along with placing feet in warm water on some colder evenings. Purposely tries to stay in one room for most of the time he is in the home. This is usually the bedroom, where the electric blanket can stay on for long periods of time and he can sit under lots of layers. Displacement behaviours are apparent; long periods of the day will be spent going for walks, visiting friends or going to the local library with the intention of keeping warm and to avoid using heat energy at home.	Some minor negotiation exists around health condition and need to save money. Condition is exacerbated when the householder is cold so he finds himself turning on heating system more often than he can afford on occasion.

High earning young family (Type: YOU)

A busy household consisting of a high earning couple, their four young children and a full time nanny. Their three-storey home has gas central heating.

|	
Comfort and health	Convenience
Needs	
Cost	Social interactions with householders
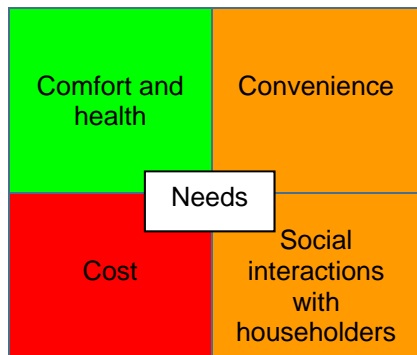
Strict routines allow the family to control gas central heating system in a way that satisfies their desire for efficiency but also comfort. The children are all young, and the need to keep them healthy, warm and comfortable overrides the parents' needs. The arrival of a new baby has seen some changes in heat energy behaviour; areas that the baby occupies are kept the warmest through top-up behaviour, electric plug-in heaters, extra blankets, etc. Cost is no real issue but they don't like the idea of waste. The mother is the main decision maker but the nanny, who occupies the home during the day, is free to control the heating system as she wishes. The property is listed so refurbishment work is limited; a lack of insulation is viewed as a missed opportunity to retain heat in the home.

Needs	Influencing factors	Behaviours	Meeting the need
Principle need is to keep children warm and comfortable. This is directly associated with the health of children and providing a comforting space for the whole family. Some evidence that the desire to be less wasteful exists as a less primary need. They are keen to use heat energy in a way that doesn't appear wasteful i.e. keeping windows open when heating is on. However, the needs of the children will always override this.	The age and listed status of the property influences how space is used. For example, the kitchen/diner is also used as the main living area as the lounge is deemed too small for the family and cannot be changed due to renovation constraints. Listed status also limits the scope of energy-efficient installations. Strict work routines also influence how the heating system is used as both parents leave for work at the same time every day and the children have set school routines.	Timer is set for early morning, before the children wake up, and in the evenings when they return from work/school. However, this is regularly overridden depending on how much the house is occupied (e.g. if the nanny is present) or on the weather (during longer spells of particularly cold weather, more likely to adjust heating system). Open fireplace in the lounge area is used only rarely, because of concern over the children's safety and is only used for aesthetic appeal. Top-up behaviour is more prevalent when there is a new baby in the home; electric plug in heater used in the baby's room, along with use of extra blankets.	Little to no negotiation of needs, only minor desire to be more efficient when using energy. This is driven by a desire to be more eco-friendly, rather than to save money. However, needs of the children override any concerns related to this.

Elderly couple (Type: ME)

An elderly couple in their late 70s living in a one bedroom property in a retirement home complex. They holiday several times a year and host their grandchildren on a regular basis.

Comfort	Convenience
Needs	
Cost	Relational dynamics
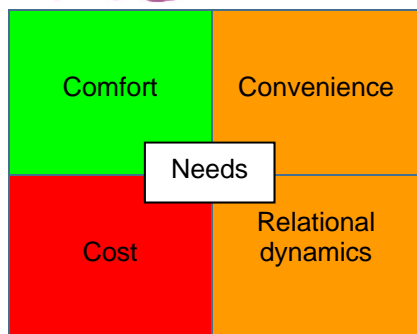
While cost is not an issue, the couple are conscious not to be wasteful around heat energy use. Their gas central heating system is on a timer and only rarely overridden during particularly cold periods. TRVs are turned down in rooms that are occupied less frequently. No sense that behaviour drastically changes when grandchildren visit, or they go on holiday, as the property retains heat well and is usually kept at a comfortable temperature. Little to no top-up behaviour as they dislike wearing lots of layers in the home.

Needs	Influencing factors	Behaviours	Meeting the need
As they occupy the home for long periods, feeling comfortable is important. They do not want to feel cold or have to put on lots of layers to keep warm. They are also careful not to be wasteful in terms of heat energy but this is never prioritised over comfort.	Learnt behaviour influences attitudes towards heat energy. Having lived in several properties over the years, they now feel confident around working heating controls, giving them complete control over how warm or cool it is. Couple also have the same routine and occupy the home for much longer periods compared to when they were working.	Gas central heating system is on a timer in both the mornings and evenings. This is rarely overridden, only do so when it is particularly cold outside or grandchildren are visiting. TRVs in all rooms are carefully controlled, upstairs rooms are rarely heated as warmth from downstairs heats these rooms effectively. Due to concerns over mould/damp they have a single electric fan heater for the conservatory that otherwise has no heating source. This space is only used during the summer time and the electric fan is used only to prevent mould.	Little negotiation exists as cost is not a factor and routines of couple are exactly the same. Comfort is never sacrificed and they feel confident they are able to control the heating system effectively.