Programme Area: Smart Systems and Heat

Project: Consumer Response and Behaviour

Title: Solution Scenarios Report

Abstract:

This report was prepared for the ETI by the consortium that delivered the project in 2013 and whose contents may be out of date and may not represent current thinking. The initial ideation process was carried out by the SSH team at the ETI in Birmingham. These ideas were then filtered and fed into the consortiums process. This process and the outputs are captured in this report.

Context:

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

Smart Systems and Heat (SSH) Technology Programme

Work Area 5 Consumer Response and Behaviour

WP5.5 Solution Scenarios

D5.5 Deliverable Report

Version 1.0

25 October 2013

A note on printing this document:

Due to some of the detailed diagrams contained within this report, a number of pages are sized at A3, interwoven with the standard A4 pages. When printing a hard copy of this report, it is recommended that these pages are folded according to the diagram below:

Contents

1. Executive Summary

Work Package 5.5 concerns the initial creation of smart energy concepts (solution scenarios) to be tested with consumers in forthcoming consumer research. These concepts are based on previous Work Area 5 project work including qualitative workshops, in-home interviews and literature review.

For the purpose of this Work Package, a solution scenario is defined as a technology or integrated system of technologies that meets one or more consumer needs and the supporting value chain elements that enable that technology or system to deliver a positive consumer experience. Therefore, a solution scenario concept could include consideration of:

- Financial support
- Data or IT infrastructure
- Physical infrastructure
- Supply chain
- Legislation
- Education, training and skills
- Enabling products and tools
- Other stakeholders

To develop these concepts, the consortium, in partnership with the ETI engineering team used Hitachi's Business Origami® methodology to create six concepts. Business Origami® is a visual prototyping methodology where teams work together to identify all the elements of a potential service offering and determine the key relationships and interactions between these elements.

Using personas based on real WA5 research case studies and ideas developed by the ETI, the process created the following six concepts:

- **Healthy Home HEMS** - A home energy management system for an existing heating system supported by an advice service that responds to real-time information from home sensors (e.g. temperature, humidity, air quality, occupancy) to help maintain a healthier environment and ensure peace of mind for the customers;

- **Remote Zone HEMS** - A home energy management system for an existing heating system that enables individual rooms to be controlled remotely by occupants and provides accurate, real-time information on environmental conditions wherever they are;

- **Designer Retrofit** - A bespoke whole-home retrofit and holiday designed around the needs of a household by a single point of contact service provider who manages everything for the customer;

- **Smarter Secondary Heating** - An array of products that deliver localised, secondary heat to customers supported by intelligent, wireless controls and a new standard wireless protocol for such devices to allow mixing and matching between product suppliers. Wireless room sensors optimise performance of the products according to the local environment.

- **Complete Comfort** - This concept challenges the status quo of paying for utilities like gas and electricity, by instead paying for a guaranteed level of comfort. For a fixed monthly fee, the provider would provide the technology, fuel, maintenance and optimise the controls to guarantee that the family would always be comfortable.

- **Community Retrofit Pathways** - A business model to deliver energy efficient retrofit to a community through a phased masterplan, with wider community benefits.

Each solution scenario revealed elements that should be tested as part of forthcoming concept development work, unique to that solution scenario. However, a number of recurring themes emerged for multiple concepts that could be considered across these, and potentially other, concepts. Therefore, these key considerations could have implications for the wider SSH programme as concepts are developed and plans are made for the Phase 2 field trial:

- **Payment** - Who pays for the service (capital costs, ongoing costs, etc.) and what funding mechanisms would best suit the concept from a customer and commercial perspectives?
- **Data Management and Protection -** What data is essential for the delivery of the concept? Who needs to access and manipulate this data and how will this data be protected?
- **Trust -** How can customers be inspired to trust the concept in terms of the technologies themselves, the parties responsible for delivering the concept and in the advice they receive throughout?
- **Communication Channels -** How will information be conveyed to the customer? From first contact through the life and usage of the system? Who will the messenger be? How will the concept be marketed?
- **Cross-Tenure Appeal -** How might the concept appeal to different tenures? What about to different customer types? What is the market size for the concept?

Forthcoming concept development work in this Work Area includes:

- Ongoing collaboration with the ETI engineering team to interrogate and develop these initial concepts and consider issues such as those listed above;
- Concept testing with consumers in workshop and interview settings;
- Development of customer journeys which explore each concept in terms of each stage of the customer experience;
- Collaboration with other Work Packages on computer modelling and case study development to enrich understanding of key solution characteristics and understand variations in response by customer segment.

2. Introduction

2.1 Background and context

Work Area 5 of the ETI Smart Systems and Heat Programme focuses on exploring consumer response and behaviour in a smart heat setting. It aims to understand people's current needs and behaviours relating to the use of heat energy and how they might respond to future smart energy solutions, in order to better design these future systems.

Work Package 5.5 Solution Scenarios aims to build on existing primary and secondary research within the project, supported by input from the wider SSH programme, to define a small number of preliminary solution scenario concepts, which will be developed in future work and tested with consumers in forthcoming primary research activities. This work will work towards answering the following research questions:

RQ7. What is the likely consumer response to potential smart energy system solutions?

- By defining a selection of potential smart energy system solutions, based on consumer requirements research (WP5.4), to be tested in forthcoming research.

RQ8. How can smart systems meet current and future needs?

- By basing solution scenarios on existing needs and relating these to future trends highlighted in previous research such as WP5.3 External Factors.

WP5.5's position relative to the rest of the project activities is detailed in Figure 2.1:

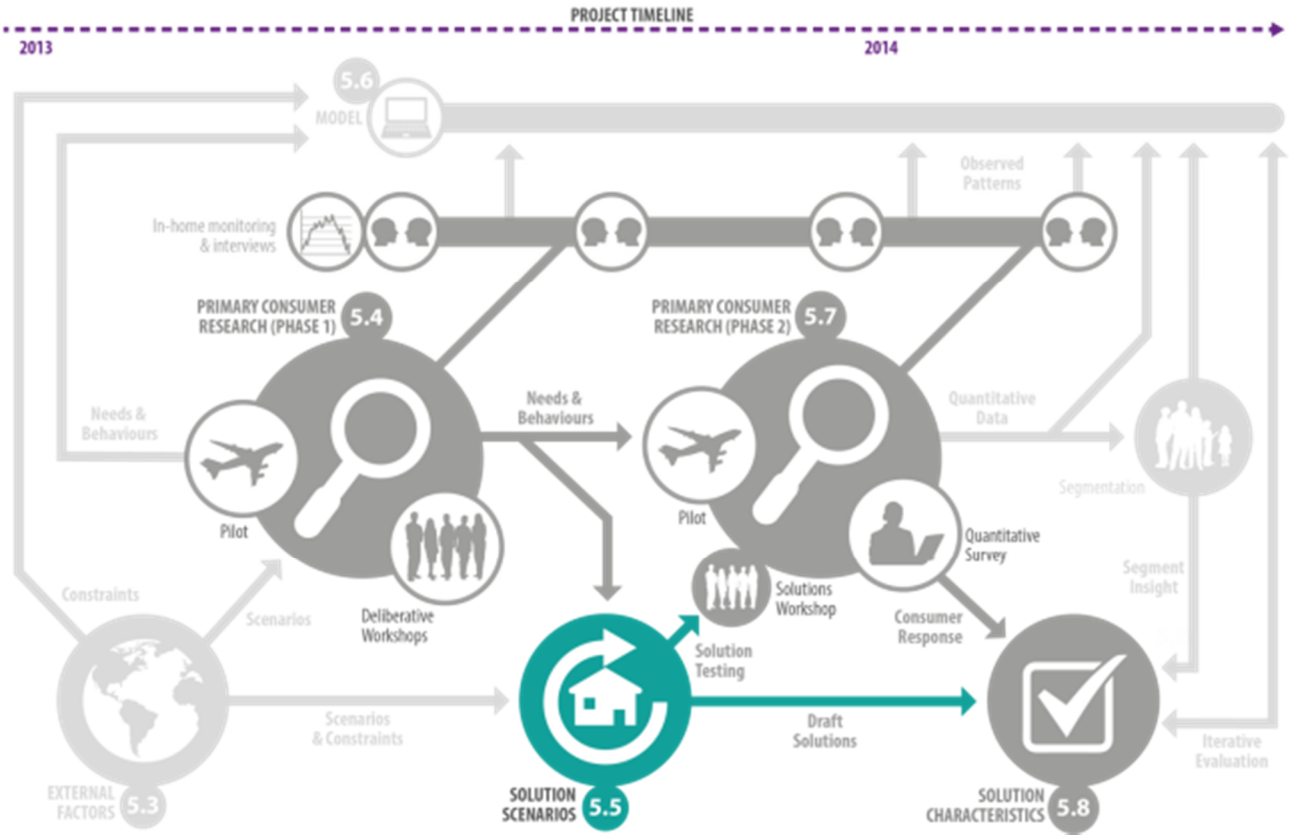


Figure 2.1: WA5 Research Diagram

2.2 What is a Solution Scenario?

As an early part of the WP5.5 work, a kick-off meeting defined and agreed the scope of a solution scenario as:

"A technology or integrated system of technologies that meets one or more consumer needs and the supporting value chain elements that enable that technology or system to deliver a positive consumer experience"

In the above definition, "supporting value chain elements" could include any of the following:

- Financial support
- Data or IT infrastructure
- Physical infrastructure
- Supply chain
- Legislation
- Education, training and skills
- Enabling products and tools
- Other stakeholders

As such, the draft solution scenarios detailed in WP5.5 must look beyond technologies that just provide or retain heat to include the things that consumers require to be in place to enable them to access these technologies, operate them effectively and gain the maximum value from them.

Figure 2.2 – Solution Scenario Elements

3. Methodology

- Early discussions within the consortium highlighted Hitachi's Business Origami® design method could prove suitable for the generation of solution scenario concepts to test in further work;
- Two sessions within the team piloted the method and trained PRP and Peabody staff. This proved that, with minor changes, the method would prove effective for WA5 purposes;
- Personas were developed based on the monitoring sample from WP5.4 to present real situations and real problems and to allow direct testing of concepts with these people in future;
- Idea generation was conducted by ETI, using these personas, to generate a long list of ideas organised into six core ideas, from which Business Origami® sessions could be based;
- Two Business Origami® workshops were held over two days to develop and explore the systems-level operation of each concept with attendees from the consortium and ETI.

3.1 Methodology Selection

Early discussions within the consortium revealed that one potential method for generating solution scenarios could be Hitachi's Business Origami®. Furthermore, ongoing discussions suggested that, to get the most out of, and deliver greatest value to the rest of WA5 and the wider SSH programme, personas should be based on real research participants and ideas should be based on ETI's growing understanding at a programme level.

The solution scenario concepts developed in WP5.5 will be evolved over the remainder of the WA5 project, through continued collaboration between the ETI and the WA5 consortium and further consumer research. This work will include the development of consumer journeys and will be further detailed in Chapter 6. As such, the structure for developing solution scenarios is detailed in Figure 3.1

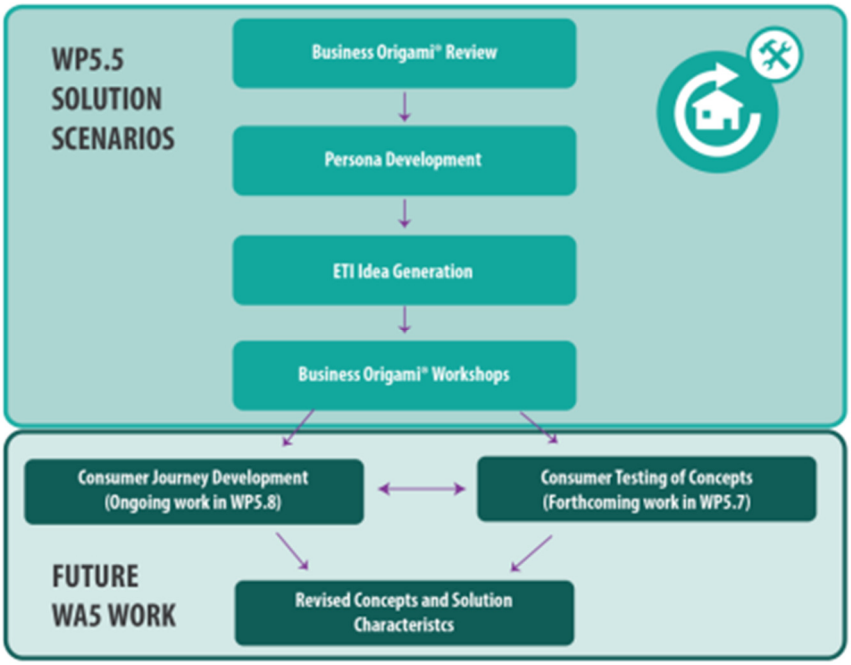
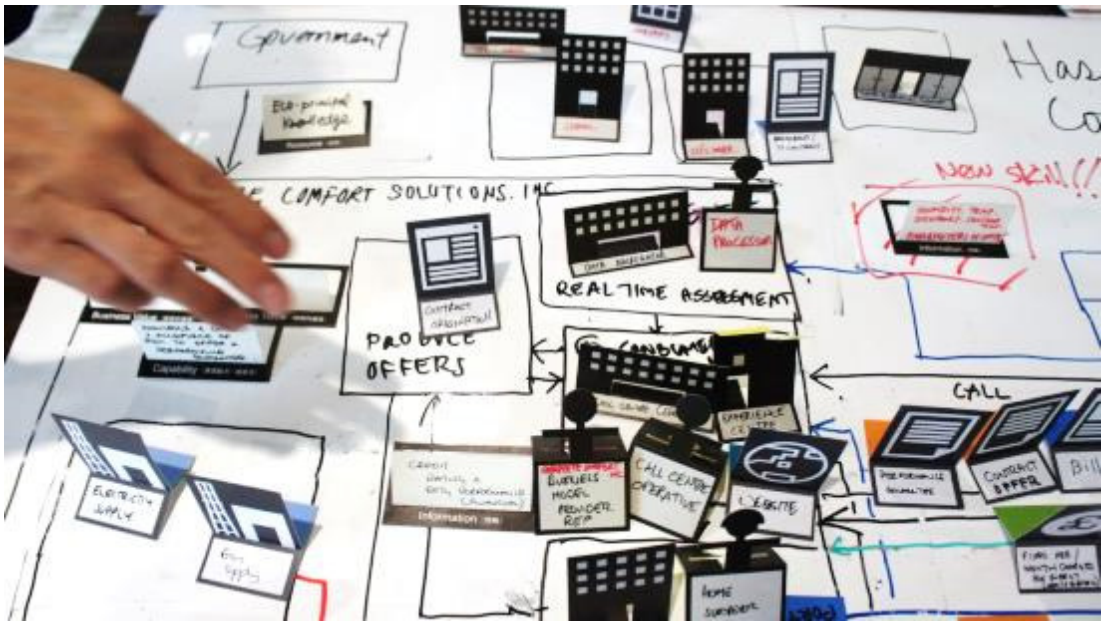


Figure 3.1 – Solution Scenario Development

3.2 What is Business Origami®?

Developed and patented by Hitachi's Tokyo-based Design Team, Business Origami is a visual prototyping tool for designing new product and service models. The tool uses group working and physical, moveable figures to identify all of the elements of a service system and identify the linkages between these.

Business Origami® is a registered trademark of Hitachi, Ltd. Hitachi has provided a license to the consortium to use the method for the purpose of concept generation for Work Area 5 of the Smart Systems and Heat project.



3.3 Business Origami® Pilot

Following identification of Business Origami® as a potential method for developing early concept solution scenarios, two sessions were held to train the members of the team that would facilitate the Business Origami® workshops and to test the process for its suitability for WA5. The key lessons from the pilot to incorporate into the planning of the main workshops were:

- **Teams should include a maximum of six people** – larger teams would potentially struggle to focus on a coherent and single task and may hinder the development of the idea;
- **Two facilitators per group are necessary** – a visual recorder to capture ideas as they arise and a facilitator to prompt and manage discussion are needed. These jobs could not be completed by the same person effectively;
- **Team composition should be carefully designed –** to ensure effective team working and a strong output, the make-up of the teams would be extremely important, in terms of experience and expertise as well as interaction with other group members. One key aspect of this would be to ensure a "customer" expert was appointed from the NatCen team of researchers conducting the field work and consumer research analysis under WP5.4 in addition to technical and commercial experts who understand the potential solutions under the SSH programme. In discussion with ETI, it was agreed that members of the ETI engineering team would be best suited in these cases;

- **Some floating participants and a facilitator would be effective –** As long as the majority of participants are fixed to one idea, a few participants who could move from group to group would help gain greater insight from these participants and help share insights from each group during the process. A floating facilitator would, similarly, help maintain a level of consistency across the groups;

- **Only one idea should be developed per day** – it was originally considered to hold full-day workshops where two concepts were developed. The pilot highlighted that the process of developing ideas is taxing and could lead to the second idea of the day being effected by fatigue. Keeping to one idea per session would help to mitigate this.

3.4 Persona Generation

WP5.4 comprised the first phase of consumer research for WA5. This included a series of workshops exploring consumer needs and behaviour, individual in-home interviews and physical monitoring of homes.

Following larger workshops held around the country, thirty households were recruited to have monitoring equipment installed in their homes and take part in a series of four interviews throughout the year. For these thirty cases, the research team have a rich picture of their situation, comprising demographic data, property information, current system characteristics, needs and behaviours and the key challenges faced by each case.

From this pool of households, a sub-sample of six cases were selected to develop into personas – anonymised case studies that provide a rich portrait of the household, the property and system characteristics and their particular needs and behaviours. These were selected to provide breadth in terms of property type, occupant characteristics and challenges. To preserve anonymity, names were changed and different but representative property photographs were provided to support idea generation work.

The six personas are included in full in **Appendix A**.

3.5 Idea Generation

Subsequent to the generation of personas and the completion of many of the early areas of work in the other SSH Work Areas, members of the ETI's engineering team carried out a series of idea generation workshops. These sessions served to generate ideas that could address the needs and challenges of the personas and cover the range of smart energy solutions considered by the SSH programme.

The workshops yielded a list of ideas that were refined before being presented to the consortium as six core ideas:

- Home Energy Management Systems – ease of control
- Home Energy Management Systems – sensors and automation
- Retrofit (improving insulation) and service design
- Products that store energy or provide localised heat
- Business Model – Energy Outcomes (pay for comfort)
- Business Model – Community Energy

Using the longer list of ideas these core concepts were translated into six idea sketches that formed the basis of the Business Origami® sessions. The full list of ideas can be found in **Appendix B**.

3.6 Business Origami® Workshops

The final agreed format of the Business Origami® sessions featured a pair of workshops with three working teams of five participants and two facilitators.

Participants were drawn primarily from within the consortium (NatCen, PRP, Hitachi, Frontier Economics and Peabody) and the ETI's SSH team. A selection of invitations to a limited number of third parties was made, to add value and expertise beyond the range available within the existing team. In the final workshops only one attendee was from a third party. An NDA was signed prior to participation to preserve any IP generated within the course of the workshops.

Following participant introductions and an explanation of the Business Origami® process, the personas and idea sketches were introduced to the full group. Groups then split to carry out the main exercise.

3.6.1 Business Origami® Process

The Business Origami® process, as used for these workshops, comprises four key stages, each taking approximately thirty minutes:

1. **Identify as many elements as possible** – Identify objects (e.g. technologies, bills), processes (e.g. home assessment, delivery) and stakeholders (e.g. customers, companies, friends and family) that might exist for the idea to work;

2. **Situate elements** – Place each of the above elements on the whiteboard, grouped together into locations (either physical or virtual – e.g. a data cloud);

3. **Identify flows and connections –** Describe how the elements and locations interact with each other by drawing lines that represent a movement of information, money, assets, heat or electricity;

4. **Determine values –** think about the value that each of the stakeholders derives from the interactions and confirm that this is a win-win relationship.

Following the main session, the group then had the opportunity to share their idea with the other groups in a plenary discussion, highlighting any key areas of discussion that presented challenges or strengths with each idea.

Following the workshops, each idea canvas has been digitised and the ideas summarised to be included in this report. Work has also begun on developing consumer journeys, which will be detailed in Chapter 5.

The process generated six concepts, detailed in Chapter 4.

4. Solution Scenario Concepts

- Six concepts are presented as outputs of the Business Origami® workshops:
  - Healthy Home HEMS
  - Remote Zone HEMS
  - Designer Retrofit
  - Smarter Secondary Heating
  - Complete Comfort
  - Community Retrofit Pathways
- Concepts should be viewed as initial stage ideas and represent faithful transcriptions of the workshops. Further development work is detailed in Chapter 6.

4.1 Format of Concepts

Each concept in this section is presented in the following format:

- Name of idea with supporting illustration;
- A brief summary of the idea detailing its key features;
- A summary of the persona that the idea has been developed for, how the idea helps solve their problem and which other customer groups could find it attractive;
- A digitised version of the Business Origami® canvas as created in the workshops, accompanied by some notes highlighting key points of interest;
- A summary of the key barriers and challenges related to the idea, as discussed at the workshop;
- A summary of things to test with customers in forthcoming work;

It is important to note these are initial concepts and, as such, need testing and refinement. As much as possible, the concepts and canvases attempt to stay true to the canvases as created in the workshop. As such, it should be expected that some elements (e.g. the relationship lines and flows) need challenging and reworking. It is intended that these canvases are revised as part of ongoing work with the ETI as detailed in Chapter 6.

It is also important to note that these concepts have been devised independently from each other, however there is no reason that there could not be an overlap or combination of concepts as part of a real world offering.

Finally, the summary of key items to test at the end of each concept section should not be seen as a final list and will be added to in forthcoming workshops between PRP, NatCen, UCL and ETI, as the scope of the testing phase is developed.

4.2 Idea 1 - Healthy Home HEMS

4.2.1 Overview

What is it?

A home energy management system for an existing heating system supported by an advice service that responds to real-time information from home sensors (e.g. temperature, humidity, air quality, occupancy) to help maintain a healthier environment and ensure peace of mind for the customers.

The system could be configured to provide real time alerts to third parties (family members, health care professionals, etc.) for times when the condition within the home is potentially unsafe. It could also integrate with a security system to improve home security. These features could help more people live in their own homes for longer when they might otherwise need assisted living. The idea could also be intelligent to learn patterns of behaviour and preferred levels of comfort to automate control and allow the system to function without the requirement for continual adjustment.

The idea is delivered through a single-point of contact from a network of suppliers providing maintenance, installation and ongoing support, referred to as "The Bridge".

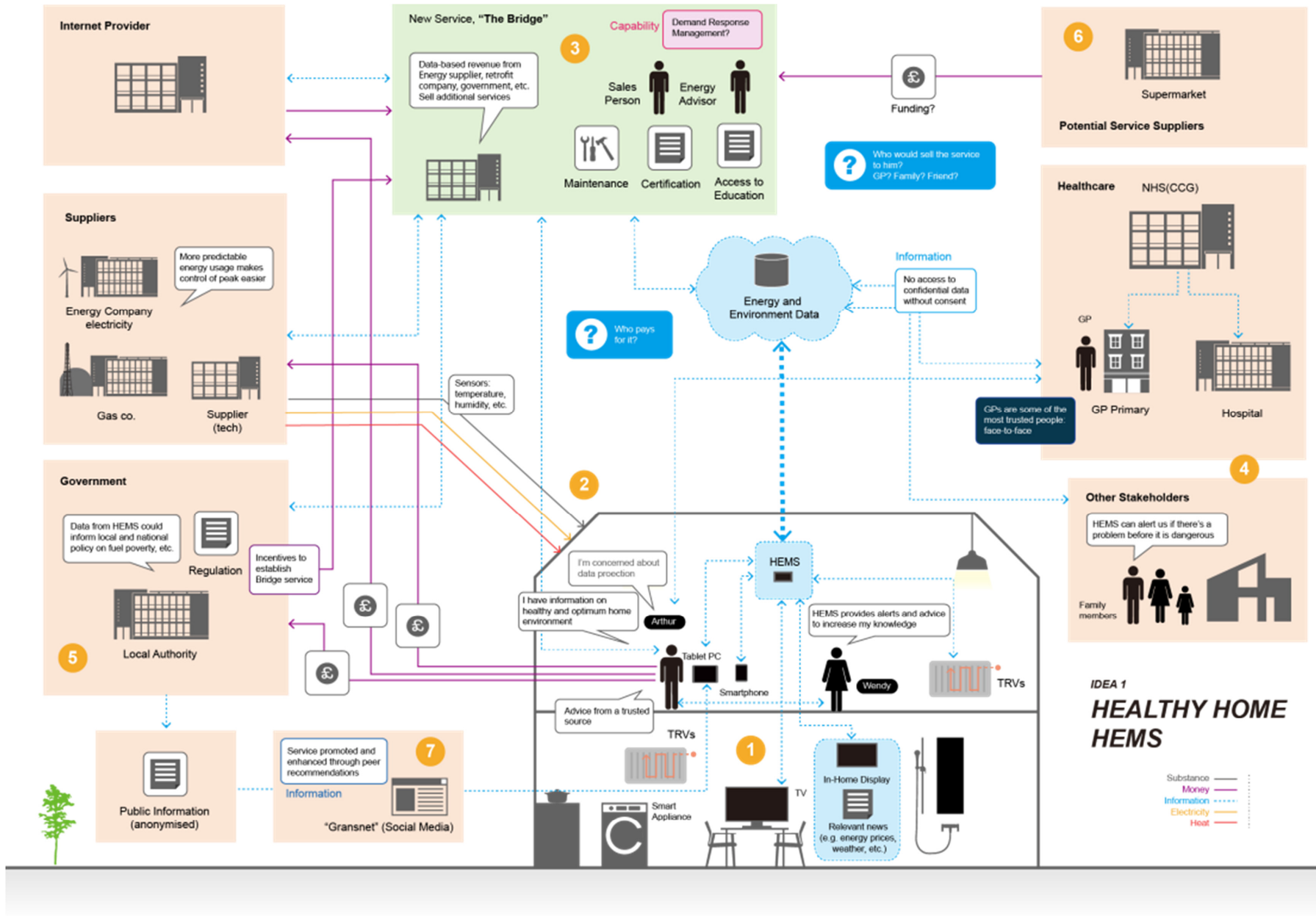
Who is it for?

This idea has been designed for the persona of Arthur Johnson (65) who lives with his wife, Wendy (61) in a relatively efficient, post-1980 detached home with gas central heating. They are both retired and live on a low income with limited savings. Arthur uses his controls every day to maintain a level of efficient comfort for the couple. They live predictable lifestyles so Arthur finds it easy to plan ahead.

Despite regular interaction, Arthur struggles to know how to optimise the heating system and relies on habit and anecdotes to inform his behaviour. A lack of zoning (no TRVs on radiators) makes it even more difficult for Arthur to optimise his system performance. This solution scenario provides Arthur with greater control, greater confidence in the home environment and greater peace of mind.

With an aging population, a smarter system that makes it easier to maintain a healthy living atmosphere and alerts users and caregivers to unsafe conditions could be a valuable tool to support customers in maintaining physical and mental health and independence. The system may also appeal to households with vulnerable individuals (e.g. young children or those with chronic health concerns).

4.2.2 Business Origami® Canvas



Notes

1. **HEMS Interface** – Interfaces with a range of household electronics – e.g. in-home display, tablet computer, smartphone, television to display information about current condition and any alerts**.**

2. **Sensors and Controls** – HEMS is supported by temperature and humidity sensors in each room. Control could be fully automated, controlled by the provider or controlled via the interface.

3. **"The Bridge"** – Potential coordinating service that manages the HEMS data and provides bespoke advice to Arthur or direct control of home system. Could also work with energy provider for demand side response activities. The Bridge could also manage and maintain the equipment.

4. **Other stakeholders** – Information on the condition of the home and impact on occupant health could be shared (with consent) with healthcare professionals or family members.

5. **Government support** – The scheme could be subsidised by government in return for potential NHS savings and access to valuable data that could inform policy development on fuel poverty, retrofit, etc.

6. **Potential Service Suppliers** – if not delivered by an energy supplier or as a standalone new service, the service could be delivered through an existing brand such as a supermarket as with similar energy, insurance and telecommunications services.

7. **Peer-to-peer advice –** in addition to advice direct from The Bridge, a social network (e.g. "Gransnet") could utilise public information and user experiences to support usage of the HEMS system.

4.2.3 Key barriers and considerations

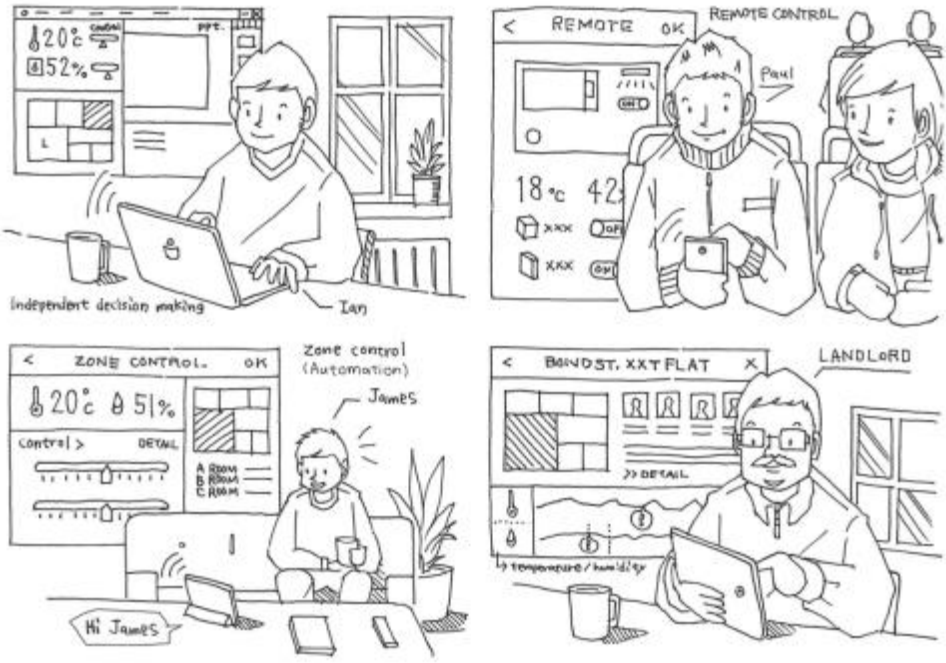
- **Payment –**Should the capital outlay of the sensor and control equipment be packaged in with heating system or boiler installations? Whilst Arthur, an advocate for heating controls, may be motivated to pay for the equipment, this may not be true for the mass market. Ongoing costs to maintain the network and equipment are another consideration. Could this be packaged in with existing energy supply or telecommunications offering? Government subsidies could also be a consideration. The idea has already highlighted how the system has the potential to save energy and assist independent living for vulnerable individuals that may save money on healthcare.
- **Data security and protection –** The core offering requires data on home condition (which could include information about periods of no occupancy) to be shared with potentially multiple third party organisation. Ensuring that this data is secure and encrypted will be vital to ensuring that the solution is robust and can be trusted. This is particularly true should it be expanded to link with family or healthcare professionals to ensure that sensitive personal data is completely secure.
- **Trust** – For a service that hinges on providing advice on how to effectively operate the home, trust in the advice and the technology is crucial and should be completely transparent.

4.2.4 Key elements to test and refine

- **Core concept** – Would people be motivated by a system that would make it easier to know how to maintain a healthy home and alert them to poor conditions?
- **Payment options** – As detailed above, there are a number of options for paying for the service, from direct user payment through to indirect payment via bills or taxes. If willing to pay, how much?
- **Automation versus manual controls** – Which is more appealing and why? Under what circumstances?
- **System usability** – How would people like to interact with the technology? Through television, tablet, smartphone or dedicated controller? Could the controls be simple enough for all people, even those who struggle with technology?
- **Interaction with third parties** - How would external family members interact with the service – would third party awareness of occupancy and other information be desirable to customers such as Wendy and Arthur? Is the concept of sharing data with a GP or care worker appealing?
- **Data Protection –** How freely can their data be shared between other agencies, is this something they would be comfortable with? What data are they happy sharing? What assurances and safeguards would they need?
- **Delivery Agent** – How would they prefer the service to be delivered (e.g. through the Bridge)? What would work best for the consumer?
- **Channels of Discovery** – Where would they feel most comfortable finding out about information on the service? Who is the most trusted source? “Gransnet?” GP? Supermarket?
- **Additional features** – Would an integrated security system appeal to customers?

4.3 Idea 2 – Remote Zone HEMS

4.3.1 Overview



What is it?

A home energy management system for an existing heating system that enables individual rooms to be controlled remotely by occupants and provides accurate, real-time information on environmental conditions wherever they are.

This idea started as a concept for allowing house sharers to more accurately determine bills based on tracking individual energy consumption but was revised during the workshops to reflect the need to respond to the relative comfort needs of the occupants.

Designed to be easy to fit and remove, the service could be packaged in with a maintenance service operated by the landlord or managing agent, or could be delivered by an energy supplier. Over time, the system would also gather information about the property that could be used by the property owner to inform future improvements.

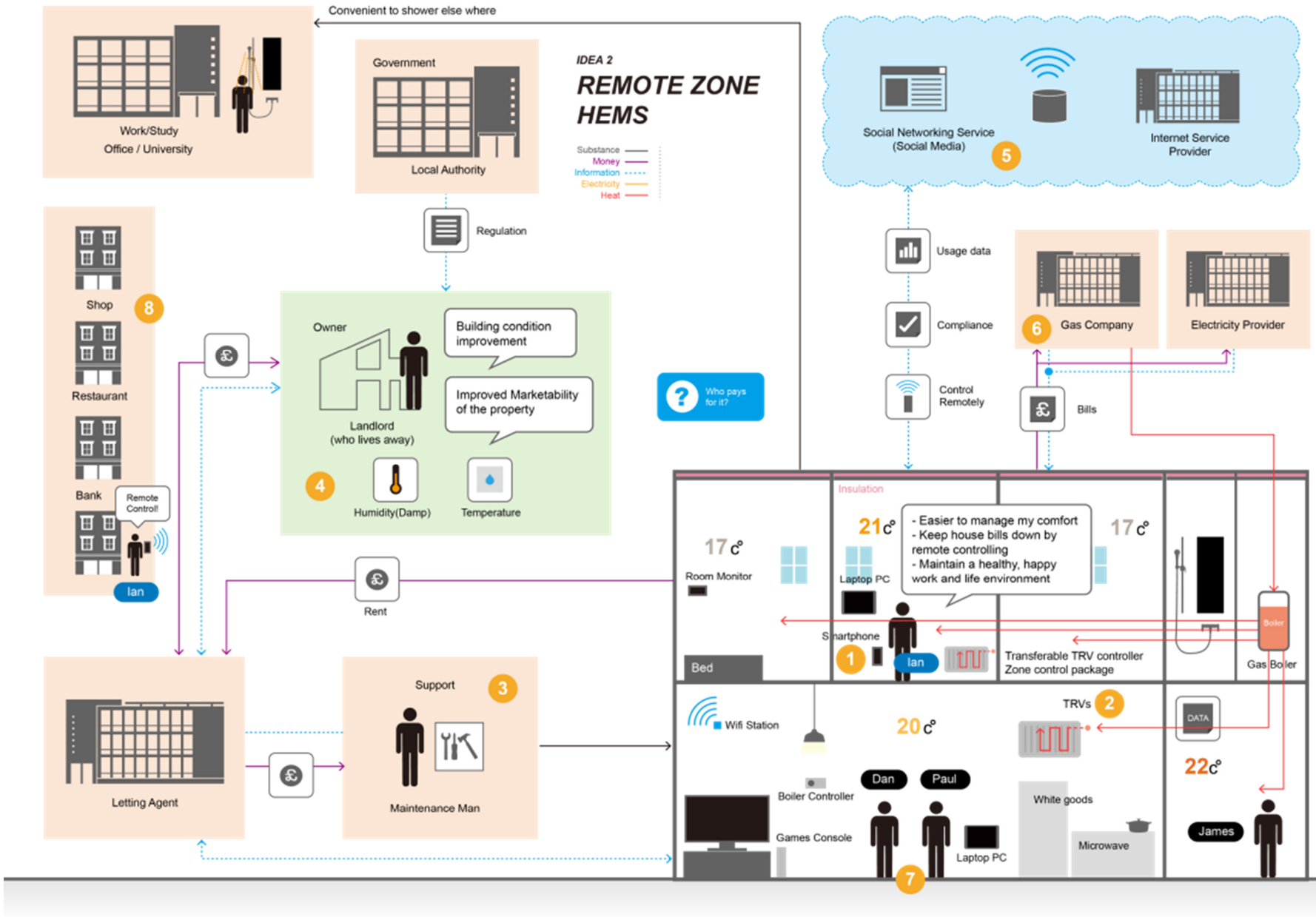
Who is it for?

This idea has been designed for the persona of Ian (24) who lives with three male housemates, all in their twenties. They live in an urban, purpose-built flat, which is moderately efficient and rented from a private landlord. They have gas central heating and a hot water cylinder supported by controls that are regularly overridden and TRVs set to maximum. All household members have a comfortable income and unpredictable routines.

A key challenge for this persona is the independence of the housemates, with little communication between them about their unpredictable and erratic routines. As such, the heating for the whole house is regularly left on when the house is empty.

As people who use smartphones and computers every day, a technological solution to energy independence could be attractive to this group. Also, as a solution built for renters, it could appeal to the growing private rental sector and to landlords facing growing energy efficiency regulation.

4.3.2 Business Origami® Canvas



Notes

1. **HEMS Interface –** Interfaces with a range of household electronics so the housemates are able to track who is where and when to optimise the heating system so it is not constantly overridden.
2. **Controls –** A transferable TRV controller is installed in each of the rooms, an additional zoned control package is bought in conjunction.
3. **Support –** As part of the control package, a maintenance 'add-on' could be purchased to carry out gas servicing and heating system maintenance.
4. **Other stakeholders –** Due to the transient nature of the houseshare, the letting agent, the landlord and potential new tenants need to be briefed on the system that is in use. The house could increase in marketability due to the system.
5. **Social networks –** Due to the age of the houseshare, they are assumed to be 'digital natives': frequently using social media to communicate with peers. This could be utilised to develop a competition between friends, colleagues, neighbours etc to incentivise energy efficient behaviours which is promoted via these networks.
6. **Supplier –** Could be a service that is provided by their energy supplier or a service that the letting agent could offer.
7. **Moving on – I**mportant that the service can be adapted, such as the controls easily removed when housemates move out or cheap enough to be left.

4.3.3 Key barriers and considerations

- **Payment –** As with most solutions related to the rental market, payment is a challenge. Improvements to the home are the landlord's responsibility, but the tenants are the ones to benefit from the intervention. With this idea, the ease of installation and removal may mean that the tenants should pay for the devices, but they may be resistant to this idea as there is no comparable precedent. If testing reveals that such a technology might be valued by tenants, this could be seen as a device to increase rental value. Incentives from government could also be considered for part payment.

- **Detachment from home** – Private renters are typically more transient and less emotionally invested in their homes, so improvements such as this may be less desirable than others. Similarly, landlords are often less emotionally invested, seeing the property as a business asset. Also, in general, improvements are typically made by the landlord between tenancies with any other works being in response to a failure (e.g. boiler breakdown) rather than as upgrades. An improvement to controls is rarely considered by landlords and tenants, so how could this be overcome?

- **Ownership and control** – With remote control of the system, access to the controls and the data is an important consideration. If the tenants move out but the system remains, how is the remote control functionality transferred? A new digital "key" would need to be "cut". Also how much control or visibility of the system data should the landlord see?

- **Regulation** – Related to the above, the private rental sector remains relatively unregulated and energy efficiency requirements such as Energy Performance Certificates have been, historically, poorly enforced. However, legal requirements such as the annual gas safety check are, more commonly, well enforced. Future regulations that might focus on upgrading energy systems and controls should learn from the successes and failures of schemes such as these.

4.3.4 Key elements to test and refine

- **Core concept** – Would people be motivated by a system that allows remote zonal control?

- **Payment options** – As detailed above, there are a number of options for paying for the service. Who should pay and how?

- **Tenure differences** – Is a system like this, which has been designed around the private rental market, appealing to this tenure? How about landlords? Are other tenures (e.g. owner occupiers) more interested in the system?

- **Ownership** – Who should "own" the system? Tenants or a landlord?

- **Permissions** – Would a system like this be able to be installed without a landlord's permission? Would that model be attractive to tenants and would they trust that landlords don't need to be involved?

- **Control Interface** – How should the system be controlled? Should a web portal be used with apps for computer, smartphone and tablet? Which is most appealing?

- **Social networking** – Would customers be interested in the social networking element of the idea, where users could "tweet" about their energy savings in a similar way to exercise achievements? Could a "gamified" approach be taken to heating?

- **Additional features** – Original discussions had included a fob or presence detector that automated the process of turning the heating on and off, as households may prefer this. Could this feature be of interest to customers?

4.4 Idea 3 – Designer Retrofit

4.4.1 Overview

What is it?

A bespoke whole-home retrofit and holiday designed around the needs of a household by a single point of contact service provider who manages everything for the customer.

A coordinating expert consultant develops a rapport with the householder through an initial assessment and builds the desired package in collaboration with the customer. This consultant then coordinates the project management of the work, sources and arranges the funding and efficiently schedules the work to be done in a minimum amount of time.

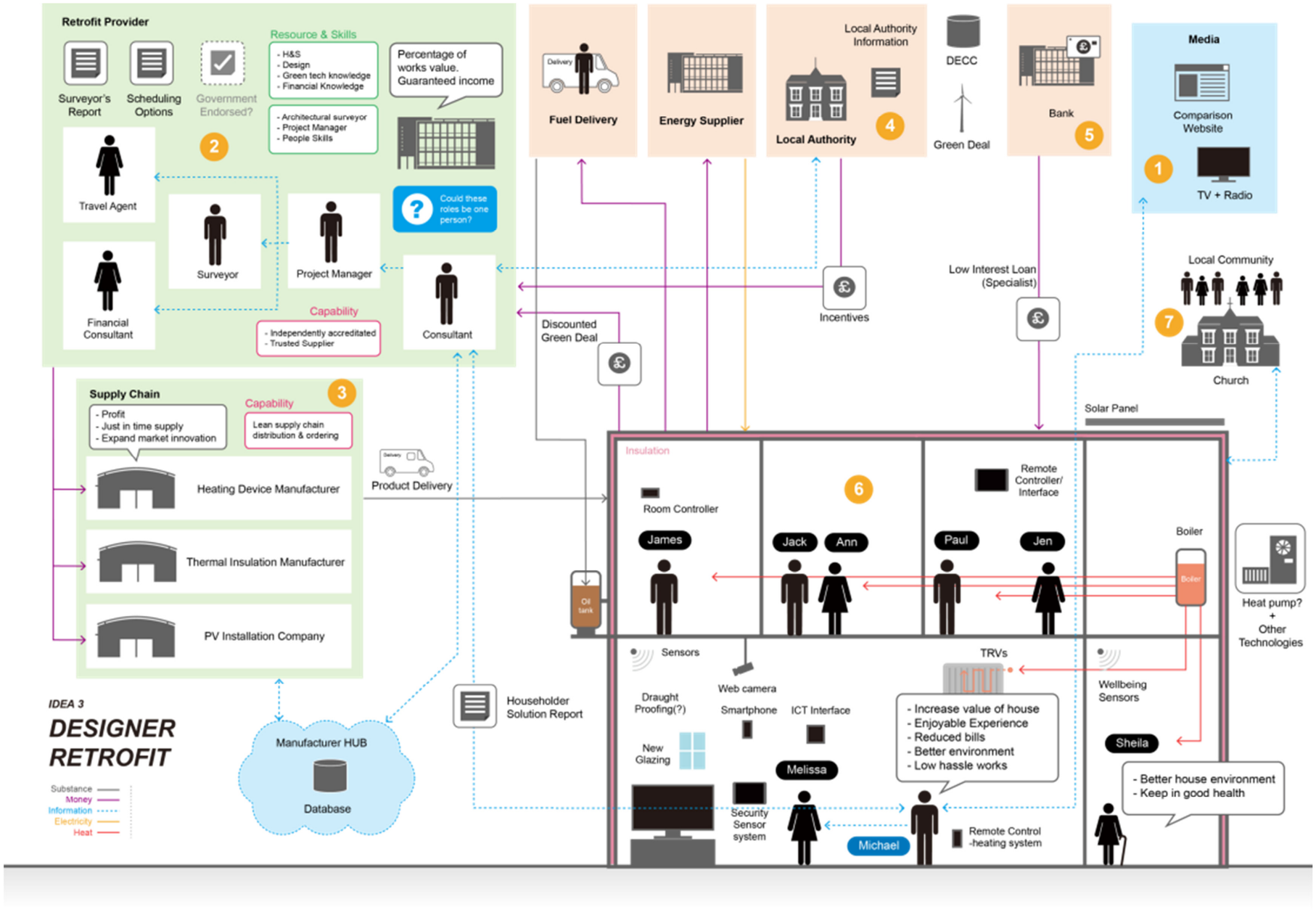
Technological innovations are employed at each step of the way to minimise labour, whilst still delivering a high level of service to the customer. To further minimise hassle, the consultant also arranges a discount holiday, which could be different places for different members of the household, so that occupants are able to avoid the upheaval surrounding the works. Webcams are provided, if necessary, to keep an eye on the works whilst away and maintain high levels of trust. The solution could also integrate security systems and wellbeing sensors for vulnerable householders.

Who is it for?

This idea has been designed for the persona of Michael Broad (56) who lives with his wife, three adult children, their partners and his mother-in-law in an inefficient, off-gas, pre-1900 cottage in a rural location. Michael runs a business from home with one of his daughters, but the house is currently heated largely by expensive plug-in heaters and a wet underfloor heating system that provides an unsatisfactory level of warmth alone. Michael is a high earner, so the expense doesn't bother him, but the poor functionality of the system and lack of convenience is a primary concern.

Whilst the wider UK housing stock requires some level of retrofit, this high-end (and likely higher cost) solution is likely more attractive to those who have disposable income and might otherwise be interested in major refurbishment or property extension.

4.4.2 Business Origami® Canvas



Notes

1. **Media –** Customers may be made aware of the service through website, TV and radio adverts.
2. **The Retrofit Provider –** Offers a range of knowledge covering financial, surveying, technical and project management services. They offer initial advice based on remote data collection and then a detailed schedule of works following a site survey.
3. **Supply Chain –** The retrofit provider receives information from the supply chain about latest innovations, available products labour availability. They place orders on the customer's behalf.
4. **Finance –** Banks offer a specialist loan at favourable rates or a mortgage product for the funding of energy efficiency works.
5. **Local Authority –** The retrofit provider communicates with the Local Authority and other external institutions about local issues and initiatives. The provider notifies and makes the appropriate submissions for planning consents, building regulations and any other permissions needed. The provider applies for and obtains any local subsidies and deducts these from the householder's costs.
6. **Phased Installation –** The customers decide which measures they would like installed and receive these works in scheduled phases to minimise disruption and to suit cash flow.
7. **Peer-to-peer communication** – The customer receives recommendations on the service from trusted peers and intuitions and gives feedback on the service.

4.4.3 Key barriers and considerations

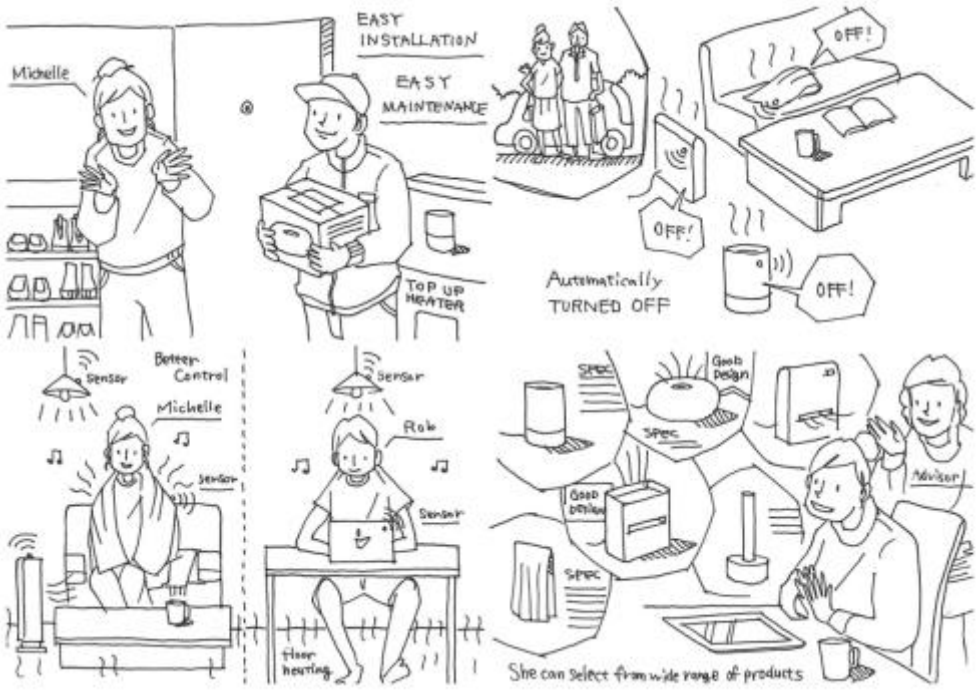
- **Payment –** This concept is likely to be an expensive customer offering that will need to be paid for by someone. The coordination role may save money on delivery but is unlikely to be enough to cover the cost of the role, where a multi-skilled individual is likely to demand a high day rate. These costs could potentially be subsidised by government (e.g. through ECO) if it is shown that such an approach could lead to increased take up of retrofit.
- **Multi-skilled provider –** Whether delivering as a multi-skilled individual or group of differently-skilled individuals, bringing all these skills under one roof could be challenging. Furthermore, as above, this could be costly. The role of technology in reducing labour costs needs careful consideration.
- **Trust** – Delivering such a service would require high levels of trust, not just for the customer, but between the consultant, local authority and supply chain. Ensuring that the brand can be trusted will be key, as will differentiating the service from "rogue traders".
- **Supply Chain** – such a service does not currently exist and would require a step change in the way that the current supply chain works. Understanding how to create motivation to inspire the supply chain to work in new ways will be critical.

4.4.4 Key elements to test and refine

- **Core concept** – Would people be motivated to take up a retrofit designed to minimise hassle?
- **Payment options** – How much would customers pay for this service? What value would they place on this? How could it be subsidised? When would payment happen? Would they trust the flow of grants and subsidies to the retrofit provider?
- **Delivery Agent** – What kind of organisation would be trusted and what referral would be needed. E.g. high street provider with TV advert or independent specialist with personal recommendation?
- **Holiday** – Would customers value the idea of a holiday packaged into the works? Would they trust an organisation to carry out the works with them absent? If not what would it take to build such trust? Would the webcam surveillance idea appeal?
- **Decision Making** – How comfortable would customers be handing over control of the decision-making process to a third party?
- **Channel of Discovery** – How do they find out about it? Where do they look for information? How do they want to receive information about the potential options?
- **Staged or One-hit?** – Would people like works delivered in one go or in phases?
- **Maintenance –** Would customers like this included as an option?

4.5 Idea 4 – Smarter Secondary Heat

4.5.1 Overview



What is it?

An array of products that deliver localised, secondary heat to customers supported by intelligent, wireless controls and a new standard wireless protocol for such devices to allow mixing and matching between product suppliers. Wireless room sensors optimise performance of the products according to the local environment.

The product range could encompass traditional secondary heating technologies such as electric fan heaters as well as wearable products such as heated blankets or clothing. The wireless standard would ensure that they could communicate with a wireless hub from a different manufacturer and open the market to a wide array of technology providers.

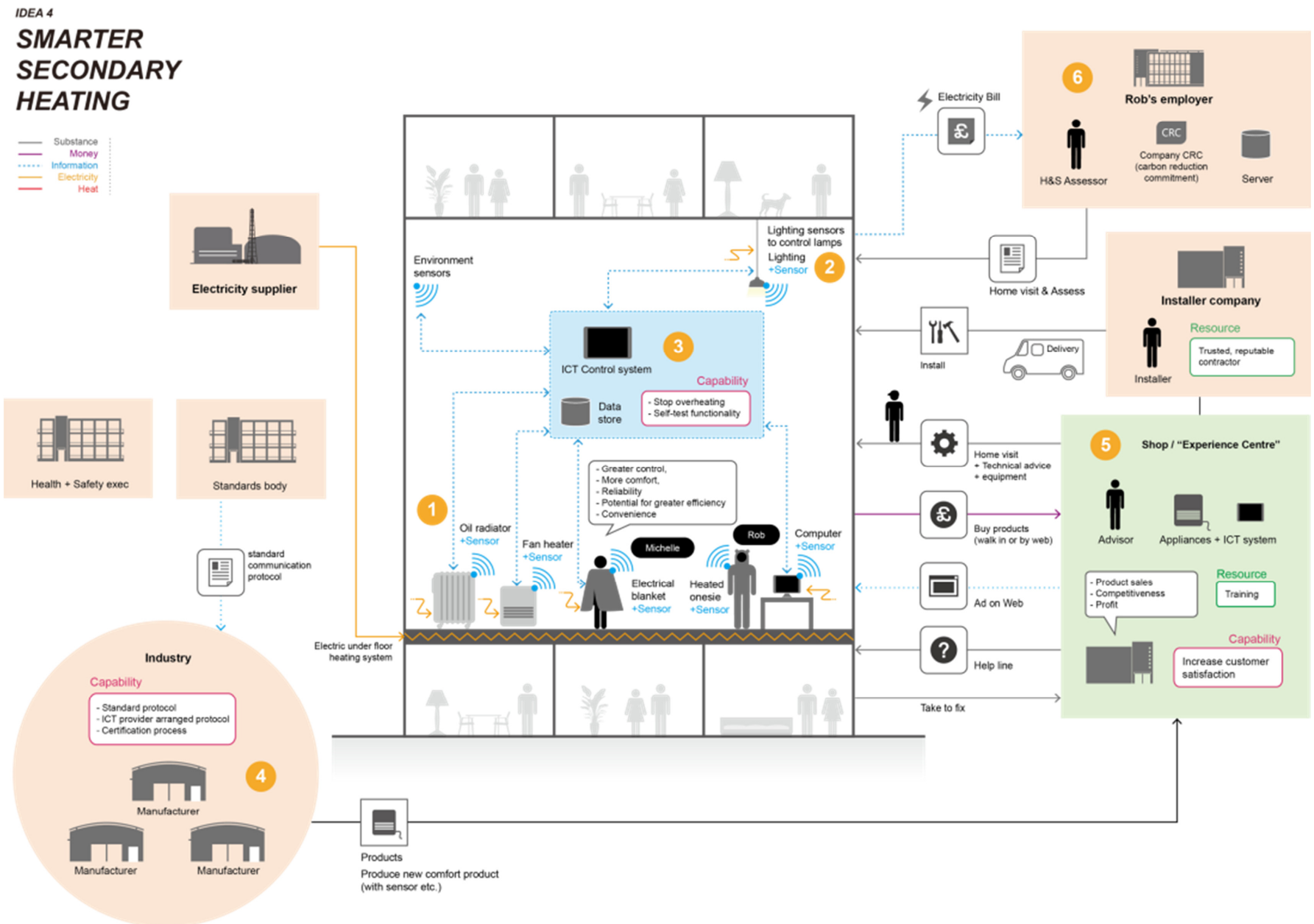
Products could be ordered online or be sold from high street “experience centres” where a specialist advisor could help recommend products. This business could also offer maintenance or hire of the equipment and ongoing technical advice and support to customers.

Who is it for?

This idea has been designed for the persona of Michelle Hall (34) who lives with her husband, Rob (36), in a leasehold 1960s purpose-built flat with Grade II listing that prevents making many changes to the fabric of the property. The property is heated by low-level, “background” electric underfloor heating which requires them to use top-up portable heaters to meet their heat requirements. Rob works from home and they are both high earners with unpredictable lifestyles.

With a rise in private renters who cannot control improvements over their own home, this concept could overcome problems where tenants struggle to maintain a level of comfort in their homes. The technology could also be used as a temporary solution for heating in the case of a boiler failure where maintenance providers could quickly deploy the solution whilst planning repairs to the main system.

4.5.2 Business Origami® Canvas



Notes

1. **Heating technologies** – A range of potential technologies are envisioned for this concept. These could include individual heaters as well as wearable blankets and clothing**.**

2. **Sensors and Controls** – Wireless room sensors optimise the operation of the devices to automatically maintain levels of comfort**.**

3. **Hub** – A central, wireless hub coordinates the data from the sensors and devices to prevent overheating and contains self-diagnosis features to highlight any problems and notify the customer.

4. **An Industry Standard** – The core value in this idea comes from a standard agreed by industry for wireless communication of secondary heating systems. This would allow customers to use technologies from different manufacturers seamlessly with each other and drive innovation in the sector.

5. **Supply** – A dedicated supplier, with a High Street "experience centre" could offer services such as system design/advice, installation, hire or maintenance.

6. **Home working support** – To assure Rob's employer that his home-working conditions are safe and comfortable, a link to the hub data could be provided. Reducing Rob's need to travel and demonstrating use of efficient secondary heating could support the employer's sustainability agenda and go towards meeting requirements such as the Carbon Reduction Commitment.

4.5.3 Key barriers and considerations

- **Value of Product –** Many users of secondary heating are happy with their products and how they use them. Understanding why a "smart" version of the product, which requires room sensors is significantly better than the current technologies is vital, to prove a market and to ensure that the concept is not an overcomplicated redesign of secondary heating. Proving that the technology can also result in energy savings will also be critical.
- **Industry Cooperation –** Establishing an industry wide protocol for secondary heating will be a challenging and costly thing to do. For it to work it would need to be driven by Government or by a significant enough consumer demand to warrant manufacturers cooperating on the standard.

4.5.4 Key elements to test and refine

- **Core concept** – Would people be motivated by products that provide localised heat, with intelligent, wireless communication features?
- **Payment options** – What would people be willing to pay for these technologies? Would they want to buy online or from an "experience centre"? Would people like a rental option with ongoing support?
- **Product range** – What sort of secondary heat products would appeal? Would people see the appeal of clothes that integrated heating and wireless sensors?
- **Tenure differences** – Would such products appeal to some tenures more than others (e.g. private rental where changes to the system are less easy)?
- **Channel of discovery** – How would people find out about the system? How would they hear of new products?
- **Sensors** – Do customers see the relevance of sensors? Are these off-putting?
- **Awareness of needs** – Would customers have enough awareness of their needs in order to specify a system or communicate this to an advisor?
- **Differentiation from existing** – At what point might customers want to switch from existing secondary heating to this concept?

4.6 Idea 5 – Complete Comfort

4.6.1 Overview

What is it?

This concept challenges the status quo of paying for utilities like gas and electricity, by instead paying for a guaranteed level of comfort. For a fixed monthly fee, the provider would provide the technology, fuel, maintenance and optimise the controls to guarantee that the family would always be comfortable.

Charges would be fixed over a long period of time, rather than fluctuating with wholesale energy prices and companies would profit by reducing the energy consumed by the customer, rather than by selling more. This could drive companies to innovate and deliver efficiency improvements to homes for profit reasons, rather than by imposed obligations.

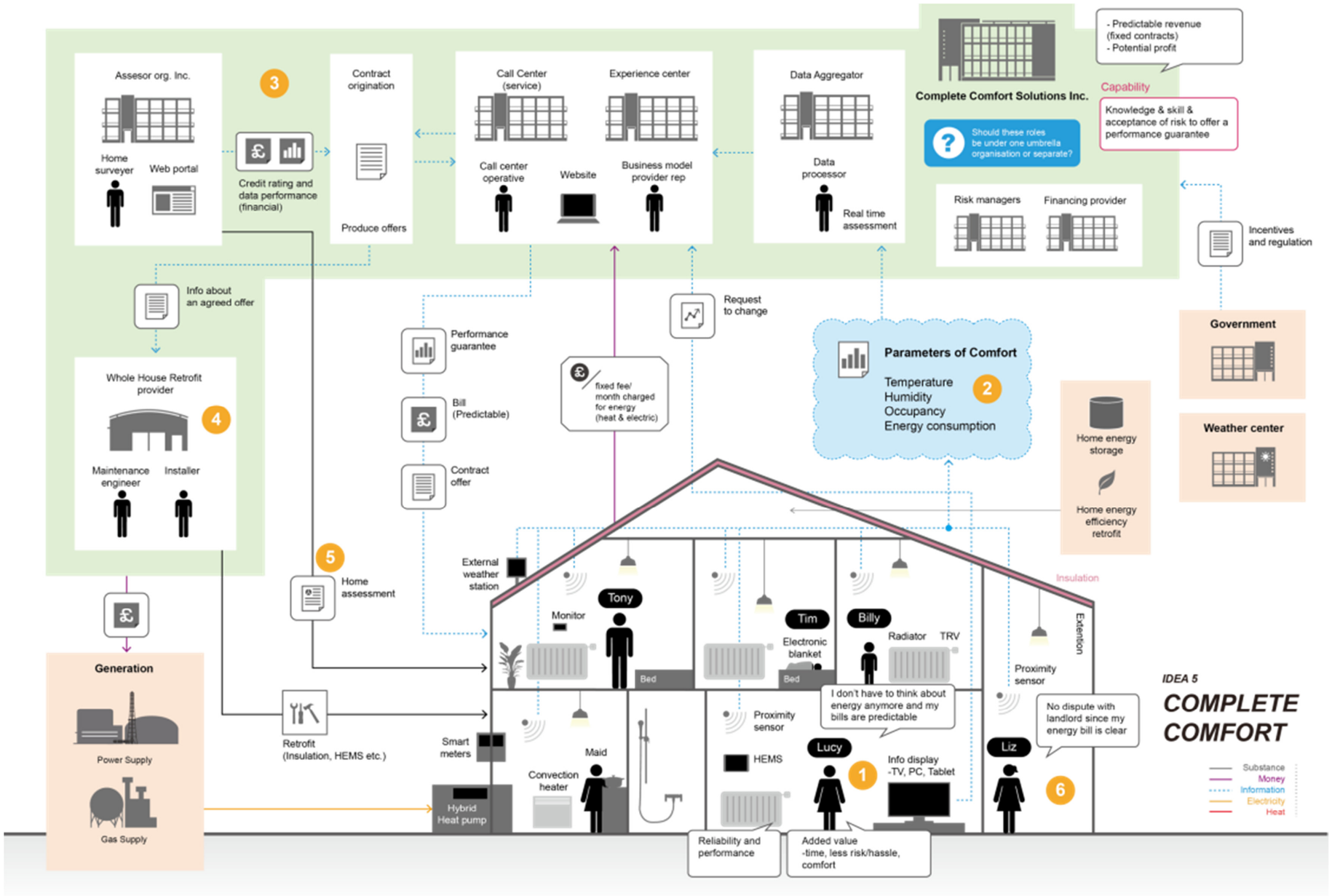
The house is necessarily fitted with enhanced controls and sensors that enable the provider to optimise and maintain comfort levels in the home. This rich data could be used for applications like submetering or identifying which areas of the home use the most energy.

Who is it for?

This idea has been designed for the persona of Lucy Churchill (32) who lives with her husband, Tony (37), their two young sons and a lodger, Liz (25). They live in a relatively efficient, pre-1980 semi-detached home with gas central heating and an extension where the lodger lives. They have a high household income and lead busy lifestyles so feel they have earned a high level of comfort and want this to be provided to them as conveniently as possible.

With the rise in popularity of “unlimited” telecommunications packages and developments in smart metering, new tariff and service offerings from utilities could become increasingly popular with middle and higher earners who are becoming increasingly used to a service-based economy.

4.6.2 Business Origami® Canvas



Notes

1. **Customer engagement** – The customer signs up to a minimum term contract with the provider in exchange for a guaranteed minimum level of comfort**.**

2. **Sensors and Controls** – To maintain a guaranteed level of comfort, the house is fitted with an array of environmental sensors that are communicated back to a central hub. This information is used to responsively control the home to optimum efficiency**.**

3. **Complete Comfort Solutions Inc.** – A range of services are required to deliver the service, from assessment, to finance, to customer service. Whilst the customer would only see these delivered as one package, these could be different legal entities.

4. **Retrofit options** – The organisation is incentivised to reduce customer energy consumption to maximise profits, so could offer energy efficiency retrofit products as part of the service, either bundled in with the service or at a subsidised rate.

5. **Home assessment** – To determine the comfort needs of the household, an initial assessment would need to be carried out and sensors gather behavioural data on the home to optimise the comfort package for the specific household.

6. **Additional benefits and offerings** – the scale of the monitoring means that the customer could be offered detailed information on the consumption of different parts of the house or by different occupants, allowing for submetering for lodgers, etc.

4.6.3 Key barriers and considerations

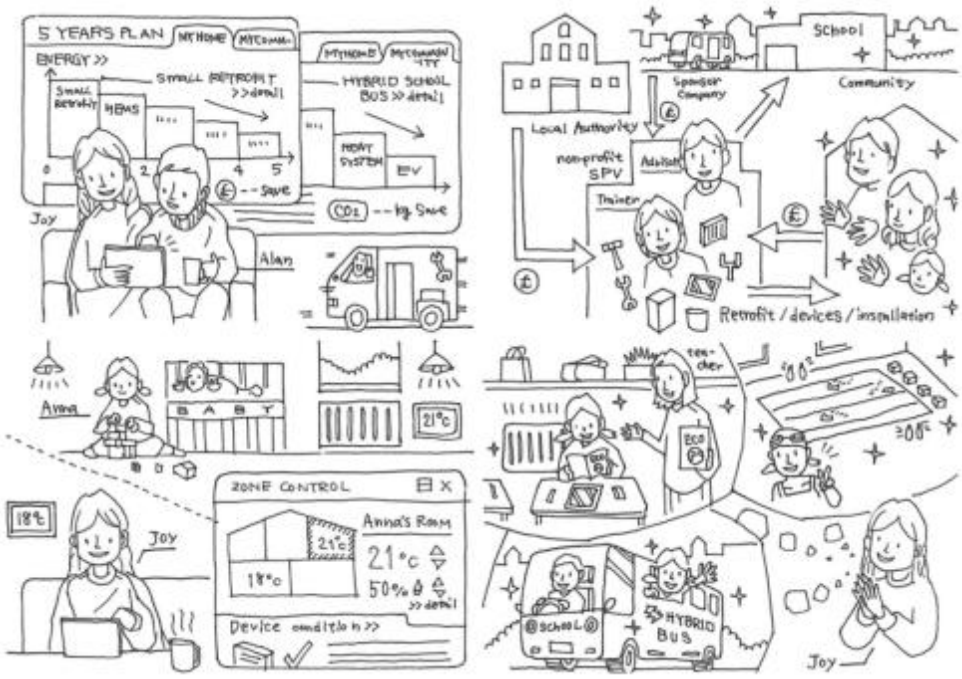
- **Differentiation from current offerings –** Many utility providers offer customers fixed monthly payments, through direct debit, that can be fixed for long periods of time. Similarly they offer maintenance of heating systems and insulation schemes. Ensuring that the concept can convince customers that this service offers something different and improved from these offers will need careful work.
- **Acceptable usage** – The concept of paying a flat rate for "all you can eat heat" could be analogous to when people stay in hotels or live in properties with unmetered communal heating. In these cases, there is evidence to show that people increase their energy usage to "get the most for their money". As such, safeguards must be put in place for this concept to avoid that. An acceptable usage policy that charges extra when customers override the controls or engage in inefficient behaviour (e.g. leaving windows open while heating is on) could be effective but would then need to address the point of differentiating from an existing tariff that charges based on consumption.
- **Trust** – If the concept requires control to be handed over to a third party, there is a barrier of trust that must be overcome in order for customers to accept this concept. Related to that is the requirement for sensors to be placed around the house. This may present further concerns for customers and they would need to understand the need for these as well as trust the organisation responsible for delivering the service.
- **Data protection** – With the amount of data from the sensors and instruction to the control systems involved, robust and secure data transfer mechanisms must be in place to ensure that data, and the household, are secure from malicious parties.
- **Flexibility** – The concept will need to be flexible enough to adapt to changes in customer circumstances, such as a new baby or household members moving out.

4.6.4 Key elements to test and refine

- **Core concept** – Would people be interested in a service where they pay for comfort rather than a fuel?
- **Payment –** What payment options would customers want? Would they be willing to pay for additional sensors or improvements or would they be happy to have these included as part of a premium monthly charge?
- **Sensors** – Would people be comfortable with sensors in their home? What level of monitoring would they be happy with?
- **Level of control** – Would people be happy to relinquish control of their home to a third party? If not, how much control would they like to retain?
- **Defining comfort** – How to define and specify comfort? How to manage variation within the household?
- **Acceptable usage** – Are customers happy with the potential for acceptable usage agreements and additional charges for wasteful behaviour? How would this need to be conveyed to them?
- **Delivery agent** – Who would customers like to deliver this service? Existing utilities? Supermarkets and existing brands?
- **Channels of discovery** – How would customers like to find out about the service?

4.7 Idea 6 – Community Retrofit Pathways

4.7.1 Overview



What is it?

A business model to deliver energy efficient retrofit to a community through a phased masterplan, with wider community benefits.

A community, potentially at the scale of a local authority, establish a non-profit organisation or SPV to transform the homes within the area. An initial data-gathering stage lays the basis for a five-year plan delivering retrofit in phases.

The SPV creates local jobs and develops the skills required to deliver each stage of the retrofit, from assessment to installation, and coordinates the procurement of retrofit materials to drive down costs. Over the five years, the new workers develop a broad range of skills and can deliver maintenance services within in future or diversify into other home improvement fields.

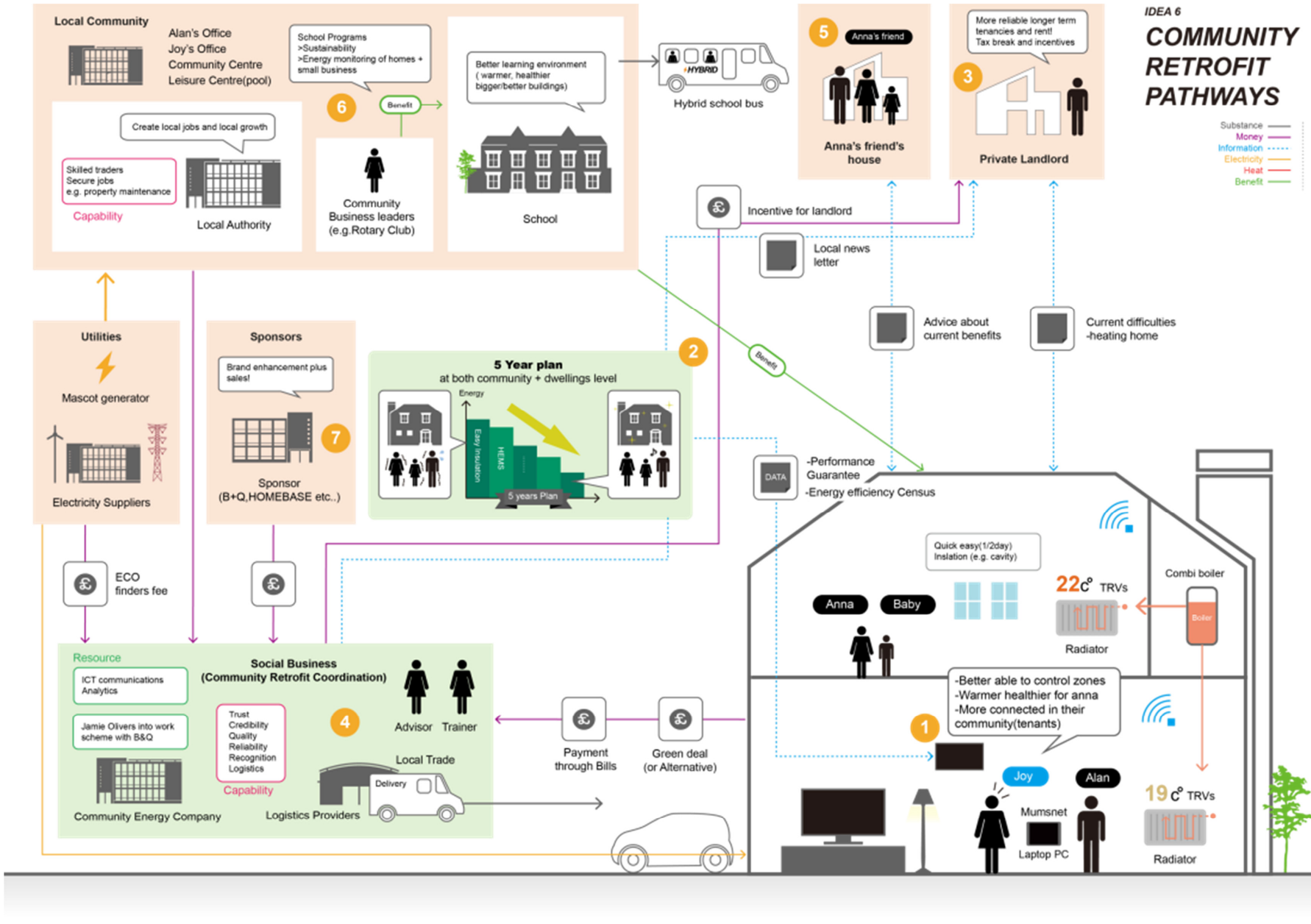
Any profit generated by the SPV can be reinvested in the community (e.g. providing the school with a hybrid bus) to support the benefits of job creation and investment in the local economy.

Who is it for?

This idea has been designed for the persona of Joy Ross (35) who lives with her husband, Alan (37) and their two young children in an inefficient, pre-1980 detached bungalow, which they privately rent from a family member. They have gas central heating but find that the system struggles to keep the house warm enough so use a number of top-up electric heaters. The needs of their children are the primary focus of this household and they are extremely keen to ensure that their children are in a warm and healthy environment.

The UK's housing stock is amongst the least efficient in Europe. Schemes to promote insulation and retrofit measures have struggled to gain momentum in many cases. A community-based approach could be a way to gain momentum and inspire enthusiasm for a mass market of homes, not just for families like this persona.

4.7.2 Business Origami® Canvas



Notes

1. **Data gathering** – As part of a community campaign data is gathered on all dwellings in the area. This could be through a self-completion census or door-to-door stock condition surveys**.**

2. **5-Year Plan** – A community-level 5-year plan is agreed and communicated to residents in terms of a dwelling-level plan. Each year will see a single phase of works delivered to dwellings.

3. **Permissions** – Before works can be carried out, landlord permission is obtained. The dwelling plan is shared with the landlord and tax breaks or incentives are offered as incentives.

4. **Social Business** – The plan is coordinated and executed by a non-profit SPV run by local champions and delivering training, procurement and logistics to support the scheme.

5. **Local inspiration** – Local momentum is achieved through promotion via schools and demonstration of the benefits at a local and relevant level. Customers can see the benefits of works directly from their local, social networks.

6. **Community benefit** – Community champions use any profit from the SPV to invest in the community, through education programmes in schools as well as efficiency upgrades. The local authority benefits through local economic growth and reduced unemployment.

7. **Additional funding and sponsorship** – businesses with a local presence could sponsor the scheme to enhance brand and offer discounts on retrofit products to guarantee sales during each phase of works.

4.7.3 Key barriers and considerations

- **Payment and funding –** The funding and operation of a local SPV could be a costly thing in a market requiring low delivery costs and low margins. Finding innovative ways to fund a scheme like this will be crucial. There could be a role for funding schemes like ECO and Green Deal, but it is likely that other funding sources would be needed, specially designed around this concept (e.g. to incentivise landlords).
- **Local appetite –** Community schemes such as this are difficult to establish and often struggle to make an impact. Ensuring that this concept has wide buy-in and can be driven by local government and championed by local residents will be important.
- **Trust** – Whilst there is evidence to show that customers have a higher level of trust in information that comes from local sources and members of their social network, ensuring that customers can trust the concept will be challenging.
- **Logistics and Coordination** – The coordination and logistics of planning and delivering a programme like this will be complex and very challenging. What skills are needed to deliver? Could architects and regeneration experts or town planners be used? Achieving maximum buy in from local residents and businesses will be crucial and difficult.

4.7.4 Key elements to test and refine

- **Core concept** – Would people be interested in a community-level approach to retrofit, delivered in phases with wider local benefits?
- **Payment options** – As detailed above, there are a number of options for paying for the service. Would customers be happy to pay? How much? Would they be willing to pay more if they knew the money was directly benefiting the local economy?
- **Community value** – Would customers value a community-led approach to retrofit? Do they care enough about their local economy? Does this vary by customer type? How much involvement might customers want in directing the community's approach?
- **Tenure differences** – Would this have a cross-tenure appeal? Would renters be willing to participate in improving a home that they do not own? What assurances or incentives would landlords need to take part?
- **Delivery Agent** – What does the SPV need to look like? Would it need a local celebrity to act as a figurehead? Who would they trust?
- **Communication channels** – How would they like to find out about the scheme? How would they like to be kept aware of progress? What messaging would inspire them to take part?
- **Choice** – Would customers be happy buying into a programme that made the decisions about the timings and order of improvements on their behalf? Would they be able to opt in to some stages and not others?

5. Conclusions and synthesis

Work Package 5.5 has concluded by delivering a series of six solution scenario concepts that can form the basis of ongoing work to develop and refine the concepts and test key elements with consumers. Each concept has looked beyond the technologies and the consumer to explore a number of other elements that are required to ensure the solution can be delivered and maintained effectively by the consumer and other key stakeholders.

5.1 Summary of elements to test

Whilst the concepts vary significantly from each other, there are a number of recurring issues and elements that are true for most, if not all concepts. These include:

- **Payment** – As might be expected, the issue of payment is crucial in most ideas, particularly where there are split incentives (e.g. with tenants and landlords) or where there may be opportunities for funding and subsidy. Services that might require an ongoing service charge, need additional interrogation to determine how people may respond to such charges. Each concept will need to consider the potential payment options and how these may affect the customer experience, before testing these;

- **Data** – As most of the solutions involve the gathering, transfer and utilisation of data, managing data protection is vital. We will need to test, for each concept, the level of data collection necessary, how much and what kind of data customers are comfortable with being gathered, who they trust to manage the data and what assurances they would need to be satisfied that this is secure;

- **Trust** – With the establishment of new services, utilisation of new technologies and approaches and the processing of large quantities of data, understanding who customers would trust to deliver these will be vital. What assurances, standards and regulation might be needed? Would existing brands be preferable to new unknowns? Each concept will need to consider consumer trust and interrogate the ways to deliver the services with maximum trust and consumer confidence;

- **Communication channels** – Each concept will need a strategy for how customers find out about the service, how they might interact with the service provider and what those interactions might look like. How can customers experience excellent customer service in their communications? Concepts will also need to consider the role of the messenger and who this person or organisation might be. How customers might require education or training to use the solutions will also be vital;

- **Tenure differences** – As many of the concepts may require changes to the property or heating systems within, how might the concept work in the social and private rental sectors? How could landlords be engaged and how might offerings be designed to avoid landlords? Understanding whether the concepts that are designed to be portable or easy to fit and remove are attractive to tenants will be crucial;

Each solution scenario also features individual elements to test that are unique to the concept. In all cases the core concept will need testing with consumers before challenging specific elements.

The strategy for drawing out a testing methodology will be developed as part of Work Package 5.2 and is detailed further in Chapter 6.

5.2 Evaluation of methodology

Overall, the Business Origami® workshops can be seen to have been a success in terms of developing and exploring initial concepts. The method was refined to work for the purpose of this deliverable and functioned well as a result.

One area of potential weakness to consider is that more time between the idea generation process and workshops would have helped with the planning and delivery of the later stages of this workstream. In addition, the six ideas were not strictly linked to the needs and circumstances of the six personas as originally intended. Ultimately, both of these weaknesses were able to be mitigated by effective working between ETI, PRP and Hitachi during the lead up to the Business Origami® workshops, and the final concepts remain rich and valuable to the project and programme.

Future applications of Business Origami® across the SSH programme could aid further concept development into Phase 2 and could be carried out with Local Authority partners to develop a collaborative approach to the field trial planning and delivery. As with this Work Package it is strongly recommended to pilot the method with Hitachi's design team to ensure that the method can be tailored to the needs of the exercise.

6. Next Steps and Ongoing Work

- The six solution scenarios are still raw, early stage concepts that require further testing and development;
- The consortium will work with the ETI engineering team to develop these ideas going forward;
- Consumer journeys will be developed for each idea to explore the various stages of the user experience
- Concepts will be tested with consumers in workshop and interview settings
- Work Package 5.8 Solution Characteristics will summarise the findings of these ongoing elements of work and make recommendations for the SSH Phase 2 field trial.
- At this early stage, implications for the wider programme are difficult to confirm. However, the concepts suggest that crucial, cross-cutting things to address will include payment, data management and protection, trust building, channels of communication and cross-tenure appeal.

The solution scenario concepts developed within WP5.5 are effective starting points for ongoing concept development work, but are still, in their current form, very early concepts. Further work in WA5 is needed to develop these into refined potential solutions. This chapter details some of this work.

6.1 Concept development with ETI

Using the digital Business Origami® canvases and commentary contained within this report as a starting point, we will work with the ETI engineering team to review and revise these core concepts. Particular focus will be paid to the stakeholders and the interactions between each, to explore possible permutations and draw out the essential factors that need testing within this Work Area and any implications for the wider SSH programme.

Crucially, further refinements should avoid aiming to narrow the scope of the concepts by basing elements on assumptions about consumer response. These aspects can be tested in future consumer engagement, detailed in section 6.3. Similarly, concepts should not necessarily be narrowed by technical or regulatory limitations as in many cases these have the potential to be overcome.

At the time of writing, the final details of ongoing concept development work are in the process of being agreed between the consortium and ETI.

6.2 Consumer Journey

A forthcoming way of presenting concepts is as consumer journeys. Consumer journeys take the core concept as detailed in a Business Origami® canvas and explore how the consumer experiences the solution at every stage, from first discovery through until stopping using the product or service.

6.2.1 Consumer Journey format

Initial work on consumer journeys is underway, with the consortium developing a sample template for each concept and completing initial data entry.

Each consumer journey is represented as a matrix with each stage of the journey (e.g. Discovery, Installation, Through-Life) included in chronological order as columns along the horizontal axis and

they key elements of each stage of the journey represented as rows down the vertical axis. Each journey maintains the use of the persona used in the Business Origami® canvas.

Each stage of the consumer journey varies from concept to concept (e.g. some may involve an assessment stage or a contract stage), but the row categories that describe each stage are consistent across each concept. These categories are currently proposed as:

- **Stage of experience –** The header for each stage of the journey (e.g. “Installation”);
- **Theme of experience** – A brief sentence that sums up the experience for the consumer (e.g. “Simple advice that I can trust”). This can spread across multiple stages;
- **Narrative of experience** – An account or story of the consumer experience at that stage;
- **Description of experience** – Pictorial representation(s) of the key touchpoint(s) within the stage;
- **Emotional response** – A speech bubble that represents the consumer’s verbal description of how this stage has made them feel;
- **Emotional value** – A score, out of 10 related to each touchpoint related to the positive emotional value created by each touchpoint (e.g. happiness, surprise, etc.)
- **Tangible value** – As above but for more tangible value such as improved comfort or financial benefit;
- **Service providers and stakeholders** – a list of who is involved in delivering and experiencing the stage, beyond the consumer themselves;
- **Resources needed** – a list of the resources required to deliver and experience that stage including legals, permissions, standards, training, etc.;
- **Technologies needed** – as above but focusing on the required technologies;
- **Barriers and challenges** – a list of key barriers, challenges or risks in delivering the stage, from any perspective (e.g. customer, commercial, technical, etc.)
- **Possible variations within stage** – how could the experience be different within the stage (e.g. installation could be carried out by a single contractor or group of specialists working in partnership)

A sample consumer journey is included in **Appendix C.**

6.3 Consumer testing

Possibly the most important step in forthcoming concept development work is the opportunity to test ideas with real consumers in face-to-face interviews and workshops. Whilst it is important to refine the ideas somewhat ahead of this testing, it is also important to retain some of the raw elements that may be challenged during further deliberations.

It will also be important to focus on the consumer-facing (e.g. user experience, marketing and support) or consumer-impacting (e.g. indirect elements that may be important to consumers such as data security) elements in ongoing work.

The rationale and methodology for testing concepts with consumers is currently being developed and will be detailed as part of a forthcoming deliverable under WP5.2.

6.4 Solution Characteristics

Work Package 5.8, Solution Characteristics consolidates the work listed above to deliver refined concepts, consumer journeys and summarises key characteristics of future solutions. Crucially, this work package will also consolidate findings from quantitative and qualitative research activities to indicate consumer response to solution characteristics linked to key customer segments.

This piece of work will draw in work from across the wider project including insights from real case studies to determine the potential impact that solutions could have. The work will also be developed alongside model development, so the WP5.6 model can help answer questions to inform the presentation of final solution concepts and, in turn, the ongoing work can inform key inputs to the model (i.e. inputs can be varied to represent the changes that the concepts might bring to the household).

The detailed content and format of this work package are currently under development between the consortium and the ETI.

6.5 Implications for SSH

At this stage of concept development it is difficult to state, with confidence, which ones are viable and what elements need further development. However, comparison between concepts reveals common threads that need to be thought out, regardless of the concept. This could inform discussions within ETI's engineering team and in other Work Areas by a list of questions used to evaluate concepts, including:

- Who pays for the idea and what funding mechanisms would best suit the concept from a customer and a commercial perspective?
- What data is essential for the delivery of the concept? Who needs to access and manipulate this data and how will this data be protected?
- How can customers be inspired to trust the concept in terms of the technologies themselves, the parties responsible for delivering the concept and in the advice they receive throughout?
- How will information be conveyed to the customer? From first contact through the life and usage of the system? Who will the messenger be? How will the concept be marketed?
- How might the concept appeal to different tenures? What about to different customer types? What is the market size for the concept?

The final concept, Community Retrofit Pathways, may prove to be of greatest interest to those involved in planning the Phase 2 field trial. As such, it may be useful for the ETI to test the concept within the timescales of the WA5 project with the short list of local authorities for the field trial to incorporate their feedback into the ongoing concept development.

The consortium will endeavour, as the concept development work continues to highlight any implications for the wider SSH programme and the Phase 2 field trial and discuss these with the ETI.

APPENDIX A – Customer Persona Profiles

Michael and Melissa Broad

Nine family members across three generations living under the same roof in a rural, extended building

CORE NEEDS

Comfort
Comfort is important to some family members more than others

Convenience
The family is busy so convenience is important, but they have become used to inefficiencies

Cost
Household income is high, so cost is a low concern

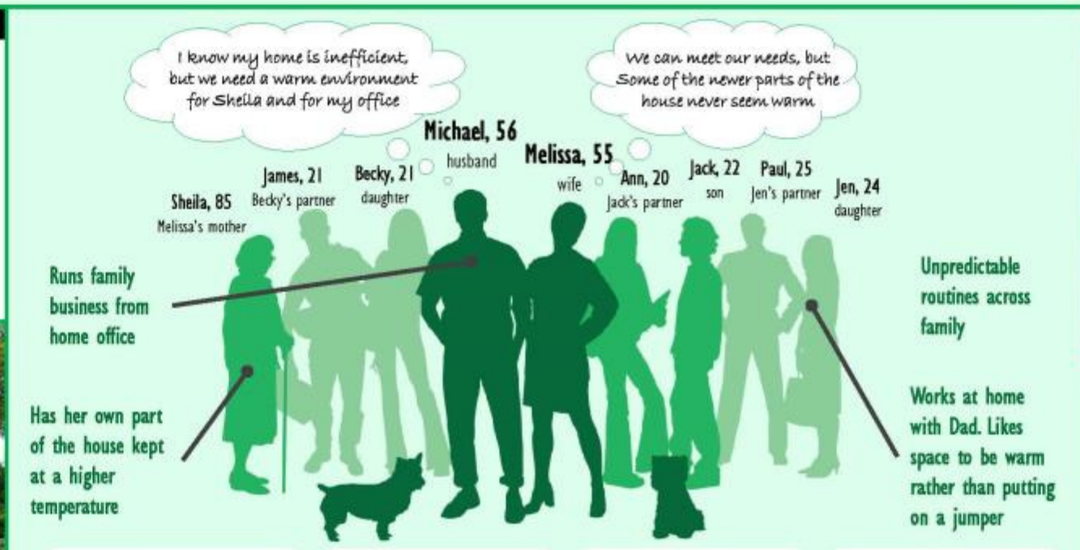
Relational Dynamics
Keeping the family happy, particularly Sheila, is the top priority

KEY
- Low priority
- Medium priority
- High priority

2 pre-1919, stone wall, semi-detached cottages ,converted into single, 5-bed detached property

Large garden and driveway

Heavily refurbished with new, ground floor extensions and large conservatory



Household Type: Dependent, Other

Tenure: Owner-occupier

H'hold Income: Over £50,000

Occupancy: High and unpredictable

Future Projections:

External Factors work (WP5.3) has shown that with an aging population and a limited pension pot, multigenerational households could become **more common**

CURRENT SYSTEM

LIKES

- Electric heaters allow a level of room-by-room control
- Thermostats throughout ground floor supported by portable "top-up" mean that Sheila can keep her part of the home warmer

DISLIKES

- Underfloor heating can take days to warm up
- Parts of the ground floor never seem warm enough
- During cold snaps, neither the underfloor heating nor electric heaters can keep the space warm
- Electric heaters sometimes get left on by accident

NEEDS:

Comfort of all family members drives all behaviour.

Health of elderly relative closely linked with comfort. Important to provide a **comfortable environment.**

There is also a **need for control**; individual control is needed for family members with **varying lifestyles** and **unpredictable routines**.

The home must also be a **comfortable and productive environment** for work as the family business is run from **a home office**.

BEHAVIOURS:

The underfloor heating system **remains on constantly** during the winter. Temperatures are controlled in different **"zones"** of the property through a number of **thermostats**.

The heating remains at a **constant, higher level** in the area of the home occupied by the eldest family member. Lots of **"top-up" heating** used throughout. **Electric heaters** are used in all upstairs rooms. **Electric blankets** are also used.

A day in the life

06:30 Michael wakes up and takes a shower. It's a particularly cold day and the upstairs corridor and bathroom are freezing cold. After his shower he returns to the bedroom which is warmer as the electric heater has been on all night.

07:00 Michael pulls on a jumper and heads down for breakfast. Jack and James, his daughters' partners are having breakfast already before they leave for work. The rest of the family is still in bed.

08:00 Michael heads to the home office, which is cold despite the underfloor heating having been on all night. He turns on a spare electric heater as he goes through his emails

09:00 Daughter, Jen, joins Michael in the office and complains that it's too cold. Michael suggests putting on a jumper but Jen turns up the heater instead.

10:00 Melissa gets up and goes to check on her mother, Sheila. Sheila's room is much warmer thanks to the underfloor heating and electric heater being on constantly.

11:00 Ann and Jack wake up and pack their bags for a trip away. They're often travelling or staying with Ann's family meaning that it's difficult to predict when they'll be in.

13:00 Melissa heads to the kitchen for lunch. Ann and Jack are just leaving. Becky is under a blanket watching television on her day off. She works unpredictable days and hours at a shop in town.

15:30 Michael takes a break from work to look at a news article about energy efficiency. The idea appeals to him as he feels his home is wasteful, but he wouldn't know where to start and doesn't have time to investigate.

19:00 Michael finishes work and joins his family for dinner. There are six of them tonight – but this varies from day to day.

23:10 Michael walks into the office to find that he has left the electric heater on since finishing work hours earlier. He also finds that Ann and Jack have left their bedroom heater on too before they left for their trip. This wastage frustrates him but has become commonplace in their home.

INFLUENCING FACTORS:

The **diversity of needs** as a result of the number of occupants remains a crucial influencing factor.

Built from two old cottages and then extended, there is **no insulation** and the **scale of the property** provides difficulties in maintaining consistent temperatures across rooms.

The underfloor heating system is also felt to be **inadequate** for the scale of the property. This prompts much of the "top up" behaviour such as electric heaters.

CHALLENGES:

Comfort and warmth needs are met with lots of reactive behaviour and generally with **great difficulty**.

Property size and renovations have a negative effect on the ability to retain heat in the property. The **need to be efficient** is not being met as a result of trying to achieve comfort for the whole family, especially Sheila.

Cost is **not a consideration** but there is a motivation **not to be inefficient or wasteful**. This remains challenging to overcome as **lack of technical knowledge** and **an inadequate heating system** fosters regular inefficiencies.

Wendy and Arthur Johnson

A semi-retired couple who enjoy entertaining and providing a warm home for both themselves and guests

CORE NEEDS

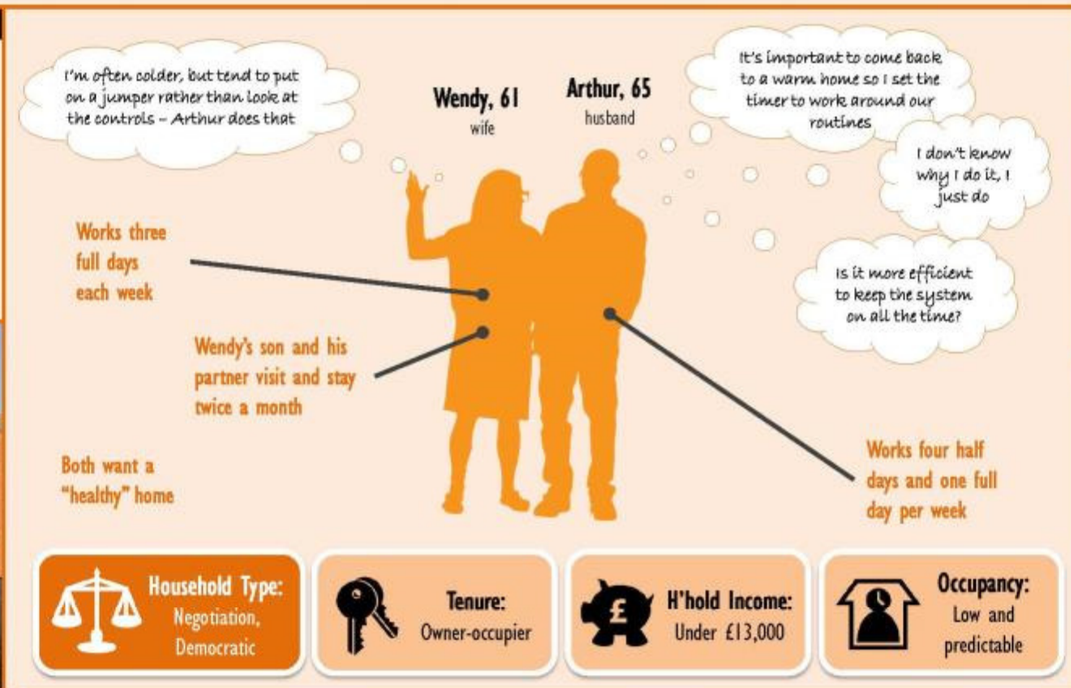
Comfort
Comfort is the key driver, both for themselves and to welcome their guests

Convenience
The system needs to be convenient, but Arthur is happy to tinker with the system regularly

Cost
Bills are affordable so cost is not important when weighed against other needs

Relational Dynamics
Want to maintain comfort for both, but only Arthur uses controls

KEY
- Low priority
- Medium priority
- High priority



Household Type: Negotiation, Democratic

Tenure: Owner-occupier

H'hold Income: Under £13,000

Occupancy: Low and predictable

Future Projections:

External Factors work (WP5.3) has shown that with an aging population, longer life expectancy and good health into older age, more active retired couples are likely to be an important group up to 2050.

CURRENT SYSTEM

LIKES

- Likes to be able to utilise timers and thermostats to adjust system according to needs and current weather
- Like coming home to a space that's already warm, having set the timer to come on before they return

DISLIKES

- Lack of TRVs makes zoning difficult. Would like to be able to control different areas better
- Due to past experience of freezing pipes are worried about maintenance and keep heat on low when they go away for long periods of time.

NEEDS:

Comfort and convenience are the main priorities for this busy couple. It is also important to provide a **welcoming environment for visitors.**

The need to be able to **control the system** seems particularly important for Arthur.

Both live **fixed and rigid routines** and need a system that reflects this need for **predictability** and **planning**.

BEHAVIOURS:

They keep the **heating on constantly** during the winter season with **small degree of zoning** (turning valves down on radiators in unused rooms – e.g. spare bedrooms).

They occasionally **adjust temperature on thermostat** although both **prefer to put on a jumper** to get warmer if needed.

Very little top up behaviour, **gas fire in lounge** used on occasion when it is particularly cold outside, but never for more than an hour.

A day in the life

07:00 Their alarm clock wakes up Wendy and Arthur. The house is warm despite it being cold outside thanks to Arthur setting the central heating timer to come on at 6:30am

07:30 After both have showered, they sit down to breakfast together and agree where they will meet for lunch – a Friday tradition.

08:25 Both leave at the same time. The heating has already switched itself to "low" at 8am, thanks to the timer settings programmed by Arthur. Wendy shuts the thick curtains before they leave to keep the heat in

09:00 Wendy drops Arthur off at work before going on to meet her friends for their weekly coffee morning as today is a day off for her.

13:00 Wendy and Arthur meet for lunch at a local restaurant in town. They talk about their weekend plans – the weekly food shop on Saturday morning and their weekly walk on Sunday after lunch.

14:00 Both have a hot drink before leaving the restaurant and wrap up warm as it has started snowing.

14:30 They arrive home to a warm house as the heating is timed to come on at 14:00 on Fridays

15:00 Wendy's son calls up to say that they're coming over to visit this weekend. Arthur goes upstairs to release the radiator valve in the spare bedroom.

18:00 Wendy cooks dinner for the family, opening the kitchen door to let out smells for ten minutes when she's done.

22:00 The heating goes off automatically as they all head to bed.

INFLUENCING FACTORS:

Having picked up strategies and developed habits related to heat energy throughout their lives, their current decision making is impacted by past learning. As such, **long-standing habits drive much of their behaviour**.

One example is that, in a previous home, hot water pipes froze and burst during a particularly long cold period when they were away. Since then, they **keep the heating on constantly** (despite now living in a thermally efficient home) with a low background setting for when they don't need the space comfortably warm.

CHALLENGES:

Negotiation exists between **comfortable temperatures of both** occupants.

Whereas the **male occupant usually controls** heating system (therefore satisfying needs around comfort) **his partner will often feel much colder**.

Zoning areas where the female occupant is likely to spend most time, and keeping them warmer, is now a **regular part of routine**.

James, Dan, Paul and Ian

Four single males sharing a rented flat with busy, varying schedules who rarely spend time together

CORE NEEDS

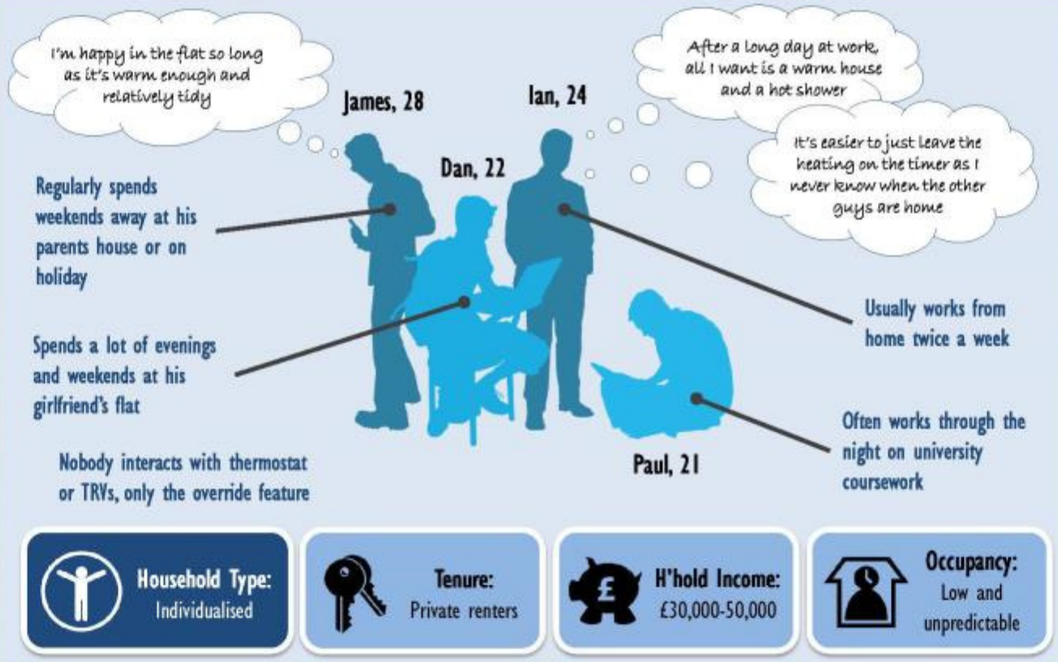
Comfort
A key driver, with frequent changes to the timer and windows to maintain comfort

Convenience
The system needs to be convenient and fit their hectic lifestyles above all else

Cost
Bills are affordable so cost is not important when weighed against other needs

Relational Dynamics
It is important to keep the peace in the flat

KEY
- Low priority
- Medium priority
- High priority



Future Projections:

Whilst the 5.3 External Factors work didn't highlight any clear signals that the proportion of shared dwellings will rise up to 2050, there is a likely increase in privately rented properties such as this over the coming decades.

CURRENT SYSTEM

LIKES

- Override feature and responsive system means home can heat up quickly as needed
- Hot water on demand is useful
- Like that the home is usually warm thanks to being well insulated

DISLIKES

- When the heat is left on by another housemate, the house can often get too hot and uncomfortable
- Too easy to leave the heat on when no one is home
- Often have to open windows if it gets too hot when people have left heating on or used oven

NEEDS:

Convenience is the most important core need for all the occupants. Their transient lifestyle, and **unpredictable schedules**, require heating and hot water on demand.

Some of the occupants also **work from home on occasion**. Having a productive, comfortable environment to work in is also a key need. Individual control is important in achieving a harmonious household.

BEHAVIOURS:

Although a timer is used in the mornings and evenings, the **occupants frequently override the timer** settings to suit when they are at home (but no interruption of thermostat). The occupants **use little top up behaviour**, being more likely to put on a jumper while also adjusting the heating system if they are feeling cold.

There is some inefficient behaviour evident, such as window opening in certain rooms while heating is on.

A day in the life

06:30 James wakes up. The house is cold as the heating doesn't come on until 7:00am. He heads to the kitchen to override the timer so that the house has already warmed up when he gets back from his run.

07:00 When James gets back, Dan and Ian are making their breakfasts before work. Paul is in the shower, which means James has to wait. He hopes there is still hot water when it's his turn.

08:15 On the bus on his way to work, James realises he forgot to change the boiler back to the timer setting. He thinks Ian might be working from home that day, so the extra heat may not be a total waste.

13:00 At lunch, Dan sees an email from their landlord about the annual gas safety check. He notices it has been sent to the other housemates, and hopes that someone else will arrange it.

17:45 Ian returns home from work (despite his original plans to work from home for the day) and realises the heat has been on all day. The house is really hot, so he opens the windows in the living room and in his bedroom.

19:00 Paul gets home after football practice and has a quick shower. He isn't sure if anyone is home, but decides to close the windows that have been left open before cooking his dinner.

23:00 James returns home after dinner at the pub with friends. The house is still warm, and he remembers he needs to turn the timer back on, otherwise the heating will be on all night again.

23:10 James heads into his room and packs his overnight bag for this weekend when he heads home. He thinks he should tell his housemates that he'll be away, but he often forgets. He watches an episode of his favourite TV programme on his laptop before going to sleep.

INFLUENCING FACTORS:

The **variability of household routines** influences many behaviours, resulting in inefficiencies. To ensure the home is kept at a comfortable temperature, while also **not knowing when the home will be occupied**, it is sometimes more convenient option to the keep the home warm all the time.

The flat itself is well insulated so it means little to no top up behaviour (such as electric heaters) is needed.

CHALLENGES:

The **unpredictable occupancy** and **lack of communication** between household members are key challenges to establishing an efficient heating regime and avoiding periods of heating an empty home.

As the property is rented and improvements are out of the hands of the occupants there is little sense of attachment to the property that might motivate a desire to improve the current home.

Michelle and Rob Hall

This busy, high earning couple own this Grade II listed property with electric, under floor, communal heating

CORE NEEDS

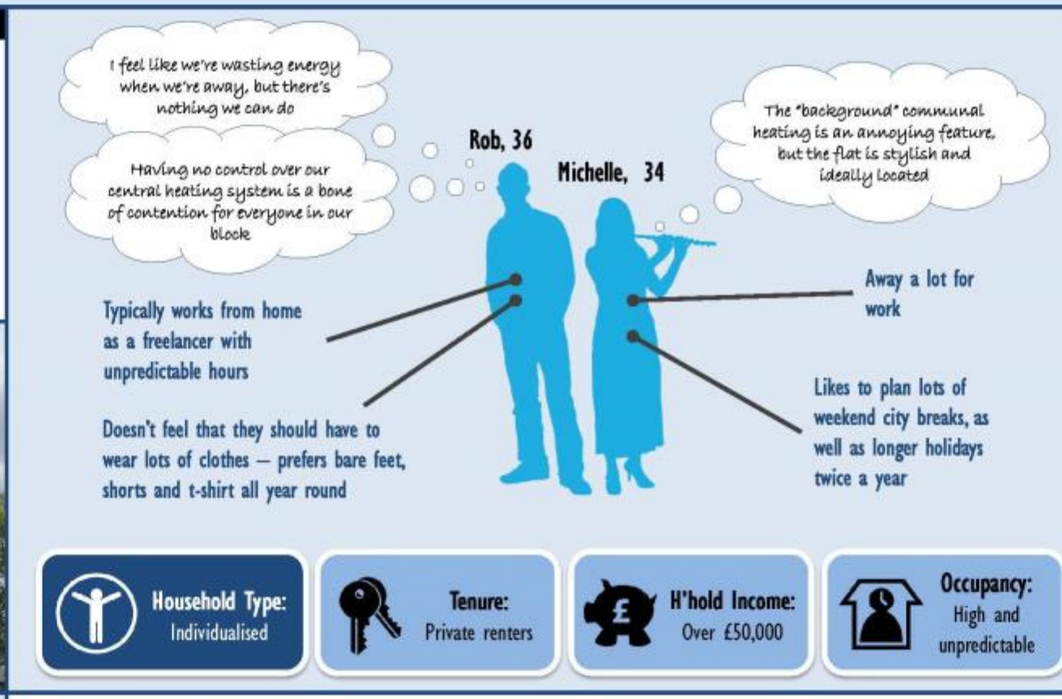
Comfort
Comfort is a key driver, with frequent top-up behaviour to maintain warmth

Convenience
Minimal interaction with heating is convenient but lack of control is an issue

Cost
Bills are affordable so cost is not important when weighed against other needs

Relational Dynamics
Compromising because of differing temperature preferences

KEY
- Low priority
- Medium priority
- High priority



Future Projections:

External Factors work (WP5.3) has shown a growth in high density, urban dwelling which could lead to increased prevalence for communal systems such as this. There is also a growing trend for working from home.

CURRENT SYSTEM

LIKES

- Likes the house to be very warm during the winter, so has invested in electric heaters and blankets which work well

DISLIKES

- Can't make changes to improve the flat, including new windows or heating controls
- Having to keep the curtains drawn most days in order to keep the flat warm
- Lack of control and insufficient heat from the communal system

NEEDS:

Thermal comfort is the biggest need. Both occupants were brought up in very warm homes, so do not like to wear a lot of clothing indoors and want to achieve a similar environment in their own home now.

Rob typically works from home so being in a comfortable, warm environment aids productivity. They would like to have control over system due to variable routines and spending extended periods away from the home.

BEHAVIOURS:

The occupants have **no control over the under floor communal heating system** and as a result, regularly open doors and windows when overheating becomes an issue. During the winter, curtains are closed more regularly in the day to prevent draughts. There is an **electric plug-in-heater** used in the main living area where Rob usually does his work**. Electric blankets are used** in both the living area and bedrooms every day.

A day in the life

08:30 Rob wakes up. He makes himself a coffee, and turns on the electric fan heater in the living room. Since Michelle has been away on work, he hasn't kept the flat as warm as she normally does with extra heating.

09:30 After a shower and a quick read of his favourite news website, Rob settles in at his desk to check e-mails and start work.

11:00 Michelle arrives home, having been away the last few days. Despite the extra heater, she finds the house cold and settles on the couch with an electric blanket while she chats with Rob.

13:00 Michelle looks through the mail as Rob cooks them lunch. She notices a flyer for the installation of new double glazed windows, and wishes she could upgrade the old, draughty ones they have now, but can't as the building is listed. She thinks about investing in new, thicker curtains.

17:45 Rob finishes work while Michelle has popped out to do a bit of shopping. He also researches destinations for their spring holiday, which they take every year for two weeks. Unfortunately, the heating is still on during this time, which they get charged for. He considers if his Aunt and Uncle may want to house sit again.

19:30 They head out to a local restaurant to meet friends for dinner. Rob leaves the electric heater on so the flat is warm when they get home. Michelle makes sure the curtains are drawn to keep the heat in.

20:00 When they return from dinner, Rob finds the house too stuffy, and opens the window in their bedroom. Michelle brings the electric blanket back from the living room to make up for the fact that the window is open.

22:30 Since Michelle has fallen asleep before Rob, he unplugs the electric blanket before he gets into bed. He also remembers to close the window- while it's still stuffy in the room, he still worries about security.

INFLUENCING FACTORS:

The property itself is the biggest influencing factor. Inability to control heating system results in top up, often inefficient, behaviour. Property is also Grade II listed so any **potential energy efficient renovations are restricted**.

Safety also influences a lot of the ventilation behaviour, with concerns over keeping windows open for an extended time. The lifestyle and routine of occupants also influences a lot of behaviour.

CHALLENGES:

Needs related to comfort and control are not being met. No control over the unresponsive heating system means they are unable to control temperatures as they would like and are therefore **continuously using heating/cooling top up behaviours** i.e. plug in heaters, electric blankets, curtains, fans etc.

Negotiation also exists between partner and wife. **Wife prefers it much warmer** so will make use of blankets and heaters more.

Alan and Joy Ross

This busy family features two parents working nearly full time, one young child, and a second child on the way

CORE NEEDS

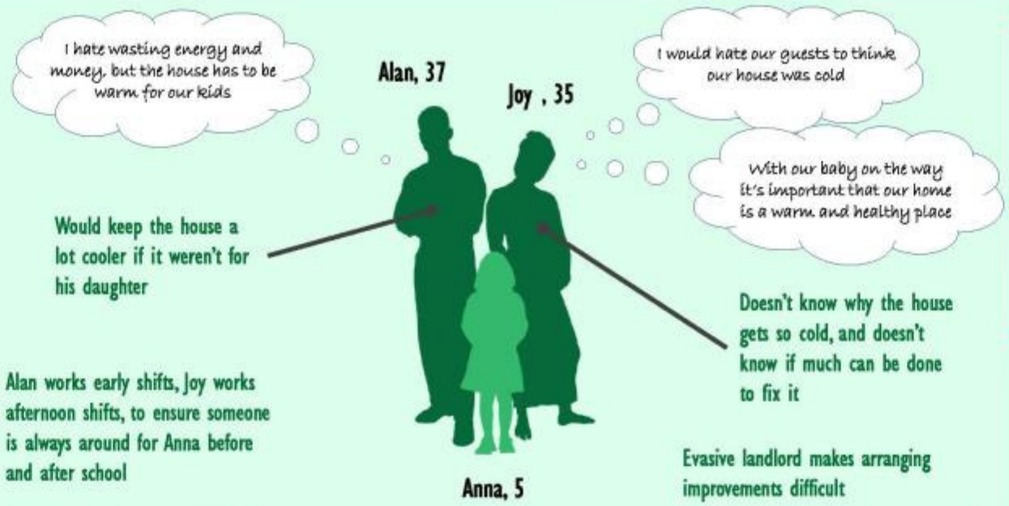
Comfort
Comfort is a key driver, with frequent top-up behaviour to maintain warmth

Convenience
Need to be able to adjust the level of heating as necessary

Cost
The concern for their child's health trumps the cost of keeping the house warm

Relational Dynamics
Parents compromise comfort for warm house for child

KEY
- Low priority
- Medium priority
- High priority



Household Type: Dependency - other

Tenure: Private renters

H'hold Income: £13,000-30,000

Occupancy: High and predictable

Future Projections:

External Factors work (WP5.3) has shown a growing trend towards households in the private rented sector.

CURRENT SYSTEM

LIKES

- Likes the house to be very warm for their daughter
- Like being able to change the heating as necessary- make use of controls multiple times during the day

DISLIKES

- The house doesn't seem to retain heat, and often can't get warm in cold snaps
- The house is uncomfortable when it gets too hot, but they need it to be warm

NEEDS:

The family's heating **needs are focused solely on the health and wellbeing of their young child**, and nearly all behaviour is directed to achieving this. The heating system must be convenient and responsive.

Although **the parents are conscious of inefficiencies**, with the desire to reduce waste more than the cost, this concern is sacrificed for the child's need.

BEHAVIOURS:

The **property is poorly insulated and this has influenced some behaviours**. For example, the occupants frequently adjust the heating system during variable weather conditions.

The overwhelming influencing factor for this family is the comfort and wellbeing of their child.

Despite having TRVs, the whole house is kept warm for daughter, Anna.

A day in the life

06:00 Alan wakes up. He is always the first one up. It's a particularly cold morning and the house feels chilly while he gets ready, so he quickly increases the thermostat before his daughter is out of bed.

06:30 Anna wakes up after hearing her father leave for work, and wanders in to wake up Joy. As Joy gets breakfast ready, she opens the kitchen door to let the dog out and to let in some air. Alan has obviously increased the temperature, and she feels too hot in the kitchen.

08:15 Joy bundles Anna up, and walks her to school. She worries Anna may be getting a cold, and makes a note to check her bedroom radiator when she gets back. She turns down the heat before leaving, to reduce waste while Anna is at school.

13:00 After returning home, and having a bath, Joy gets ready for her shift at 14:00. She also checks Anna's radiator - it seems particularly cold. She makes a note for Alan to contact the landlord when he gets home. She also turns off the central heat completely before she leaves, since Alan doesn't like to waste the heat.

14:00 Alan gets home from his shift early, and sees Joy's note about the radiator. He calls the landlord, but he is notoriously difficult to get a hold of. He wonders if he could fix it himself, or if he could find a solution at the DIY shop. The house is cold, so he puts on a sweater before watching television.

16:30 Alan does some housework after picking up Anna, as well as a schoolmate. He's turned the heat back on, and has also put the fireplace on in the living room while the girls keep busy.

20:00 After Joy returns home at 6 and cooks dinner, they put Anna to bed with an extra blanket, and are sure to tuck her curtains behind the radiator to try and keep the heat in. Joy and Alan watch television. The heat and the fireplace are turned off, and they both settle on the couch with a blanket.

22:00 They both head to bed. Alan checks that the timer is set for the morning, since it's been overridden over the course of the day. Joy reads for a bit, but eventually it gets too cold and they go to sleep.

INFLUENCING FACTORS:

The gas central heating system is set to a timer that is mapped to the child's current routine. This is often overridden when it is colder outside. The **temperature of the thermostat is always set fairly high (i.e. greater than 21 °C)**.

On occasion, windows or doors will be left open at the same time as the home being heated.

CHALLENGES:

Negotiation exists around the child's and the parents needs. The home is **kept warmer for the sake of the child's health** which can lead to the parents feeling uncomfortable.

This has resulted in some inefficient behaviour around ventilation and also **obvious behaviour changes when the child is away for long periods**, i.e. heating is not adjusted at all or is turned off.

Insufficient insulation and an inadequate system leads to lots of top-up behaviour and a home that struggles to reach set-point temperatures during the coldest days of the year.

Tony and Lucy Churchill

A busy household consisting of a high earning couple, their two young children and a lodger, all involved in decision-making

Future Projections:

WA5 research to date has not suggested any future trends significant for this persona.

CORE NEEDS

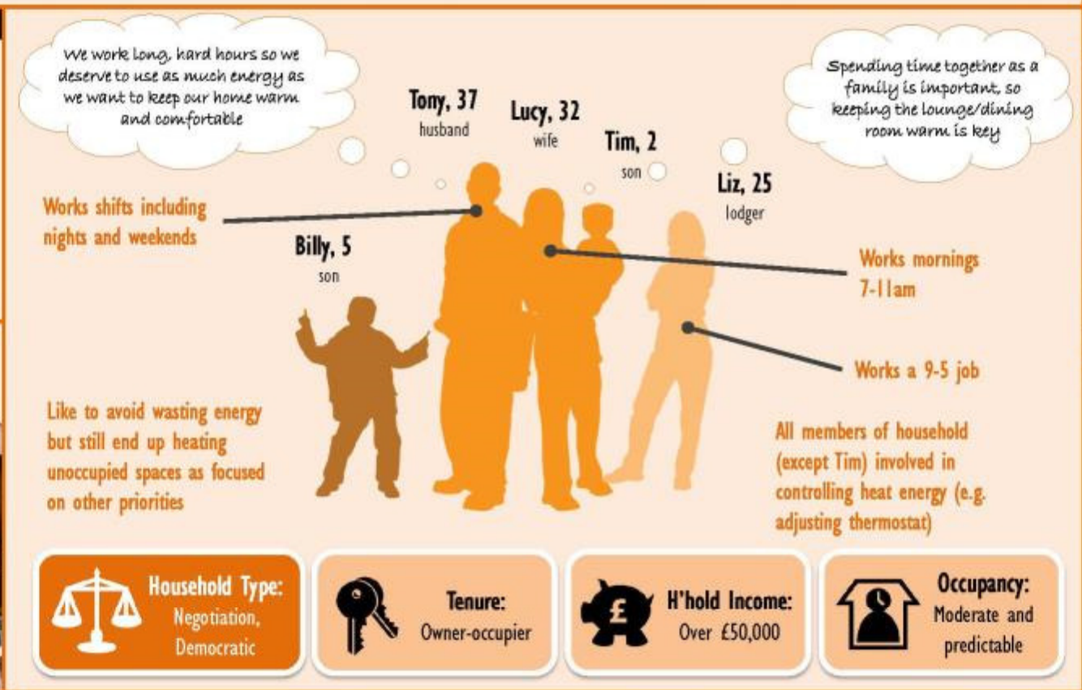
Comfort
Comfort is a high driver and perceived as an earned right due to hard work

Convenience
The system needs to be convenient as the family have very busy lives

Cost
High income means that cost of energy is nor a driving concern to the family

Relational Dynamics
Want to maintain a happy environment for all members of the household

KEY
- Low priority
- Medium priority
- High priority



Household Type: Negotiation, Democratic

Tenure: Owner-occupier

H'hold Income: Over £50,000

Occupancy: Moderate and predictable

CURRENT SYSTEM

LIKES

- Responsive nature of system – instant heat and hot water
- Top-up equipment (heaters and electric blankets) helps meet needs beyond the whole-house level.

DISLIKES

- Remembering to override the timer (and turn that off) can sometimes be inconvenient
- Sometimes inefficiencies can feel wasteful although they don't feel guilty as have earned the right to have a warm home

NEEDS:

Comfort of the whole family is most important. Keen to maintain an environment where everyone is **happy and warm.**

The family also leads **busy lives** so **convenience** is also important.

Family members believe that they **work hard** and therefore have **earned the right to be warm.**

BEHAVIOURS:

Heating is on a timer but is **overridden regularly** to meet each individual's and the whole family's needs. All family members, including children, are encouraged to interact with heating controls.

TRVs, electric blankets, convection heater, oil-filled heater are all used regularly to pre-empt needs and top-up heating around the home.

Windows opened for showers and during cooking to remove smells and avoid condensation and mould.

A day in the life

04:00 Lucy's alarm goes off and she quickly silences it so as to not wake Tony. She gets up quietly and has a shower before leaving for work at 05:00. The heating doesn't come on until 07:00 but she's used to a chilly start.

07:00 Tony wakes up and gets the boys dressed and ready for school. The maid arrives at 07:30 and tidies up the breakfast bowls and plates.

08:00 Liz wakes up and has a quick shower before grabbing a quick piece of toast on the way out of the door at 08:30. Tony offers her a lift as he's just about to take the boys to school and nursery.

10:00 Tony gets back from dropping off Liz and the boys. The heating always goes off at 09:00 so he overrides it when he gets home. The maid is just leaving after her usual three hours. Tony goes back to bed as he is working a late shift tonight

11:00 Lucy finishes work and heads straight to nursery to pick up Tim. She gets home at 12:30 to find the home warm as Tony has hit the override, but she turns this off to try and conserve a bit of energy.

15:30 Lucy and Tim go to pick up Billy from school. Tony wakes up and starts preparing dinner. He opens the kitchen window to get rid of smells and steam as the kitchen extract fan never seems to do anything.

17:00 The whole family sits down to dinner, as usual. They set aside a spare plate for Liz, who arrives home at 18:00

18:30 Lucy runs a bath for the boys, puts on the electric blanket in Tim's bed and turns on the electric heater in the master bedroom next to the bathroom to make sure the space is warm when the boys get out of the bath. Tony leaves for his night shift.

20:00 After putting Tim to bed at 19:00, Lucy reads Billy a story. Billy falls asleep quickly as his bed is nice and warm – thanks to Lucy turning on his electric blanket 30 minutes earlier. She turns this off now and goes to join Liz in the lounge.

22:00 Lucy heads to a bed heated by her own electric blanket. The heating timer goes off but Liz stays up until 01:00, with a blanket, watching TV.

INFLUENCING FACTORS:

As all family members are encouraged to take responsibility for thermal comfort, the major influencing factors are related to personal discomfort, triggering a response.

A sense of having **earned comfort** through hard work motivates the household members to achieve high levels of comfort for self and others, even at the expense of potential waste.

The unconventional hours worked by the adults mean hot water usage can be at any time of the day.

CHALLENGES:

Some level of negotiation exists around a **desire to be less wasteful** – i.e. they are aware of inefficiencies and would like to waste less energy. While this remains a concern, comfort and individual needs are not compromised for this.

The **busy lifestyles** of this household make it important to design a system that can deliver high levels of comfort with **low fuss and hassle** – they do not necessarily want to think about the heating too much.

APPENDIX B – Six Idea Sketches from Business Origami® Sessions

Idea	New cluster	Second cluster	Idea title	How it helps/problem it addresses	What it does/solution	Consumer notes	Technical notes	Commercial notes
1	HEMS		Home help	People are distrustful of sharing their personal data.	Entices occupants to tell HEMS more about their home in exchange for tailored advice for managing damp, getting cosy and keeping bills down. Regularly tunes up the heating system and offers freebies (e.g. free cinema tickets/subsidised restaurant vouchers to reduce peak on cold winter nights).	It's key to give people a reason to share their information with the cloud		
2	HEMS	Clothing	Energy wrist band (could be a key card)	People argue about heating and cooling because they feel comfortable at different temperatures. People in shared homes argue about who owes what on the bill. People forget to turn heat off when they go out. People heat empty rooms.	Wearable tag (e.g. doorkey, jewelery, perhaps eco-branded bracelet to save energy for some) that monitors person's temperature and location to tailor heat to get them comfortable; button to say if you're too hot/cold; turns heat off when people leave, down in rarely used rooms and on when they're on their way home; tracks how much individuals use to tailor their bill in shared homes.			
3	Clothing		Magic shawl	People are comfortable at different temperatures.Many people heat whole homes to relieve pain in their back.	Magic shawl detects how cold the wearer is and warms itself up to ensure they're comfortable. It's warmer down the spine where the back aches most. It cools down towards bedtime to enable them to sleep more easily.	It's cheaper to warm a person than a room. It's convenioent because it's automatic. It's very quick to get warm/cool because it can be removed.		Doesn't fit with our current commercial strategy, but could be made into a commercial proposition.
4	HEMS		Home-safe	People close windows to stop burglary and leave heating on quite high to stop pipes bursting during winter. This is inconvenient, wastes heat and can cause overheating.	Reduced home insurance premium if you allow a HEMS unit that uses window sensors to stop burglary and turns guarentees to repay for frozen pipes so you don't leave your heat on when you go away (lag pipes instead or turn heat down low).			
5	Store and Use		Heat recycling	People only use some of the heat they generate	Recover heat from plugholes, ovens and cars and store/transport it to where/when it's needed. Curtains store solar heat in the day and release it at night.			
6	HEMS		Smart water	People prefer showers/baths at different temperatures. Itt's hard to make sure there's enough water and that it's not too hot for kids or too cold for people who like it hot. There are disputes over hogging the bathroom and who should pay the bill.	Detects occupant (e.g. by weight or foot size) and automatically produces the right amount of water at the right temperature. Child setting fills a bath to the right height at the right temperature. Also tracks who uses most hot water so bills can be split fairly and teenagers persuaded to hurry up. Predicts hot water demand so only heats water needed (if there's a tank).			
7	Localised heat		Sexy seconds	People fear fires caused by secondary heat left on for too long; secondary heating is hard to move around and ugly	Overlays tailored combinations of different rapid heat (radiant, air, conduction) ontop of low level constant heat. Desirable looking, lower carbon, secondary heat with various useful features - warm me up a bit and turn off when I'm warm enough or when I leave. Auto off for electric blankets to alleviate health risk. Integrated with other parts of the home where you want to be warm (e.g. sofas, skirting board, bed, bannisters for drying clothes). Dyson hand drier-esque system for toasting you when you get in on a freezing day (or when you get out of a shower on a cold day). Overcomes dispute by enabling different people to get comfortable in the same space. Build on everyday habits as means of control (e.g. closing curtains emits heat if it's a cold night).	Cost includes safety of home		
8	Cooling		Stay cool	Some rooms get too hot (e.g. upstairs in an insulated home).	Sensors turn the heating off in rooms when they're too hot and put the cooling on.			
9	Health and hygeine		Air filter	Windows opened to remove nasty odours in toilets and kitchens. People dislike 'air tight' MVHR. Poor air quality creates various health problems and damages properties (mould)	Different way of cooking that doesn't produce nasty odour, toilets that prevent smells escaping. Keeps heat in and stops need for noisy fans. HEMS provides feedback on air quality and MVHR promoted to clean the air (like a water filter) to reduce risks of hayfever, asthma etc. etc.	UCL estimate clean air could save more lives than being warmer	Yes, but it's expensive to fit mechanical ventilation	Niche if the cost is high and the intrusion is high.
10	HEMS		Butler	It's inconvenient to adjust TRVs when guests stay, people put them on earlier than required because they don't want guests to get cold, open widnows to air the room (losing heat), don't know the occupants' preferred comfort level (so windows are opened to cool overheated rooms), then forget to turn them down when they leave. Some hosts want to display hospitality rather than lose all control to an automatic system	The host can tell the butler when a guest is coming and leaving. The butler (HEMS) ensures the room reaches the right temperature by the time the guest arrives, remembers their comfort level from their previous adjustments and turns it off when they leave. Hosts can still play host.			
11	HEMS		Light and heat	Illumination levels affect how well people sleep and how comfortable they feel. Seasonal affective disorder is also related to light.	Adjust light to help people feel happy and comfortable. Red lighting makes you feel warmer (I think). Lighting slowly dims to make them sleepy.			
12	Store and Use		Bed storage, HEMS could help too	People struggle to sleep. Parents particularly worry about getting children to sleep and making sure they're safe and warm. Some people struggle to wake up if it's cold and don't like getting out of bed into a cold room.	Bed absorbs heat during the day and releases it to warm up before bed. Then stores heat from occupant so they don't overheat and releases it in the morning to wake up occupant and warm the room so it's not too cold to get dressed in. Bed designed so can deliver different temperatures on each side of the bed.			
13	Store and Use	Localised heat	Smart hot water bottle	People like localised heat	Phase change material collects heat in bottle, releases it when want it (e.g. in bed)			

Idea	New cluster	Second cluster	Idea title	How it helps/problem it addresses	What it does/solution	Consumer notes	Technical notes	Commercial notes
14	Retrofit		Home improvement lego	Most people continuously improve their homes as their situation changes (income, occupancy, occupants, fashions).	A suite of retrofit solutions that augment any other home improvement by also improving energy efficiency. Enables household to experience the benefits of a warmer, more responsive home in a simple quick step with minimal disturbance. Cheaper than a whole home retrofit because shares many costs with other building work. Examples: solid wall insulation when repoint.			
15	Retrofit		Bathroom makeover	People often do up a kitchen or a bathroom. They don't value energy savings. They dislike damp bathrooms, towells that smell mouldy and never dry; open windows to remove condensation and odours which cools walls causing more condensation so mirrors are clouded and people leaving showers feel cold	Home improvement should focus on areas with minimial disruption, maximum comfort improvement, and highest frequency of pre-existing changes. Bathroom makeover insulates walls, coats them with anti-condensation paint, recovers heat from plug and puts in a dyson style drier for towells. Insulates bath and installs tiles that can store and release heat where/when required (e.g. into toilet seat)			
16	Clothing		Smart dry clothes	Drying clothes takes a long time, is noisy (in driers), is a hassle, causes creases and can cause condensation (e.g. if on radiators). People use dehumidifiers to dry clothes and dehumidify simultaneously.	Clothes that absorb less moisture reduce energy/time requried to dry them and create less moisture in the home.			At market.
17	HEMS		Kill switch	People leave appliances and heating on when they don't use them.	Ability to turn off appliances and heating from one place with one button			
18	HEMS		HEMS lock	Kids adjust HEMS settings which causes waste	Lock prevents kids adjusting HEMS			
19	HEMS		Heat waste zapper game	Children like games, they play with heating controls, they don't get much pocket money and energy efficiency doesn't save much, but people often leave the heat on because it's inconvenient to turn it off	Heat waste zapper game is a zonal heating control interface where you get points for turning heat off in empty rooms/homes and the points equate to financial savings that top up pocket money. Perfect for kids who like gaming, have time and value small savings. They could play it remotely so they could save their grandparents cash. Override prevents you turning heat down in rooms that people want heated to warm a pet or prevent damp.			
20	Health and hygeine		Weight loss heat gain	Many people are focused on trying to lose weight.	There is common ground between the physiology of the heat and how fast the body burns off additional bulk. This is a diet that simultaneously reduces weight and makes people warmer (e.g. a thryroxin supplement)		Technically feasible. Unclear if current solutions are effective.	At market.
21	Service design		Smart box	When a boiler breaks people want a replacement that fits in the same space and works asap.	Smart box wraps around a heat pump, biomass boiler or any other solution so that it fits in the same part of the home with minimal hassle.			
22	Retrofit		Magic walls	People lose a lot of heat through their walls. They don't like the idea of losing internal space or external appearance to insulation. They do like things that improve their home.	Magic walls offer a range of features that enhance the home. Inflatable walls can trap heat in during winter, but let it out easily on hot summer evenings. Internal insulation can have various other things integrated (plasma TV, storage cupboards, mirror, whiteboard, blackboard) depending on whether it's in the lounge, kitchen, bathroom or bedroom. It could radiate heat too, removing the space required for radiators. It could also reduce sound pollution from noisy neighbours. There may be a role for very thin insulation.			
23	HEMS		Heat icon (by the window)	People open windows in cold weather to reduce odours (but also letting out heat)	Windows tell openers when the heating is on and (by default) switch it off when the window is opened (giving openers an easy override to keep it on if they want to).			
24	Service design		Smarter heat pump	Heat pumps can be noisy	Various ways to quieten the heat pump when it's causing a nuisance. Sensors so it can modulate output sound depending on what other noises can mask it. Remote control with a volumne switch/mute button. Can it learn when you want a bit of peace and quiet. Could it learn what noises are most intrusive (this will depend on your hearing - it could even measure your audiogram).			
25	Retrofit		Damp proof paint	At the moment people heat empty rooms and open the windows to stop their walls getting damp as they are trying to maintain their building and prevent lung infections.	Damp proof paint stops walls getting damp so you don't need to heat empty rooms.		Absorbant surfaces another solution (Calibre)	
26	Service design		Smart survey	Many people may feel they don't want to schedule in a half day for a thorough energy efficiency survey. Others think they do but end up being out at the time allotted.	Smart survey is a smartphone app that uses a video tour of the home to generate a detailed, tailored green deal assessment report (recommendations for energy efficiency measures with approximate costs).			
27	Retrofit		Designer homes	People love original period features (fireplaces, windows, cornices etc). This often discourages them from installing more energy efficient double glazing, wall insulation or blocking up chimneys. Designer brands dominate interior design.	Insulation that makes your building look nice. Can we develop a suite of insulation products that have some aesthetic appeal. For instance, insulated period features that can be added even to homes where the original ones have been removed. Could we make an art form out of the smarter elements that form our solution. Where could this add real value (e.g. heat pumps only noisy because the heat exchanger has to be small; it could be silent if it was the size of a children's climing frame).			

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28	Service design		Building MOT	Most systems need tweaking over time to match the changing demands of a household or as parts wear out. People know if their home is hard to heat, but not what they can do to make this easier	HEMS tunes up the heating system, but also recommends what parts of the home to modify to inform home improvement decisions (e.g. your boilers' on the blink replace it now when you're doing your kitchen; you spend most time relaxing here, so insulate this wall/floor first and buy this secondary heat so you're cosier here where you're less active). Householders also receive an annual building MOT (think EPC with infrared heat loss images and how much time/money spent heating empty rooms).			
29	Service design		Broader community heat scheme	People trust information from people they know and like to support people they like. They don't trust government or big corporations.	Offer heat solutions that are cheaper because they own part of the supply, fund local jobs, reduce local hardship (fuel poverty, unemployment, poor health) and promote community benefits (e.g. roads improved alongside district heat scheme; school gets free heat in the day if you sign up to this scheme). Jamie Oliver style scheme to train unemployed youth to retrofit care homes.			
30	Service design		Holiday retrofit	Retrofit is very intrusive. People want to be confident things are progressing but not have any interruption.	Parter with a holiday company to plan a renovation around when people are on holiday. Provide webcams so householders can check in on the work when they like and see how it's progressing.			
31	HEMS		Light switch control	People want status and control of zones, not the whole home	Heating controls integrated with the light switch so you can turn the heat on/off or up/down when adjust the lighting. Helps you understand when the heating is on/off, how the temperature is changing and when you're going to be comfortable.			
32	HEMS		HEMS adaptor	It's hard to improve HEMS for many boilers because the internal controls are inaccessible and have different control technologies	HEMS adaptor is a simple box that you attach to your boiler that allows it to work with advanced HEMS.			
33	Health and hygeine		Smart soap	People have to use more hot water to rinse detergents that seem to stick to the skin.	Smart soap makes people feel rinsed faster.			At market.
34	HEMS		Healthy competition	Peer support/pressure or keeping up with the Jones' influences what individuals do	Enable people to compare energy saving tips and share how much they use in similar homes. Settings that enable people to restrict who has access to what information so some could share everything with the whole world (think heat status on their facebook profile), others could share it with interested groups (e.g. fuel poor with church group or children helping grandparents save or villagers competing for lowest bill). Use heat model to help people understand where this is down to the property (size, level of insulation, boiler efficiency) or a tactic people are using.			
35	Payment model		Pension pot	People don't want to invest to keep their bills the same level (Green Deal) for various reasons, however, some people do plan their financial future (e.g. someone entering retirement or parents preparing for their children). People dislike Green Deal if think it passes on a debt to their children.	Design retrofit and community energy schemes so they remove running costs in retirement or provide a payback to future generations (e.g. paid off with mortgage by life assurance) and are easier to transfer the benefits (i.e. how 'loan' dealt with in the event of someone dying). What about a wind pension where contributions pay for the ideal sequence of things for you (insulate home, install heat pump) all the while contibuting to a community owned (potentially offshore) wind farm that subsidises your electricity bill.			
36	Store and Use		Priority electric parking	There is very high competition for parking spots in affluent, high density, urban areas.	Offer people a free parking space with a charing point if they have a Plug in hybrid. This would make it aspirational to have expensive plug in highbrid cars because they would start appearing all over the most affluent parts of the country.			
37	Store and Use		Heat-travel balancing	It's hard to balance supply with demand	Could homes even out demand if they used heat pumps during awake hours and charged cars when they slept?			
38	Service design		Education by trusted family member/community member/friend	Individual reliant upon other household member to manage heating. Vulnerable if anything happens and is left on own.	Gives individual confidence to manage heating/quickly learn in emergency situation			
39	HEMS		Swear box	Swear box, linked to Barclays Pingit, which charges individuals for inefficient heating behaviour	Charges individuals, rather than whole household. Entertainment value also.			
40	HEMS		Rationing of hot water	Hot water is often used up before everyone can shower in the morning	System allocates a 'fair share' of water to each person and avoids 1 person using it all			
41	HEMS		"Soft touch"	Female & pre-programmed voice alerts inhabitants to inefficient behaviour	Provides gentle reminders, and some entertainment value, similar to appealing/humorous voice on a sat nav			
42	Clothing		Heated baby suit	Parents often heat entire house in order to keep baby warm	Creates stable & warm environment for the child.			Doesn't fit with our current commercial strategy, but could be made into a commercial proposition.
43	Store and Use		Exercise heat	Household or gym fitness machines, which can generate top-up heat	Entertainment and educational value, showing how much energy is needed to generate heat. Used on a larger scale (e.g. at a gym), might also provide real benefit.			
44	Localised heat		Tent-in-a-room	Parents often heat entire house in order to keep baby/children warm	Localised heat for a particular area.			
45	Store and Use	Localised heat	Floor covering replacement	allows better transfer of heat from the underfloor heating system	Removes the existing floor covering and replaces with a more conductive covering. Possibly a heat generating floor covering ?			
46	HEMS		Diary control of heating system	Automatically controls the heating based on diaries the occupants already have	Compares the online diaries (cloud) and turns the heating system on/off in line with this			
47	Store and Use		Energy storage	Reduces bills by storing energy when plentiful for use when needed	converts solar energy to electricity, stores and then makes available for use in winter			
48	Store and Use		Magic glass	Provides a source of heat and privacy when needed	Stores heat on hot days, with the option of shutters which have built in solar panels			

Idea	New cluster	Second cluster	Idea title	How it helps/problem it addresses	What it does/solution	Consumer notes	Technical notes	Commercial notes
49	Store and Use		Kinetic energy recovery	Reduces energy consumption through recovery of kinetic energy in household objects	Micro-nano sensors recover energy from everyday appliances eg fans			
50	Store and Use		Structural battery	Reduces bills by storing energy in the exterior cladding of the building	Brickwork and tiles are coated with micro-nano technology creating a battery for energy storage, thus reducing bills overall			
51	HEMS		Building management Systems (not just HEMS) for 'GEEKS'	Controls heat along with home entertainment. Impresses like minded people	Controls not just the heat / lights but also TVs, DVD, Air conditioning, music library, TV, etc. all from the same panel / iPad			
52	Insulation		Heat curtain/invisible door	Stops heat from moving between areas if people leave doors open or having drafty windows. Different people with very different needs (e.g. elderly live in parent or baby) may occupy different parts of the home.	Provide local blown heat or pressure differences to the window area as in shop doorways. Prevents heat escaping to other areas of the house (like a fly curtain)		Technically would have to be very noisy. Potential innovation? Longer term	
53	Retrofit		Radical radiators	People can't heat rooms enough to get warm or dry clothes. Radiators warm external walls. Installers put radiators in that fit underneath windows rather than the right size for the room.	They look nice too. Higher output radiators reduce water return temperature saving money and producing more heat where it's desired. They only emit heat away from the wall. They're easier to move/rotate around a room (e.g. if you want to put a sofa by a window instead. There is a clothe drying feature that allows you to rotate the radiator out of the wall and extends it so it becomes like a clothes horse with an integrated de-humidifier so you don't need to open the window.			
54	HEMS		Service alert	Change of circumstance, which impacts upon health & welfare of individual. Parents worry for safety of children. People with impaired mobility/cognitive function may be unable to control their heating.	Reports change of condition to care services Auto-completes forms to apply for energy finance support (e.g. fuel poverty). Monitors when devices are left on abnormally and sends alerts to carer. Allows remote switching on/off. Tracks location o fsmall children and cheks they're at a safe temperature.			

APPENDIX C – Sample Consumer Journey

Complete Comfort Service ver 1.0 Draft