



Programme Area: Smart Systems and Heat

Project: Consumer Response and Behaviour

Title: What people need and do that involves heat energy: Findings from qualitative research

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This report was prepared for the ETI by the consortium that delivered the project in 2013 and whose contents may be out of date and may not represent current thinking.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 presents insights developed through a multi-faceted project of qualitative consumer research, involving a diverse sample of 186 domestic consumers in the UK. The sample was purposively selected to represent the diversity of the general population in relation to key characteristics such as household composition, property type, income and heating type. Participants took part in a range of sequenced activities. Interactive workshops were designed to map the full range of heat energy needs and behaviours that exist in the general population. To understand these in more detail and in-situ, a subsequent longitudinal element of the study involved tracking the heat energy needs and behaviour among a cohort of 30 of the workshops' participants over the course of a full year. The research design is illustrated in the diagram below and described in more detail in the main body of the report. The deliverable also includes the 8 Case Studies as part of the supporting material for the qualitative research.

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.

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What people need and do
that involves heat energy:

Findings from qualitative research

Smart Systems and Heat (SSH) Technology Programme
Work Area 5 Consumer Response and Behaviour

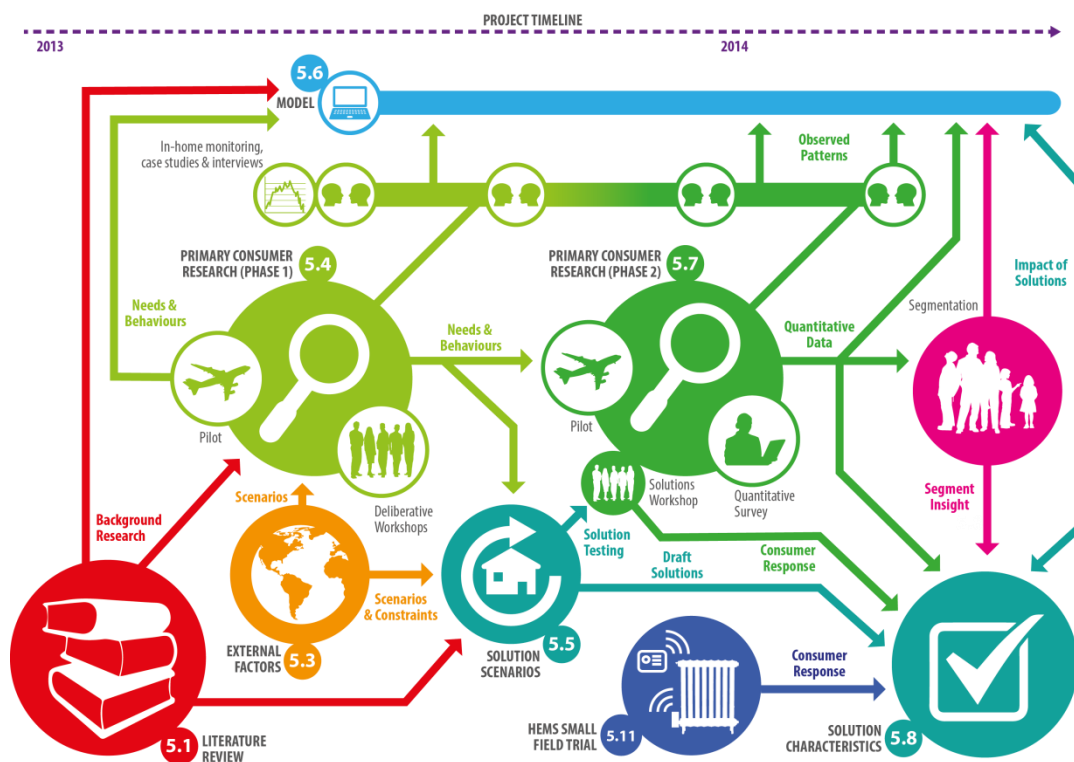


Context and Glossary

This Report, *What people need and do that involves heat energy: findings from qualitative research*, is one of the final deliverables of the Energy Technologies Institute (ETI)'s **Consumer Response and Behaviour** project, part of the **Smart Systems and Heat (SSH)** programme. The ETI's Smart Systems and Heat Programme will create future-proof and economic local heating solutions for the UK. It will connect together an understanding of consumer needs and behaviour with the development and integration of new technologies and with new business models. The associated insight will deliver enhanced knowledge across industry and the public sector, resulting in industry and investor confidence to implement SSH influenced solutions from 2020. It will enable a UK energy system transition, focused around effective delivery of heat, within an appropriate policy and support environment, which is cost-effective.

The Consumer Response and Behaviour project is a multi-disciplinary research collaboration, combining qualitative and quantitative social research, physical monitoring, modelling and concept development, supported by a thorough review of secondary literature sources.

The key research activities and work packages of the project are illustrated below.



This report comprises one of two key outputs of **Work Package 5.7 - Primary Consumer Research (Phase 2)** and details qualitative insights from workshops and interviews, and key case studies from the longitudinal in-home monitoring sample.

The other key final deliverables are:

- *"Quantifying Heat Energy Needs and Behaviours"* - an output of **Work Package 5.7 - Primary Consumer Research (Phase 2)** which details quantitative insights from the mass survey into heat needs and behaviours and the resultant consumer segmentation;

- "*Modelling Insights*" - a key output of **Work Package 5.6 - Model** which details modelled insights into the impact of current behaviours and the impacts of changes to the household or energy system;
- "*Smart Energy Solutions - The Consumer Perspective*" – an output of **Work Package 5.8 - Solution Characteristics** which details key insights to the design of future smart energy solutions based on inputs from the wider project.

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).

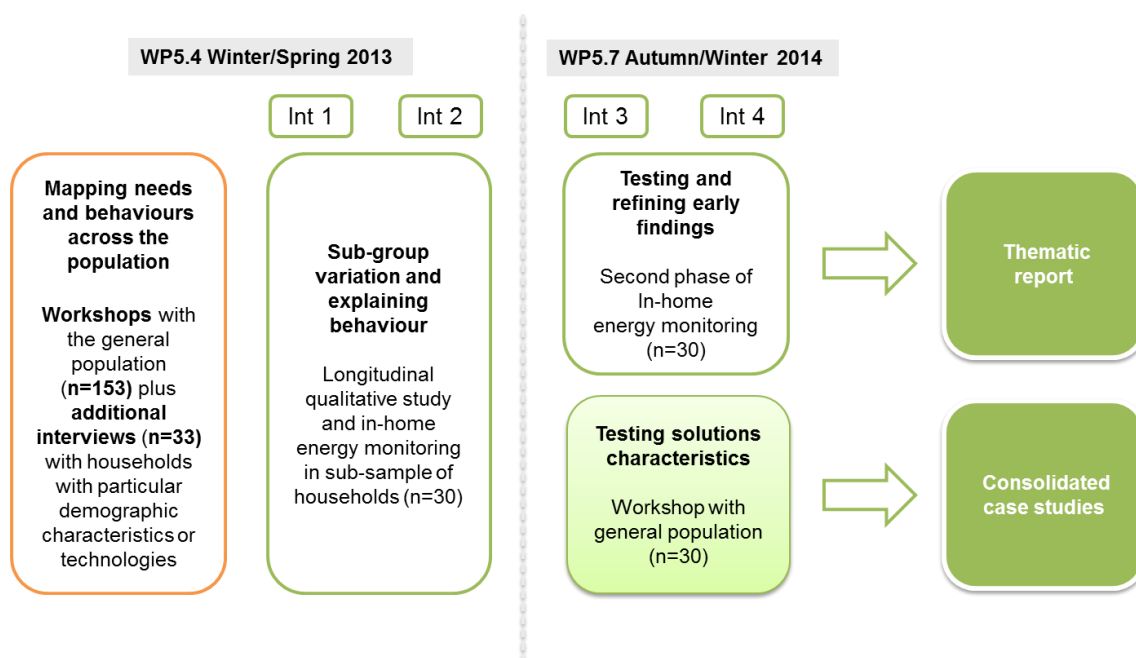
Fundamental to any successful new approach to domestic energy is a thorough understanding of the needs that consumers aim (or seek) to meet through energy use and the behaviours and technologies that they currently use to address those needs. If these are not well understood, the design of smart energy solutions (SES) risks failure as consumers will dislike or be unable to use solutions that do not meet their needs, and so be less likely to adopt them or use them as intended. The Consumer Response and Behaviour project provides an essential basis for this consumer perspective.

This marks something of a departure from other research that aims to inform 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. This research, however, takes a different starting point, but does not ignore existing understanding. Consequently, it aims to understand people's heat energy needs but to locate it within the wider context of property and system characteristics.

Methods and approach

This report presents insights developed through a multi-faceted project of qualitative consumer research, involving a diverse sample of 186 domestic consumers in the UK. The sample was purposively selected to represent the diversity of the general population in relation to key characteristics such as household composition, property type, income and heating type.

Participants took part in a range of sequenced activities. Interactive workshops were designed to map the full range of heat energy needs and behaviours that exist in the general population. To understand these in more detail and in-situ, a subsequent longitudinal element of the study involved tracking the heat energy needs and behaviour among a cohort of 30 of the workshops' participants over the course of a full year. The research design is illustrated in the diagram below and described in more detail in the main body of the report.



Key insights

At the outset of the Consumer Response and Behaviour project, we adopted a deliberately broad definition of needs. This initial definition understood heat energy needs as what people are aiming to achieve through or as a consequence of using heat energy. As a result, our findings encompass a wide range of needs from those objectively essential for life, to preferences based on individual perceived requirements or values.

An overarching insight that stems from approaching the project in this way is that, paradoxically, households see heat energy as simultaneously fundamental and peripheral to their daily lives. When considered in the context of all people's needs and behaviours and alongside their everyday preferences and considerations, heat energy appears to feature quite low down on their list of priorities. Much of what people do to keep warm and get comfortable is routine, in some cases habitual and rarely front-of-mind. And people do largely meet their current needs so are not always immediately conscious of needs that are easily met.

Given this, the longitudinal research has enabled us to develop a more nuanced understanding of these needs. It is only when you ask people to reflect on what they do, and consider why they do what they do, that heat energy emerges as fundamental to the health and well-being of the household. Typically people will not compromise on their health, well-being and comfort and may even describe being warm and comfortable as a right or as something earned.

An illustration of this paradox is provided by our findings in relation to cost. The cost of heating the home is certainly at the forefront of the minds of consumers and participants in our study described frustration in relation to rising energy bills. A cursory discussion with consumers might conclude that cost – the *need* to minimise the amount spent on heating their home – is likely to heavily drive people's heat energy behaviour. Our in-depth study reaches a different conclusion. Despite the frustrations expressed about rising energy prices and specific cost saving measures that people described, cost does not drive routine day-to-day behaviour as much as fundamental needs like health and comfort. Ultimately, people will pay what they need to (and go without other items or make savings elsewhere) in order to keep their households healthy and comfortable.

In the context of these overarching findings, the overall narrative of this report is driven by the following key insights that aim to provide a more nuanced understanding of needs and identify how these interact with other influences on people's heat energy behaviour:

- People can describe and refer to a wide-ranging set of needs that influence how they use heat energy in the home. Our detailed and longitudinal study of 30 households indicates, however, that only a relatively *small sub-set of these needs drive day-to-day, routine behaviours*. These behaviours are illustrated in **Figure 1** and described in detail in chapter 2 of the report.
- These eight needs that drive day-to-day, routine behaviours exist along a *continuum of priority*: some are fundamental needs that people describe as essential for life, while others are more peripheral and at times sacrificed, so are better described as 'wants'. While participants did not articulate this as a continuum, analysis of the data suggests that these more peripheral needs only come into focus and become an influence on behaviour as people's core needs are met sufficiently. This is illustrated by **Figure 2** and described in detail in chapter 2 of the report.

Figure 1 Consumer needs

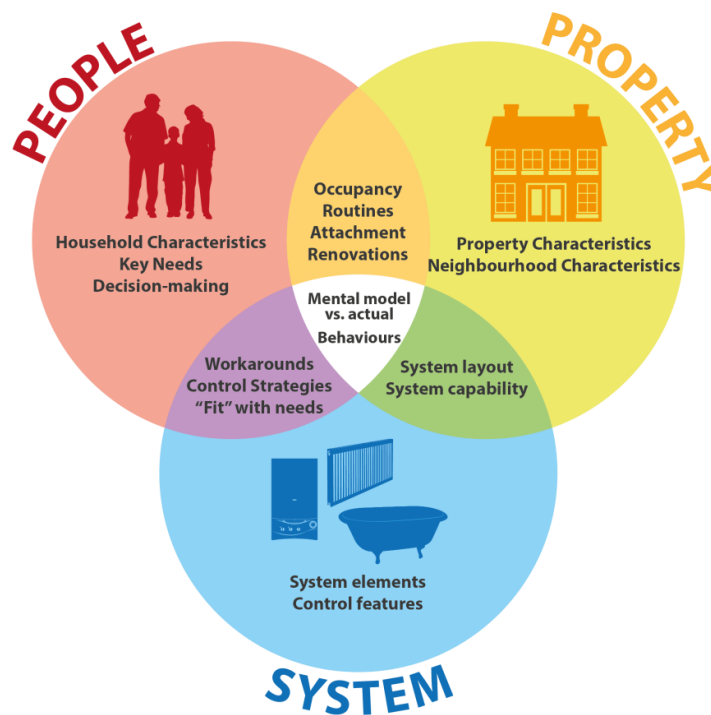


Figure 2 Prioritisation of needs



- It is not only needs, however, that affect behaviour. A dynamic and interacting set of factors at the household-level, encompassing the *people*, *the property* and *the system* also influence how and to what extent people are able to meet their needs, and which needs come into focus and influence behaviour. This is illustrated in **Figure 3** below and referred to in chapter 2 and 3 of the report as well being described in detail in the WP5.4 qualitative report.

Figure 3 Factors affecting heat energy behaviours



- As a result of these many influences, enablers and constraints, people adopt a variety of *complex control strategies* to meet their needs. Some are highly sophisticated and considered, while others may be rudimentary and reflexive. They are also highly variable, given that people are working around a variable mix of people/property/system factors.
- Despite this variety, what appears to remain constant across the population is that control strategies enable people to achieve their ends (or fundamental needs) of comfort and health, while being prepared or required to make trade-offs in relation to the *means* (more peripheral needs, such as cost and convenience) by which they get there.
- While people are extraordinarily adaptable, they are also highly resistant to change once they have developed a strategy that allows them to meet their basic health and comfort needs. They tend to make adaptations to their energy systems only when there is a disruption to their normal flow of life that 'pushes' them to change.

Implications for smart energy solutions

Our findings show that the prioritisation of needs is complex, dynamic and variable between individuals and households. The research does, however, provide some different routes into thinking about what this means in relation to what people want from heat energy systems. Our research can inform different aspects of the design, implementation and communication of SES in a number of ways:

- *Heating often contributes towards meeting more fundamental needs of caring for a family and solutions have to, at the very least, meet these basic needs.*

Heating is fundamentally for keeping warm, and comfort is how people can judge whether they are warm enough or too cold and the likely impact of thermal comfort on their health (and the health of others). So comfort is a fundamental need in that sense. Other needs will be more or less distant from this core aim. While heating may be seen as fundamental from one perspective, it can also be seen as subservient to broader concepts and purposes of the home, such as creating a safe and stimulating environment for children or using space to maximise the social interactions amongst household members or guests.

- *Aesthetics appear to be important for large-scale investment decisions, but much less so for more frequent and basic heating behaviours*

The priorities of households vary depending on the frequency of behaviour that is being considered. The research identified frequent (more-or-less daily) behaviours and the order of priorities that people appear to attach to these. In coming up with a short-term solution to a problem, people are prepared to live with something that is imperfect aesthetically, but when they make more significant structural changes or investments, this is more of a consideration.

- *System design must meet fundamental needs, but grabbing people's interest may depend more on what needs they are immediately aware of, which may be those they cannot currently meet.*

We found throughout the research that needs may be prioritised according to what consumers are most immediately able to report or needs that are not sufficiently met. However, with longer to consider and reflect on their use of heat energy and associated behaviours, people are able to describe the essential role of heating in meeting more fundamental needs.

- *Solutions should focus on improving the means by which people meet their fundamental needs, as consumers expect these to be met as a minimum*

All viable smart energy solutions (SES) need to deliver the fundamentals of comfort and health in the first instance. These *ends* are non-negotiable for consumers. In addition, an SES should also be aiming to simplify and enhance the *means* by which people achieve these needs (i.e. more convenient, cost-effective, providing more control). Everyone wants their heating system to

keep them healthy and comfortable, so it is better meeting these other needs that will distinguish one SES from another and for which types of household they are appropriate. These needs may be considered peripheral needs in relation to current behaviour, but they could be crucial to decisions about SES.

Given that the prioritisation of needs is complex, dynamic and variable between individuals and across households and no order can be considered absolute or equally applicable to all households, it is difficult to talk in terms of overall priorities for solutions to meet. For example, personal comfort can be considered “core” but is clearly sometimes sacrificed for domestic harmony. So an informed approach needs to be taken, and the form of prioritisation matched to the purpose for which it is proposed.

More generally, the findings of this report underscore the importance of designing, implementing and communicating smart energy solutions around and starting from an in-depth understanding of the needs of consumers.

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1 Introduction

This report explores the heat energy needs and behaviour of a sample of domestic consumers in the UK. Drawing on a multi-faceted project of qualitative 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.

The Consumer Response and Behaviour project 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 for this 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.

This particular study comprised Work Package (WP) 5.4 and a component of WP5.7 of the Consumer Response and Behaviour project, a primary consumer research programme using a range of complementary techniques. The aim of the study is to understand consumer needs and behaviour in relation to domestic energy usage, and how these vary between different groups in the population.

WP5.4 and 5.7 (qualitative) build 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 four particular work packages:

- **WP5.5 – Solutions Scenarios:** Informing solution scenarios, by providing a diverse set of representative characters or personas with different solution requirements.
- **WP5.7 - Primary Consumer Research (Phase 2 – quantitative):** Helping to inform the design of survey instruments for a mass survey into heat needs and behaviours by providing clusters of need and typical patterns of behaviour to test and quantify, and informing the phrasing of question items.
- **WP5.6 – Model:** Providing detailed case study material to inform modelling work into the impact of current behaviours and the impacts of changes to the household or energy system.
- **WP5.8 - Solution Characteristics:** Providing insight on the consumer perspective on solutions to inform, along with inputs from the wider project, a report on the design of future smart energy solutions from a consumer perspective.

1.2 Study aims and starting points

Work Area 5 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 that aims to inform 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.

This study 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)

A second focus of the WP5.7 qualitative research was to generate insight into the characteristics of potential smart energy solutions, contributing to addressing these research questions:

- RQ7: What is the likely consumer response to potential smart energy system solutions?
- RQ8. How can smart systems meet current and future needs?

The evidence presented within the report is structured and interpreted with the specific aim of answering these questions, although more attention is given to RQ7 and RQ8 in the WP5.8 Solutions Scenarios report, which builds on the findings presented here. 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 of which it is part. At the outset of the Consumer Response and Behaviour project, we adopted a deliberately broad definition of needs to ensure we captured the full range and diversity of goals that people seek to achieve through heat energy behaviours and use. This initial definition understood heat energy needs as what people are aiming to achieve through or as a consequence of using heat energy. This definition encompassed a wide range of needs, from those objectively essential for life, to preferences based on individual perceived requirements or values. The on-going process of research and analysis has enabled us to develop a more nuanced understanding of these needs, that distinguishes between those that are core - physiologically fundamental, and essential for life - and those which are more peripheral, and may be described as 'wants'. We return to a discussion of this when we present the study findings and conclusions.

1.3 Method overview

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 briefly outlines the methods used. A full description of the methods will be provided in a separate Technical Appendix.

The key components of the study design are summarised in the table below and are discussed in the sub-sections to follow. It is important to note that, although a total of 186 households were included in the study, the research team sometimes spoke to more than one individual in some of the households involved in the longitudinal element of the study and so were able to capture additional views.

Table 1.1 summarises the key components of the study design, which are discussed in the next sub-sections.

Table 1.1 Overview of research design

| Component | Target sample | Purpose |
|------------------------------------|--|---|
| 1. Qualitative workshops | 4 workshops, comprising 32 group discussions with 153 participants | <ul style="list-style-type: none"> Group interaction used to surface subconscious behaviours and needs Diary as pre-workshop task to stimulate critical reflection |
| 2. In-home monitoring study | 30 households ¹ recruited from workshops, involved in in-home monitoring and four interviews over the course of 12 months | <ul style="list-style-type: none"> Deeper understanding of needs and behaviours in home context Explore sub-group variation In-home monitoring used to bridge gap between reported and actual behaviour Longitudinal element helps access further depth of insight and insight into transition and change |
| 3. Additional interviews | 33 additional households, involved in one-off in-home interviews | <ul style="list-style-type: none"> Explore sub-group variation among groups not sufficiently represented within 1 and 2 above |

A full overview of the characteristics of all the participants that took part in this study is provided in Appendix A.

1.3.1 Qualitative workshops

A primary objective of the overall study was to carry out a broad mapping exercise of consumer behaviours and needs, involving the general population. A prerequisite of this approach was to ensure that we did not impose a predetermined categorisation of needs or list of behaviours on the design of the research, or assume in advance whether certain groups behave differently. This was where we felt qualitative workshops would add value. They would enable mapping through participant interaction and, with the correct pre-workshop activities (i.e. diary exercises), could help people to reflect more deeply on their energy needs and behaviours.

Four workshops were carried out in total. These were 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. These workshops were carried out during February and March 2013, during the winter heating season, to ensure that heat energy was front-of-mind as much as possible for participants.

Sample design and recruitment

Four workshops were carried out in locations across England, a selection based on specific area-level characteristics. Each workshop involved up to 40 participants, split into groups of 10 for the discussions, with 153 people taking part in total.

As with all qualitative research, the aim was to generate sample that was representative of the diversity of characteristics in the population, rather than one that is statistically representative. 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

¹ All households were drawn from the workshop sample, with the exception of 1, which was drawn from the Additional Interviews sample. Twenty-eight households completed the full four interviews.

incorporated into the sample design for the workshops (and subsequent interviews) as shown in Table 1.2. These aspects of household composition are likely to influence heat energy behaviour (through factors such as variation in needs, routines and occupancy). Additional sample criteria included urban/rural location, whether the home has district heating or is off the gas grid, tenure, property type and social grade. Table 1.2 provides a breakdown of the achieved sample against primary sample criteria.

Participants were recruited through a professional recruitment agency, which used on-street and door-to-door recruitment strategies to achieve target sample quotas.

Table 1.2 Achieved sample

| Primary Criteria | | Category | TOTAL |
|------------------------------|----------------------------|--|------------|
| Household composition | No children living in home | Adults over 60 (single, couples, sharers) | 35 |
| | | Adults under 60 (single, couples, sharers) | 39 |
| | Children living in home | One or more child under primary school age | 39 |
| | | All children over primary school age | 40 |
| Urban/rural | Urban | | 111 |
| | Rural | | 42 |
| Energy/heat supply | Off gas grid | | 22 |
| | District heating | | 22 |

Workshop conduct

Each workshop comprised a 'break-out' discussion session in the morning and afternoon. Each session involved four group discussions with up to 10 individuals in each group. A total of 32 group discussions were carried out across the four workshops.

For the morning sessions, participants were placed in mixed characteristics groups, which aimed to generate a map of heat energy behaviours and needs. Afternoon sessions were segmented by household composition and explored sub-group priorities and interdependencies between needs. Workshops included an additional session to provide information about the in-home monitoring, and to obtain consent for re-contact regarding further participation.

1.3.2 In-home monitoring study

Recruitment and sample

Thirty participants were recruited from the workshops to participate in the in-home monitoring study, carried out over the course of a full year, involving an initial in-home interview and three further interviews that would incorporate data collected through monitoring devices. The sampling criteria for these participants mirrored those of the workshops, with minimum quotas set to ensure diversity for particular characteristics. Table 1.3 provides a breakdown of the achieved sample for this group.

Table 1.3 Achieved sample: in-home monitoring study

| Criteria | Category | TOTAL | |
|---------------------------------|---|--|-------------------------|
| Household composition | No children living in home | Adults over 60 | 6 |
| | | Adults under 60 | 7 (3 single occ) |
| | Children living in home | One or more child under primary school age | 7 (4 under-2s) |
| | | All children over primary school age | 9 |
| Urban/rural | Urban | 21 | |
| | Rural | 7 | |
| Income | < £13k | 7 | |
| | > £50k | 6 | |
| Tenure | Owner occupier | 17 | |
| | Private renter | 8 | |
| | Social renter | 4 | |
| Property characteristics | Flat | 11 | |
| | Built since 1980 | 14 | |
| | Built before 1980 | 15 | |
| | <i>Built before 1980 and income <30k (indicator of fuel poverty)</i> | 6 | |
| Energy/heat supply | Off Gas Grid | 8 | |
| | District heating | 5 | |
| Occupancy | Works at home | 6 | |
| | Works shifts | 2 | |

In-home monitoring

Monitoring equipment was installed in 30 households. All of these households were drawn from the workshop sample with the exception of one household, which was drawn from the Additional Interviews sample to increase the number of low income households in the sample.

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 1.4). Monitoring equipment communicated wirelessly with a central hub in each home, which in turn transmitted data periodically to a secure cloud server.

Table 1.4 In-home monitoring sensors and associated behaviours

| Behaviour | Sensor(s) involved | Details |
|------------------------|--|---|
| Heating patterns | Multi-sensors (temperature) and temperature loggers on radiators | Time-stamped data indicated internal temperatures and periods when radiators were turned on, 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 or routine 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) and electricity clamp | Observing spikes in electrical consumption and temperature/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 space heating | 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. |

Data were then downloaded and subjected to analysis and interpretation, with reference to what was already known about the household's heat energy system and use from the initial interview.

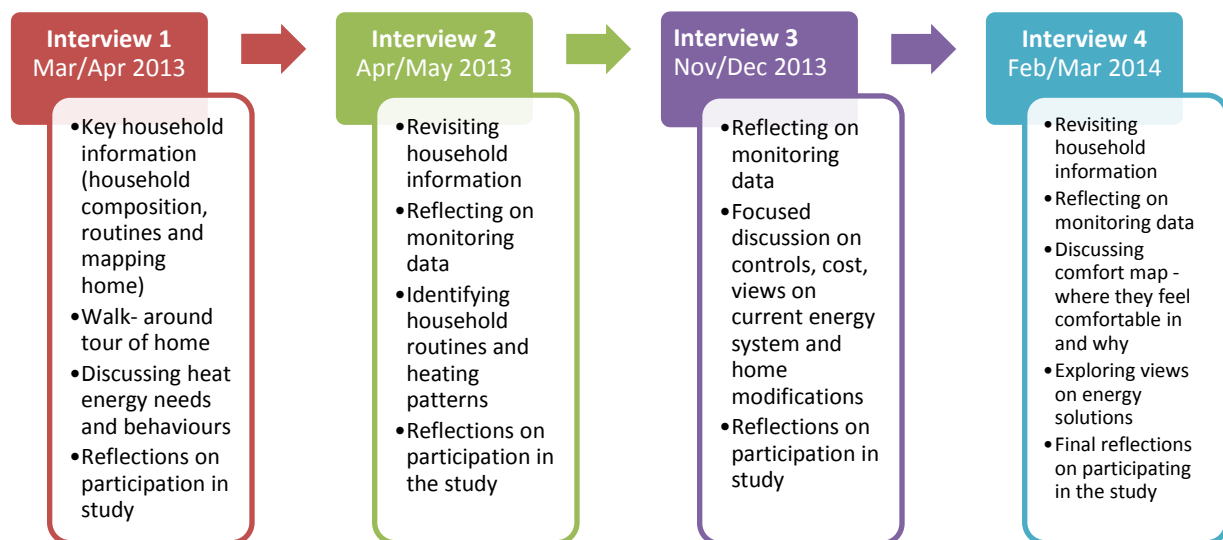
A bespoke set of information was produced for each household, including heating and occupancy patterns, ventilation behaviours, cooking and washing, and wasted energy. This took both narrative and graphic form. Table 1.4 documents key information that we aimed to produce for each household. It should be noted that, in practice, there was variability in how much information was actually captured.

Interview conduct

Initial one-hour interviews were carried out 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. These initial interviews were carried out in March and April 2013.

The second, third and fourth interviews were carried out during April/May 2013, November/December 2013 and February/March 2014 respectively. These interviews were 'data-led' and incorporated feedback and discussions informed by the monitoring data, selected from the month preceding each interview. Figure 1.1 below summarises the timing and content of the interviews.

Figure 1.1 Overview of the timing and content of interviews



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 and used to prompt reflection and discussion. The third and fourth interviews were carried out, wherever possible, in pairs by a member of the social research and technical team respectively.

While the research study 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.

Consolidated case studies

A key objective of the second phase of qualitative primary consumer research was to consolidate our understanding of a sub-set of the 30 homes in the In Home Energy study, through further analysis and synthesis of existing data, and through on-going data collection.

To further this goal, we brought together and overlaid social data (collected by social research team), energy and environmental data (collected via monitoring devices), and property data (collected via installers) to yield rich, in-depth insight. While largely an analysis task, these case studies were developed as an active and on-going dialogue among research partners and participants, and additional data were sometimes collected on a bespoke basis when gaps in a case study were identified. This process of targeted investigation yielded another kind of data, which we have termed 'forensic data'.

Only a sub-set of the homes could be subjected to this level of interrogation, given their resource-intensive nature. Eight were selected to reflect diversity across a range of characteristics. These included: household composition and decision-making 'type'; property age/type; heating system; area type; tenure; and household income. We also included cases where participants experienced specific health conditions or who were in fuel poverty and those where changes in the physical characteristics of the property (e.g. home modifications) or the composition of the household (e.g. birth of a child) were expected during the course of the year. The final consolidated case study outputs form an appendix to this report, and the sample characteristics are included in Table 1.5.

Figure 1.2 Consolidated case study data

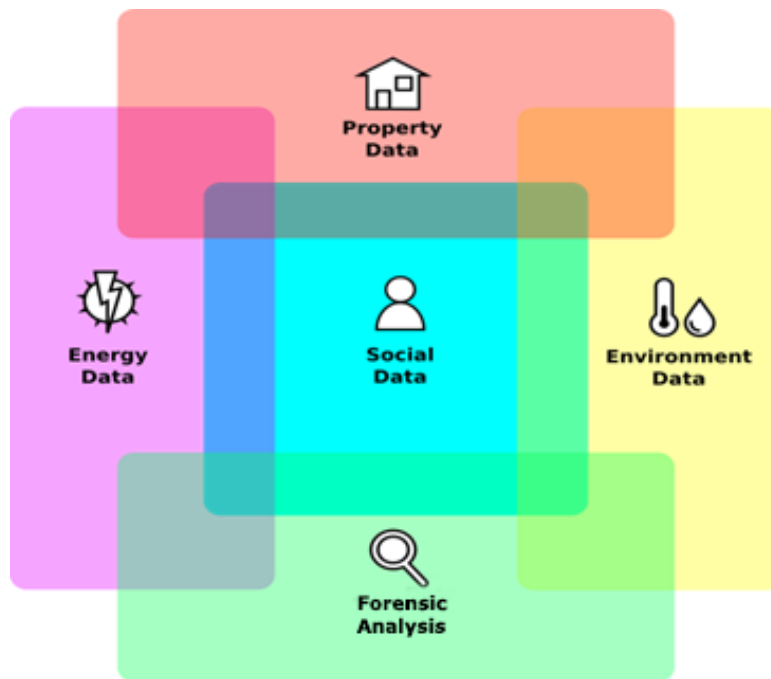


Table 1.5 Consolidated case study sample

| Case | Household Composition | Age (primary Participant) | Income | Tenure | Heating system | Property type | Location |
|------------------------------------|---|---------------------------|--------|----------------|--|--------------------------|----------|
| Child-focused family | Couple, two young children | 36-45 | Med | Private renter | Gas central heating | Pre-1980, detached | Urban |
| Health-conscious father | Couple (wife absent long term), school aged child | 60-75 | Low | Owner | Off grid, oil boiler central heating | Pre-1945, semi detached | Rural |
| Limited mobility | Single occupant | 46-59 | Low | Social renter | District heating (with controls) | Pre-1980, flat | Urban |
| Adult single sharers | Four single sharers | 18-35 | Med | Private renter | Gas central heating | Pre-1980, flat | Urban |
| Health-concerned single | Single occupant | 60-75 | Low | Social renter | Storage heaters | Pre-1980, flat | Urban |
| Business from home | Couple, two teenage children | 46-59 | High | Owner | Gas central heating | Post-1980, semi detached | Urban |
| Semi-retired/working couple | Couple | 60-75 | Low | Owner | Gas central heating | Post-1980, detached | Suburban |
| Multi-generational family | 10 people, including lodger and elderly relative | 46-59 | High | Owner | Off grid, water under-floor heating system | Pre-1945, detached | Rural |

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 or sufficiently represent 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 around 30 additional in-home interviews to ensure that groups who were not 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, homes with a heat pump, and homes with district heating).

Table 1.6 provides a breakdown of the achieved sample. A total of 33 additional interviews were carried out.

Table 1.6 Achieved sample: Additional in-home interviews²

| Criteria | Category | N (Total = 33) |
|--------------------------------------|--|----------------|
| 1. Socio-demographic characteristics | Aged over 75 | 3 |
| | Time poor / high earners | 4 |
| | Fuel poor (defined as pre-1980 home, and household income below £13k) | 4 |
| | Single occupancy professionals | 4 |
| 2. Energy features | Well insulated homes | 4 |
| | Heat pumps | 8 |
| | - Air source heat pumps | 4 |
| | - Ground source heat pumps | 4 |
| | District heating³ | 14 |
| | - Metered | 1 |
| - Unmetered | 11 | |
| - Undetermined payment set-up | 2 | |
| - Control at household level | 13 | |
| - No control at household level | 1 | |

A range of recruitment approaches, appropriate to the target sample, was used:

² Full details of recruitment approaches for these interviews are described in the WP5.4 Qualitative report.

³ Of the 14 individuals in the District Heating sample, 8 were drawn from the main stage sample and an additional 6 were recruited separately as a top up

- Participants were selected based on specific socio-demographic characteristics (Criterion 1) and drawn from the British Social Attitudes Survey⁴ respondents, using an opt-out approach.
- Participants in energy-efficient homes were recruited via Peabody (a registered social landlord), using an opt-in approach. Participants were all social renters.
- Air source and ground source heat pump participants were recruited via the Energy Saving Trust (EST), with support from the Department of Energy and Climate Change (DECC), using an opt-in approach.

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 well insulated 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 from June to December 2013.

1.3.4 Assessing the evidence

No single method can provide all the answers to any given research questions, so a number of qualifications should be made regarding the qualitative methods presented here. Qualitative samples are not intended to be, nor can they be, statistically representative of the population, rather we are providing a comprehensive picture of the range of needs and behaviours. We were aware that the process of participation in the research might also influence how people think about their heat energy use. The findings reveal a lot about the range of ways in which people prioritise heat energy needs, but further research is required to understand how prevalent these priorities are in the population as a whole. In relation to groupings of needs, the qualitative research did not focus on which needs people try to meet at the same time, or how they are related conceptually, although it does provide some evidence on this. The quantitative research will do this systematically for a larger and more representative sample, although with much less insight into the reasons for groupings.

Despite the extensive nature of this research, there are areas relevant to an overall understanding of heat energy needs and behaviour that we do not understand as much about. In particular, although we have a good general understanding of needs and behaviours related to heating water and using hot water, this is not systematic. Equally, although the interviews we conducted were led by objective monitoring data and took place 'in-situ' in the homes of participants, our understanding is based on reported behaviour. We have not conducted ethnographic or observational research as part of this project, which would allow us to view first-hand how and when households change their behaviour and in relation to what needs. However, given the fact that heating is typically in the background of people's daily lives, observation or ethnography would be very inefficient: the researcher may have to remain in situ for a long period of time before collecting any useful data. Technological advances are making this kind of research more feasible – notably the *SenseCam*⁵ – and this may be an avenue ETI wishes to explore further in the future.

Some of the evidence collected as part of the qualitative consumer research programme is presented more fully elsewhere:

- Evidence collected via the qualitative consumer workshops as part of Work Package 5.4 - Primary Consumer Research (Phase 1) activities is documented in depth in D5.4 Primary Consumer Research (Phase 1) narrative report.

⁴ British Social Attitudes is a nationally representative cross-sectional survey of attitudes run by NatCen for the last 31 years. Respondents to the survey are asked for consent to be re-contacted by NatCen for further research.

⁵ SenseCam is a wearable camera with a wide-angle lens that takes periodically photos without user intervention. It also has applications that measure temperature and can incorporate a GPS tracker: <http://research.microsoft.com/en-us/um/cambridge/projects/sensecam/>

- A more detailed account of findings from the Additional energy systems interviews is documented in D5.7 (iv) Findings Paper on Additional Interviews.
- Further evidence relating to RQ7 and RQ8 collected via the qualitative primary consumer research programme will be presented in “*Smart Energy Solutions - The Consumer Perspective*”, an output of Work Package 5.8 - Solution Characteristics which details key insights to the design of future smart energy solutions based on inputs from the wider project.
- A more detailed technical overview of the monitoring element of the study is provided in “*Environmental Monitoring to inform Social Research*”, an output of Work Package 5.10.

1.4 Report overview

The study findings are presented across two substantive chapters.

Chapter 2 aims to provide a rich description of a sub-set of needs identified as those typically driving day-to-day behaviour. It presents a deeper understanding of the meaning and relative importance of these needs to people in the context of their daily lives. Following this, the chapter discussion gives an overview of a dynamic and interacting set of contextual factors – people, property and system factors - that affect which needs become a priority in a given household at any given time, and how these influence behaviour.

Chapter 3 builds on our understanding of consumer needs and behaviour, but shifts the focus towards solutions and their uptake. The chapter provides a deeper understanding of existing systems, how people experience, use and adapt to them, and explores when and why people do – and do not – take up new solutions.

The concluding chapter then brings together the findings, drawing out key insights and implications for the design, implementation and communication of SES. We also give consideration to the research strengths and limitations, and how it fits with, adds to and complements other research activities in the Consumer Response and Behaviour programme.

2 Consumer needs and associated behaviours

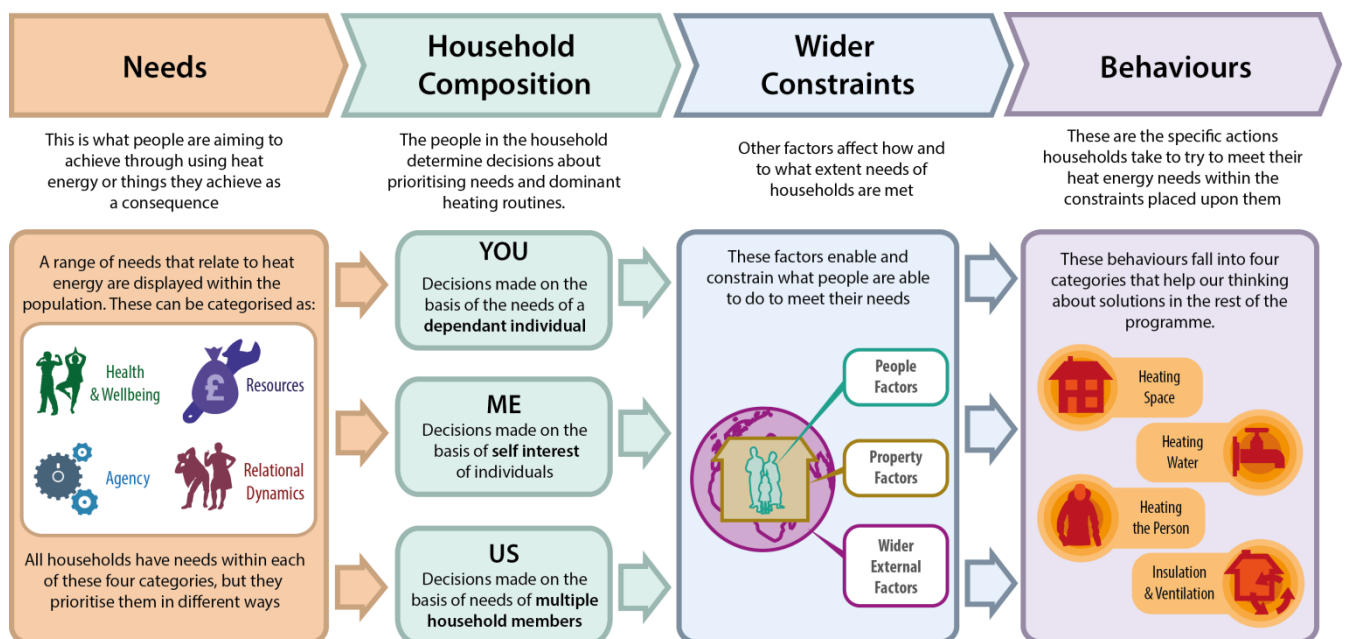
Fundamental to the successful design of any new approach to providing energy for domestic consumers is an understanding of the needs those consumers are meeting (or seeking to meet) through energy use, and the behaviours and technologies through which they currently address those needs. If these are not well understood, the design may fail to meet consumers' needs or conflict with how consumers wish to behave. This chapter provides a recap of findings presented previously, and updates these with new evidence and insights developed through the on-going research.

2.1 Introduction

2.1.1 Understanding consumer needs and behaviour: The story so far

During the first phase of primary consumer research, Work Package 5.4 in the Consumer Response and Behaviour Project, focus was placed on mapping the wide range of needs that people seek to meet through heat energy use, linking these to the similarly wide range of behaviours and technologies through which they address these. Our initial thinking of how this fitted together is illustrated by figure 2.1 and explained in detail in the Work Package 5.4 report.

Figure 2.1 Explanatory framework of heat energy needs and behaviours



As part of this first phase of research, we developed an overarching categorisation of heat energy needs drawn from the way participants had described their needs in the workshop sessions in the first stage of qualitative research. A long-list of needs was generated by participants through group discussion. Subsequent thematic analysis organised the needs under the headings recorded in Table 2.1.

Table 2.1 Work Package 5.4 Categorisation of needs

| | |
|--|---|
| <p>1. Health and well-being</p> <ul style="list-style-type: none"> • Health • Comfort • Keeping clean • Relaxation and invigoration • Avoiding harm • Ambience and aesthetics | <p>2. Resources</p> <ul style="list-style-type: none"> • Finances • Waste • Property maintenance |
| <p>3. Agency</p> <ul style="list-style-type: none"> • Convenience • Control • Routine & Habit | <p>4. Relational dynamics</p> <ul style="list-style-type: none"> • Social interactions with household members • Social interactions with guests • Social interactions beyond the home • Wider implications of energy use |

Based on which of these factors are in operation, we found that any given household could be classified as one of three ‘types’, each characterised by a distinct combination and prioritisation of the four needs categories. The typology defined 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
- *ME* – decisions made on the basis of the self-interest of individuals
- *US* – decisions made on the basis of needs of multiple household members

The typology served to illustrate high-level patterns of behaviour and made it easier to understand the complexity of household needs and behaviour. However, the typology did not explain every specific element of behaviour within a given household. We identified another set of factors that comes into play to further constrain and enable what people can actually do. These are cross-cutting factors that could potentially affect any household, and operate at the level of the individual (e.g. personal preference, knowledge and beliefs); the household (e.g. energy system and property characteristics, tenure, and finances); and the wider external environment (e.g. regulations and weather).

Figure 2.1 provides a conceptual model to help observers think through all the components we identified in the first phase of our qualitative research. The second phase of the study has allowed us to test and further refine this working explanatory framework for behaviour developed through the first phase of research. The longitudinal element of the study over the period of a full year enabled us to explore how behaviour and needs change over time, in the context of seasonal transitions and people’s life transitions. The on-going nature of the in-home monitoring study, complemented by the insights gleaned through the supplementary interviews among diverse social groups and energy systems, also allowed us to develop a deeper understanding of consumer needs, how these are prioritised, and how people meet these needs through a range of behaviours and technologies.

2.1.2 Understanding consumer needs and behaviour: The next chapter

The second phase of the study, Work Package 5.7 (Qualitative) in the Consumer Response and Behaviour Project, has enabled us to build on and advance insight in a number of key ways.

Spending time with 30 homes over the course of a year, complemented with interviews in over 30 additional homes, enabled us to isolate a relatively confined and constant sub-set of eight needs that consistently come to the surface and drive day-to-day behaviours across the sample.

These eight needs, which will be explained in detail in this chapter, cover the four overarching categories identified previously: wellbeing (i.e. comfort and health), resources (i.e. cost⁶ and waste), agency (i.e. control and convenience) and relational dynamics (i.e. harmony and hospitality⁷). These are depicted in Figure 2.2.

Figure 2.2 Consumer needs



Figure 2.3 Prioritisation of needs



The on-going research also enabled us to identify patterns and consistencies in the way that people in our sample prioritised this sub-set of needs. Our evidence suggests (described in detail in Chapter 2) that these needs exist along a continuum of priority depicted in Figure 2.3. Some are core needs - physiologically fundamental, and essential for life - while others are more peripheral and better described as 'wants'.

More peripheral needs only become front-of-mind or come into focus once core needs have been met sufficiently or when others enter the home; only then do they appear to begin to influence and drive behaviour. Simultaneously, as core needs are met, people may become less conscious of these: we found that people were less likely to articulate, and required far more prompting on needs that were met and, conversely, tended to be highly vocal about needs which were not being met adequately or which were perceived to be out of their control. There are a handful of occasions where more peripheral needs take priority over core needs, but this is only when people break their routine behaviour or when household composition changes temporarily. These examples are highlighted throughout the subsequent sections.

This chapter aims to provide a rich description of this sub-set of needs. It begins by presenting a deeper understanding of the meaning and relative importance of these needs to people in the context of their daily lives. Following this, the chapter discussion gives an overview of a dynamic and interacting set of contextual factors – people, property and system factors – that affect which needs become a priority in a given household at any given time, and how these influence behaviour.

⁶ 'Cost was previously labelled 'Finances' in WP5.4 categorisation of needs.

⁷ 'Harmony' and 'Hospitality' were previously labelled 'Social interactions with household members' and 'Social interactions with guests' respectively in the WP5.4 categorisation of needs.

2.1.3 Definitions and key terms

This study represents one of the first systematic attempts to understand heat energy behaviour in terms of what consumers are trying to achieve. At the outset of the Consumer Response and Behaviour project, we therefore adopted a deliberately broad definition of needs to ensure we captured the full range and diversity of goals that people seek to achieve through heat energy behaviours and use. This initial definition understood heat energy needs as what people are aiming to achieve through, or achieve as a consequence of, using heat energy. This definition encompassed a wide range of needs from those objectively essential for life, to preferences based on individual perceived requirements or values. We have further advanced our understanding of needs through the course of the study, and this has enabled us to develop a more nuanced definition of these, which will be presented later.

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 *four domains*: space heating; heating water; heating the person; and ventilation and insulation. Space heating involved the use of a range of heating sources, which can be further categorised as primary and secondary heating sources. 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.
- *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. 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), rare (perhaps only once during a person's occupation of a home) or occasional (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. Focus in this chapter is placed on frequent, day-to-day behaviours, while occasional behaviours, such as one-off investment decisions, are considered in the Chapter 4.

We should note here that managing overheating (in winter) and cooling behaviour (in summer) are given attention alongside heating behaviour, where relevant data was available.

2.2 Wellbeing

This is an important category of needs, which our evidence suggests are fundamental. The main needs that feature within this category are **health** and **comfort**. Given their fundamental nature, these needs are in some instances taken as a given – e.g. keeping warm and comfortable and keeping self and family healthy – and may be so deeply embedded in daily habits and routines that people are not always conscious of, and may not articulate these as needs.

This category of needs may be distinguished from the others in that they are focused on what people want to achieve through heating – the *ends* – while the other categories relate to how – the *means* by which - people want to achieve these ends. We return to this point, and draw out its significance later.

It can be useful to see health and comfort as gradations of need within the well-being spectrum, and in some instances similar behaviours can contribute towards meeting both categories of need. The difference lies in the highly physiological base of health and relatively functional behaviours, compared with comfort which has a physiological and functional dimension but also a highly symbolic one, which also has an influence on behaviour. Even here, however, the role of care giver as a custodian of health and comfort in the home spanned both of these wellbeing needs.

2.2.1 Health

- Health as a need is focused at the very basic physiological level, **a fundamental need that is essential for life** and expressed through behaviours that serve a functional purpose.
- Health-oriented behaviours can be focused on **self or others** (occupants and/or guests). When focused on others, caring for one's family, rather than heating, may be the higher level purpose served by behaviours.
- For **households in general**, it may not be expressed as a conscious need as health needs are largely met through comfort strategies. Behaviours geared at health are often less conscious, reflexive habits and routines e.g. daily cleaning routines or patterns of window opening.
- Among **households with a vulnerable individual**, health is a conscious priority and we tend to see a very narrow range of needs. Health conditions result in highly specific requirements and behaviours. Where vulnerability is life-stage related (infants and the elderly) there are more obvious patterns of behaviour, which are often highly planned and considered.

Health as a need is focused at the very basic physiological level, a need that is essential for life. It tends to be expressed in behaviours that serve a very functional purpose. However, it can also be expressed in terms of self-image and the role of carer, as with comfort, and does in this sense have a symbolic level too.

Our evidence suggests that health is a fundamental need for all households. It is expressed in day-to-day routine behaviours involving hot water (e.g. cleaning self and home), heating (e.g. keeping the home at a 'healthy' temperature) and ventilation (e.g. keeping a window open for fresh air).

However, health as a need features more in a specific set of households, and involves a more strategic approach to meeting this need. An explicit need for health is most apparent among households with infants and young children, with elderly occupants with a certain degree of frailty, and households with occupants who have a specific health condition.

When it comes to prioritisation of needs, health trumps all. For households with heat-related concerns, their top priority is to address these. Other needs therefore feature less prominently or feature as 'wants' that are not realised. Alternatively, they may feature in behaviours when these do not compromise health-oriented needs and strategies that meet these. Health as a need is less visible in households where there are no direct heat-related health concerns. For these households, comfort strategies tend to encompass health-related needs too, and people are less conscious of (and therefore less likely to articulate) the health needs that these serve.

In households with occupants with a specific health condition, this can result in very particular requirements and behaviours. For example, the **limited mobility** household included a single occupant with complex needs relating to a physical health condition. His medication causes him to overheat, and most of his behaviours are focused on cooling. This is a challenge, as the property temperature is higher than average, most likely due to solar gain as well as peculiarities of the communal heating system. He keeps his bedroom cool and dark by using blackout curtains, keeping the thermostat on low, and using a fan and opening windows to get a cool blast of air when he wants it. As a result of his condition, he has to wash clothing and bedding frequently, which he dries in the

bathroom. He has to keep the window open constantly to counteract high humidity levels caused by this. The bathroom radiator is kept on the highest setting to counteract cold air from the window, and to ensure that clothes dry quickly.

In households where health-related behaviours are oriented around people who have particular health requirements due to their life stage (very young and very elderly) we see more obvious patterns of behaviour. These are listed below, and then exemplified in greater details in the following paragraphs.

- Frequent use of **primary** heating system, often in combination with **supplementary** heating as a 'top-up' e.g. electric blankets or extra blankets in baby's room (idea that vulnerable people 'need' to be warmer).
- **Pre-emptive** heating e.g. turning on heating in anticipation of need for it or **reactive** heating, responding to perceived discomfort due to temperature. Alongside this, a desire for a highly responsive system.
- Distinctive **control** strategies e.g. heating timed to align with the routines of the vulnerable individual, active temperature control and monitoring; and zoning (where system allows it) to prioritise heating needs of vulnerable occupant in the spaces that they occupy, and also meet different preferences of other occupants.
- Needs may be expressed through **day-to-day behaviours** discussed above, and **one-off investments** and home modifications (discussed in Chapter 4).

Pre-emptive behaviours and desire for a highly responsive system featured among households with very young children and infants. 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." (Household with children under school age, owner occupier, detached property, high income)

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

Monitoring Insight: What people need and what they actually do - *Despite what people may say about the heat energy needs and priorities, their actual behaviour may not serve to meet these needs due to a lack of knowledge or misperceptions about how to do so.*

There is some evidence that even engaged and concerned households can lack understanding of how to use their systems to create healthy environments and, in some cases, create environments which could aggravate the very health problems that they are trying to manage. In **N31 health conscious father**, a father of a young daughter with asthma expressed a concern that radiators would create dry air, which may aggravate his daughter's asthma. He aimed to control this by placing containers of water on top of his radiators. The monitoring data, however, revealed that humidity levels in the home were typically excessively high (on average over 75% in most rooms) – a level that places the home at high risk of mould and dust mites – both of which are known to exacerbate asthma. In this case, the monitoring data revealed a mismatch between the desired and actual outcomes of the consumer interaction with the heating system and highlighted a lack of awareness in what constitutes a healthy internal environment.

Active temperature control, and temperature monitoring, was also apparent. For example, in the **child-focused family** household, the wife was pregnant and then gave birth to their second child during the course of the study. Before the birth, they renovated the spare room, painting it and adding a radiator which is a newer model than those in the rest of the home. When the baby was born, they re-introduced the temperature monitor that they used when their first child was a baby to ensure the temperature is 'just right'. The heating is set to a timer mapped against the young children's routines. The parents considered changing it to align better with their work routines, but have not as the noise

might wake the baby. They often find the home too hot but will sacrifice their own comfort for the health and wellbeing of their children.

Among older participants, health and comfort appear to come into focus during retirement, due to both changes in routines as well as physiological changes. The **semi-retired/working couple**, for example, are entering retirement and now use the heating system more as they prioritise health in their retirement years. The main participant had retired although her husband is still in work part-time. Heating is still controlled via a timer but now is often interrupted. The participant is keen for them to either adjust the timer settings or take it off the timer completely, as she now spends more time at home. She will at least once a day press the 'boost' button on the boiler to kick-start the system in between timer hours. Similarly, the **active empty nesters** have also recently retired. As a result, cost is becoming more of a concern yet, simultaneously, they have become more conscious of needing warmth and comfort at home – both because they're spending more time at home but also because they are starting to feel the cold more and their bodies are becoming achy.

Zoning was also a feature, where systems allowed this. This was particularly important where other household members had different needs, and allowed for these to be met while still prioritising the need of the dependent individual.

For example, in the **limited mobility** household, although the occupant lived alone, he 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. Similarly, in the **choice family**, 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 thermostatic radiator valve (TRV) in that room was turned down or 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, to suit their personal temperature preferences.

As these examples indicate, decision-making in these households centres on the need of household occupants with health requirements. Health-driven behaviours may also come into play in response to visitors, however. This is particularly apparent when family members, such as elderly parents or grandchildren visit. For example, one individual turns up the heating when his 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." (Household of adults over 60, owner occupier, semi-detached property, low income)

Similarly, in the **wealthy empty nesters** household, 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." (M23 – wealthy empty nesters)

Household decision-making around choice of heating source as well as behaviour patterns were sometimes driven by risk-averse tendencies, particularly evident among those with young children. For example, the **risk-averse planner** had particular safety concerns over gas central heating relating to potential gas leaks and the fire hazards these would pose for her family. She therefore 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 - and demanding further 'top up' and pre-emptive behaviours, such as turning on an electric heater in the child's room. She also only opens windows that are upstairs and high enough to avoid children falling out. Likewise, in the **choice family**, the participant said that he had made major home modifications when he knew his wife was expecting,

with child safety his main concern. This included extending the living room, installing a new gas boiler, and rewiring and re-plumbing the home.

In general, health-driven behaviours made in the interest of an individual with health requirements are **highly planned and considered**. Even when oriented around visitors, for only temporary time periods, people take up conscious and considered strategies to adjust to these moments. Conversely, health-driven behaviours that are oriented around healthy occupants tend to be less obvious, less conscious and reflexive, and were sometimes simply part and parcel of comfort strategies, which are discussed next.

2.2.2 Comfort

- Comfort as a need encompasses a **wide range of meanings and associated behaviours**. It had physiological, psychological and symbolic dimensions.
- **Physical comfort** related to achieving thermal comfort (being neither too hot nor too cold), important for **rest, work and leisure at home and psychological well-being and happiness**.
- Comfort was also linked with **concepts of the home** as a place of personal freedom and choice. Use of heating in the home was considered a similarly personal matter. Comfort in the home was referred to as a 'right', and heating seen as a 'necessity' likened to food.
- Comfort appears as a core or **fundamental need**, and rarely compromised except in the interest of prioritising the health or comfort needs of others in the home. It is rarely traded off for more peripheral needs, except when this involves very little discomfort within a highly limited timeframe.

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 in later sections of this chapter, including the drive for freedom, control and convenience within the home.

Physical comfort related to achieving thermal comfort – being neither too hot nor 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." (Household of adults under 60, owner occupier, semi-detached, high income)

"If we were too cold we'd not be able to concentrate and enjoying relaxing and things... and if we were too hot we'd not be able - so it's important that we have correct temperature then we can enjoy films and movies and relaxing ... Human beings can't work or have leisure if temperature wrong, can't do it." (Adults under 60, owner occupier, terraced property, low income)

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 to be 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, 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).

"... when I were 20 I were always hot, but.....but as I'm older now at 55... Your body changes as it gets older and ... I think really old people don't always know when they're cold." (Adults under 60, owner occupier, terraced property, low income)

Comfort was also linked with *general psychological well-being and mood*. People spoke of using a range of behaviours to stimulate a positive mood and 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?" (Y27 – business from home)

“Heat is part of comfort and happiness, you know.” (N31 – health-conscious father)

Comfort was also charged with symbolic meaning, linked with notions of the home as a place of personal freedom and choice:

“[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...My choice is to be as warm as I feel comfortable with [in my home]. It's like, that's why I do it.” (Household with school age children, owner occupier, semi-detached property, medium income)

Participants spoke of the home as a place where comfort is a ‘right’ that should not be compromised, evident in comments such as “homes should not feel cold ... life's too short to be sat in the cold” and “the home should be a comfortable place”. One participant likened a cold house to a “dead house” while a “warm house” has love, comfort and children. Comfort was alternatively described by some as something that had been “deserved”, “earned” or a reward at the end of a productive day, week or lifetime:

“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.” (Household of adults under 60, owner occupier, flat, medium income)

“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.” (Household of adults under 60, owner occupier, semi-detached property, medium income)

Comfort is rarely compromised, and considered a fundamental need and even a right by some. Heating was spoken about in terms of being “compulsory”, “essential” and as a “necessity” likened to food. The priority attached to comfort in the home, and the importance of heat in facilitating this, is perhaps best illustrated when understood in relation to other needs, particularly cost, which is discussed later (see 2.3.1).

We identified only a few instances where comfort may be compromised voluntarily. This may be the case where an individual sacrifices a degree of their own comfort for the health or comfort needs of others. For example, when a young child or elderly relative visits (as discussed in 2.2.1), people may compromise their own comfort for the health of these groups who are considered particularly vulnerable. In the **business from home** household, the participant generally seems happy to sacrifice his own comfort for that of the others in the home, to keep them happy – for example, having the bedroom window closed means kicking off the bedcovers and sweating so that his wife can be “nice and toasty warm”. The participant says that he sometimes finds the heat “overpowering”; when it gets “too much” he may lie down on the living room floor too cool down, or retreat to the back room alone and turn off the TRV. But he only intervenes in a way that serves his own temperature preferences when his youngest daughter displays signs of discomfort (e.g. she retreats to the garage to cool down).

As aside from the need to promote or maintain household harmony discussed above, we did encounter other rare instances where people appear to trade on the core need for comfort for one of the more peripheral needs – e.g. convenience, or hospitality - but this tends to be only when this involves limited discomfort during a limited timeframe. For example, the **single mum** feels that comfort is important because she grew up in a cold home. However, she has not learned how to adjust her timer to ensure that the home does not overheat in the morning on weekends. As a result, she feels some discomfort during these times – but finds it easier to tolerate this than to learn how to use her timer. Contrasting with this, when her boiler broke down, this was considered too much to bear, and she replaced it within a week.

2.3 Resources

Resource-related needs included **cost** and **waste**. While the other needs discussed in this chapter tend to feature as needs that people actively *seek* (e.g. comfort, health, convenience), resource-related needs tend to feature in terms of *avoidance* (e.g. reducing cost and avoiding waste).

Contrasting with wellbeing needs, which can be seen as the *aim* of a behaviour, resource-related needs can be seen in relation to the *means* by which an aim is achieved i.e. a behaviour that enables an individual to meet their comfort needs (aim) in a resource-efficient way (means). While the aim (e.g. comfort) can be seen as having a higher priority, the means might be closer to people's consciousness. Accordingly, we may see cost articulated as a need quite vocally – sometimes more so than comfort and health - but this does not necessarily mean that this is a more fundamental need.

2.3.1 Cost

- People take up various strategies for managing cost concerns. One group involves **management of finances** rather than heating use e.g. cutting back elsewhere in the household, or payment options that help people manage their energy spend. These strategies reflect the relative importance people attach to comfort over cost,
- Another group of strategies involve **adjustment of heating use** in the interest of reducing spend and/or getting better value for money. As a general rule, cost considerations only begin to influence heating use once health and comfort needs are met sufficiently, and heating use will not be adjusted in a way that compromises these core needs.
- In exceptional cases, evident among fuel poor households, **dramatic adjustment of heating** strategies is made in the interest of minimising energy spend. Alongside this, people find ways to maintain a basic level of comfort, which is understood in very functional, physiological terms.

Cost featured powerfully in discussions, and people frequently complained about energy prices loudly and vocally. However, while clearly a concern, in practice, people nonetheless tend to **prioritise comfort above cost** - reflected in both their talk and their behaviour.

Participants rationalised spend on comfort through a variety of ways that were linked with ideas of the home (e.g. there is “no point” in saving money if you have to live in a cold home; by appeal to the idea that people should be able to do as they wish within the privacy of their own home, without constraint) and notions of comfort as a necessity, “essential” or “compulsory” and the idea that “you can't put a price on comfort”. For example:

“I want everybody in the house to be happy and not have to think, oh, I can't turn the heating on because we can't afford it, you know? ... I mean, it is down to cost, I don't like having the heating on if we don't need it on, you know? But if somebody's cold I wouldn't say, 'Oh, you can't put it on', you know, so...If they're cold, they're cold, and you'll not wanna be uncomfortable in your own home, you know?” (Y27 – business from home)

“The home should be a comfortable place; it shouldn't be a place where you should be making economies and living frugally...” (Household of adults over 60, owner occupier, semi-detached property, low income)

Many of the strategies people take up to avoid compromising comfort for cost do not involve management of heat energy use, but rather **management of finances**. Discussions suggest that this is in the interest of avoiding a compromise on the comfort of themselves and their families.

A key strategy here involved **making adjustments elsewhere in the household budget**. For some, this involved cutting back on things considered non-essentials or “luxuries” such as holidays, new clothing, or “fancy” food brands. For example, the **single busy mum** with a young child said that, while cost is a concern she will pay whatever the bill is because she “needs it”. She is on a limited income, so if costs continue to rise she would have to forgo “little luxury type things” – such as new outfits or weekends away – whereas heating is an “essential”.

Some conversations suggested that people are more willing to adjust and compromise on their other routines and habits than adjust their heating practices. One individual explained:

“Well it has an impact on everything doesn't it really because it has an impact on your household budget. So summit has to go if, if [energy prices] goes up and it costs me another £20, that's £20 that's got to come from somewhere, so it's either got to come off your shopping ...or you don't go out ... You have to adjust. It's like, you don't have roast beef on Sunday dinner. Instead you buy mince because it's cheaper ... But it's a matter of making the best of what you've got ... You just, you change your habits. You change what you do.”
(Household of adults under 60, owner occupier, terraced property, low income)

Another strategy included taking up **payment options** that enable people to manage their energy spend without adjusting their heating behaviours, such as fixed payments or tariffs.

Interviews with people on unmetered set-ups in district heating blocks were revealing in this regard. A constant supply of heat and hot water at a fixed cost was seen as beneficial in a number of ways. People liked that the (typically weekly) instalments were always the same, as this helped them to budget more easily. Once they had made the payment they could ‘forget about it until the next payment point. Some participants also liked that they could use as much heat or hot water as they needed without having to worry about being sent a bill that they could not afford. This was particularly important to one of the participants with a long-term health condition, who did not want to have to worry about heating bills on top of this.

However, people do not seem to like the idea that they might, in effect, be contributing towards someone else's heating bill (and paying for more than they use; and for overall), and some were concerned that this arrangement encouraged waste (discussed in 2.3.2). Where comfort needs were not met, this convenient, worry-free set-up was also viewed less positively. This was evident among participants who paid a flat rate but who did not have the control or responsiveness they would like from their system. For example, one individual liked paying a fixed amount as it helped her to budget, but did not feel she was getting value for money as she did not feel her heating was effective enough. She feels she is “paying way too much for this rubbish heating system” and also resents having to pay for an oil radiator on top of her main heating system.

A second group of strategies involve **adjusting heating practices in order to reduce spend and/or getting better value for money**. These include minimisation strategies (i.e. strategies geared at reducing the amount of heat energy used, for example, restricting use of primary heating system, and potentially substituting with more cost-effective options such as extra clothing) and maximisation strategies (i.e. strategies geared at making the most of the heat energy they use, for example, window and door opening behaviours used to retain and disperse heat, or using a single device to serve multiple functions e.g. using radiators to dry clothes when they are on anyway, or using the oven to heat the kitchen while cooking in place of central heating). Strategies may also include ways of keeping track of energy use and spend, for example, through the use of energy monitors or meters.

As a general rule, we found that cost considerations will not begin to affect heating behaviours until needs for health and comfort have been sufficiently met, and that cost saving strategies will tend not to compromise health and comfort levels. For example, the **builder**, who lives with his wife and two teenage children, sees heating as a necessity, along with food. He feels his family “deserve” to be warm, and costs are clearly a lower priority than the comfort and wellbeing of his family. He is nonetheless motivated to reduce costs – to avoid profiting energy companies, and to save money to spend on other things like holidays. The strategies he takes up do not affect comfort levels though – for example, not boiling the kettle unnecessarily or adjusting TRVs. However, people do not appear to like the idea of facing restrictions on their heating use. Even in households with limited means, people seem to face tensions between the need to manage their energy spend by keeping a watchful eye on and restricting their heating use on the one hand, and the idea of the home as a place of freedom and comfort on the other.

The **multiple boilers** household, for example, was struggling with heating bills, and went onto a fixed rate and lower tariff to manage this. They have also invested in an energy monitor that lets them know what they are using and when the heating is on, which they use to manage the amount of money they are spending. However, they think of their health more than bills – the participant's husband says “as

long as you're warm, sod the bills for heating, put it on". The participant maintains that she would not like it "if someone said you can't have that or this on"; it is their home so they should be able to do what they want to in it.

The most **dramatic adjustment of heating strategies around cost is evident among fuel poor homes**. Here, we tend to see more extremes in behaviour, with obvious minimisation of primary heating use and maximisation strategies. Examples among this group included the following:

- Avoiding use of primary heating systems.
- Taking up options that offer insulation or local heating, rather than heating the whole space, such as clothing, bedding or electric blankets, portable heaters or hot drinks.
- A highly restrictive form of zoning, involving staying in one room and heating only that room.
- Secondary heat gain from other homes, i.e. (actively) capitalising on heat from surrounding homes.
- Displacement, i.e. spending time in other homes or public spaces where there is 'free' heat and/or hot water.
- Physical activity (engaged in with the explicit purpose of keeping warm).

Among fuel-poor households, people also adopted ways to manage their energy spend; for example, some of these individuals had key meters (voluntary or imposed) to pre-pay for energy.

A number of households in fuel poverty were home to an individual with a health condition which meant that their requirements for warmth were greater. These are illustrative of how people work productively with limited means to ensure their needs are met – but do sometimes find themselves pushed beyond their means, or compromising their health or comfort.

The **Fuel poor single occupant** lives in a local authority rented one-bedroom property. It is condemned for demolition, meaning on-going maintenance issues have not been addressed – windows are broken and there is no insulation or adequate flooring. The participant suffers from a long-term health condition which prevents him from working, and which is exacerbated by the cold. He keeps warm at home by wearing heavy jumpers and coats, taking regular showers to warm up, and placing his feet in warm water on colder evenings. He purposefully stays in one room when at home – usually the bedroom, where the electric blankets can stay on for long periods of time and he can sit under layers of bedding. He purposefully spends time out of the property in public spaces such as the library to capitalise on 'free heat' and goes on long walks to keep warm. The gas central heating system is only used as a last resort, and he is on a pre-paid Smart Meter system which helps him control the amount he spends. However, the inefficiency of the property works against him. He sometimes sacrifices comfort in the interest of minimising cost – or, alternatively, when his health problem flares up, he uses more heating than he can afford on occasion.

As this example indicates, there may be instances where comfort is sacrificed due to cost considerations. However, even among households with very limited means, this tends to be for limited periods and it is the more peripheral needs that tend to be compromised. For example, people may avoid the 'easy' option of putting the heating on a timer and rather only turn it on manually when it is deemed absolutely necessary.

Interestingly, it appears that it is not so much that comfort is compromised or de-prioritised in these households, as understood in different terms. Among the fuel poor sample, we found that comfort is spoken about and understood in far more functional, physiological terms (rather than symbolic terms of being a right etc.), and heating is used similarly in a very functional way. For example, one such participant said he sees his use of heating as "practical", as he heats the home when he needs it but would first layer up with clothing or wrap an electric blanket around him. Another says he only puts radiators on when it's really cold, needs it to dry clothes, or because a guest is cold. He doesn't think he uses radiators as much as other people do, but:

"you need warmth to be able to function properly. Just maybe like you need the light to be able to see. ... You cannot function ... if it's too hot that way or if it's too cold that way, you are out of the comfort zone for any human species to actually thrive in." (Single household, social renter, flat, low income)

Income alone is not, however, the overriding determinant of people's experiences and behaviour. As discussed in the explanatory framework, people factors interact with property and system factors to shape people's experiences of need and behaviours.

For example, the **unemployed young mum** with two young children appears on the surface to be someone for whom cost is a particularly salient need. However, despite being unemployed and with two dependents, cost is not an issue: they live in a well-insulated, modern first floor flat with an effective heating system and controls. They rarely find they need to put the heating on much in the evenings, because of heat from neighbouring flats. But, even if bills doubled, she would still use the heating system in the same way because heating the home is absolutely necessary – she “would not want to put her children through that”. It's their home, and homes should not feel cold. Heating the home is important and life is too short to be sat in the cold.

As another example, in the **stay-at-home mum** household, cost is a major issue, despite being (at present) a high earning household. The family business went under in 2009 during the recession and they lost around two thirds of the household income. They could not afford to move, and had to prioritise which bills to pay. The participant explained that “you have to pay your mortgage, you have to pay council tax, because otherwise you've got the bailiffs at the door” – so they let electricity and gas bills slide. As a result, they had to have an electric meter installed and built up a debt with the gas company. There was a point where they would go to bed early because it was too cold and could not afford to put on the heating, or where they would have to put on extra clothes to stay warm rather than switch on the heat. They would skip bathing the children, and they would avoid cooking as much or for as long, choosing sandwiches over roasts. Since then, their business has been established, and they now enjoy a higher than average household income – but bills nonetheless remain a “nightmare” as the household struggle to pay off their debt, which is likened by the participant to “a noose”.

2.3.2 Waste

- Waste features in behaviours that are driven by the ethic or **principle of being efficient** with energy use.
- For participants who were concerned about the principle of ‘not wasting’ in all areas of their lives, this appears to be a fundamental concern that translates into day-to-day behaviours and patterns of consumption more generally, rather than purely confined to heat energy. For this group, cost savings, when achieved, may be a welcome consequence, but not a primary driver of behaviour.
- For participants who are less concerned about waste in all areas of their lives, the principle of not wasting heat energy is less apparent. Waste may not feature as a concern, or only feature once comfort and cost-related needs have been met sufficiently, or where behaviours geared at reducing waste also serve the interest of comfort or cost (e.g. closing windows in winter to simultaneously retain heat and to make the home warmer and so ‘cosier’). Behaviours geared at avoiding waste are more marginal, and tend not to be routine or involve too much effort or discipline.
- There was a view that **certain inefficiencies are acceptable**, or have to be accepted, in the interest of meeting other needs (e.g. comfort, cost, convenience). While people are willing to engage in inefficient behaviour if this is their choice, there is far **less tolerance** of waste when energy systems are **wasteful beyond their control**.

Waste also featured as a resource-related need. There were a number of different attitudes towards waste, with varying levels of influence over behaviour.

For a minority group, waste was considered a fundamental concern. Among this group, waste tended to be referred to as an ethic that had been instilled as part of how they were “brought up”:

“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.”
(Household of adults under 60, owner occupier, terraced property, medium income)

At times, this was seen as an ethic of a previous generation who grew up during times of rationing:

"I don't see the sense of ... going absolutely violently mad, heating, when I could put a jumper on and it would achieve the same effect. And okay, it wouldn't cost anything, but that's not why I do it. And it's wasting heat, you can't do that. I think possibly this is because I grew up in the Second World War, and you didn't have very much heating of any sort. You used to have a coal fire... and don't forget coal was rationed as well. And you used to have to save everything and you never wasted a thing, and I think this is where I'm coming from, because I'm not used to wasting stuff ... No, just don't see the sense of using stuff for the sake of using it, 'cause that's what you're doing." (Single household over 75, owner occupier, terraced property, medium income)

For this group, the principle of avoiding waste appeared to be part of an ethic that translates into their day-to-day behaviours and patterns of consumption more generally, rather than purely confined to heat energy (for example, avoiding food waste). Among this group, behaviours geared at avoiding waste were not driven by cost savings (for example, one individual said that even if gas prices dropped significantly, she would not start using more heat energy). While manifesting in similar strategies used in the interest of saving money, behaviours are 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 than a driver of behaviour).

For another group, who appear to be more in majority, waste may not feature at all (although this was only consciously asserted by people who feel strongly that the use of heat energy at home is an issue of personal preference or freedom) or may begin to feature as a need in people's talk and behaviour only once comfort and cost requirements have been met sufficiently, and/or where behaviours also serve the interest of comfort or cost. One view was that certain inefficiencies are acceptable, or had to be accepted (notions of 'acceptable' or 'conscious' inefficiencies), in the interest of meeting other needs (e.g. comfort, cost, or convenience).

For example, in the **transition family**, cost is not a major issue, given a comfortable household income. However, the participant upholds an ethic not to be wasteful, and has invested in various installations such as double glazing and cavity wall insulation to address this. He also tries to encourage his family to put on extra layers before turning on the heat – but really sees warmth as a right for working hard and also feels this is justified because they don't have any other "vices". The rising cost of fuel does worry him and he would consider bringing forward some of his energy saving plans if he needed to save money, including an energy generation project – but he has not yet taken action on this.

As this example and others illustrate, behaviours geared at avoiding waste tend not to be routine or involve too much effort or discipline (and, where there is hard work involved, may need additional monetary incentive). Rather, they tend to be ad hoc, 'easy' or 'when I can', as in this extract:

"I don't see the point in stuff blasting away when it's not needed ... whilst I said to you I wouldn't leave the heating off if we were in the house, I feel we need to be comfortable if we're in the house. If we're not in the house we're outside or we're away for whatever reason I don't see the point in things working for nothing ... It's heating the house up but there's nobody here to appreciate it." (Household of adults over 60, owner occupier, detached property, medium income)

At times, people may try to counterbalance their energy-inefficient behaviours with these more marginal strategies. For example, in the **choice family** household, the main priority is comfort. They engage in a lot of 'top-up' behaviour – for example, the use of plug-in heaters and convection heaters, in addition to central heating was geared at 'extra' comfort and cosiness, rather than a need for greater warmth per se. The participant nonetheless said that they were 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 such as air conditioning. However, none of these measures came at the expense of the family's comfort.

The participant is aware that some of their behaviours may be wasteful and have a detrimental impact on the wider environment. But he attributes this to a focus on more immediate concerns – caring for those in the household:

"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." (Household with children under school age, owner occupier, semi-detached property, high income)

When people are motivated to reduce waste, conversely, this may be in response to proximal concerns rather than wider environmental concerns. For example, in the **business from home** household, the participant is focused on how he can minimise energy wastage in his home in order to avoid higher future costs to the household resulting from depleted natural resources, and not the costs to the environment:

"I do think about the environment and the effects 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 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?" (Y27 – business from home)

On the whole, it seems that **people are willing to engage in inefficient behaviour if this is their choice**, particularly if this serves a more core need such as comfort, but also for similarly peripheral needs such as convenience, as discussed later (2.4.2). We found, however, that while people may be tolerant of consciously 'chosen inefficiencies', there is far **less tolerance of waste when energy systems are wasteful beyond their control**.

This was particularly apparent among people who lacked the ability to control their heating systems (e.g. homes with district heating without temperature controls within the home), people who lacked confidence in using their heating systems or controls, those who lacked the means to replace or modify inefficient energy systems (e.g. social and private renters in energy-inefficient properties who were unable to change their energy systems or make modifications such as insulation), and people who felt they lacked the knowledge or feedback on how to reduce waste.

Some participants complained about being unable to prevent waste. This can sometimes feature in concerns about 'wasting money' but can alternatively relate more to the principle of waste. For example, a participant living in a flat with district heating explained that his only means of regulating the room temperature was through opening the windows, which he "hates" doing. Despite the fact that he was on a fixed rate, he saw it as 'wrong' to be wasting energy in this way: *"...it's unethical, it's immoral to be burning energy and just letting it go out of the window"*.

Where resources are understood in terms of money, and not in terms of energy, this can result in inefficient behaviours when cost is managed. One view was that in unmetered set-ups where people pay a flat rate, this can encourage over-use (even abuse) and waste of heating and hot water, and does not **incentivise energy-efficient behaviour**. One participant, living in a block where heat is unmetered, explained that *"because it's the communal heating system there's no benefit in turning it off ... I pay a fixed rate through my service charge on the flat so there is no incentive to turn the heating off."* Another said he "might as well use it" as he was paying a fixed cost. Where participants suspected their neighbours of using more heating and hot water than needed, their accounts suggested that this encouraged them to behave in a similar way. For example, one participant who suspected others in her housing block of "abusing heat energy", talked about there being "no point switching off" her heating because she felt others were doing the same. Contrasting with this, she mentioned being more careful with hot water, as she pays for what she uses.

Monitoring Insight: What's waste? - Participants may have very different understandings of what certain terms and concepts mean compared to a technical understanding; in relation to waste this also takes on a very personal dimension of what constitutes waste.

In discussion about waste, L15 said she never opens windows in winter. The monitoring data showed that this was not the case, identifying lots of window opening in the rooms she spent most of her time, particularly the living room and on some occasions for a long period of time. When she saw data, the participant realised that when she smokes she opens the windows, but she had not associated this with waste and didn't realise she sometimes accidentally left it open.

2.4 Agency

In this report, we understand agency as the capacity and willingness of a person to act independently and make choices. As for 'needs' or 'wants', the factors considered under agency – **control** and **convenience** – together relate to a desire to be actively in control of heat energy use within the home and the time and effort people are willing to put in, often to meet personal or household requirements and preferences.

Agency may feature in the positive sense, where 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). Control and convenience may feature as flip sides of a coin in some instances – where convenience appears in the form of giving up 'active' control in the interest of ease.

2.4.1 Control

- Relates to the need to feel in control of heat energy use at home.
- Control has both a **functional** purpose (e.g. having the heating on when required or desired) and a **symbolic** purpose (e.g. linked with meanings attached to the home, particularly where the home is considered somewhere that people should be in control of their own comfort and wellbeing).
- Control as a need rarely features in a standalone way. Control is often expressed in terms of **having control over how and whether other needs are met** (e.g. cost, comfort or convenience) or even **equated** with these other needs.
- There is variation in terms of what types of **technical control systems** (e.g. manual vs. automatic, central vs. zonal, remote vs. local) enable people to enjoy a sense of control, or feel in control. Personal preference and household composition, routines and occupancy patterns appear to play a role in mediating this.
- People appear to value having **technical control** over resources such as cost and waste – even if, in practice, they choose to expend these without restraint.

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 required or desired) and a symbolic purpose (e.g. linked with meanings attached to the home, particularly where the home is considered somewhere that people should be in control of their own comfort and wellbeing).

Participants described control in terms of influence, choice and freedom: as “feeling you have influence over what happens” and being about to “pick and choose” when the heating comes on, and being able to “switch something on when you want it and off when you’ve had enough of it”.

Control also linked back to notions of the home as a place of personal freedom to act and feel as one chooses:

“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.” (Household with school age children, owner occupier, semi-detached property, medium income)

As the extract above indicates, it can be difficult to de-link control from other needs, and was often understood in terms of having control over comfort, cost, and convenience, or even equated with these other needs.

For example, for one individual, control was equated with convenience: he explained that, for him, control means never having to think too much about the heating system. He wants to be able to control his heating system “without having to find the instruction manual for the programmer” (N38).

For another individual, control was equated with comfort: for him, control means having a responsive system that gets the home warm quickly when they want it. His current system gives him this, but results in overheating. He constantly adjusts the thermostat to deal with this. He feels it would be easier to maintain comfort levels if he didn't have to think about this all the time. Better control also would mean avoiding negotiation with his wife over different temperatures (L33).

Control as a need rarely features in a stand-alone way, as other needs may do. It may be that this need is something of a different order to the others, one that is more cross-cutting or foundational. As a concept, control is also multi-dimensional: it manifests as both a need and a behaviour, and is reflected also in the technical control offered by the heating system. This makes sense, because talking about 'control' in isolation begs the questions, control of what, and for what purpose?

There were different views on what type of technical control systems (e.g. levels of manual input required, central versus zonal) enabled them to enjoy a sense of control or feel in control. A sense of control could correspond to systems requiring various levels of manual input.

For one group, having a set-up in which systems functioned with limited (usually initial) manual input was seen as *offering* control. One participant likened himself to a "king" who "ruled" over his energy system by implementing the desired settings, and the energy system is his subject that executes his wishes:

"The hot water comes on at eight o'clock in the morning, goes off at nine. That warms everything up and gives us enough hot water to get showered and do any washing up that we need to do ... And we've got hot water for the dogs. Similarly at night we've set it to come on at four and go off at five. So we've got hot water for washing the dishes or whatever we happen to need it for ... We're controlling it albeit it's doing it itself ... We've done the initial controlling factor, we've ruled that. We've told it what to do." (Household of adults over 60, owner occupier, detached property, medium income)

Another reflected that:

"Yeah, it was lovely [having a thermostat in previous home]. And you just like seeing it come on ... 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 to 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..." (Household with children under school age, private renter, terraced property, low income)

Contrasting with these examples, another group felt more in control with greater manual input. For example, the **stay-at-home mum** manually adjusts the heating, rather than using a timer as she "like[s] to be in control" and does not think a timer would achieve the constant, ambient temperature she seeks, and because of unpredictable household routines and occupancy. She feels it's important to be able to choose when she has control so the system is "not just taking over". If her daily routine changed, she would want to be able to adjust her system accordingly.

Control preferences, strategies and requirements appear to vary based on personal preference, but also on household composition, routines and occupancy patterns. For example, among households with multiple occupants with conflicting routines, we found that some turned to the simple somewhat crude solution of leaving the heating on constantly, rather than taking the more challenging approach of adjusting the heating according to the specific situation. 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.

The need for control is particularly salient and was articulated most vocally by those who lack control. For example, **high-earning busy professionals** live in a flat with communal heating, with no control over day-to-day or seasonal operation of the heating system. Lack of controllability is compensated for by lots of top-up heating alternated with ventilation behaviours (opening the windows) to cool down to meet basic comfort needs but also results in wasted time and effort and on occasions wasted energy and money. The participant dislikes the fact that he does not have control over those parts of the home which are heated, he sees no point in heating rooms such as the bathroom and bedroom

where he spends little time. He feels that this lack of control leads to heating waste. Equally, having no control over costs (despite high income) is also a big frustration – the participant currently pays a fixed fee but would like to be more in control of what he pays.

“Not being able to control [the system]...Not knowing exactly what things are costing. That’s annoying as well. Because you get these service charges...the service charge is expensive. Everybody complains about their service charge...you can’t have a smart meter, you know, for water or for electricity here, just because of the way everything’s set up. And that’s annoying.” (Household of adults under 60, owner occupier, flat, high income)

Discussions around control are highly revealing. These suggest that people attach value to having control over factors such as cost and waste – even if in practice they choose to expend these resources freely, without restraint. There is a sense that they just want to know they are in a position to exercise control – even if they choose not to exercise this control in practice (for example, in instances where it is ‘easier’ not to bother – discussed next under convenience – or spend freely on energy because they think ‘you can’t put a price on comfort’).

Monitoring Insight: Who’s in control? - *Understanding behaviour in a multi-person household is complex and can generate conflicting behaviours between the main controller of energy systems and other household members.*

In a number of instances, there were small variations in the way the main participant in the monitoring study thought the home was heated as a result of the behaviour of another household member. This illustrated the complexity of needs and behaviours in multi-person households. For example, In **Y29 builder**, the monitoring data identified daily swings in temperature which the main participant had not explained, nor was aware of. On discussion with others in the household, the main participant had discovered that, misunderstanding how it works, was turning using the thermostat as an on/off control, turning it up to the maximum until she was too hot and then turning it down again.

2.4.2 Convenience

- Convenience relates to the need **to make life easier**, and is reflected in strategies that reduce the amount of time and/or effort (whether thinking or doing) involved in heat energy use.
- Convenience may feature in the form of giving up ‘active’ control, and may even appear to be the counterpoint or **‘flipside’ to control**.
- Generally convenience only becomes a priority need in households where health, comfort and cost-related needs have been met. Reducing waste and pursuing convenience can appear to be in opposition, and households may make a trade-off of one need for another.
- A highly **situational need**, associated with different behaviours depending on the circumstances.

Convenience relates to the need to make life easier. While factors related to resources relate to expending something tangible – money, energy – the need for convenience relates to the less tangible but nonetheless valuable resources of **time and effort** that are expended in heating strategies.

The pursuit of convenience is reflected in strategies that reduce the amount of time and/or effort (whether thinking or doing) involved in heat energy use. For example, preferring to take clothes off at home rather than adjust a thermostat or timer; not using a TRV as it is perceived to be too much of an effort to “fiddle” around with; use of timers as it saves thinking about putting the heating on; or, alternatively, using a thermostat to turn the heating on or off as this is perceived to be easier to use than a timer (either due to ease of using the controls, or their locations).

Sometimes convenience features in the form of giving up ‘active’ control, and may even appear to be the counterpoint or ‘flipside’ to control. However, even where active control was not desirable, this was only on condition that 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." (Household with school age children, owner occupier, semi-detached property, medium income)

In other instances, a more 'active' or manual control may be considered the easier option. For example, the **busy mum** uses the thermostat to control temperatures centrally for all rooms rather than adjusting TRVs individually as she finds this easier. She manually controls the times that the heating is on for two reasons: firstly, because she finds the timer overly complicated and secondly, because as her home is small and well insulated it is quick and easy to heat up and keep at a desired temperature. This means she can heat up her home quickly before she feels cold without the need for a timer. As such, she thinks that additional controls would be a "waste of time" and an unnecessary "luxury"; she is confident that she has sufficient control and would rather keep things simple.

Convenience generally only manifested itself as a need in households where health, comfort and cost-related needs have been met. It was uncommon for people to put convenience before these more core considerations. For example, among the fuel-poor sample of households, convenience appeared to be an area where compromises are made. In one case, the occupant would use TRVs to only heat one room (the living room) when he could not afford to heat the whole home. This sometimes meant that he and his daughter would have to get ready for work/school or even sleep in this one room. Another chose to spend long periods outside of the home, in shopping centres or the library, in the interest of minimising his heat energy spend.

However, waste may be traded off for convenience. It seems that waste and convenience are of a fairly similar priority order and households tend to choose one or the other when these are in conflict. Whereas one group (discussed previously) may prioritise waste due to their lifestyle and the way in which they have been "brought up", others with different lifestyles and habits may prioritise convenience at the expense of waste.

For example, the **adult single sharers** household comprised four single adult young professionals living in a flat-share, all of whom were high earners and worked full time. Household routines were irregular, and none of the household members had fixed routines outside of standard working hours. Individuals were likely to be out on evenings which they could not predict in advance and for long periods of time at the weekends. Cost is not within their control, as occupants pay a flat rate to their energy company, and concerns about waste are 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 time, even when they knew they would be out (i.e. prioritising comfort over minimising waste). The bathroom window was left open (even when heating was on) or alternatively closed (even when humidity levels were high due to 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.

Convenience as a need appeared to be highly situational, and could mean different things and be associated with different behaviours depending on the circumstance. For example, the **builder** does not use his TRVs for the sake of convenience – he does not want to think about which rooms he can or cannot use and finds it a hassle to go around room by room to adjust TRVs. He did, however, mention that he started to use TRVs during the course of the study – interestingly, in the *interest of convenience*. He was sitting in the lounge watching TV and became too hot; instead of the effort of getting up to adjust the heating centrally, he leaned over to adjust the TRV.

2.5 Relational dynamics

This category of need is focused on social relationships as these play out in the household context. The needs considered under relational dynamics include **harmony** and **hospitality**. These needs relate to interactions with householders and guests respectively, and tie in closely with self-image and social acceptance. These needs appear to be more peripheral than needs within the other three categories.

2.5.1 Harmony

- Harmony relates to the drive to **facilitate or maintain a particular social dynamic or social order**, or supporting the existing ‘status quo’ among household occupants.
- The focus is on facilitating a desired type of social interaction – whether it is about promoting household **unity or cohesion**, or allowing individual occupants to get on with their lives in an **individualised** way.
- Harmony is understood in separate terms from meeting the various needs of others in the home, although closely linked with comfort strategies.

The need that we have termed ‘harmony’ relates to the drive to facilitate or maintain a particular social dynamic or social order, or supporting the existing ‘status quo’ among household occupants. The focus is on facilitating a desired type of social interaction – whether it is about promoting household unity or cohesion, or allowing individual occupants to get on with their lives in an individualised way. ‘Harmony’ as a need is deeply implicated in how decision-making around heating works in the home, and can also be rooted in social identities and roles within the homes. It can also be implicated in the way people use space in the home, for example, keeping doors open to communicate with one another or to keep an eye on the children. In this sense, this need goes beyond functional requirements relating to heat.

‘Harmony’ as a need is considered in our framework 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 wellbeing. However, in practice harmony may appear under the guise of comfort – for example, sacrificing one’s own comfort for another’s in order to avoid an argument, complaints or “moaning”. However, this is sought after in the interest of maintaining a particular set of relational dynamics and social interactions in the home. Meeting comfort needs is, in this instance, a means to an end (the end being a desired relational dynamic), rather than purely an end in itself.

While seemingly a more peripheral need within the framework, harmony is closely embedded in the strategies that people take up to meet fundamental health and comfort needs; achieving harmony can be seen as a *consequence* of these behaviours, or understood in terms of the *means* by which people achieve the *aim* of comfort e.g. in a harmonious way.

We identified two key ‘types’ of decision-making at play, supporting two distinct relational dynamics – the first being **collective** and highly negotiated, and the second **individualised** and not negotiated.

For the *collective* type **decision-making is negotiated, but not always harmonious**. We identified three dynamics in operation, which fed into different behaviours.

Among one group, decision-making was made *democratically*, and resulted in behaviours that found a compromise or middle-ground between the needs of all householders. For example, take the **L28 choice family**, a busy family on a high income. Their comfort is taken care of by an effective heating system and controls, and they do not worry too much about cost. Their focus is on more peripheral needs including convenience and harmony. Maintaining a happy family dynamic is important for this household, who value their family time, and use heating for ambience and cosiness. This means lots of top-up heating activity, and also pre-emptive activity, such as keeping unused rooms warm or warming them in preparation for when they will eventually be needed. The heating is on a timer: the timer settings were discussed and agreed upon as a family, and fitted around their daily routines. However, householders (even the five-year-old) also adjusted thermostats frequently, room by room, to cater to their individual needs.

In a second group of households, decisions tended to be made *autocratically* by a dominant member of the household, in the interest of self and others. This did not always serve the needs of all householders equally. For example, the **stay-at-home mum** makes the decisions about heating in the household. She feels like she’s responsible for the house and that others view her as responsible for the house and what happens in it as well.

“...anything to do with the house is me...the four walls, the home, the atmosphere, the ambience, everything, I'll clean the house, this is what we're having for dinner, everything about the house is me.” (M5 – stay-at-home mum)

The expectation from the family is on her for the temperature to be right: her husband, children, mother, friends and visitors will turn to her if they have a problem with the heating. She likes the house cooler than her husband but the decision on temperature is down to her – he'll moan about it, but she's the one who does something about it. She feels that she is a good judge when it comes to balancing her heat needs with those of her husband: she knows how much she can 'get away with' before her partner will start moaning about the temperature and ask her to put the heating on.

Finally, decision-making could be *conflict-ridden*, resulting in arguments (e.g. a husband and wife arguing over temperature levels), inconsiderate behaviour (e.g. a teenager using all of the hot water for a long shower, regardless of the needs of other householders) and sabotaging behaviours (e.g. 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). For example, in the **business from home** household, the participant tends to defer decision-making around the heating to his wife. It frustrates him that she refuses to use TRVs and insists on having the temperature set higher than his liking. He sometimes secretly adjusts the TRVs in the room he is occupying.

Alternatively, **decision-making may be highly individualised and not negotiated with others**. This includes households where decision-making is made at the individual level, for and by the individual, but can include both single occupant and multi-person households. Decision-making is relatively straightforward, as negotiation is neither sought nor required, and behaviours tend to be driven by individual lifestyle and needs, rather than attempting to bring in a solution that meets a collective set of lifestyles and needs. These households contain independent and relatively active individuals and, in the case of multiple occupant households, those who do not make decisions as a household unit.

In the **adult single sharers** household, for example, decision making around the heating system is dispersed; no one member of the household is in charge of the heating. This leads to a lot of overriding of the system, forgetting to turn it off, and overheating. Whereas other households might view this as a frustration or a waste, this household view this as an inevitable bi-product of living in a house share and it is not considered an issue.

In some cases, a household may make structural adjustments to support different relational dynamics in a given home. For example, the **multi-generational family** have a lodger who has his own heating and control system, while the main family who occupy the rest of the house have a separate and different heating system type which they control according to their own needs.

2.5.2 Hospitality

- Hospitality is centred on **interactions with visitors to the home**. This is the most peripheral of needs that drive day-to-day behaviours - as it is not focused around household occupants, and is more situational and occasional. As with harmony, this need is centred on facilitating a desired type or quality of interaction with others, rather than their comfort per se.
- Tends to feature in homes where most other needs were taken care of, those where there are less complex routines and requirements among occupants, and those for whom visitors make up an important feature of their home life.

Hospitality as a need is centred on interactions with visitors to the home. This is the most peripheral of needs that drive day-to-day behaviours. This is not unexpected, given that it is not focused around household occupants, and is more situational and occasional. As with harmony, this need is centred on facilitating a desired type or quality of interaction with others, rather than their comfort per se.

We found that this need tended to feature in homes where most other needs were taken care of, those where there are less complex routines and requirements among occupants, and those for whom visitors make up an important feature of their home life. Examples include 'empty nesters'

where children are no longer in the home (and who may want to create a welcoming environment to encourage their children to return home for visits), retirees or simply people who entertain a lot.

While perhaps a seemingly more superficial need than others in this framework, when one digs deeper it is clearly not limited to 'keeping up appearances'. Rather, it is also about social acceptance, pride and self-esteem – and these in turn link back to what the home means to people. For example, the **active empty nesters** are a retired couple with three dogs who maintain an active lifestyle. Comfort, cost and control are needs but ones that have been met. Having a welcoming, warm home for visitors is important. They use the wood burner to top-up the heat in order to give a pleasant ambience. They have frequent visitors who stay overnight, and the participant likes to be able to offer his guests complete control over their home, including use of heating and opening and closing windows for ventilation.

This need comes into play only occasionally for most households, whereas other needs within the framework have a more day-to-day presence. It can mean that people put aside their own needs for the moment in order to project a particular identity to others. For example, the **health-conscious father** is extremely cost-conscious and the household is effectively in fuel poverty. While he cuts back on heating when he is home alone, and ensures he spends a lot of time out of the home with his daughter to cut back on heating bills, he makes sure the home is warm and welcoming when visitors come over:

"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." (health-conscious father)

2.6 Chapter summary and insights

People have wide-ranging needs that influence how they use heat energy in the home. But it appears that only a relatively small sub-set of these needs drive day-to-day, routine behaviours. These needs can be classed into four categories:

- Wellbeing (health and comfort)
- Resources (cost and waste)
- Agency (control and convenience)
- Relational dynamics (harmony and hospitality)

Other needs documented in our report of the first phase of research do come into play – but these tend to feature only to the extent that they drive ad hoc, one-off behaviours – either short term or long-term investment decisions such as an installation. For example, aesthetic concerns featured powerfully in people's decision-making around home modifications (discussed in the next chapter) but did not appear to play a powerful role in mediating people's day-to-day behaviours. We return to a discussion on frequency of behaviour and how this relates to people's priorities in the conclusion of the report.

These needs appear to exist along a continuum of priority as described in chapter 2 – some are fundamental or core needs, while others are more peripheral and better described as 'wants'. More peripheral needs only become front-of-mind or come into focus once core needs have been met sufficiently, and only then appear to begin to influence and drive behaviour.

A dynamic and interacting set of household-level factors, encompassing people, property and heating system affect how and to what extent people are able to meet these needs, and which needs come into focus and begin to influence behaviour.

- **People factors** include socio-demographic characteristics such as household composition, income, and tenure, as well as personal preferences, attitudes and values, and knowledge and beliefs. These also include needs and decision-making dynamics.
- **Property characteristics** include characteristics of the building, such as property age, size and type, and aspects of the neighbourhood, such as housing density.

- **System factors** include characteristics of the heating systems, including control features.

People factors clearly have a great weight in influencing the pattern of priority needs in a given household, as well as patterns of decision-making and behaviours. However, property and system factors also play a powerful role in setting the parameters within which people are able to make decisions and act. There is enormous complexity and variability in these factors, and their impact on decision making and actions should not be underestimated. Moreover, people, property and system factors need to be understood in interaction, and behaviour understood as a product of the very specific combination of these in a given household.

In Figure 2.6 presented above, we have also highlighted characteristics of a given household that are a product of two types of factor in combination. For example, household routines and patterns of occupancy, the attachment people make to their homes, and the changes people make to these are a product of people and property factors in combination, primarily the location of the property in relation to where members of the household work and where their relatives live. Similarly, people's control strategies and workarounds are a product of people in interaction with systems, and are influenced by both elements of the system and control features afforded by these and 'people factors' such as knowledge. Finally, system layout and capability are a function of both the system and property in interaction. For example, a heating system might be more or less effective depending on how well insulated a property is.

In the middle of the diagram (Figure 2.6), where people, property and system factors all intersect together, we see people's mental models (their understandings or thought processes that represent, in their minds, how property and system factors 'work' in reality, which can play a powerful role in shaping behaviour) and actual behaviours.

The combinations of people, property and system factors are variable. Consequently, behaviours are very diverse and highly context specific. We found that a given behaviour may be taken up to serve a wide range of needs. Similarly, any given need may be served by a wide range of behaviours.

In addition, importantly, households are not 'stuck' in one place on the needs continuum. Rather, there is dynamic movement left to right as factors in the people/property/system context change. When changes happen, and these affect people's ability to meet their needs through current strategies, people might take up a different set of behaviours or even a new technology (as discussed in the next chapter). When changes in the people/property/system context are short-term, changes in behaviour might be equally temporary. For example, a child visiting and then leaving again during the course of a day might prompt someone to turn the heat up, and then down again. As this simple example suggests, behaviour can be highly circumstantial or situation-specific. For example, adjusting one's TRVs might be seen as a 'hassle' at one point but seen as a convenient option at another. Conversely, longer term and more enduring shifts in the people/property/system context (e.g. life transitions such as birth, retirement, ageing) might result in more sustained adoption of a new behaviour (discussed earlier in this chapter) or a new technology. We discuss this in greater depth in the next chapter.

Given the complexity and variability of the behavioural context, consumer behaviour is similarly widely varied and cannot be explained or 'predicted' through a linear, deterministic model. Moreover, given that behavioural outcomes are a product of 'people' factors in interaction with technical ('property' and 'system' factors), these findings suggest that a demographic segmentation will be of limited practical use.

However, what the findings do also point to is the relatively constant and consistent set of needs that drive people's heating use, and an order of priority that people attach to these. In addition, there is also consistency in the fact that people 'work around' variable interacting factors creatively and adaptively, developing often complex control strategies to meet their core needs, and trading off more peripheral needs in the process. These ideas are taken forward and evidenced further in the following chapter, and we draw out key implications for smart energy systems in the concluding chapter.

Key insights

- People have wide-ranging needs that influence how they use heat energy in the home. But it appears that only a relatively *small sub-set of these needs drive day-to-day, routine behaviours*.
- The needs that drive day-to-day, routine behaviours exist along a *continuum of priority*: some are fundamental needs, while other more peripheral and better described as 'wants'. These peripheral needs only come into focus and become an influence on behaviour as people's core needs are met sufficiently.
- It is not only needs, however, that affect what people actually do. A dynamic and interacting set of household-level factors, encompassing *people, property and system* affect how and to what extent people are able to meet these needs, and which needs come into focus and influence behaviour.
- These are useful insights for design and engineering teams developing a SES; this is discussed in detail in the WP5.8 Solutions Scenarios report.

3 Consumer requirements for, and responses to, solutions

While the previous chapter afforded a lot of attention to ‘people’ factors, a less systematic focus has been placed on the ‘property/system’ side of the equation, except in passing through case illustrations. This chapter aims to address this part of the story, exploring how people experience existing energy systems, how well these systems meet their needs, how people respond and adapt to them, and what motivates people to take up new ones. As is suggested by these aims, the focus is shifted away from behaviour and moves towards solutions and their uptake. However, a rich understanding of consumer needs and behaviour was vital in developing the insights we present here, and we draw heavily on findings laid out in the previous chapter in order to make this step.

3.1 How people use and adapt to existing systems

The second phase of the qualitative primary consumer research was focused in part on solutions requirements. It therefore made sense to explore people’s experiences of existing systems, and attempt to assess the extent to which these already meet people’s needs. We set out to explore people’s likes and dislikes relating to a range of energy system types. However, it quickly became apparent that this was an almost impossible task, for a number of reasons.

On one level, this is due to the great variability of energy systems in practice. Overlaid with this, there is also great variability in the way that people operate these systems as well as variability in their ability to optimise their use.

There also appears, at times, to be a mismatch between the way in which people experience energy systems and the way in which energy systems are designed and thought about from a technical perspective. In practice, it is difficult to isolate the influence or impact of one element of a system on how and to what extent the needs of a household are met without understanding it in interaction with other elements. Furthermore, current systems and controls are designed chiefly with technical functions in mind – however, when people talk about the things they like and dislike about their system they refer to needs (such as not being able to get comfortable or the system being inconvenient) rather than the specifics of the technology. People could not often identify the medium that was serving or not serving their needs. For example, people in highly insulated homes sometimes complained of overheating, but could not attribute this to the insulation levels.

On another level, however, our findings suggest that asking whether a given system meets or does not meet people’s needs is not appropriate in isolation – as people will work with (and frequently around) existing systems in the context of the characteristics of their property to meet their needs. In short, it is people who meet their needs in interaction with technology, not technology alone. We return to this discussion in the conclusion of the chapter.

Monitoring Insight: (Un)Conscious behaviour - *Heating the home is not often front of mind for households; even in the winter, behaviour is typically routine or reactive and therefore people are not always fully conscious of what they do, when they do it and why.*

One participant, **N18 busy mum**, felt she always had the heating on in the mornings in winter. The monitoring data revealed that she only had it on 40% of the time. On reflection, she revised her view saying that she only turns the heating on in the mornings when it’s cold enough that she needs to. While behaviour was clearly triggered by the temperature, in the mind of the participant it felt like everyday, almost habitual, behaviour.

3.1.1 Variability in existing systems and their use

- There is great variability in how energy systems are designed, evolve and operate in practice.
- There is also great variability in the way that people use and interact with these systems as well as variability in their ability to optimise them.

Our interactions and observations in the 30 homes involved in the longitudinal study, complemented by the one-off visits to the additional 33 homes, drew attention to how varied existing energy systems are. Even apparently standard systems have multiple variations in the way that they are set up, and outcomes experienced depend on a range of technologies/systems in interaction (which have often been designed in isolation).

We found that the **specificities of set-up may have a greater bearing than the overarching type of system** on how people experience their heating systems, how well they are able to meet their needs through these, and the behaviours they take up to do so. The following paragraphs expand on this for three types of system.

Gas central heating: Among homes with gas central heating, this apparently 'typical' and effective system type, which is also the most prevalent in this country, showed great variability in practice. For example, the **business from home** is a good illustration of a home with a primary heating system (gas central heating) that works very effectively, helping to keep the family warm, and the participant has good understanding of controls and how they work. Despite this, multiple mismatches and workarounds are at play. The main participant and his wife work from home downstairs during the day, yet have to heat the entire home as there are no TRVs upstairs. Conversely, during evenings, if the couple are downstairs and want the heating on, this becomes a problem if the daughter is sleeping upstairs as she prefers the bedroom to be cool at night. They resolve this by putting on the gas fire in the lounge. Another major issue is that the hot water does not heat up to the desired temperature when the heating is on, due to the way the system has been plumbed. They have to switch off the heating during the times they need hot water (in the morning for showers and shaving and in the evening for washing up and bathing). In the mornings, they sometimes have to put on the gas fire, to substitute for the central heating, in order to be warm enough, or wear a fleece or slippers. The participant gets particularly frustrated when the water is not hot enough for him to shave, and he ends up boiling a kettle.

District heating (DH): For the DH sample, participants' experiences and ability to meet their needs were strongly mediated by payment set-up, control and responsiveness of the system, and aspects of the building (including insulation). Among this group, there was an added factor contributing to experiences due to community-level control and maintenance.

Heat pumps: While generally found to be an effective heating source, there was still variation in how these were set up, and how people ultimately experienced these. For the most part, among this group, inadequacies could be attributed in part to compromises that people had made on the retrofit, by choice or due to constraints of the property e.g. not replacing original (smaller) radiators with the recommended larger ones, or not installing optimal levels of insulation.

For example, one participant complained that his ground source heat pump could be slow to react to changes in the outside temperature and that it struggled to heat the upstairs of their home. It transpired that this was linked in part to the fact they had not upgraded all of their radiators to be suitable for a heat pump. Another individual explained that his wife continues to use hot water bottles and blankets, but due to an underlying health problem that required extra warmth. In this case, they had also been unable to fully insulate the home due to its listed status. A different participant reported that he did not think his new air source heat pump was any more effective than his oil-fuelled heating had been, as they needed to supplement it with hot water bottles, a log burner and a Dyson heater. However, he did feel this could have been connected to the fact that they made their house more open plan at the same time. These findings suggest that people might only see the full benefits of heat pump technology when they invest in the 'full package' – something which people are not always able to do, due to constraints of the previous system or building itself, and which may not happen when people are motivated to 'cut corners' in order to reduce the disruption or cost of retrofit.

At times, **variability is a product of the overlay of systems that builds up over time** as consecutive sets of occupants make adaptations to the property. People may inherit systems and then overlay new ones as part of system upgrades and wider home modifications, which can result in unanticipated outcomes. For example, in the case of the **business from home** family described above, some of the problems they face stem from the overlay of a new heating system onto an older

one. In other instances, the specific circumstances of a particular household may result in a very idiosyncratic set-up. For example, in the **multi-generational family** the occupant invested heavily to build up a single storey cottage into a sprawling family home (see the case study appendix for more information). However, due to a dramatic drop in income during the course of the renovations, he decided to cut off the central heating system to the upstairs to avoid the cost of heating such a large-scale property, and instead the family rely on portable heaters upstairs. He has had to resort to makeshift solutions in some instances – for example, installing a Perspex sheet over a doorway to prevent draughts into and heat loss from the living room. These scenarios can mean that systems, over time, can come to be set up and used in ways that are very out of line with original design intentions.

As this suggests, another layer of complexity becomes apparent when people interact with their systems. As discussed, systems are not always able to meet needs due to technical limitations. But, in addition an effective system might be limited in its ability to meet a household's needs due to the **user's inability to optimise it fully**.

For example, the **single mum** has an almost ideal set-up from a technical perspective: she lives in a first floor, modern flat that is well-insulated, with gas central heating and has TRVs. However, she is not able to use the technology – she “whacks up” the heating by turning up the thermostat to its highest setting (using it as an on-off switch), and does not know what TRVs are or how to work them.

In the **adult single sharers** household, the participant is totally divorced from his energy system and lets one of the other housemates set it. He uses a TRV in his room but does not touch the timer or thermostat. He thought the cylinder was “the boiler” and when it was pointed out that the boiler was in a cupboard in the room he was being interviewed in, he was surprised as he had never noticed it before.

In an extreme case, the **health-conscious father** lacks the knowledge or the means to optimise his energy system, compounded by a property that is very inefficient and a system that lacks adequate controls. Due to health concerns for his daughter, who has asthma, he tries to keep the property as well ventilated as possible. He places cups of water on radiators to discourage ‘dry air’ circulating the property because he deems this unhealthy. However, the monitoring data shows us that humidity levels are extremely high across all rooms – the combination of minimal heating and high moisture levels means this actually does the reverse of what he is trying to achieve and is fuelling an unhealthy environment. At interview 3, the participant was advised by our technical team to either start keeping the home slightly warmer and/or to take away the cups of water to try and combat the mould problems. He has since purchased a dehumidifier and taken away the cups of water. At the moment, a concern over cost does not allow him to heat the home more frequently or at a higher temperature. He is in fuel poverty and says he struggles to afford to heat the home to the healthy temperature recommended by our technical team.

3.1.2 People's adaptation to existing systems

- People are highly adaptable in the face of complicated existing systems, and take up complex control strategies to meet their needs. Some strategies are highly sophisticated and considered, while others may be rudimentary and reflexive.
- Reflecting the variability of existing solutions, people's control strategies are highly varied. What ties these strategies together is that they enable people to meet their core needs of health and comfort, trading off more peripheral needs.

Our evidence shows that people will engage in both **rudimentary and complex control strategies to make the available technology and set-up work** for their particular household and available means.

We encountered a multitude of idiosyncratic workarounds and ‘low tech’ solutions that people had implemented in order to get around limitations in their system's ability to meet their needs. These were highly specific to individual circumstances and therefore very difficult to categorise in a coherent manner – for example, using chopsticks to hold a window open, keeping a door open using a piece of

string during the summer, wrapping a curtain behind a radiator to trap its heat, using a camper oven as a primary heating source, or nailing a piece of Perspex over a doorway to keep out draughts. Some were highly sophisticated and considered, while others were more rudimentary and reflexive responses.

What appears to remain constant across the population is that **control strategies enable people to meet the ends (or core needs) of comfort and health** and make trade-offs in relation to the *means* (more peripheral needs such as cost, waste, or convenience) by which they get there.

People appear to **normalise these strategies over time** – even when very demanding – and can sometimes become unconscious of the extent to which they are ‘working around’ the system, rather than the system ‘working for them’. In fact, it would seem that these are not ‘workarounds’ from their perspective, just ways of getting what they need with the resources available.

For example, in the **modern family** household, they live with an out-dated hot air system. The participants like the fact that the system provides “pretty instant heat” – the downstairs will heat up in five minutes – but the whole house will be “sweaty hot” within the hour. He opens and closes vents on a room by room basis to control the temperature. This manual requirement is demanding, given that the vents are in the ceiling and he has to climb a ladder to adjust the vents. However, he still maintains that he has as much control as he needs and therefore cannot justify the costs of a new system, despite the inconvenience of the current set-up. This makes an interesting contrast with people, discussed in the previous chapter, who cannot be ‘bothered’ to adjust their TRVs. Here, the need for comfort overrides the need for convenience.

Some people were remarkably **adept at achieving a desired environment in the absence of sophisticated control technology**. For example, the **techy** heats his home using gas fires and an oven, and manages to maintain a relatively stable temperature of 22°C. He says he is unable to change things as he cannot afford to; he will not get a loan and get into debt when the way they are doing things is doing the job. Similarly, the **single mum** does not know how her timer works but has developed a workaround that works well for her: leaving the system on timer during the week, and controlling the heating manually at the weekend. In both of these instances, the monitoring data corroborate that these strategies are serving to achieve the desired outcome with great precision.

Monitoring Insight: Circumstantial secondary heating - *People may meet their energy needs in ways they are not aware of through generating heat or ventilating or cooling their home as a consequence of other activities.*

Participants were able to describe well the formal types of secondary heating they used to supplement their main heating system when their home was particularly cold. Participants reported the use of electric heaters, gas fires and the use of extra clothing. However, participants were not always fully aware of secondary heat they were generating through other activities, even if they appeared to benefit from it. L28 was surprised to see the monitoring data showing a spike in the temperature of her utility room, where she would rarely turn the radiator on. On inspecting the room and discussing with the participant how it was used, it became clear that the spike in temperature recorded by the monitoring data was a result of using the tumble dryer. The participant was clear that this wasn't a conscious strategy but did reflect that she would not turn the radiator on when using the room at the same time as the tumble dryer.

Even with the **high-earning busy professionals** – presented in the previous chapter as an example of a household where the occupants felt they lacked control in a range of ways – the participant actually felt that he had things under control by the fourth interview. Compared to previous winters, the participant felt they had “got it right” this time as they have never really felt cold in the property. This could also be down to it being quite a mild winter compared to previous years.

Learned behaviour plays an important role in mediating how people experience and interact with energy systems. For example, in the **empty-nesters with shift work**, private renters in a property with storage heaters, the participant and his wife disagree on how effective the storage heaters are.

He feels that the heat released later in the day is not sufficiently warm, while his wife feels that all they are required for is “taking the chill off”. She has grown up with storage heaters and thinks they are effective if people use them correctly because they turn on every night without fail and heat release can be controlled through the individual heater controls. The main participant would replace the current system with gas central heating if he owned the property, as he sees this as more convenient (it doesn’t rely on someone remembering to turn the heater on at night) and can be controlled better using timers and thermostats.

3.2 When and why people take up new solutions

3.2.1 Why people resist changes to their energy systems

People may not consider heating as the fundamental purpose of being in the home, and are likely to focus on higher level purposes for the space in which they live. Therefore, other changes to their property may take priority and changes to the heating system may just be something that happens alongside wider renovation.

People also face specific barriers that may prevent them from making changes to their energy systems, related to finance, tenure and property.

However, a whole range of other mechanisms can make people resistant to change, independent of whether they have the means to do so:

- People do not know what to expect from current systems or alternative solutions.
- People may be aware that a system is not meeting their needs but do not act because they cannot diagnose the source of the problem.
- People want to know how to optimise their current systems before they will consider a change in technology.
- People tend not to have a wholesale dislike for their systems, and may feel that their system 'dislikes' are 'acceptable frustrations', balanced out by their 'likes'.
- People are highly adaptable in the face of limitations in their energy systems, and are reluctant to make changes when what they are currently doing 'does the job'.
- People have limited knowledge of more sophisticated existing systems on the market and lack the willingness or confidence to invest time in finding out more.

Our discussions and interactions with the participants involved in this study revealed the remarkable adaptability of people in the face of limitations in existing solutions. However, people can be surprisingly resistant to making changes to their existing systems. Resistance to adopting new solutions appeared to be rooted in a number of additional, sometimes converging factors.

Resistance is considered here separately to the **barriers** people face in making changes. We uncovered a range of obvious reasons that stop people from making changes to their energy systems. These included financial barriers relating to the upfront costs of installing a new technology, and also constraints imposed by tenure (e.g. renters could not make major modifications to the home or energy system), property characteristics (e.g. those living in listed buildings faced restrictions on the types of adaptation they could make and might, for example, be unable to install insulation), or area-level factors that affected heating system options available (e.g. being on district heating, or off gas grid may limit options). These barriers can mean that people lack the means to make changes. However, a whole range of other mechanisms appear to be at play that may limit people's potential to make changes that are independent of having the means to do so.

First, we found that people **do not know what to expect from their current systems or alternative solutions**. We found that, particularly among participants who had been living in the same property for many years, they lacked a point of reference or comparison to assess their system against. This can result in people being accepting of system inadequacies. Similarly, we found that people do not always have a clear (or even vague) picture of how things could be better with a different set-up or system, and lack knowledge about tangible alternatives. Participants could struggle to articulate what their 'ideal' solution would be – yet, when presented with a concrete, detailed example of a potential solution by the research team, would respond enthusiastically. Information is important here, but so is the messenger it seems: the importance of trust featured strongly in people's accounts of changing energy systems. We found that advice and recommendations from trusted individuals (including 'lay' people such as family members or neighbours or, alternatively, trades people, often encountered while making wider home modifications) played an important role in determining whether people would act on information.

Alternatively, people may be aware that their system is not meeting their needs, but not act because they **do not know the source of the problem**. This can happen where people do not have enough technical knowledge to diagnose the problem (and therefore identify what solution is required). This is understandable; the complexity and specificity of interacting technologies and systems means that diagnosis was sometimes even a challenge from our team's expert perspective, let alone from a lay perspective.

People can also be unsure whether it is the system, or their ability to use it optimally, that is the source of the problem. We found that participants in the study wanted to know how to optimise their current systems before they will consider a change in technology. In this, there is a sense that people would first rather change their behaviour before turning to a change in technical solution.

Finally, we found that people **tend not to have a wholesale dislike for their current system**, and tended to be able to list their 'likes' alongside their 'dislikes'. Even when 'dislikes' were strong, these were sometimes framed as 'acceptable frustrations' given that they are balanced out by other aspects of the situation that were seen as more favourable.

In addition to the specific factors listed above, we also uncovered two broader patterns of logic at work that appear to play a pervasive role in underpinning resistance to change.

First, we found that people's sheer **adaptability in the face of limitations in existing systems** makes them, somewhat counter-intuitively, highly resistant to making changes to these. They are reluctant to make changes when what they are currently doing is considered to being 'doing the job', even if this involves a relatively round-about way of doing so.

Second, more broadly, but linked with the point above, we sometimes also observed an undercurrent of resentment towards the idea of having to give concerted thought, effort and investment in their heating system. In part, this is possibly because people feel that heat is something they have a 'right' to, and should not have to work hard for. In other part, this is may be because **heating – while fundamental from one perspective – can also be seen as subservient to broader concepts and purposes of the home**. In this sense, heating is not people's primary objective of being in the home, but rather the means to achieving what they see as the more fundamental purpose of caring for their family, and providing a safe and comfortable place to live. We return to this in the next section.

3.2.2 When and why people make changes to their systems

- When people do make changes to their energy systems, decision-making can be **reactive and responsive, or proactive**.
- Reactive changes: people appear resistant to making changes to their heating systems until there is a **disruption to or breakdown** in their normal flow of life that 'pushes' them to change – whether it is a breakdown in technology, an impending birth or retirement (where current strategies and technologies were seen as no longer sufficient to meet needs in the immediate or longer-term) or wider home modifications (which people might capitalise on as an opportune moment to make a change).
- Proactive changes: adaptations to heating systems may also be motivated by a **range of high-level goals or purposes**. These can be mapped across a spectrum, from those where heating considerations are front-of mind, on the one end, to those where heating is secondary to wider purposes of the home and 'home-making'. Where heating is the primary purpose, people tend to be motivated by relatively functional considerations, whereas adaptations driven by wider concepts and purposes of the home tend to be more aspirational.

We identified a number of levers that drive people towards making changes to their properties and heating systems. We identified two main lines of variation: **intentionality** (ranging from reactive to proactive) and **purpose** (where heating can range from being front-of-mind and primary to 'not a factor').

Another dimension of variability included scale (i.e. large-scale home renovations versus minor modifications) and progression of change (i.e. incremental versus wholesale changes). The data have not been presented through this lens, as we found that, among the sample involved in this study, these appeared to be determined to a large extent by available means (whether people are in a financial position to make substantial changes, and the extent to which they are constrained by tenure). However, the data does indicate the types of adaptations that people do prioritise within available means, and we give attention to this in the discussion below.

Note that the focus of this section is on changes people make to their properties and heating system, and not to behavioural change in its own right.

Intentionality of adaptations

Adaptations to heating systems can be classified across a spectrum from those that are highly reactive, on the one hand, to those that are considerably proactive on the other.

Highly **proactive decision-making** in relation to changing existing heating systems appeared to be limited to a group who may be considered 'outliers' or exceptions. These individuals made proactive decisions to replace their heating systems based on a desire for better technology, often focusing on specific technical features and functionality in a way that others appear not to (primarily getting their needs met in a non-technical sense). This was particularly characteristic of the households with heat pumps. In these cases professional expertise in science and technology appeared to play a role in influencing the decision to install a heat pump as people were willing and able to do a lot of background research to inform their decision-making. This also meant that the consumers were able to make the most of their new systems and features in a way that others did not appear to.

People involved in the study tended not to make changes to their heating systems unless there is a disruption to their current situation that 'push' them to change. With the exception of those people on the highly proactive end of the spectrum, people generally appear to undertake changes only when something disrupts their normal flow of life – whether it is a breakdown in technology, an impending birth or retirement, or wider home modifications. This group can be divided into those for whom decision-making is highly reactive and those who are somewhere in the middle of the spectrum, showing a more responsive and pre-emptive kind of decision-making.

Reactive decisions are those that tend to be made in response to a 'crisis' moment or one-off event. We found, for example, that while people might aspire towards a new system and be painfully aware of a current system's inadequacies, a complete breakdown in the current heating system may need to take place before people are pushed to make a change. For example, take the **single mum** who works full time. She lives in a three-bedroom property with gas central heating. She had made incremental modifications to her home over time: rather than following a grand vision or strategy, these were made in reaction to property and system issues. For example, she replaced her boiler when it packed up. She had had an eye on having a new efficient boiler that could save her money in the long run, but was only motivated sufficiently to make the change when the old one completely broke down.

Somewhere in the middle of the spectrum, we found a more **responsive and pre-emptive** type of decision-making, made in response to transitional factors, rather than one-off events or crisis moments. Adaptations to heating systems are made in a more consciously considered way in these instances.

This kind of decision-making is most obviously at play during **life transitions** (pregnancy and birth, retirement and ageing, transition from health to illness) that bring core needs strongly into focus, such as health, comfort and cost. Life transitions appear to bring about a shift in needs that result in disruption of routine behaviours and longer-term changes. Often, people change how they work within the confines of existing technologies to meet changing priority needs – although this can entail a significant and enduring adjustment of previous heating strategies. But people may (in addition or instead) also take up technologies or install new systems as a result of transitions, when existing control strategies are no longer deemed to sufficiently meet needs with available means.

For example, in the **child-focused family** household, the wife was pregnant and then gave birth to their second child during the course of the study. Before the birth, they renovated the spare room, painting it and adding a radiator which was a newer model than those in the rest of the home. When the baby was born, they re-introduced the temperature monitor that they used when their first child was a baby. Similarly, in the **choice family**, the participant said that he had made major home modifications when he knew his wife was expecting. This included extending the living room, installing a new gas boiler, and rewiring and re-plumbing the home. Child safety was his main concern.

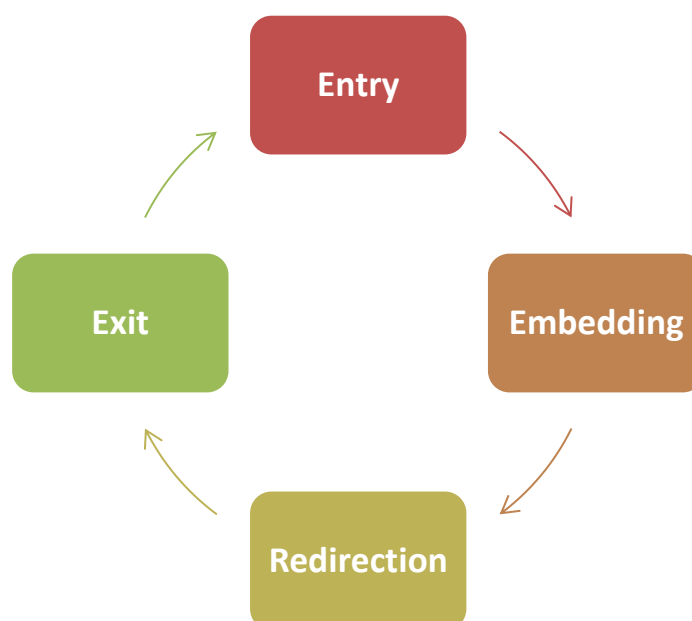
Changes of this nature were also apparent as part of the retirement and ageing process. As noted in the previous chapter, people may start to make changes in the way they use their heating systems as they enter retirement and as they age, due to shifts in their economic circumstances, changes in routines and occupancy and physiological changes. Longer-term investments may also be made as part of this life transition. For example, one individual had been motivated to install a heat pump because he had wanted an effective system that he and his wife could rely on in their old age, and their current boiler was getting old and would soon require a replacement. He anticipated that they would want the house warmer, and have the heat on more as they got older, and saw the heat pump as an option that would meet these needs in a way that would lower running costs.

Finally, fluctuations in financial circumstances may also come into play. For example, in the **multi-generational family**, due to a drop in income, the family decided to take on a lodger, to bring in extra income, which meant blocking off the annex, and installing a cheaper electric boiler to heat this space.

A more responsive kind of decision-making is also evident as part of people's **property/system transitions** which coincide and intersect with life transitions, discussed above.

General property and system maintenance and upkeep may be an on-going process, while other changes and modifications are more cyclical, and part of a process of making a home one's own. We found that people may follow a chronological pathway of typical stages in their 'home modification journeys', outlined in Figure 3.1 and the accompanying bullet points below.

Figure3.1 Property/systems transitions



- **Entry:** 'Patching up' and early adaptation of property to meet owners' needs and taste (e.g. redecoration. May be superficial, and deepened during embedding phase.

- **Embedding:** Making changes that make a home more functional, reflecting how occupants understand and want to use the home, including changes that involve embedding their personal identities and preferences (see next section).
- **Redirection:** Reassessment and making changes at transitional moments in response to changes in circumstances and lifecycle (e.g. a change in income means a household takes in a lodger and decides to create a separate space and heating system for them; an impending birth prompts a household to make modifications to the nursery). Reassessment can result in adaptations or, alternatively, a decision to move.
- **Exit:** 'Drop and go' (i.e. leave the home in its current state, as current occupant will not benefit from investments) or 'upgrade' (i.e. make new investments in order to maximise re-sale value for current occupant).

People might make changes or upgrades to their systems as part of **general maintenance and upkeep**, for example replacing an old boiler or pipes. These are distinct from event-driven changes in that these are more proactive rather than reactions to complete breakdowns in the system. Alternatively, people may make changes to their systems/properties due to changes or **disruption brought about by wider home modifications**.

For example, the **builder** lives with his wife and two children in a three bedroom house with gas central heating. Originally, the house had a small dining room that was closed off from the kitchen. However, he had felt that the space wasn't being used to its full potential; his family were only using it to store their belongings. This motivated the participant to knock down the dining room wall and create an open-planned kitchen and dining room. During the refurbishment process, he decided to replace the boiler too. Although old, it still had a couple of year's life in it. But it was more convenient to do the whole kitchen up all in one go, rather than endure further disruption at a later point. He also thought it was "daft to have a new kitchen and an old boiler".

In a slightly different scenario, the **semi-retired/working couple** are considering replacing their heating system as they enter retirement – thinking that this will add considerably to the resale value of the property. This is both about exiting the house (property transition) and life transition.

Purpose of adaptations

Adaptations to heating systems may also be classed in terms of the goal or **purpose** that drives people to make these changes. Decisions may again be mapped across a spectrum, from those where **heating considerations are front-of mind**, on the one end, to those where **heating is not a primary or even conscious consideration** on the other end.

On one end of the spectrum, **heating considerations may be front-of-mind**. Decisions tend to be motivated by the relatively specific, **functional** goal of getting a better heating system. In some cases, people were not necessarily looking for an improvement on their existing system, per se, but were seeking to ensure that their needs remain met (i.e. focused on maintenance) or, when existing control strategies and technology no longer serve needs adequately, were seeking to address a deficit or unmet need. In this sense, the focus is largely functional rather than aspirational.

Somewhere in the middle of the spectrum, heating considerations may be **conscious but secondary** – sometimes an afterthought, and certainly not the main motivator. For example, in a case illustration presented in the previous section, the **builder** was pushed to make a change in his heating system because of wider disruptions caused by home modifications. But the overriding purpose driving the wider modifications to the home was to create a more functional space for the family to use and enjoy. In other instances, changes made to energy systems were conditional on wider home modifications that were under way, and people would not have been willing to tolerate the disruption and cost entailed in installing a new system in its own right. For example, a number of participants who had installed a heat pump (HP) had done so while making other major changes to the property (e.g. extension, re-build, new build). Heat pumps work best with underfloor heating and/or larger than average radiators – both of which typically require upheaval and renovation of the home. Many said they would not have installed a HP if they had not been doing other refurbishment work at the same time.

On the other end of the spectrum, the changes people make to their heating systems may not be made with heating in mind, and are **motivated by the more encompassing goal of home improvements or 'home-making'**. Here, people appear to be motivated by **aspirational** rather than functional considerations, and this seems to be driven by broader concepts and purposes of the home, rather than heating in its own right.

In the **Y27 business from home** household, the main participant has lived in the home for 23 years. The occupants are a tight-knit family who spend a lot of time in the home, for both work and leisure. They are proud people who are proud of their home. The home is used for family bonding and often used for entertaining guests. Given that they spend most of their time there, the home is important to the family - the hub of their lives. They are attached to the home and they seem to have a lot of connections in the local community. They are keen to invest in the home, reflected in on-going extensions and redecoration work that they have undertaken. At the moment, they are redecorating the upstairs bedrooms. The plumber had to remove the radiators in order for the work to be undertaken, and it seemed a convenient and cost-effective moment to install TRVs: "there's no point in paying him to come and fit the radiator and then come back and do the TRVs".

As this example suggests, decisions to make adjustments to heating systems alongside wider home modifications may serve practical purposes. However, wider home modifications seem to be influenced by people's attachment to and the meaning they attach to their homes, and how it is used both functionally and more symbolically to reflect and express themselves and their personal identities. It is difficult to evidence this more symbolic attachment people have to their homes: we built up this insight often through informal interactions and observations over time, which allowed us to develop a wider understanding of what people value, their motivations and aspirations.

One of the striking findings emerging from these discussions was **a strong focus on aesthetics over functional considerations**, evident both in how they prioritise investments that can affect the energy profile of the home, as well as decision-making around different technologies.

For example, one participant was keen to replace the windows because he felt that these were "not the most efficient" and were "letting the air in". However, when our technical team advised him that the problem could be solved easily and cheaply by simply replacing the seals, the participant admitted that his wife dislikes the discolouration and dirt between the glass. Significantly, he wants to be "proactive" on this problem, while in contrast he has delayed the decision to install a new boiler until it "picks in" because of the expense. In another instance, a participant had installed underfloor heating as part of wider efforts to extend her property, to accommodate her growing family. This was not based on its effectiveness as a heating system, but rather because of aesthetics. It allowed her to remove 'unsightly' radiators, and de-clutter her living area space.

Wider considerations and ideas about what makes for good aesthetics do not necessarily align with or make for an effective heating system. For example, the individual who opted for under-floor heating in order to de-clutter her living space now finds this costly to run and has avoided using it during the last winter, meaning they are unable sit around the table for dinner as a family in the cold dining room.

As a need, aesthetics appear to be most salient and expressed in one-off big investments, and only peripherally in day-to-day behaviours. While seemingly a superficial concern, aesthetic considerations appear to be very tied in with pride, self-image and social acceptance.

3.3 Chapter summary and insights

This chapter began by demonstrating the **variability of energy systems in practice**. Overlaid with the above, there is also great variability in the way that people operate these systems as well as variability in their ability to optimise them.

However, people are **highly adaptable** in the face of complicated existing solutions, and take up complex control strategies to meet their needs. Some are highly sophisticated and considered, while others may be rudimentary and reflexive. Reflecting the variability of existing solutions, people's

control strategies are highly varied. What ties these strategies together is that they **enable people to meet their core needs of health and comfort**, while trading off more peripheral needs.

The chapter has also served to illustrate that people's adaptability makes them, somewhat counter-intuitively, **highly resistant to making changes in technology**. They are reluctant to make changes when what they are currently doing 'does the job' and want to know how to optimise existing technology before considering new options.

When people do make changes to their energy systems, **decision-making tends to be reactive or responsive, rather than proactive**. People appear resistant to making changes to their heating systems until there is a disruption to their normal flow of life that 'pushes' them to change – whether it is a breakdown in technology, an impending birth or retirement (where current strategies and technologies were seen as no longer sufficient to meet needs in the immediate or longer-term) or wider home modifications (which people might capitalise on as an opportune moment to make a change).

Adaptations to heating systems may be motivated by varied **high-level goals or purposes**. These can be mapped across a spectrum, from those where heating considerations are front-of mind, on the one end, to those where heating is secondary to wider purposes of the home and 'home-making'. Where heating is the primary purpose, people tend to be motivated by relatively functional considerations, whereas adaptations driven by wider concepts and purposes of the home tend to be more aspirational.

Key insights

- People adopt *complex control strategies* to meet their needs. Some are highly sophisticated and considered, while others may be rudimentary and reflexive. They are also highly variable, given that people are working around a variable mix of people/property/system factors.
- What appears to remain constant across the population is that control strategies enable people to meet the *aims* (or fundamental needs) of comfort and health, while being prepared or required to make trade-offs in relation to the *means* (more peripheral needs, such as cost and convenience) by which they get there.
- People are extraordinarily adaptable yet highly resistant to change once they have developed a strategy that allows them to meet their basic health and comfort needs. They tend to make adaptations only when there is a disruption to their normal flow of life that 'pushes' them to change.

4 Conclusion

In this chapter, we draw out a high-level summary of substantive findings and insights, identify implications for the design of SES, and situate the findings in the context of the wider activities and aims of the Consumer Response and Behaviour programme.

4.1 Key insights

Key insights from the research are:

- People have wide-ranging needs that influence how they use heat energy in the home. But it appears that only a relatively *small sub-set of these needs drive day-to-day, routine behaviours* (Figure 4.1).
- The needs that drive day-to-day, routine behaviours exist along a *continuum of priority*: some are fundamental needs, while other more peripheral and better described as 'wants'. These peripheral needs only come into focus and become an influence on behaviour as people's core needs are met sufficiently (Figure 4.2).
- It is not only needs, however, that affect what people actually do. A dynamic and interacting set of household-level factors, encompassing *people, property and system* affect how and to what extent people are able to meet these needs, and which needs come into focus and influence behaviour (Figure 4.3).
- People adopt *complex control strategies* to meet their needs. Some are highly sophisticated and considered, while others may be rudimentary and reflexive. They are also highly variable, given that people are working around a variable mix of people/property/system factors.
- What appears to remain constant across the population is that control strategies enable people to meet the *aims* (or fundamental needs) of comfort and health, while being prepared or required to make trade-offs in relation to the *means* (more peripheral needs, such as cost and convenience) by which they get there.
- People are extraordinarily adaptable yet highly resistant to change once they have developed a strategy that allows them to meet their basic health and comfort needs. They tend to make adaptations to their energy systems only when there is a disruption to their normal flow of life that 'pushes' them to change.

Figure 4.1 Consumer needs



Figure 4.2 Prioritisation of needs

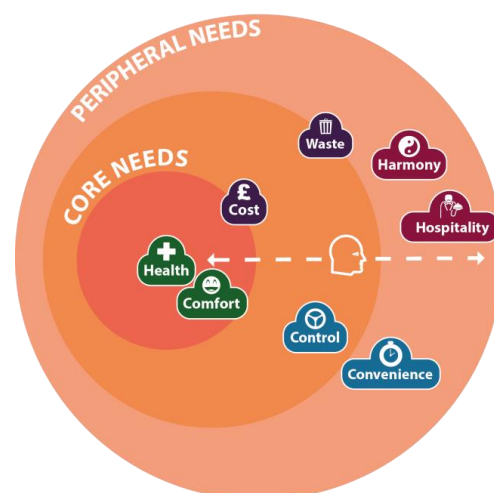
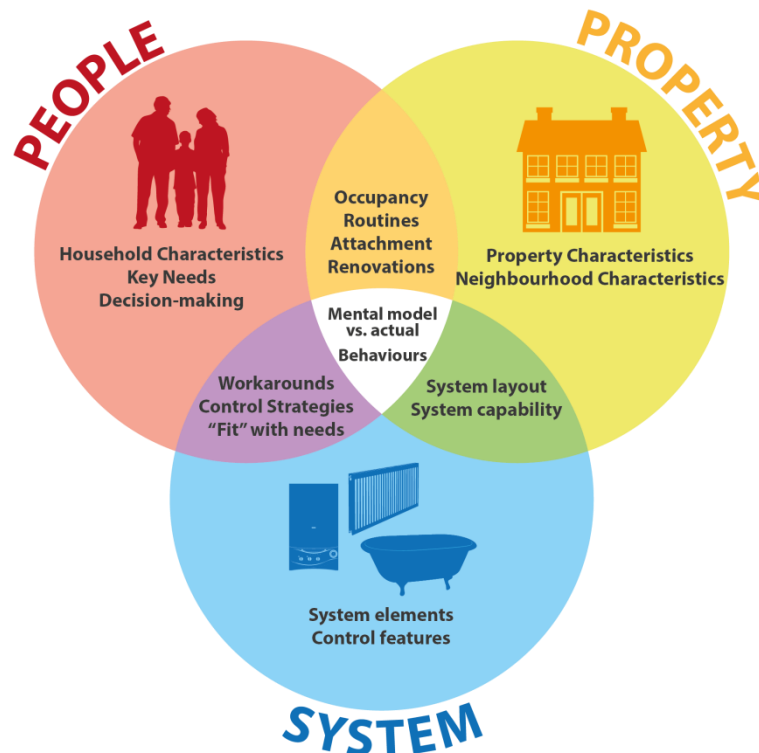


Figure 4.3 People, property and system factors



4.2 Implications for smart energy solutions

The prioritising of needs is complex, dynamic and variable between individuals and households. Our research has provided some different routes into thinking about what people want from heat energy systems that can inform different aspects of the design, implementation and communication of SES.

- *Heating often contributes towards meeting more fundamental needs of caring for a family and solutions have to, at the very least, meet these basic needs.*

Heating is fundamentally for keeping warm, and comfort is how people can judge whether they are warm enough or too cold and the likely impact of thermal comfort on their health (and the health of others). So comfort is a fundamental need in that sense. Other needs will be more or less distant from this core aim. While heating may be seen as fundamental from one perspective, it can also be seen as subservient to broader concepts and purposes of the home, such as creating a safe and stimulating environment for children or using space to maximise the social interactions amongst household members or guests.

- *Aesthetics appear to be important for large-scale investment decisions, but much less so for more frequent and basic heating behaviours*

The priorities of households vary depending on the frequency of behaviour that is being considered. The research identified frequent (more-or-less daily) behaviours and the order of priorities that people appear to attach to these. In coming up with a short-term solution to a problem, people are prepared to live with something that is imperfect aesthetically, but when they make more significant structural changes or investments, this is more of a consideration.

- *System design must meet fundamental needs, but grabbing people's interest may depend more on what needs they are immediately aware of, which may be those they cannot currently meet.*

We found throughout the research that needs may be prioritised according to what consumers are most immediately able to report or needs that are not sufficiently met. However, with longer to consider and reflect on their use of heat energy and associated behaviours, people are able to describe the essential role of heating in meeting more fundamental needs.

- *Solutions should focus on improving the means by which people meet their fundamental needs, as consumers expect these to be met as a minimum*

All viable smart energy solutions (SES) need to deliver the fundamentals of comfort and health in the first instance. These *ends* are non-negotiable for consumers. In addition, an SES should also be aiming to simplify and enhance the *means* by which people achieve these needs (i.e. more convenient, cost-effective, providing more control). Everyone wants their heating system to keep them healthy and comfortable, so it is better meeting these other needs that will distinguish one SES from another and for which types of household they are appropriate. These needs may be considered peripheral needs in relation to current behaviour, but they could be crucial to decisions about SES.

Given that the prioritisation of needs is complex, dynamic and variable between individuals and households, it is difficult to talk in terms of overall priorities and no order can be considered absolute or equally applicable to all households. For example, personal comfort can be considered “core” but is clearly sometimes sacrificed for domestic harmony. So an informed approach needs to be taken, and the form of prioritisation matched to the purpose for which it is proposed.

More generally, the findings underscore the importance of designing, implementing and communicating smart energy solutions around, and starting from an in-depth understanding of, the needs of consumers.

4.3 Findings in context of the wider programme

The study and its findings should be understood in the context of the wider Consumer Response and Behaviour programme. The programme as a whole is producing insight into consumer needs and behaviour from three main streams of evidence, each with its own strengths and weaknesses: the existing literature, qualitative research and quantitative research.

The literature review considered a wide range of evidence, from multiple studies and perspectives. This, in turn, helped inform the qualitative research to include investigation of the relevant needs. The literature was invaluable in identifying the wide range of needs and developing a logic as to why each might be relevant, and its possible impacts on behaviour. However, it was not the best basis on which to define different types of need, or to group or prioritise needs in a way that readily supports the aims of the Consumer Response and Behaviour programme. Neither did the literature provide the required in-depth understanding of the dynamics of how needs influence behaviour.

The great strength of the Consumer Response and Behaviour qualitative research has been to advance the understanding of those dynamics provided by the existing literature and thus expose key perspectives on consumers' priority needs. It explores how the participants demonstrate their priorities through how they behave, and how they explain why they do what they do. This represents one of the first attempts to do this in a systematic manner.