LEEDR: what are the results? Participant feedback for H99

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What are the results?

Participant feedback for H99
The LEEDR project was a four-year study that explored energy consumption in family homes. 20 households took part, being involved for about three years. Insights were fed back to the participants at the end of the project in the form of a unique, tailored book for each family.

This book represents the style, formatting and information content of those books. This version has been called ‘H99’ and it is an amalgam of chapters from multiple homes, and therefore should not be used as a source of data or analysis: please refer to publications. The information contained here has been released generally in the hope that it might inspire and inform the development of feedback from other similar projects.

In developing the feedback there were number of pieces of information that we felt were important to householder. These were:

- an outline of the research issue and the project;
- a record of data collected;
- an example record of photographic images taken;
- household consumption characteristics and comparison to other households;
- analysis of energy demand reduction measures and the impact on their home;
- data visualisation;
- insights generated from the ethnographic studies;
- demonstration of the design tools and concepts developed;
- highlighted observations;
- exercises to inspire further engagement with energy;
- project staff with photographs and biographies;
- contact information for contractors that we used on the project; and,
- list of our project outputs.

We hope that others will find this useful and would request that the LEEDR project to be acknowledged and that our papers maybe referenced if you have found this work to be of use to you.

Best Regards,
Richard Buswell and the LEEDR team.
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1.1 A big Thank You!

First of all, Thank You for your participation in the LEEDR project. Understanding energy consumption is a challenging and important issue and knowledge cannot be furthered without willing participants such as yourselves. Our 4 year journey is at an end, but the data we have collected will continue to be used to answer important questions. This book contains information about you and the project, which we hope you will find informative and interesting to read.

1.2 Results at a glance

1.2.1 Headlines

- The highest consumption was 3 times the lowest;
- all significant reductions are in connection with heating; and,
- consumption can be reduced by changing preferences and routines.

1.2.2 Achievements

- New energy reduction analysis results;
- a new website for those interested in developing better products in the home energy space;
- a box of design tools for informing innovation in the demand reduction area;
- 20 unique targeted feedback books for participants; and,
- advances in the methods used for building energy research.
1.3 **Content map**

We hope that you like this book, it has been put together for you and is unique. In the book you will find sections that talk about the energy issue and the project as well as giving you feedback on your consumption. There are different sections, and you’ll want to look at some more than others. What we wanted to do was to give you a permanent record of your time with us on the project, give you feedback on our research and explain how the project has helped to support PhD students and the careers of our research staff. This will hopefully be something you can ‘dip in to’ when the moment catches you, as well as being something to share with friends and family to help explain what you have been doing with us. Enjoy!

**Monitoring**
The monitoring data was used with property and appliance survey data to develop the analysis presented in the following chapters:

**Video interviews**
We carried out a video tour in each home and further tours and interviews in some. These were used to create detailed insights and informed:

**Getting to know you**
We had dinner with you one evening early on and the analysis of this combined with the insights and other work led to:

- **House to house:** Comparing your home with others, page 21.
- **Reducing consumption:** Analysis of the potential in your home, page 31.
- **Making energy visible:** Presenting your seasonal data and things that change, page 37.
- **Insights:** exploring what we found from talking to you and your home, page 53.
- **Design activities:** which explores new energy reduction concepts, page 63.

**Additional content**
We have included a chapter (‘Project information’) that introduces the energy problem (page 9), the aims of the LEEDR project (page 10) and provides an overview of the data collection in your home (page 12). At the rear of the book there is information covering the project staff, the outputs we have generated to date, acknowledgments and contact details on pages 83, 91, 97 and 99 respectively.
In this chapter we would like to show you how you fit into the LEEDR project, how LEEDR fits into UK research and how that research helps the UK as a whole move towards a future where we are consuming less energy. We begin with an overview of the energy issue and how the UK moving forwards. We highlight ongoing UK research and then tell you a bit more about the LEEDR project. The chapter completes with an overview of the information and a selection of the images we gathered from you and your home during the project.

2.1 Energy in 2050

The energy future of the UK is uncertain. The rising dependency on foreign imports of oil and gas are escalating fears of energy security whilst environmental policy and the Climate Change Act are pushing for changes in the way in which energy services are delivered. The need for the reduction of the demand for energy is a global issue and the UK Government has committed the UK to an 80% CO$_2$ reduction target by 2050. Dwellings accounted for 30% of all the UK energy consumption in 2008. The UK Government has recently published an ‘indicative pathway to 2050’ when it is intended that the emissions from buildings will be as close to zero as possible. This will be achieved through: the ongoing refurbishment of the UK building stock initially involving the installation of insulation to reduce heating demand; the replacement of more efficient heat generation equipment such as condensing boilers and heat pumps; and finally, to the installation of micro-generation and renewable energy systems. Additionally, competition for cheap energy means that energy providers need to generate electricity more efficiently and there is considerable interest in Demand Side Management, where consumers are persuaded through pricing schemes to shift some demand to off peak generation.

A significant challenge that arises through the implementation of renewable energy sources is that they are intermittent: for example, solar PV only generates electricity in day time. This does not necessarily coincide with when we want energy; on winter evenings, for example. Hence some flexibility in when we can generate and use energy is required. It is anticipated that this flexibility will be ‘managed’ through Demand Side Management techniques. It is also likely that more of our energy needs, particularly for heating, will be met from electricity and this is driving the roll out of technologies such as heat pumps.
As we progress towards 2050, we need to reduce what we consume and become more flexible about when we consume energy. Demand Side Management will use the data collected through smart meters, which the government is rolling out across the UK. These will replace the existing gas and electricity meters and will allow real time monitoring of your consumption. This means that you will be able to monitor what you use, but also, of course, so will your energy provider. This is likely to lead to variable pricing of electricity that will be used to persuade us to shift our consumption patterns. Regardless of the potential successes of us shifting our demand in the future, the first step, and arguably the most important, is for us to start using less energy in the home. Understanding how families might begin the journey to living with less energy is where the LEEDR project fits into this picture.

2.2 Energy research

Research is needed to help answer important questions across the breadth of the sciences and to ensure we train and develop bright young people to help tackle current challenges. The UK government supports this through the ‘Science Budget’ which is about £5 billion every year. The majority of this funding goes to higher education institutes, which is were the bulk of research takes place in the UK alongside teaching under and postgraduates. The Research Councils UK (RCUK) distributes these funds across 7 science councils: Arts and Humanities Research Council (AHRC); Biotechnology and Biological Sciences Research Council (BBSRC); Engineering and Physical Sciences Research Council (EPSRC); Economic and Social Research Council (ESRC); Medical Research Council (MRC); Natural Environment Research Council (NERC); and Science and Technology Facilities Council (STFC) (www.rcuk.ac.uk).

Some of the funding is allocated to bigger research themes that cut across these councils, which are: digital economy; energy; global food security; global uncertainties; security for all in a changing world; living with environmental change; and lifelong health and wellbeing. All of these tackle the most significant issues facing our society in the UK and the Energy and Digital Economy programmes funded the LEEDR project.

Digital Economy and Energy programs recognised the challenge of energy demand reduction in homes in the UK and developed a call for proposals from multi-disciplinary consortia of academics to propose projects in 2009. This call for proposals was called ‘Transforming Energy Demand through Digital Innovation’, or TEDDI for short. LEEDR was one of a number of projects that was successful and there have subsequently been other projects funded in a similar area. The work carried out on LEEDR itself has underpinned a new project for the EPSRC looking at the future of hot water provision in homes called ‘Hothouse’ which will run between 2015-2016 (www.hothouse-project.co.uk). There is also now an academic energy research network called TEDDINET that brings researchers together (www.teddinet.org).

2.3 The LEEDR project

In the UK, as in many Western societies, we have come to expect living standards that are energy intensive. The services we expect include heating (and increasingly cooling), readily available hot water and electric lighting. We also use energy for food storage and preparation, as well as for many areas of work and entertainment. However, different systems, devices and controls in the home along with peoples’ routines and priorities all vary significantly across households, making energy demand reduction a particularly complex research challenge.

We generally do not have a very good grasp of how much energy we are using in the home

Project information
2.3 The LEEDR project

Figure 2.1: The research disciplines, techniques and methods used in the research.

because we do not use energy, we use the services and comfort they provide. When we use the car, we are forced to visit the petrol station when the tank is empty. This helps us gauge how much fuel (energy) we use in the car. In the home, however, our bills are paid by direct debit and are only related to our actual consumption by occasional meter readings and some guess work by the energy provider.

Measuring consumption in an automated way helps us to monitor and keep track of how much we are using, but studies have shown that this alone often does not always result in engagement from home owners and the consequential reductions are lost. We need to understand more about how and why we do the things we do in our homes, how that relates to heating and appliances and then understand where reductions can be made. This we tried to do on LEEDR by working across the traditional disciplines of engineering, social science and user centered design, depicted in Figure 2.1. We achieved this through monitoring your home, generating detailed insights using analysis of interview and video footage and employing workshop based methods to help develop potential new ways of helping families like you to reduce your consumption.

2.3.1 Household selection

In our recruitment drive we had responses from over 60 households, of which 20 were selected to part in the LEEDR project. We were looking for homes that were owned and occupied by families. Our ‘ideal’ middle ground in terms of size and build type was a semi-detached 1930s building, although we actually ended up with a range of homes. Your home was of interest to us because family homes of this size represent about 30% of the homes in the UK (approximately 8 million). Energy reduction in this group of buildings is therefore significant nationally. Other criteria we used to select the homes were: location of the property; occupant age and type; energy metering arrangements and systems; we wanted a mixture of environmentally and energy conscious people; and, we needed people who were willing to give time to engage with us (very important!).


### 2.3.2 Engagement

Your involvement in the project was staged, starting with an initial inquiry from yourselves, through to the various activities you were involved with and finally the decommissioning of the monitoring equipment. Table 2.1 lists these key activities and dates.

**Table 2.1: Your LEEDR project activity.**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial enquiry/phone call</td>
<td>16/11/2011</td>
</tr>
<tr>
<td>Initial visit</td>
<td>24/11/2011</td>
</tr>
<tr>
<td>On-line survey</td>
<td>11/2011</td>
</tr>
<tr>
<td>Technical survey</td>
<td>6/12/2011</td>
</tr>
<tr>
<td>Getting to know you exercise</td>
<td>16/12/2011</td>
</tr>
<tr>
<td>Video tour</td>
<td>4/1/2012</td>
</tr>
<tr>
<td>Monitoring installation began</td>
<td>20/6/2012</td>
</tr>
<tr>
<td>Audio session: video your follow-up</td>
<td>4/7/2012</td>
</tr>
<tr>
<td>Video practice session: cooking, digital media, laundry</td>
<td>6/9/2012</td>
</tr>
<tr>
<td>Audio session: digital media and domestic time</td>
<td>6/9/2012</td>
</tr>
<tr>
<td>Video practice session: laundry, bathroom, digital media</td>
<td>12/9/2012</td>
</tr>
<tr>
<td>Video practice session: laundry, digital media, cooking, bathroom</td>
<td>12/9/2012</td>
</tr>
<tr>
<td>Video practice session: bathroom, digital media,</td>
<td>17/10/2012</td>
</tr>
<tr>
<td>Shower intervention</td>
<td>16/7-3/9/2013</td>
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<tr>
<td>Video session: Shower intervention debrief</td>
<td>1/11/2013</td>
</tr>
<tr>
<td>Monitoring decommissioned</td>
<td>1/7/2014</td>
</tr>
</tbody>
</table>

### 2.4 Data collection

Through the activities in Table 2.1, we have collected information about you and your home. The following briefly describes these project activities, although you may not have participated in every one.

**Initial enquiry:** all homes approached us and there will have been a telephone conversation where we briefly explained the project.

**On-line survey:** you filled out a survey for us on-line where we collected information about you, your home and how it is constructed.

**Initial visit:** the initial visit enabled us to tell you more about LEEDR and helped us to identify whether your home was viable for the project.

**Technical survey:** we carried out an electrical appliance inventory and a more detailed survey of your home where we captured the layout and dimensions.

**Getting to know you:** we had dinner with you one evening while you participated in the ‘getting to know you’ exercise. From this we gained some insights into your routines, aspirations, motivations and how you use energy and digital media. The data from these informed the development of the personas and then the concepts developed in ‘Design activities’ (page 63).

**Video tours:** a video tour of your home was carried out, which gave us insights on your appliance use, daily routines and the aesthetics of how you create your home ‘atmosphere’. Further activities involved most but not all families and is discussed in ‘insights’, page 53).
Monitoring: the monitoring installations varied across the homes in our study. We measured electrical power consumption in all homes, gas in 11 out of 20 and hot water in all but 1 home. We used this data to prepare the chapters entitled ‘House to house’ (page 21), ‘Energy reduction’ (page 31), ‘Making energy visible’ (page 37), and to generate the laundry plots in ‘Insights’ (page 53).

2.4.1 Monitoring list

A list of the monitoring undertaken in your home are given in Tables 2.2 and 2.3. The ‘%’ sign indicates how much data is available over the monitoring period noted in the small text and ‘Ref’ is the device reference number. The ‘†’ symbol indicates where the data is imperfect. The room names refer to the floor plans we developed which can be seen in Figure 2.2. Your data is on the USB stick presented to you with this book.

2.5 Photos

We have taken a number of photos of your home and appliances during the activities you took part in such as the ‘Getting to know you’ exercise. These have helped us remember important things about the layout of your home, where your appliances are and details of our monitoring installation. A selection of images are presented here. Can you spot anything you know?
### Table 2.2: Monitoring summary: power, temperatures, gas and hot water.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Group</th>
<th>Device</th>
<th>Room</th>
<th>Ref</th>
<th>%</th>
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<td>Power</td>
<td>Circuits</td>
<td>Mains</td>
<td>-</td>
<td>024</td>
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<tr>
<td></td>
<td></td>
<td>Sockets up and down</td>
<td>-</td>
<td>616</td>
<td>70</td>
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<tr>
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<td>Lighting</td>
<td>Lights</td>
<td>-</td>
<td>618</td>
<td>70</td>
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<td></td>
<td></td>
<td>Extension lights</td>
<td>-</td>
<td>619</td>
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<td>Tumble Drier</td>
<td>Utility †</td>
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<td></td>
<td>Dishwasher</td>
<td>Kitchen †</td>
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<td></td>
<td>Washing Machine</td>
<td>Utility †</td>
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<td>FridgeFreezer</td>
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<td>Kitchen</td>
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<td>TV, Games Console</td>
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<td>310</td>
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<td>TV</td>
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<td>306</td>
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<td>Computing Equipment</td>
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<td>Mobile Charger</td>
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<td>TV</td>
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<td>- Hall</td>
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<td>477</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Hot water</td>
<td>-</td>
<td>-</td>
<td>†</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Gas</td>
<td>-</td>
<td>-</td>
<td></td>
<td>91</td>
</tr>
</tbody>
</table>
### Table 2.3: Monitoring summary: window opening and activity.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Group</th>
<th>Device</th>
<th>Room</th>
<th>Ref</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open/close</td>
<td>Doors</td>
<td>-</td>
<td>Front</td>
<td>459</td>
<td>82</td>
</tr>
<tr>
<td>20/6/2012-30/6/2014</td>
<td></td>
<td>-</td>
<td>Back</td>
<td>460</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>Backroom/conservatory</td>
<td>466</td>
<td>82</td>
</tr>
<tr>
<td>Windows</td>
<td>-</td>
<td>Front Room</td>
<td>462</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kitchen</td>
<td>464</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bathroom 1</td>
<td>478</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 1</td>
<td>479</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 2</td>
<td>480</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 3</td>
<td>481</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 4</td>
<td>482</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 5</td>
<td>483</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Movement</td>
<td>-</td>
<td>Front Room</td>
<td>841</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>20/6/2012-30/6/2014</td>
<td></td>
<td>Backroom</td>
<td>844</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kitchen</td>
<td>843</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utility</td>
<td>842</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hall</td>
<td>840</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bathroom 1</td>
<td>845</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 1</td>
<td>846</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 2</td>
<td>847</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 3</td>
<td>848</td>
<td>98</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 4</td>
<td>849</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bedroom 5</td>
<td>850</td>
<td>96</td>
<td></td>
</tr>
</tbody>
</table>
To enable you to compare your energy consumption and other interesting characteristics with the other homes in LEEDR, you need to know a little bit about your neighbours. To do this we have taken a snapshot of the LEEDR homes in 2013, presented in Table 3.1. We have loosely grouped the households according to the ages of the properties: up to 1940, 1950-1960 and 1970 onwards. There are other characteristics that relate to the insulation levels and heating systems, as well as the number of occupants and whether the home is occupied in the week: all of which will influence energy consumption.

Two checkmarks in ‘insulation’ means loft and cavity walls are insulated, one means that only one of these has been done and if there are no checks it means there no insulation installed. We were unable to verify the loft insulation in a couple of homes and so these are marked ‘X’. In the double glazing column, one check means partial double glazing, two means fully double glazed. The number of checks in the shower category relates to the number of showers installed. Most homes utilised combination boilers to supply hot water (‘C’), some use traditional tanked systems (‘Tank’). We have described the size of the house by the number of rooms or ‘spaces’ in the property: for example a house with a lounge, kitchen, hall, landing, bathroom, three bedrooms and a workshop in the garage would count as 9 rooms. D, SD, T stand for ‘detached’, ‘semi-detached’ and ‘terraced’ house respectively.

**Try this... 3.1** Find your home in the table and compare yourself to the other families in the group. Do any of these strike you as particularly similar? Pick a couple of other families that you think are similar to you and then focus on these homes in the energy analysis section to give a direct comparison to your energy consumption.

Remember that the size and level of insulation are key factors that affect your space heating and hence energy consumption. The more frequently your home is occupied (if you work from home for example), then the use of heating and electricity is likely to be higher. If you spend extended periods away from your home, than you may find you consumption is slightly lower, unless the heating is left on.
| House | Family | Owners Occupied | Years Occupied | Adults | Adults 2-14 | 7+ | Holidays | Holidays 1-5 | Holidays 2 | House to house | Insulation | Glazing | Rooms | Showers | Hot water | Appliances | Adults 2-14 | 7+ | Holidays | Holidays 1-5 | Holidays 2 |
|-------|--------|-----------------|----------------|--------|-------------|---|----------|-------------|-------------|----------------|-------------|---------|-------|--------|--------|----------|-------------|-------------|---|----------|-------------|-------------|
| House | Family | Owners Occupied | Years Occupied | Adults | Adults 2-14 | 7+ | Holidays | Holidays 1-5 | Holidays 2 | House to house | Insulation | Glazing | Rooms | Showers | Hot water | Appliances | Adults 2-14 | 7+ | Holidays | Holidays 1-5 | Holidays 2 |
3.1 Your consumption statistics

Figure 3.1 provides the most detailed breakdown of your energy consumption that we were able to determine from the monitoring undertaken. The broad categories are: space heating (warming your home on cold days); hot water (hygiene); lighting; digital media (computers, TVs, Game machines, etc); laundry (washing machines and tumble driers); cold appliances (fridges and freezers); and other electrical consumption (which is everything else that is plugged in that we were unable to measure, or does not fit one of the previous categories: review Table 2.2, page 14).

We have included a cost estimate based on 4p/kWh for gas and 15p/kWh for electricity. ‘Space heating’ (green) just accounts for the gas consumption, and the orange is the electricity. Hot water (blue) can be a combination of gas and electricity, usually depending on your type of shower. The CO₂ production associated with burning gas and electricity is given in the final plot.

Note that the reductions discussed in this report (Chapter 4) are based on energy reductions, i.e. the kWh used, regardless of fuel source. This means that the heating and hot water (green and blue bars) consume the most energy. You can see that if you want to reduce your bills, electricity is more expensive and hence the energy consumed by electrical appliances becomes more important.

Your household consumes a higher proportion of gas for space heating than the average LEEDR household (66.7%), relative to the other energy demands within your home. 80.9% of energy is used to heat your home, with proportionally less energy being used to heat water, at around 3.9% compared to 7.9% to the average. Less power appears to be used in your home relative to other homes, with an even spread of that power between laundry, cold goods, digital media and lighting (Laundry and cold appliances are shown together, as are digital media and lighting). 9.5% of energy consumed within your home is unaccounted for in unmonitored electrical appliances, this is less than the LEEDR average of 15.2% (See Table 2.2, page 14).
3.2 **Group comparison**

Presented here are a number of plots that show all the LEEDR homes including yours, referenced by your house number (see the front page). We have also included some national statistics for reference. We have chosen a number of comparisons that you might be interested in. From talking to you, we know you are interested in overall consumption and you will probably be interested in the various things we have explored through the ethnographic work discussed in Chapter 6 (page 53). We also thought you might like to know about how your room temperatures compare when you are heating your home and how long others have their heating system on for. These plots are presented in Figures, 3.2, 3.3 and 3.4.

**Observation 3.2.1** The national average energy consumption per house is 18.8MWh/yr (megawatt-hours/year). A hard working human can generate around 100 watts per hour. In an 8 hour day that would be 0.8kWh, in a year 292kWh or 0.292MWh. So the average house is powered by roughly 64 humans working 8 hours a day for 365 days of the year!

### 3.2.1 Gas and electricity

In 2013, the average UK household consumed 19MWh of energy through both gas (89%) and electricity (11%). Figure 3.2a gives the total consumption figures for the LEEDR homes. The average LEEDR household consumed around 18.7MWh of gas and 5.9MWh of electricity and so the average LEEDR household consumed 13% more gas and 79% more electricity than the UK average. H11 consumed well below the national average at (14MWh) and H43 consuming more
than double the national average (39MWh). The greatest gas demand was from H08 (29MWh) and the least from H28 (10MWh). H43 used the most electricity (12MWh) and H11 takes the prize for the least electricity consumption (2.5 MWh).

One thing we were not able to measure is the contribution to space heating through open fires and log burners, so if you use these regularly the amount of gas you use might be a little lower than if the fire was not in use. If used intermittently, this is unlikely to affect these results to any significant degree.

3.2.2 Space heating and hot water

Looking only at your gas and electricity consumption does not tell the whole story, understanding how energy is used gets complicated because we use different fuels to do the same job. This is related to the types of appliances and heating systems we have installed in our homes. For example, you might have radiators that are heated from the boiler that uses gas, but also electric underfloor heating in the bathroom and an electric heater in your conservatory. These all contribute to the amount of energy it takes to heat your house.

Hot water is also complicated. We tend to think of hot water production as what we use when we turn on a tap, but we heat water in kettles, washing machines, dishwashers as well as instantaneously through electric showers or showers connected to a combi-boiler. We have tried to take these factors into account in calculating your space heating and hot water energy consumption depicted in Figure 3.3a.

Observation 3.2.2 According to the UK government around 12.9MWh/yr of energy goes into providing space heating in the average home and around 3.3MWh/yr for the provision of water heating. From monitoring your homes we have found that around 16.9MWh/yr goes into space heating, 31% greater than the UK average, and 2.3MWh/yr on water heating, 30% lower than the UK average. One reason for this might be the temperature that the hot water is heated too in the LEEDR homes, which appears to be lower than what we might expect according to reports by the Energy Savings Trust (Figure 3.3b).

Try this... 3.2 Think through the tasks you do in the home and list them: which of these requires hot water? Ask yourself what heats the hot water and which is used, gas or electricity? Pick a couple of these examples and think about how you use the hot water - do you use hot water effectively, or are there ways to be more efficient?

3.2.3 Heating duration and temperatures

Figures 3.4a and 3.4b depict the variation in the average temperature the LEEDR homes are heated too and the proportion of the year the heating system was active. Note that proportions in Figure 3.4b are not the number of days when your heating is on, it is the proportion of the number of hours your heating is on over the total number of hours in a year. Both of these factors play a significant role in how much energy you use for space heating as well as how well your home is insulated and how much it is ventilated.

3.3 Appliances

On LEEDR we have spent some time exploring your digital media and laundry routines. Here we have plotted how much your devices and appliances consume per year except for a small number
Figure 3.3: Annual space heating and hot water consumption for 2013.

(a) Annual space and hot water heating energy.

(b) Hot water temperatures.
(a) Average temperature when heating.

(b) Proportion of the year with heating on.

Figure 3.4: LEEDR household comparison data for 2013.
of homes we did not monitor the appropriate equipment. We have also included a comparison of cold appliances since these were of common interest across the homes in the study. There are given in Figures 3.5a, 3.5b and 3.5c.

In Figure 3.5a the principle differences between the homes are the number of fridges, freezers, and fridge-freezers people own. What we did find was that it is quite common for people to replace the main fridge, and then keep the old one in the garage. Often the idea associated with this kind of action is connected with not wanting to scrap the device as this is wasteful. However, it is important to remember that these devices run 24-7, 365 days a year and so can become a significant part of your electrical energy consumption.

Observation 3.3.1 Between 1970 and 2013 the energy consumption of cold appliances has increase 91%. Since 2000, the energy consumption of our fridges and freezers has dropped by 19%. The average energy consumption for cold appliances in the LEEDR homes for 2013 was 642kWh. To put this into context, a new ‘Hotpoint First Edition RFAA52P’ fridge freezer which is rated $A^+$ claims to consume just 256Kwh/yr, very close to H37.

Figure 3.5b depicts the laundry energy consumption. Bare in mind that some homes have tumble dryers and others do not, in fact of those households with tumble dryers, there was considerable variation in the frequency of use. There was also a large range in the operation of washing machines, H46 being the highest user. The Department for Energy and Climate Change estimates that energy consumption within laundry appliances has risen by 24% between 2000 and 2013. To give some context a ‘INDESIT IWSD61251 ECO Washing Machine’ consumes roughly 1kWh per cycle and is rated $A^+$. A ‘INDESIT IDV75 Vented Tumble Dryer’ consumes roughly 4kWh per cycle and is $B$ rated. The Energy Savings Trust estimates that households get through around 270 wash cycles a year, so that's about 1350kWh/yr if you use your tumble dryer for each load.

Digital media use has soared in use over recent decades: the Department for Energy and Climate Change estimates that energy consumption in home computing alone has risen by 125% between 2000 and 2013. Figure 3.5c shows the consumption related to digital media for those households where it was possible to monitor the appropriate devices. We found an average value of 624kWh/yr.

In the LEEDR homes, digital media uses only just less than your cold appliances in terms of annual energy consumption and is a whole 24% greater than the energy used to wash your clothes! The variation between households is of course significant: H28 consumes only 134kWh/yr whereas H43 consumes 2100kWh/yr, i.e. 14 times more.

Try this... 3.3 If you have more than one appliance, think about how you do your shopping and how you use each of these. How frequently do you go to each appliance? Could you manage without an appliance if it were to break down? Would you replace it? If you are answering ‘no’ to these questions, then you probably have a non-essential device, so do you really need it? The time be right for it to moved out of the house and off your energy bills!
Figure 3.5: Annual appliance consumption.
### 3.4 Summary

Understanding where we use energy and how we compare to others is of interest to us all. We have attempted here to present you and your home in the context of the other LEEDR homes and against national figures. Through the study we found that on average in the LEEDR group of homes:

- space heating accounts for around 67% of household energy demand;
- hot water was the third largest demand in most homes, at around 8%;
- lighting represented only about 3% of demand;
- use of washing machines and tumble driers accounted for 2%;
- although digital media use is increasing, we found that these use 3% of energy; and,
- fridges and freezers also about 3%.

The above values are averages across households. We were not able to monitor all devices in all homes and some homes did not have important devices monitored. For example, we did not measure the washing machine in H38. The unmonitored consumption in each house accounted for about 15% of the total energy demand. We were also not able to separate certain energy demands from others, the most important being the amount of energy consumed by gas cookers, hence this was added to the space heating. Other idiosyncrasies effecting the results include lighting, where we were able to monitor what was labelled as *lighting circuits* on your distribution board, but perhaps not all lamps, or lights fed off other circuits.

**Try this... 3.4** Look through the items we were able to monitor in Table 2.2 and reflect on the pie chart categories. Think about whether we captured all the devices in each category. If we were not able to monitor something, then the consumption of those items will appear in the ‘Other appliances’ section. Does this make a difference to the pie chart? Does this make a difference when you compare yourself to the other households?
Reducing your energy consumption helps lower your bills and contribute to the reductions in CO₂ we need to make in order to impact climate change. To help explain how you might make reductions in your consumption, we analysed your monitoring data alongside the on-line and technical survey information we gathered.

We developed a mathematical representation, that we call a ‘model’, of your home based on the data. This allows us to estimate potential reductions and makes its possible to explore a wide range of options. However, reality is more complicated than a model like this and so it should be remembered that the results represent our best estimate of the reductions you might expect.

Use these results as a comparative guide to inform and reflect upon. We have taken great care to generate what we believe are good estimates of potential reduction, but in reality, what is achieved will be affected by many things and hence we are not making specific recommendations.

### 4.1 Measures at a glance

We carried out a review of energy reduction measures and selected what we felt were the most relevant to the LEEDR homes. We have chosen to present these to you in 3 broad categories:

**Lifestyle:** these do not necessarily cost anything, but require you to accept a lower level of service or comfort than you are used to;

**Replacement:** items that require small to moderate investment, but are not particularly disruptive to carry out, such as replacing an old appliance; and,

**Retrofit:** major undertakings that usually affect the building fabric or heat production (i.e. the boiler) that are a significant cost and undertaking.

A number of reduction measures in each category were modelled and we used published performances of old and new products and materials to do this. We then calculated the total reductions for you and compared these to current projections of household consumption in 2050, which is linked to the floor area of your home. Table 4.1 gives an overview of the measures have been assessed in your home.
Table 4.1: Energy reduction measures at a glance.

<table>
<thead>
<tr>
<th>Type</th>
<th>Affects</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifestyle</td>
<td>Service reduction</td>
<td>One fridge-freezer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No standby loads</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No tumble drying</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heating when home</td>
</tr>
<tr>
<td></td>
<td>Reduced comfort</td>
<td>No heating &gt;15°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heating to 17°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ventilation</td>
</tr>
<tr>
<td>Replacement</td>
<td>Cooking appliances</td>
<td>New cooker and microwave</td>
</tr>
<tr>
<td></td>
<td>Cold appliances</td>
<td>New fridge-freezer</td>
</tr>
<tr>
<td></td>
<td>Laundry appliances</td>
<td>New tumble dryer</td>
</tr>
<tr>
<td></td>
<td>Digital media devices</td>
<td>New TV</td>
</tr>
<tr>
<td></td>
<td>Doors</td>
<td>Insulated doors</td>
</tr>
<tr>
<td></td>
<td>Lighting</td>
<td>Replace bulbs</td>
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<tr>
<td>Retrofit</td>
<td>Loft</td>
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<td></td>
<td>Windows</td>
<td>Triple glazing</td>
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<td></td>
<td>All building</td>
<td>Sealing</td>
</tr>
<tr>
<td></td>
<td>Heating system</td>
<td>New boiler</td>
</tr>
</tbody>
</table>

4.2 Measures in depth

The reduction measures are described here in more detail and represent the complete list considered in the analysis (you can skip to the results section on page 34). The measures described here also relate to the discussion in Chapter 3 (page 21); in particular look at Figures 3.2 (page 24), 3.3 (page 26), 3.4 (page 27) and 3.5 (page 29) which help to visualise the relevant energy consumption. In the descriptions that follow, relevant tables and figures elsewhere in the report are referenced in italics.

Reductions that relate to replacement required the appliance to be monitored and so reductions may be underestimated is there are lots more appliances we didn’t monitor. Where we have not been able to verify the state of insulation (no access to the loft, for example) we had to make an assumption based on the construction date of your home and hence reductions maybe over or underestimated.

Lifestyle

One fridge-freezer: applied only if you have more than one fridge/freezer, i.e. you would only be able to use one fridge and one freezer OR one fridge-freezer. The measure could affect your way of shopping and storing food. (*Figure 3.5a, page 29*)

No standby loads: standby loads are present when some appliances are not used and hence can consume more than we expect, particularly in older appliances/devices. These can be switched off, but this will impact the convenience of using them (*Table 2.2, page 14*).

No tumble drying: tumble dryer loads can be significant. We quantify how much energy you could save if you were not to use it at all (*Figure 3.5b, page 29*).

Heating when home: heating the house when no one is at home can be wasteful. In this analysis we have made assumptions as to when you are at home and used this to estimate when the heating could be switch off (*Figure 3.3a, page 26*).
In use heating: controlling the temperatures in rooms based on their use and occupancy can mean that some rooms can be kept at lower temperatures, or even not heated at all. We estimate how much energy will be saved if you were to heat the whole house for only one hour in the morning, the living room for the whole evening as usual and to heat only one specific room if someone is at home during the day. The temperatures in the ‘unused’ rooms are maintained to at least 16°C (Colour plates in Section 5.2, page 40).

Heating to 17°C: the temperature you heat your homes to is strongly related to energy consumption. 2050 lifestyle scenarios in the house suggest an indoor temperature of 17°C and so the amount of energy you would save has been calculated based on this, which is probably significantly lower than you currently prefer (Figure 3.4a, page 27).

No heating >15°C: the duration of your heating period can impact energy consumption (Figure 3.4, page 27). We turn our heating on or off seasonally, but the actual time we do this depends strongly on our preferences and the outside air temperature. If we want to minimise the duration of heating the house, we need to accept a slightly lower temperature indoors for a little longer. To quantify this for the analysis, when the outside air temperature is at about 15°C, the internal temperature should be a bit higher (maybe about 17°C) and so we should not need our heating on (i.e. if we are only heating to 17°C as above reduction). We have considered the potential reduction from switching off the space heating as soon as the outdoor temperature is over 15°C.

Ventilation: because the humidity in the UK is quite high, we often feel the need to ventilate our homes to prevent them from being ‘stuffy’. Ventilating in the heating season does have an energy penalty. We heat the air in the house to be warm, but this leaves the home through open windows to be replaced by cold air from outside, which needs reheating. In the analysis, we selected a hypothetical scenario where you only ventilate the home to the minimum level required to satisfy the physiological needs of the occupants, much lower than what you would typically feel comfortable with. This extreme case is probably unobtainable in reality, but it demonstrates the lowest possible ventilation rate and hence the greatest possible reduction. Having doors closed between rooms to prevent air movement and reducing the opening of windows and doors to the outside will get you part of the way to achieving the reductions presented here.

Replacement

New appliances: we have estimated the reduction from buying new highly efficient appliances. The analysis distinguishes between cold appliances, cooking, digital media (computers and audiovisual devices), lights (CFLs and LEDs) and laundry appliances. Estimates of the current efficiency of your devices is used as a basis to compare to the efficiency of the new appliances. In addition, new appliances designed under European Commission’s regulation have very low standby loads (1W) and so these are included. The appliances we considered in the analysis are listed in Table 4.1, based on those we monitored (Table 2.2, page 14).

Insulated doors: doors and windows are a source of heat loss. Replacing the door with one that is more air tight and has higher insulation will be of benefit. The savings are estimated by comparing the heat loss with the best standard door.

Replace bulbs: LED lights are far more efficient than older incandescent bulbs. Here we estimated the number of lights that used older bulbs in your home and replaced them with the most efficient LED bulbs.
Reducing consumption

Retrofit

Loft insulation: increasing the loft insulation (i.e. rockwool or equivalent) to 300mm will reduce the heat loss through the ceiling upstairs. The analysis compares the current depth to this.

Wall insulation: this is applied on top of your existing wall even if it has insulation in the cavity. This increases the insulation the fabric of your home provides. If you currently have an uninsulated cavity wall, then insulating this will achieve some of the reductions reported here.

Floor insulation: solid floors without insulation or traditional raised floors are often cold to the touch, even through carpet. Insulating the floor is very disruptive, but will yield some benefit. The study compares the standard ground floor type and insulation applied at the year of construction of your house with the best standard that can be achieved, either removing a layer from your solid floor and adding an insulating floor decking, or taking up the wooden floor and adding insulation between the floor joists.

Triple glazing: changing your windows, even double glazing, for the latest triple glazing will have an impact on heat loss.

Sealing: air can pass through gaps and cracks in the structure. By sealing these, you prevent unwanted cold air from coming into the building and hence reduce the space heating requirement. We estimated the current levels of this unwanted ventilation from your data and used results from published case studies that have demonstrated the impact of sealing; loft hatches, chimneys, pipework, old extractor fans, cracks in walls and wall joints.

New boiler: the efficiency of the boiler and how it operates is an important factor in determining energy consumption. In this analysis we have assumed efficiencies of your boiler and compared it to that of the quoted efficiency of a new replacement. The operational efficiency of condensing boilers is complex and is also dependent on the size of your radiators and the settings on the boiler. Note: if you already have a modern condensing boiler its performance might be improved by turning down the flow temperature settings and replacing the radiators with larger ones.

4.3 Your reduction potential

The energy reductions for your home are given in Figure 4.1. The plots a - c (green, red and blue) show the savings from each reduction measure if applied on its own in each of the three categories: Lifestyle, Replacement and Retrofit, allowing you to identify the action that will yield the greatest impact. The width of the ring in the three plots represent the relative weight of impact reductions in that group. Reductions less than 1% were not shown in the Lifestyle and Retrofit categories (green and blue).

If you put all of the reduction measures together, you do not generate the sum of the individual benefits because the measures interact. For example, if you reduce the temperature you heat the house to, you will save energy because of that. The reduction you would achieve through increasing the insulation as well, however, would be proportionally less than it would have been with the old, higher temperatures. Figure 4.1d brings together the total reduction potential from our analysis and the 2050 energy ‘target’.

The circumference of Figure 4.1d represents the annual energy consumption today, the reductions are applied to this in a clockwise fashion, hence the ‘white’ section represents the minimum energy consumption after applying all the reduction measures; the 2050 target is indicated by the orange bar. When looking at this plot, recall the assumptions described earlier, particularly with
4.4 Reductions across LEEDR

We looked at reductions across the LEEDR homes and total potential reductions between 50% and 70% were achievable in all homes. Tailoring reduction analysis to specific homes is important, however, because we did find that the effectiveness of the individual reduction measures between homes did in fact vary, which we attribute to:

- variation in the level of insulation, size and number of windows;
- age of the appliances;
- window use preferences;
- occupancy patterns; and,
- temperatures and heat system settings.

Figure 4.1: Breakdown of potential reductions based on the average LEEDR home today.

ventilation: Figure 4.1 represents a best case scenario and in reality it may not be possible to realise all the reductions shown.

Figure 4.1 is an average of the homes we studied and representative of a good proportion of those. We found that most homes could improve their consumption with by insulating the property to a greater extent, reducing the temperatures on the thermostat and reducing the number of rooms heated. The analysis demonstrated that a great deal can be achieved through applying changes to Lifestyle at little or no additional cost.
Reducing consumption

Compared to factors affecting the heating of the home, replacing appliances had the least impact at an average of only 3% reduction in energy consumption and was similar for all homes which were between 2% and 5%. Reductions from the retrofit measures was significantly higher with an average of 28%, but this did not vary greatly across the homes (±5%).

It was the lifestyle category where the reductions varied the most. An average of 33% reductions could be made through implementing all the lifestyle measures which is very similar to the total available through the retrofit measures. However the level of reductions varied ±15%, three times that of retrofit measures. These results suggest that:

- replacement of old for new appliances can wait until they reach end of life;
- the type, size and maintenance of the properties are fairly similar hence retrofit reductions, although significant, do not vary greatly house to house; but,
- how we choose to live in the homes does impact our consumption and does vary considerably between homes.

It should be noted that some of the reductions measured are quite extreme cases, notably minimum ventilation and adding wall and floor insulation, and its unlikely that the savings, at least all modelled here will be achievable in practice. You can impact on ventilation by reducing the duration windows are open, but this probably will not achieve the background level modelled in the analysis. In addition, the addition of external wall insulation to your home is very expensive and has implications for the aesthetics of your property.

Try this... 4.1 Carry out your own review of the reductions you’d like to implement.

Reflect on the the ways of reducing energy suggested in Table 4.1. Make a start by reviewing the Replacement section: do you have any appliances or devices that might need replacing in the near future? New appliances will almost certainly lead to reductions in consumption, unless you replace them with bigger appliances. Note those you are likely to change.

Consider the Retrofit options: start by ranking the measures by how disruptive that might be to do and how costly. Reflect on these and decide whether the benefits outweigh the costs. List any reductions you might consider doing.

Now consider the lifestyle options: one by one think about how implementing the measure might affect you. Ask yourself and your family:

1. Are we prepared to do this? If not,
2. Are we prepared to go some way towards this, but not the whole way?
3. How can we as a family actually make this happen?
4. When do we start?
5. How long do we do it for to see if it works for us?
6. Do we need to purchase anything to help us?

List the ones you want to have a go at. With Figure 4.1, reflect on the likely effectiveness of each. For you, will capital investment be the most effective option or will lifestyle changes?
In this section we present some of your data in a way that we hope will help improve your understanding of how you consume energy and how your heating system works.

We chopped up your data into 30 minute chunks and coloured that chunk according to the measurement: for temperatures, blue is cold, red hot and yellow/green somewhere in the middle. Placing these in a row gives 48 chunks that represent 24 hours, and you can see the night is cooler than the day time. Stacking consecutive days you can then add weeks and months to the same image to give the seasonal impression. We used blue/red colours for temperature and a black/copper colours for fuel consumption.

We corrected the data for daylight saving and so the plots show ‘clock time’. On each plot midnight, 6am, midday, 6pm and midnight are noted at the top and bottom of the plot so these can be followed vertically upwards. Months are delimited with the white dashes on the left and right hand edges and are labelled to help you locate interesting periods like holidays.

5.1 Electricity and gas consumption

We measured both gas and electricity consumption in your home. We have taken some of this data and presented it on the following two full colour plates. We took data from 1st January until the 31st July 2013 so that the plots of data would be legible and help you visualise your consumption patterns.

The first plate depicts your demand for electrical energy over the period. On this plot the darkest sections are not zero consumption, but your background consumption: appliances like fridges, freezers, standby loads that constantly consume energy. The lightest cells on the plots are any load over 2.5kW (the washing machine heating water, for example).
The main features are the two parallel ‘bars’ of high load regions that run vertically through each day (07:00-12:00 and about 18:00 onwards), the lighter region evident in the evenings (each day after 18:00): probably easier to see at a distance. These represent the greater consumption in the mornings and evenings, although the morning period tends to ‘blur’ into the middle of the day. Your evening consumption does appear to decrease a little as the days get lighter from about April onwards. There is quite a bit of activity in the weekdays because the home is occupied in the day.

The second plate depicts your gas consumption. Again, the morning and evening heating periods can be seen and there is a significant setback on the heating controls at the weekend.

5.2 Temperatures around the home

We measured a number of temperatures around your home and this data is presented in the following set of colour plates that are formatted in a similar way to the previous electrical consumption plots. The data allows you to see how the outside temperatures change through the day and through the seasons and also how they change in the rooms in your home. We also captured when there is hot water flowing from your boiler indicating whether the heating is on.

A colour scale is used: on the outside air plot the darkest blue is around -3°C and the deepest red is anything above 26°C. In fact, the warmest temperature in this period was about 32°C, but only for occasional periods. On the ‘Outside air temperature’ plot you can see the temperatures rising in day time as you move from left to right, and then cooling off in the evening. The other plates show room temperatures where the dark red areas represents temperatures at or over 26°C and the darkest blue represents 14°C: Figure 5.1 shows this mapping.

![Temperature scales used in the room temperature plots](image)

Figure 5.1: Temperature scales used in the room temperature plots (°C).

The second plot shows when your heating system is on, essentially when the colour is dark red. You can see that you have a weekend set-back on your controller: the heating comes on about half an hour later, for 2 days every 5 days. You often heat your home for the majority of the day a the weekend, but infrequently in the week.
5.3 **Summary**

We hope that you enjoyed looking at the plots and that they helped you understand how your home and its heating system operates. Using these insights might help you to assess whether your heating and electricity use is all necessary, or whether there are changes you can make to reduce consumption. Finally, try the following exercise:

**Try this... 5.1** When things change in the home these can be useful moments of reflection to think about how your energy consumption might change. Use Table ?? to think about how these events might have impacted on your energy use. Were there opportunities to change routines that could save energy?

If you have completed the energy reductions exercise on page 36, think about how you might implement these and whether there are future opportunities on the horizon that might make this easier for you.
The Social Science team used a research approach called Sensory Ethnography to work with you to understand how you lived out everyday life in your homes and the implications that your everyday practices, activities, routines and habits have for how you use energy and how much you use.

Sensory Ethnography research seeks to gain an understanding of not only what people do, but also what it feels like to be living out everyday life in a particular home environment. The idea of understanding what everyday life ‘feels like’ is especially relevant when we want to understand energy use because many of the reasons why we use energy are connected with how we want our houses to feel. For example we use heating when we feel cold, put on a fan when we are too hot, we put music on when we want to create a particular sound atmosphere, we use plug-in air fresheners to change the odour of our homes. We also use other things to change the feel of our homes, that do not directly use energy, but that have implications for other things we do that do use energy – for example, opening up windows to bring in fresh air, or having particular floor surfaces that feel or sound right underfoot but that need to be cleaned using energy consuming technologies. Often we do not even think about the fact that we are using energy when engage in normal everyday activities, for example having a cup of tea while watching our favourite TV programmes with the radiator on requires energy to boil the kettle, power the TV and the radiator, and to wash up the teacup later.

Therefore we were interested in finding out what it felt like for you to live in your homes, and to do normal everyday activities such as using digital media, showering, laundry, using the heating and cooking. We were also interested in what your daily habits and routines were like. To research this we used three key methods: the video tour of the home, the video reenactment of bed time and morning time and going out and arriving home routines; and a longer study of the activities you do in your home. We also showed you the videos we made of you. All 20 of our participating households participated in the video tours and reenactments and 11 households carried on to participate in the everyday activities study. These different methods were:

**Video tour:** when we did the video tour we were interested in finding out what you needed to do to make sure your home ‘felt right’. We asked you about this instead of simply asking you about how much energy you use because we were interested not just in energy use but in all the different things you have to do to make your home comfortable and feel the way
you want it to feel. Energy use is just part of this jigsaw, and we were interested in how it fitted in with everything else.

**Reenactments:** We did the reenactments with you at the same time as the video tours. These focused on asking you to remember and show us what your routine was like for getting up in the morning, going out, arriving home and then going to bed at night. Our hunch was that these would be key transition movements for energy use – when things might be switched on or off. We asked you to perform the routines for us in order to help you remember then and discuss with us what you actually did. Our motive was that we believe that actually doing and showing the routines helps people to remember them better, and importantly to remember what they feel like. The reenactments, particularly those of the bed time routines were very important in helping us to understand how people change the atmospheres of their homes – for example in making the feel of the night time home, and how they actually need to use energy to do this.

**Everyday activity studies/practice studies:** 11 of our participating households further agreed to take part in the next stage of our project where one or two of our researchers came to spend more time with you at home to video record, observe and discuss with you the ways that you do your laundry, use your bathroom, what you do in the kitchen and how you use digital media in your home. We called these the Practice Studies because we focused in on a set of specific activities and tried to both understand them as separate practices and as a mixed up set of activities that always impact on each other. These activities are also non-stop because they are the very things we need to keep doing so that everyday life continues to run smoothly. Through this activity we were interested in understanding how you actually perform different tasks, how you feel about them, how they are mixed up with other tasks, and of course, importantly for our study, what the implications of these ways of doing things have for the ways that you use energy in the home.

We have developed the Energy and Digital Living web site where we report on the methods, some of the key insights and design inspirations from this project. The web site also shows some video clips which participants have agreed to include: www.energyanddigitalliving.com.

### 6.1 Key Insights

The Sensory Ethnography strand of LEEDR produced a series of insights that are being used in academic debates, to compare and link up with the statistics produce by our Engineering team, and to inform the way energy demand reduction technologies are designed, and which we also hope will be interesting to you when you think about the ways that you are using energy in our homes. We write about some of these insights on our Energy and Digital Living web site. Here in this section we write about some of the insights that we thought would be most interesting to you as householders.

While there are certain things that people can do to change the ways they use energy in their homes, there are also many things that are already part of everyday life that make change difficult to accomplish. Our research aimed to demonstrate some of these issues and challenges so that the design interventions made by our design team could account for them.

**People are inconsistent:** When we do sensory ethnography research we usually find that people are not consistent in the ways they behave across all the things they do, and we of course expected this would also be found in the LEEDR project. What we were interested in was to find out what sorts of things we could learn from this about what was most important for people to have in their lives and homes, and what this told us about energy use. For
example, while some householders were very committed to saving energy and made big efforts to reduce their energy consumption in some areas of life, in other areas it seemed not to matter. This is usually because everyday life is complicated and we cannot always make the decisions that would be best for energy demand reduction because we have to account for multiple other things in our lives. Any solution then needs to account for these other things therefore we used our findings to explain how this worked so that the LEEDR design team could account for this. One example is the way that people used standby modes in technologies, especially their TVs. Several people who participated in this project went to sleep with their TV on a timer, then the TV would go off as they went to sleep. Even though they might have been keen to reduce, other uses of energy, the priority of getting off to sleep comfortably with the background noise of the TV was more important than saving energy by not using standby mode.

**Everyday routines are important moments where energy-savings might be made:** Our research into the routines of getting up in the morning, going out, arriving home and going to bed was very informative about the everyday moments of habitual activity that people engage in. Bed time routines were particularly interesting for us because they showed us how people turned their homes into a night time environment, and all the things that you felt that you needed to do before you went to bed. Unsurprisingly most people go through a final tour around parts of their homes at bed time – they lock up and switch off everything that they think they need to switch off. However we also learned how nighttime is not just a moment for closing down and switching off, it is also a time for switching on. TVs or music devices get switched on and left to go off on a timer, mobile phones are plugged in to charge. Washing machines are programmed to come on at a certain time during the night. Heating systems are waiting to come on before the family gets up in the morning. These insights helped us to both think of the idea of the night time home, as a time when the home is actually quite busy while we are asleep and often using energy to do those activities that are carried on while we are asleep. At the same time we also learned about the ways that people go about setting up their nighttime homes. Most people have very habitual routines and this means that when they go to bed they know their route through the home very well. This is where lights are switched on and off, things are set on timers, doors are locked. We came to see these routines as being very important, as they are the times of the day when you have to remember to do everything that is important to you to do at the end of the day. Routines are also important generally in life to make sure that we feel that all is well, and that we have accomplished what we need to. This made us think about the potential of routines themselves for energy saving. One of our key suggestions based on this is that routines like bedtime routines could be just the right moment in the day to introduce small energy saving activities or technologies, or small changes in routines and habits that will help people to save energy.

**Our energy using activities are difficult to separate out from other activities:** While we set out to research different activities – media use, laundry, heating, showering and cooking, in reality we found that these different activities get mixed up with each other, and therefore the ways in which they use energy likewise are mixed up with each other.

The example of showering shows this very well. We found that often when people have a shower they do this as part of a daily routine which involves multitasking (eg cleaning the bathroom at the same time, or as part of getting ready to go out). Having a shower might also be part of a sports activity outside the home. Also having a shower and the way energy is used during it is related to other characteristics of the bathroom. For instance, some people use the shower to heat the bathroom by leaving it on for a few minutes before they have a shower. For some this might seem like a ‘waste’ of hot water and energy, but for others this might seem like a good use of
energy to heat the room.

The same finding applied to our research about how people use digital media, which very often happens while doing something else. For example many people do the ironing while they watch TV – or watch TV while they do the ironing, others check their smart phones or tablets while having breakfast.

Laundry is another good example. Here we found, for instance that for some families doing the laundry might be part of the process of feeding the cat, the morning routine, or it might involve putting the heating on for drying. Below we tell you more about how people in this study did their laundry, what this meant for energy demand, and suggest an activity that you and your friends might like to do in order to reflect about how laundry forms both part of your life and why it is so important to your energy use.

We also found that the buildings – that is specific houses – that people live in and the particular technologies and systems they already have installed in them impact on the ways in which people can undertake these activities and therefore on the ways they use energy in their homes.

6.2 Focusing on laundry

Laundry practice visits took place in 11 households. Different households were found to have distinctive methods of carrying out their washing and drying. Three kinds of laundry groups could be distinguished. The first group is called wash-day washing. This group’s washing loads are generally concentrated on specific days over the weekends. The second group is the daily and nightly washing group where wash routines are spread more evenly over days and nights across the week. The third group is the opportunistic washing group. In this group washing becomes dependent on weather, time or is carried out when a full load comes together. Washing cycles change by season and are also effected by school terms or changes in one’s working hours. Emergency washing or the rare event of washing and drying as quickly as possible was found to be general among households. This can effect and occasionally prompt the wash of other items.

6.2.1 Washing machine settings

Wash and spin time settings were found to vary greatly across households. Generally, settings are influenced by elements like fabric of clothes, colours, methods of grouping colours or drying options of a household. The concepts of dirt, hygiene, properness and cleanliness are exposed to large variability and even different people within a family can have different concepts of them. Stains, marks or shadows are obvious and visible signs of dirt but items might be put into wash because they were worn not because they were necessarily dirty. In general, clothes do not have to be visibly dirty to prompt washing. Making sense of laundry and washing settings depends on one’s sense of laundry loads, quantity and urgency of loads, how one identifies ‘problems’, ‘risks’ (e.g. delicates and runny colours), establishes regularity or know the little particularities about their own washing or drying machines.

Your household fits in to the daily and nightly wash group. You wash overnight by setting a timer or early in the mornings. You generally have 6 or 7 loads per week that are mostly whites, see Figure 6.1. You sort your colours into lights, whites and darks. You tend to use 40°C Quick Wash unless garments are visible dirty. 60°C is used occasionally for sheets and towels or when you see stains like mud on whites. You also use non-biological washing powder due to skin conditions in the family.
6.2 Focusing on laundry

6.2.2 Drying

Three groups of tumble drier users could be identified. The first group uses the tumble drier routinely, the second group includes the less regular users who combine tumble drying with the use of outdoor airer depending on the load and weather. Some families own a tumble drier but do not use it at all. Driers also tend to be under-filled because the drum is larger than the washing machines’ and not all items make it to the drier. Some of the pros and cons participants expressed in relation to tumble drying are included in Table 6.1.

Your drying routine includes the utilization of tumble drier, outside line and warm spaces in the house (Figure 6.2). You use the tumble drier routinely and set it on overnight timer. Jeans and towels are dried for 80 min and other garments for 60 min. Your use of outside line is weather-dependent and mainly includes sheets due to the fresh quality you prefer when drying outside. You tend to utilize warm places indoors like the radiators in the back room or hallways or the airer in the porch and patio. During the winter most radiators are used for drying.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience in winter and rainy days</td>
<td>Sunshine &amp; breeze gives freshness to clothes</td>
</tr>
<tr>
<td>Useful when there is an urgent need to dry</td>
<td>Extra energy used</td>
</tr>
<tr>
<td>Compensates for lack of indoor drying space</td>
<td>Amount of laundry is manageable indoors</td>
</tr>
<tr>
<td>Easy movement if close to washing machine</td>
<td>Tendency to damage materials</td>
</tr>
<tr>
<td>Gives quality in touch</td>
<td>Noise</td>
</tr>
<tr>
<td>Reduces the amount of ironing</td>
<td></td>
</tr>
<tr>
<td>Warms up the room</td>
<td></td>
</tr>
</tbody>
</table>

6.2.3 Ironing

There is a large degree of variability in how households carry out ironing. Two groups could be distinguished based on the relationship households formed with ironing. One group dislikes
ironing and tries to reduce it as much as possible (e.g. hanging up garments to reduce creasing, not ironing duvet cases, towels etc.) The other group likes ironing and do not mind spending time doing it. Interestingly, as your household and others showed, the practice of ironing is caught up in media practices. These practices are for instance watching TV or listening to radio.

You iron most clothes if needed. Ironing days are either Thursday afternoons or Sunday evenings. Your ironing routines intersect with digital media use because you tend to watch TV or listen to radio while doing ironing.

6.2.4 Morning Routines

We were partly interested in the sensory environment of the bathroom and related spaces trying to understand feelings, processes and routines of washing, showering, bathing, shaving, styling, brushing teeth, and so on. We also attended to what people do to their bathroom before, during and after use. This provided some insights into the negotiation of flows of heat, cold and humidity (e.g. relating to heating and window use) but also into the ways in which family members organised and experienced bathroom activities around each other. Morning routines could entail a range of ‘bathroom practices’ and other activities broadly linked to body hygiene, styling, and beyond, in bathrooms and other spaces around the home. We learnt through your and other examples that bathrooms can turn into ‘problem spaces’ because of lime scale, plug holes blocked by hair, smell and so on. Generally bathrooms were described as either ‘purely functional’ or socially relevant parts of the home. So, what can be learnt from these insights?

1. It becomes problematic to look at energy consumption without looking at the surrounding domestic context in which it is situated.
2. Energy consumption is tied to a wider set of domestic activities. Understanding electricity consumption and washing machine use goes beyond user interaction with control points. Laundry becomes inseparable from other practices like drying and ironing.
3. Exposing variability of how people use energy at homes illuminates stereotypes and can translate into better tailored products and services.
6.2 Focusing on laundry

Try this... 6.1 Laundry is one of the fundamental and most mundane activities that we engage in in our everyday lives. It is something that in order to do the more exciting, public and outdoor things we do we have to have covered – that means we either have to do it ourselves or have someone else do it for us. All of the households in our study did their own laundry, but not everyday in all the households did the laundry. In most households it was the wife/mother who undertook this role.

Laundry is also part of our homes – it is absolutely inescapable, yet we often do not think about it, or see it as a background activity. When we have guests or visitors over, although people often have laundry drying all around their homes – sheets hanging off banisters, things drying on radiators and more – suddenly it appears as if we have no laundry at all.

This exercise is designed to make us think a bit more about how laundry is important in our lives, how doing the laundry involves a lot more than the washing machine, and how the energy we use when we do laundry is needed to power a range of different technologies. It might give you some surprises:

1. Go round your home – make a note or take a photo of everything in your home that has been, will become in the future, or actually is at the moment in the process of being laundry (remember that this might include things like cushion covers as well as towels, sheets, clothing, tea towels and much more. How many separate items have you discovered.

2. Explore your home and garden, make a note or take a photo of anything you can find that is in the process of being laundry – that is that is waiting to be washed, being washed at the time, being dried, waiting to be ironed, waiting to be put away. Where did you find these things? How many different rooms (including the garden) did you find them in?

3. Now find out what happens when laundry is done in your household. Who does this? When is laundry sorted, when is the machine put on, what else is done right before and what right after. Count how many other technologies are used around the time you put the laundry on (do you make a cup of tea or have breakfast at the time? Are you listening to music? Is the TV on in the background?).

4. What happens to laundry in your house when it comes out of the machine? How is it dried, are radiators used for this, are they ever put on to dry the laundry or is the laundry done to coincide with the need to dry things. Have you ever left the heating on all day because you needed it to help you dry the laundry? Do you have music or the TV on when you are unloading the machine? Why was it important to do this?

5. Who does the ironing in your family? And what does that person do when they are ironing? What do they need around them to do the ironing? How many technologies that use energy are involved (e.g. do they have a cup of tea? Do they watch TV when ironing, or listen to music, do they talk on their smart phone with the earphones on?).

Answer all these questions. Then count how many laundry items, how many rooms, how many different technologies you have listed, and how many different people are involved in doing laundry in your household. Now you will have an idea of how much space, time and how many energy consuming technologies are implicated and how many people are involved when laundry is done in your home. This should also give you an idea of why laundry and the use of heating as part of it is a big user of energy in homes, and why we are keen to make digital design interventions to help people use less energy.
6.3 Digital media and time at home

Besides domestic energy consumption, the LEEDR team was also interested in the ways in which digital technologies were used at home by all the family members. This was because we wanted to propose interventions for reducing energy demand that were based on existent digital devices such as tablets and smartphones, as well as considering new ways to interact.

Domestic life is becoming defined nowadays by the use of many information and communication technologies. The Communications Market Report published by Ofcom (2014) in August this year shows that 44% of UK households own a tablet computer – which is a figure that doubled from the past year – while 14% of homes claimed to have two or more; and six in ten adults own a smartphone that they use to access the internet. The ways in which these new devices are used in relation to traditional media technologies, such as TV and radio, is often defined by multi-tasking. Almost every adult (99%) recalls being engaged in two or more media activities at the same time, with watching live TV and making voice calls being the most popular multi-tasking combination. The report suggests that the average adult in the UK spends over half of their waking hours engaged in media or communications activities; however, because some media activities are conducted simultaneously, a total volume of 11 hours 7 minutes of media and communications activities undertaken by an adult per day is squeezed into 8 hours 41 minutes.

We wanted to find out more about the ways in which you and your family use digital devices at home and about how these technologies can contribute to saving time, or to making home time feel longer. You were one of the eighteen of the LEEDR families who took part in an interview to explore this topic. The interview with your family took place on 31/07/2012.

The interviews showed that, besides being used for work and for leisure, digital devices were often used for scheduling and organising – through multiple apps, such as calendars, to-do lists and holiday organising – for shopping of items that were momentarily needed or for special purchases, and, generally, for finding diverse pieces of information that the user wanted to know immediately.

We found out that the record function of TV set top boxes is often used in order to save time, by recording a live programme that would subsequently take less time to watch – through skipping adverts and through playing it at double speed, in the case of a sports match, for example. At the same time, media multi-tasking – such as using one’s smartphone or tablet while watching TV – makes evenings feel longer, as one would feel that they get ‘more’ from their time when engaging with different types of content, on multiple platforms.

These insights convinced us that existing digital devices, such as smartphones and tablets, might be successfully used for keeping track of one’s energy consumption, as they are already part of everyday life and as they might be more fun to use than a new purpose-built technology, such as a smart meter. We developed design concepts for apps and games that can be employed for visualizing the level of energy consumption of the household and for developing individual targets and strategies for lowering demand. These apps could be accessed on smartphones and tablets at any time, while watching TV or while engaging in other media multi-tasking activities, making evening family time feel longer, rather than asking for the user’s full attention and for their time apart from the routine of family evenings. In this way, one could be aware of the energy demand of one’s household little by little, accessing information and setting targets in their own time. Examples of these concepts can be seen in section xxxx. We were also inspired to explore ways to ‘stretch and bend’ time in order to encourage energy saving. These concepts are also illustrated in Section 7.2 and in the concept ASTICHIN in particular, on page 79.
6.4 Summary

The sensory ethnography studies were part of our whole project and they were designed to complement and work with the engineering and design studies. They offered us the kinds of insights that energy research projects do not usually achieve, because we used them to focus in on questions about how the ways you already live your life and how you make your home feel right require you to use energy. We were very keen to bring the complexity of this to the fore, and to allow ourselves to notice things about the usually hidden elements of our lives – like how we do our laundry and what we do on the way to bed – that are actually pivotal to the ways in which energy is used in the home. These might seem to be very mundane parts of our lives, but in fact they are inevitable and very important in relation to the way that the rest of our lives are lived and the ways in which we care for, maintain and feel about our homes.
During the early stages of the project we visited your homes one evening and over a take away meal, started to get to know you as families. The things we learnt from this time with you, combined with the findings from our social science colleagues have informed our design work. We wanted to be able to design future products and ways of doing things that would encourage you as a family to save energy at home. Our concepts are deliberately designed for the near future rather than the present as we have wanted to challenge existing thinking about how energy use information is currently fed back to householders.

7.1 Personas

It’s hard to consider the lifestyles and needs of 20 families all at once within design. We therefore created a set of ‘personas’ which are fictional families designed to represent key things about the actual LEEDR families that we need to remember when designing. Personas have long helped designers to move from insights based on the lives of individuals to representing key characteristics of a target market in a way that is relevant to all stakeholders within a project team. Personas are not averages (a persona, like a real family, cannot have 2.4 children!) but archetypes. They can provide details about a person or group of people. They are designed to help designers and others remember who they are designing for. The personas included here are designed to remind us of the different ways families choose to do their laundry. It’s unlikely that there is a family exactly like you in the set as the personas are fictional. However you may be able to spot some similarities!

The personas have two pages. The first introduces the family, their lifestyle and their attitudes towards saving energy and environmental issues. It tells us something about what’s important to them about their home and how they like to relate as a family. The second page provides a snapshot of how they go about washing and drying their clothes using knowledge that we gained from working closely with our social science colleagues (More on their work in Chapter 6 on page 53). It also provides an example of how this pattern of doing things relates to energy use. These personas have helped us as researchers and designers to move between detailed understandings of ‘real world’ information to considering wider patterns across households. They have been useful tools to enable us to generate new insights and design concepts.
The Child Constrained Family: David, Sarah & Oliver.

Background
David and Sarah are married and both in their mid-thirties. Both educated to degree level, David is in full time employment at the local university whilst Sarah is currently a full time home-maker, looking after toddler Oliver.

With a recently reduced household income of around £32,000 p/a, this new family would describe themselves as being both financially and time constrained.

Basic Human Goals:
• To protect our child and to consume as much as necessary to give him the best start in life
• For Sarah to be a full time home-maker
• For us to feel and share as a family

End Goals:
• To save us money in line with our reduced income
• To relax the time and financial constraints of having a baby
• To allow our good intentions to be followed through

Experience Goals:
• For us to feel confident in our decisions
• For us as parents to not be inconvenienced through change
• For us to not feel isolated or alone
• For change to ‘fit’ within our new family and to not feel rushed or under pressure

About the Family
• David and Sarah are both very busy and active due to their respective work roles and the age of their child. They prefer to sit and relax together in the moments when they are not rushing around.
• Although Sarah and Oliver are usually at home, they are not entirely isolated with friends and grandparents visiting often. The internet and mobile phones are very important to this family for outside contact.
• As a family, David and Sarah share the space at home with Oliver; watching the TV, playing games in the lounge, or having meals in the kitchen.
• Occasionally David will work from home in the study.
• David and Sarah’s lives are organised around the routines of Oliver.

‘Home’
• The family generally feel at home and find it practical and family friendly, although they would like to do more including extensions and changing the flooring but don’t feel as if they can due to the limitations of having a new baby and the uncertainty of whether this house is ‘it’.
• The family home has had the latest energy related energy fittings (new boiler, windows, insulation) over the five years that they have lived in the property with interior aesthetics updated through low cost (finance and effort compared to building changes) state of the art appliances.

Sustainability and the Environment
• Both David and Sarah understand climate change and global warming and are familiar with sustainability, and whilst they would be willing to make changes in order to become more environmentally friendly, this would be driven from a cost and time saving perspective rather than any environmental or societal concerns.
• Furthermore, any change would have to be easy to enact and fit in with this family’s daily life, primarily workable around Oliver.

Energy and Technology
• The family own all new state of the art energy related appliances and fixtures with only a small number of digital media devices.
• David and Sarah are generally energy savvy, primarily focussed on the safety of Oliver.
• David and Sarah have made some changes to reduce their energy consumption, such as buying a new boiler a couple of years ago and a conscious effort to switch lights off when not in use, but feel that they cannot follow through on any further good intentions due to the financial and time limitations that accompany having Oliver.
• For this family, energy primarily means convenience, with Sarah and David having no idea of how much energy they use and only a limited idea of their energy costs.
• Energy at home is primarily used by the home-maker, Sarah.

The Child

Constrained
Dirty Laundry Collection

and Prioritisation

Washing Machine Loading,
Running and Unloading [1]

Tumble Dryer Loading and
Running [1]

Airers Loading and
Running [1]

Washing Machine Loading,
Running and Unloading [2]

Tumble Dryer Running and
Unloading [1]

Airers Running and
Unloading [1]

Tumble Dryer Loading,
Running and Unloading [2]

Airers loading, Running
and Unloading [2]

The Drying of Clean Laundry [Airers]

The Drying of Clean Laundry [Tumble Dryer]

The Washing of Dirty Laundry [Washing Machine]

The Collection of Dirty Laundry

Constrained by Sound

- Sound and its interplay with Oliver’s routines, specifically nap or bedtimes, has a considerable effect on activities performed and appliances that can be used. Both Sarah and David would love to be able to use both the washing machine and tumble dryer when Oliver goes to bed in an evening, but fear that the noise generated would disturb and awaken him.

Constrained by Time

- Done daily, the specific time of laundry activity is dictated by the family’s daily routines, primarily driven by meeting Oliver’s needs. Peak housework periods are between 7-9am (breakfast), 1-3pm (Oliver’s afternoon nap after feeding), and after 7pm when Oliver is down for the night. Dry laundry is often left in the dryer for hours until the next housework period.

Appliance Dependency

- Sarah and David are both heavily dependent on their washing machine and new tumble dryer (both rapid and automated). Although they didn’t need a tumble dryer when it was the two of them, in order to now ‘stay on top of it’, controlled and rapid tumble drying and indoor airers near radiators/sunshine are preferred over slower outdoor line drying, especially in winter.

Embedded Associations

- There are fixed points in time around which laundry is scheduled, a point of reference for other activities. Laundry is part of breakfast and the parents getting washed and dressed; Oliver’s nap time initiates the cleaning of the house and next laundry load; and in the late evening emptying the dryer and folding of clothes is part of tidying the house ready for the next day.

Daily Laundry

- Laundry for this family is done during the day, spread across the week and driven by Sarah during the weekdays and David on the weekends. This is so that they can ‘stay on top of it’, ensuring that Oliver is never without (part of learning to be new parents). As a result both the washer and tumble dryer tend to be used very frequently.

Laundry Routes

- Laundry routes are intertwined with other activities, often combining chores with family time, such as breakfast. Laundry is generally kept out of sight and reach of Oliver in the parent’s bedroom. As Oliver is only a toddler, it is Sarah and David that determine what constitutes his ‘dirty’ laundry (2-3 outfits per day), driven by new parental responsibility within social rules.

Winter Laundry Day

Background
Karen and Paul are married and both in their early forties with two young children in primary education, Charlotte and Joshua. Both educated to degree level, Paul works full time as an accountant whilst Karen, recently back to work part time, works as a teacher at a local college.

With both parents working, the household income is around £61,000 p/a. They would describe themselves as being a very informed and principled family.

Basic Human Goals:
• To use ‘gadget’ technology for pleasure and to stay ‘up-to-date’
• To be part of a strong community
• To evaluate and question things against our strong principles

End Goals:
• To save money
• To be able to understand and question our energy consumption
• To relax the constraints of having young children

Experience Goals:
• To feel part of a larger impact
• For family life not to feel inconvenienced through change
• For change to ‘fit’ within our strict and close family... to not feel rushed or under pressure

About the Family
• Karen and Paul would describe themselves as being very informed and principled, and as such, they tend to be quite a sceptical and questioning family.
• The entire family are quite busy and are part of a strong community network that promotes sustainable and resilient living.
• As a family, they spend time together when watching TV and playing games, such as on the Wii (games console).
• Occasionally Paul will work from home and Karen, who was a full time home-maker, is now back at work part time.
• Karen and Paul’s parenting style could be described as strict.

Sustainability and the Environment
• Both Karen and Paul have a strong understanding of sustainability, climate change and global warming, and how their behaviours and lifestyles impact upon them.
• For this family, constraints of time and children are a motivation barrier for change in order to become more environmentally friendly, with the family primarily motivated by convenience and money. This is reflected in their travel schemes. Paul, Charlotte and Joshua walk to work and school, Karen car shares to get to work (money), or occasionally drives to work and school with Charlotte and Joshua (convenience).
• Karen and Paul believe that as their current impact is so small, any change they could make is unlikely to have an effect on a wider scale.

'Home'
• The family have lived in their house for around eight years and have made few changes or extensions to their property, but would like to make changes to the kitchen, garden and children’s bedroom in the future.
• The kitchen is the hub of family activity, being the room where Karen, Paul, Charlotte and Joshua usually spend and share time together.
• Charlotte and Joshua like to play in their bedrooms.

Energy and Technology
• Despite being part of the ‘green’ community, this has not translated to action or reflection upon the family’s own energy consumption.
• Karen and Paul have no idea how much energy they consume and are only aware of how much they financial spend as a consequence of consumption.
• As a family, they are not low energy consumers but tend to be quite energy hungry and moderate consumers of technology, owning many ‘gadgets’ to keep ‘up to date’, such as TVs and laptops (although many other domestic non-media appliances are well worn).

...we could give up vegetables out of season, but I mean, there’s some things we wouldn’t want to stop using energy for. When you have two incomes it doesn’t matter so much...

...one thing that struck a chord with me was we saw this programme – it was a house and all of the electricity was generated by this hangar full of cyclists with generators on their bike...

...why should we really put ourselves out and make life hard when nobody else cares and is just carrying on sort of like obviously using loads of energy and so forth?...

...you can’t expect the human race to go back into caves, it’s just not going to happen. How you educate people that’s a different argument...
Priorities & Knowing One’s Laundry
- Wash loads within this household are temporally contingent, driven by and prioritised through the predicted need for items for specific activities or weather. Triggered by the need for underwear/uniforms/work clothes etc., wash loads are built around these items by colour or material with large piles sub-piled by priority. Conversely, unrequired items are demoted.

Laundry Stuff & Knowledge
- As one would expect for such a questioning family, they have a very specific knowledge of which settings to use on their washing machine and tumble dryer, as well as which detergent and fabric softener to use. Sensory (how dirty) and the material qualities of laundry determine wash time, spin speed and temperature, as well as drying and ironing operations.

Work Constraints
- With both parents working, laundry has become a maligned almost daily night time event. Unless requiring overnight soaking, wash loads are completed just before bed, taking advantage of Economy 7, and hung out in the morning. Ironing is usually a night-time activity (kids in bed) with quick morning top ups based on drying times, creases and priorities.

Routes & Material Presence
- Laundry routes for this family are not associated or embedded within other forms of household maintenance and cleanliness (household cleaning is undertaken by a cleaning lady). The family have ‘better things to do’. The material presence of laundry is hidden, with laundered items and dirty items stowed in a dressing room, and drying items kept in the spare bedroom.

Undesired Laundry Flows
- Karen uses a dehumidifier if the laundry is airing inside the house in the upstairs spare room, set to turn itself off at certain levels of humidity. This helps to speed up the laundry drying process, remove undesirable condensation from the room and prevent garments from starting to smell when they do not dry quick enough.

Drying Convenience
- Karen very rarely dries any clothes outside due to working hours and her night time laundry regime; they don’t even own an outside line. Laundry is primarily dried upstairs on airers although items that are used a lot, such as towels, socks and bed wear, are tumble dried along with bed sheets for drying convenience and sensory qualities, such as ‘fluffiness’.

Winter Laundry Day

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<th>Time</th>
<th>Ironing of Clean Laundry</th>
<th>Washing of Dirty Laundry</th>
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<th>Collection of Dirty Laundry</th>
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The Wholesome and Frugal Experientialists: Ian, Julie, Rebecca and Abigail.

Background
Ian and Julie are married and both in their late forties with two teenage children in secondary education, Rebecca and Abigail. Both educated to a higher degree level, Ian works as an engineer whilst Julie has returned back to work part time after being a full time home-maker.

As a family, they have a combined income of around £72,000 p/a. The family would describe themselves as being wholesome educators and learners with a strong moral code.

Basic Human Goals:
• To be part of a strong community
• To abide by our strong moral code and religious beliefs
• To live for experiences, not material wealth…to make do and reuse (unless for work/education)

End Goals:
• To save money, not to be green for the sake of it
• To protect our children from excessive digital media exposure
• To be educated and in a position to educate

Experience Goals:
• To feel part of a larger impact
• For family life not to feel inconvenienced through change
• For change to ‘fit’ within our very strict and disciplined family

I mean using the tumble drier instead of putting it on the washing line is either laziness or lack of time. It’s not that I think “I can’t afford to do this.”

‘Home’
• Ian and Julie have made some alterations to their home, building extensions and decorating the interior their house.
• The family are not aesthetically ‘house proud’, believing that it is the people that make a home. They therefore feel ‘at home’ despite the further changes they wish to make for practical reasons.

...the boiler’s on a timer, but I go round making sure the thermostats are at a low level on each radiator and I just turn them off as necessary and that kind of thing...

Sustainability and the Environment
• Whilst Ian and Julie try to do as much as they deem feasible to reduce energy consumption (financial cost rather than for a ‘better planet’), such as install solar panels, they will not attempt to make savings or change behaviours if they believe it will inconvenience family lifestyle.
• Both Ian and Julie believe that their impact is already small compared to the ‘bigger picture’, not seeing the point in making lifestyle compromises to just be ‘green’, especially if ‘others’ do not join in.
• The family walk, cycle or use public transport as much as possible, helping to foster these beliefs.

...I suppose sometimes you just feel like powerless – that you could do your bit and you almost feel like it won’t make any difference. What’s the point if no one else is bothering?...

Energy and Technology
• Ian and Julie are extremely energy frugal, motivated by what they consider to be financial restrictions.
• Although they have no idea of how much energy they actually consume, Ian and Julie are very aware of the financial cost in addition to being aware of the environmental and ethical impacts that their behaviour and lifestyle contributes to climate change.
• The family could also be described as experiential rather than materialistic and not consumer driven, which is reflected in the general lack of digital media and the fact that the majority of their energy related appliances and fittings are well-worn, with only the TV and laptops related to work and education being relatively new.
• Although Ian and Julie own mobile phones, they are only used as a basic tool for communication and are not smart phones.

...there are things we have changed. When we’re cooking vegetables we don’t heat the water in the pan, we heat it in the kettle, it takes the same energy but for a shorter period...
Dirty-ness
- Generally, clothes are not washed unless visually dirty, when they actually ‘need’ a wash. Combining a large quantity of clothes and the policy of re-wearing, sometimes for several days at a time, individual items don’t get laundered that often (aside from the weekly priority school uniform, PE kit and work items), with an average of 3-4 laundry loads per week.

A Family Affair
- Although orchestrated by Julie, each family member must ensure that dirty laundry is put into wash baskets or on the floor by the washer with stains pointed out and pockets emptied. Sometimes Rebecca and Abigail will put everything from their bedroom floors to be washed, worn or not, which Julie will secretly fold and put straight into the pile for ironing when sorting.

Tradition & Economy
- Julie uses a timer to run the washer in the early morning on Economy 7, sometimes hearing it spin when they wake. The settings are usually 40 deg max spin, washed by colour load, as the temperature is believed to be good for everything and the speed removes the water for line drying. Sometimes traditional materials such as vinegar are used, informed by her mum.

Integrated Nature of Laundry
- Over the week the family tries to have only one load on the go at any one time as its material presence takes up so much space that they feel overloaded. Laundry starts with looking up the weather forecast to decide the best wash nights that precede a good drying day. Weather, wash basket weight and working from home days dictate the laundry cycle.

Laundry Flows
- As soon as the washer finishes, it is unloaded to hang outside throughout the day (somebody is usually home). If forgotten, it starts to smell and needs rewashing. If the weather is poor, airers are used, hung to let the warm air flow and rise, regularly checked and turned - learnt from mum. Sometimes a window is opened to let a breeze through. The dryer is rarely used.

Ironing Event
- Ian and Julie share the ironing, which is most things, turning it into a regular Sunday night TV event (for school and work week ahead). Ian irons his own work shirts and doesn’t tackle ‘difficult’ items, sometimes dawdling through in 4 hours. The children also get involved, ironing their own school shirts. Everyone has their own ironed pile that they should (in theory) put away.

Winter Laundry Day

The Ironing of Clean Laundry [Steam Iron]

The Drying of Clean Laundry [Airers/Line]

The Drying of Clean Laundry [Tumble Dryer]

The Washing of Dirty Laundry [Washing Machine]

The Collection of Dirty Laundry
About the Family
- The whole family are very active and busy, coming together as a family to support (and spend money following) their favourite football team.
- The family could also be described as having a multi-generational income, with Christine, Lisa, Simon, and Jack, all in employment.
- As Christine, Lisa and Simon all work shifts, there is usually someone at home.

'Home'
- The whole family feel ‘at home’, although they have a few minor concerns with their built environment, although Simon is an avid DIY’er and could correct these issues in the future.
- As a family, Lisa likes to keep the younger children, Ryan and Sophie in sight, however being a multi-screen household, the older child, Jack, tends to fragment and disperse around the house. In general, family dispersion is not considered a negative thing, giving busy family members their own private space.
- The grandmother, Christine, has her own living space within the home.
- When the family do spend time together, it is usually to watch TV.
- Friends visiting this family are the norm.

Energy and Technology
- The family have a mix of state of the art and well-worn energy related appliances with numerous forms of digital media.
- Partly due to the size of the family and due to the inconvenience of restraint and control, the family are very energy hungry.
- Energy at home is generally felt to be used equally between all members of the household, usually for watching the TV.
- Although the family are prolific consumers and have no idea how much energy that they use, Lisa and Simon do know how much their bills costs and will act due to financial concerns. However, Christine and Lisa will leave a TV on all day as a child ‘calming’ measure and use the tumble drier for convenience; and although the family have changed their light bulbs to energy saving bulbs, turning them off is too ‘inconvenient’.
- The family do tend to walk, cycle or use public transport as much as possible to reduce the cost of transportation.

Sustainability and the Environment
- None of the family have any concept of sustainability. Although remotely aware of climate change and global warming, they choose not to believe everything that they ‘hear on TV’.
- They also do not see the point in changing their lifestyle unless the world was going to go ‘bang’, and there was a deadline to that event.
- This family resolutely cannot abide waste; driven from financial (less disposable income due to low wage and number of dependencies) and social history perspectives.
- The family believe that society is unfair and suffers from benefits abuse.

The Multi-Gen Prolific Consumers:
Christine, Lisa, Simon, Jack, Ryan & Sophie.

Background
Lisa and Simon are married and both in their late thirties, living with Lisa’s mother, Christine, and their children; Jack (apprentice plumber), Ryan (primary school) and Sophie (nursery depending on Lisa and Christine’s shifts). Simon works in the local factory whilst Lisa and Christine both work part time in the local supermarket.

The combined household income is around £41,000 p/a. The family would describe themselves as a large multi-generation family of workers.

Basic Human Goals:
- To earn your keep and look after your own within the family.
- To make time for family activities
- To enjoy new digital media entertainment as a family, otherwise make do until broken

End Goals:
- To save money, not to prevent the world from going ‘bang’
- To reduce our energy waste
- For change to be effective across three generations of family

Experience Goals:
- For the family to not be inconvenienced through change
- For change to ‘fit’ within our dispersed and multi-generation family
- For any change to be ‘fair’
Dirty Laundry Collection

and Prioritisation

Washing Machine Loading,
Running and Unloading [1]

Tumble Dryer Loading and
Running [1]

Airers/Rads/Line Loading,
Running and Unloading [1]

Washing Machine Loading,
Running and Unloading [2]

Tumble Dryer Running and
Unloading [1]

Airers/Rads/Line Running,
Unloading [1]

Washing Machine Loading,
Running and Unloading [3]

Ironing of Clean Laundry

Tumble Dryer Loading,
Running and Unloading [3]

Airers/Rads/Line Loading,
Running and Unloading [2]

The Ironing of Clean Laundry [Steam Iron]

The Drying of Clean Laundry [Airers/Radiators/Line]

The Drying of Clean Laundry [Tumble Dryer]

The Washing of Dirty Laundry [Washing Machine]

The Collection of Dirty Laundry

Laundry Routes

• Christine will bring her clothes down in a basket whilst the rest of the family leave them in the bathroom, or in the corner of the living room in the morning where the kids get dressed. If Lisa is rushed, Christine will pick up and sort loads by colour whilst tidying. There is usually at least one load per day, but in winter it’s a case of trying to ‘keep it down’ as drying takes much longer.

Not ‘fresh’

• Clothes do not need to smell or be visibly dirty to prompt washing. For Lisa, ‘used’ equals ‘dirty’, so towels are only used once and anything that has been worn, no matter for how long, becomes laundry. This rule, to Lisa, is an important part of parenting and caring and the rhythm of the household, linked with conceptions of cleanliness and presentability.

Multi-Generational Discord

• Whilst Lisa dominates the laundry rules of the household, such as what is ‘dirty’, Christine dominates the act of laundry washing. Laundry loads may be put on lower temperatures for shorter cycles if she doesn’t deem it dirty – in effect, going through the motions. Combined with often smaller loads, to allow water/hot air to flow, this is also part of getting laundry moving.

Multi-Generational Harmony

• Timings, prioritisations and teamwork - Christine always puts the shorter wash on first, so that she can put that up on the line/airer/tumble dryer whilst the longer load is washing. The longer load goes on as Christine goes off to work, for Lisa to take over when she comes back from work, with minimum sitting time in the machine to reduce creases and smells.

Winter Laundry Day

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

The Ironing of Clean Laundry [Steam Iron]

The Drying of Clean Laundry [Airers/Radiators/Line]

The Drying of Clean Laundry [Tumble Dryer]

The Washing of Dirty Laundry [Washing Machine]

The Collection of Dirty Laundry

Heating & Weather Cycles

• Heating is never put on just to dry laundry. The outside line is used only in good weather and if somebody is in, although certain items are never put outside (underwear) or are limited (towels finished in dryer to soften for kids). Items that can’t be tumbled are put on radiators (if heating is on) or airers in warm rooms (such as from the heat of the tumble dryer).

The Pleasure of Laundry

• Elements of the laundry process are enjoyed. Ironing is deemed relaxing and ‘therapeutic’ for both Lisa and Christine, partly because it is a child free time with the TV or whilst listening to the radio (the ironing is done when the kids are in bed - for safety). There is also a sense of achievement in getting clothes from dirty to clean, particularly if it was a challenge.
The Young Good Lifers: Mark, Nicola, Ben & Ellie.

Background
Mark and Nicola are married and both in their early thirties with two young children in primary school, Ben and Ellie. Both educated to a higher degree level, Mark works as a designer for a local company and Nicola is a home-maker with part-time work for the same company.

The combined income for the household is around £78,000 p/a. The family would describe themselves as being fun, proud, stylish and enjoying the good life.

Basic Human Goals:
• To consume technology for the pleasure it brings
• To be active, competitive and to have fun
• To be a stylish and proud family

End Goals:
• To maintain and enhance our high standard of living
• To save money through investment not reduction
• To make the desired consequences of energy consumption more convenient to attain

Experience Goals:
• To feel unmitigated in consumption
• For family life not to feel inconvenienced through change
• For change to ‘fit’ within our flexible, relaxed and close nuclear family

About the Family
• The whole family are very active and sociable, sporty and busy and see their lives as being chaotic, creative and fun.
• As a family, they usually share the same space when at home, spending time together in their favourite rooms, the dining room for homemade ‘centrally cooked’ meals and the lounge for watching TV and playing games as a family.
• Mark and Nicola try to maintain a flexible and relaxed living style around some basic structure and a lenient parenting style.
• The home is not usually empty, as Nicola is a home-maker with part-time hours and Mark occasionally works from home.
• Mark and Nicola have an open house attitude, with friends and visitors quite often letting themselves in.

Sustainability and the Environment
• Mark and Nicola understand climate change and global warming and have a deep grasp of sustainability and self-sufficiency (hence ‘good life’). Although they understand that their lifestyle may contribute to climate change, to them making changes would be about cost saving rather than enacting their sustainability awareness or high values.
• Ultimately, any change would be assessed by Mark and Nicola based on the cost of implementation, the inconvenience and ‘fit’ with the family.
• Any measure of change must be fun and enjoyable to do.

Energy and Technology
• The family have state of the art energy related appliances and own numerous digital media. They could be termed technophiles, although this is primarily driven by Mark, with Nicola tending to ‘go along with it’.
• The family are reasonably energy hungry and aware of the financial cost only when the bills go up.
• Mark and Nicola hold a vague belief that they consume above the average, but will ultimately consume as much as they feel is needed.
• For this family, energy means convenience.

...any new stuff has to fit in around the family and be sign-posted, I suppose, because Mark and I don’t have the free time to investigate things like we used to 5 years ago...

‘Home’
• In the many years that the Mark and Nicola have lived in their property, they have made numerous extensions and recent changes.
• Several changes have recently been made to reduce energy consumption at home, including a new boiler, double glazed windows, and insulation, helping the family to feel at home (although they predict making further changes as Ben and Ellie become teenagers, such as the installation of solar panels).
• Mark and Nicola both believe that this house is ‘it’, and is the place where they will grow as a family.
• The family is very house proud and stylish, and love their garden.

...I hate to say it, but as you have a little bit more money you tend to care less unless it’s very ingrained within you. It’s there in my mind, but if I’m cold now I just put on the heating....

...I couldn’t give up my washer because I’m not going to wash clothes by hand, it’s a huge labour saving. But I could give up the dish washer because we like washing up together...

...we’re probably a bit cash rich and time poor. You might have the money to make some changes, but you just don’t have the time to implement them at all...
A Sense of Laundry Loads
- There is no set day, as Nicola is not that organised, and will do a load when she knows that there is a full load (that’s most days). With 6-7 loads per week, sometimes colour groups are mixed otherwise Nicola will be waiting too long for half loads to finish. They also use an economy setting on 40 if not too dirty, such as for underwear that is always in the wash basket after being worn once.

Contingencies & Flows
- To this family the garden really is like an outside room, using it for breakfasts in the summer and playing year round. This sense of the natural extends to laundry, shunning their drier for line drying (airers and bannisters to catch the rising heat within the home during poor weather). The 2 load line capacity, which she monitors and circulates, limits the amount of washing in a day.

Laundrying Abilities
- Mark is no good at choosing the right washer settings, hanging on the line or removing creases. Nicola will try to covertly correct his decisions as she appreciates his intentions, but foresees the extra work it will bring her. Mark does help with ironing his work shirts. Despite Nicola wanting rid of the tumble drier, Mark is anticipating using it more once the solar panels are up.

Sensory Ironing
- Clean laundry is separated into two piles, those that need ironing and those they can get away without doing; Nicola detests ironing. Ironing usually happens in the lounge with the radio during free time, done by Sunday for the school week ahead. She finds the smell of line dried items to be fresher, with lengthy ironing of tumbled items to smell unpleasant and nauseating.

Social Stories
- Occasionally when Nicolas mum comes over she will do the ironing for her, otherwise she will be watching on with a bemused expression. Other titbits of information, techniques and materials (such as a new eco-ball) are regularly passed down. Nicola also regularly meets other mums when out and about with the kids, who discuss how they launder in passing.

Routes & Laundry Secrets
- Laundry is collected in a wash basket in the upstairs bathroom. Children are encouraged to wear things several times before washing, which they try, but sometimes they’ll hoard it in their rooms then dump it in one load, creating surges - although Nicola will sometimes secretly fold them (but not as neat as her mum would do it) if clean, and put them back.
The Mature Good Lifers: Jacqueline, Stephen, Hannah & Lauren.

Background
Jacqueline and Stephen, in their early fifties, are married and have two teenage children in secondary education, Hannah and Lauren. Both educated to a higher degree level, Jacqueline works as a manager of a local firm whilst Stephen works as an independent IT consultant.

The combined income for the household is around £105,000 p/a. The family would describe themselves as technophilic, stylish and enjoy a great standard of living.

Basic Human Goals:
• To consume energy for the pleasure and work/education benefits it provides
• To be very active and sociable
• To be a stylish and proud family

End Goals:
• To maintain and enhance our high standard of living
• To reduce our energy waste
• To make the desired consequences of energy consumption more convenient to attain

Experience Goals:
• To feel unmitigated in consumption
• For individuals within the family to not feel inconvenienced through change
• For change to “fit” within our flexible, relaxed nuclear family

About the Family
• The entire family are confident and unmitigated consumers of technology and energy. They are very stylish, sociable, busy and active.
• As a family, they usually spread around the house, the teenagers wanting their own space. When together as a family, it is usually when watching TV or in the kitchen.
• Jacqueline and Stephen are lenient parents. The family are very flexible aside from Hannah and Lauren’s extracurricular activities.
• There is usually somebody at home with Stephen working from home for two days of the week and they own a dog.
• The family has an open house attitude, with friends and visitors quite often letting themselves in.

Energy and Technology
• The family own state of the art energy related appliances and numerous digital media. They could be termed technophiles, although this is driven by Stephen who loves gadgets and works often from home.
• Jacqueline and Stephen use smart technology for work, whilst the teenagers use mobile phones and other digital technologies for games and education.
• The family are very energy hungry, living in energy bliss. They have an idea of what they ‘should’ do, consuming as much as they like with no idea of how much they use or the cost; they pay no attention to it.
• Jacqueline and Stephen drive and take the train to work and long distances, walking for shorter distances. This family cannot live without their car, depending on it for convenience.
• The family has an open house attitude, with friends and visitors quite often letting themselves in.

Sustainability and the Environment
• Jacqueline and Stephen have a deep understanding of climate change and sustainability, and are aware that their lifestyle has a negative impact despite growing their own vegetables, recycling, composting and baking.
• Although willing to make changes to become more environmentally friendly, their priority is to protect their lifestyle, including life aspirations, love of technology and comfort.
• Jacqueline and Stephen believe that they will probably move house once Hannah and Lauren go to university.

‘Home’
• In the years that the family have lived in their property they have had numerous extensions and changes to their home, creating a stylish open plan home in addition to the latest fixtures, such as windows. Because of all these changes, the whole family feel very much at home.
• As Jacqueline and Stephen get better at DIY, they would prefer to make changes themselves rather than employ a professional.
• Jacqueline and Stephen believe that they will probably move house once Hannah and Lauren go to university.

...if I’m working from home, then the heating’s on for the day, but it’s not convenient to do it any other way. We have thermostatic radiators, but we never get anything sensible out of them...

...we don’t go without, I mean, I was always brought up with a family that did things to cut waste, but it’s not like we are grandma’s only doing it for money...

...the dryer’s on all the time but I’m willing to spend the money for a clean load that I don’t need to iron. I’m aware it’s not environmentally sound, but I want easy to fold dry clothes!...

...we, like, buy a device that has an eco-button without necessarily knowing what on earth the eco-button did. Yeah, I suppose that’s a good example of the sort of things we do...
winter laundry day

locations
- Certain visible marks, for Jacqueline and Stephen, are acceptable within the confines of the home or activities, such as painting, gardening or dog walking. Although Lauren tends to launder her own clothes, this tends to involve putting whatever is on her bedroom floor into the wash basket, whether 'dirty' or not. She has an abundance of clothes so isn't too fussed.

routines & priorities
- Jacqueline usually orchestrates the laundry on Sundays with 2 to 3 loads (although Stephen will often do a load if working from home). Split by colour, wash loads are driven by and prioritised through key laundry items needed over the coming week, school uniforms first and then work shirts. Kitchen cloths and towels are exchanged daily to 'stay on top of things' hygienically.

laundry knowledge
- Jacqueline prefers to only use one or two settings on her washer, usually a 30 degree quick wash and then rammed into the tumble dryer (unless it can't be tumbled, then it's put on airers in the kitchen away from the dog). The dog's basket and towels get washed last on a higher temp' wash, sometimes with bleach when trying to remove the smell in the washer.

social stories
- Although Stephen sometimes attempts the laundry whilst working from home, Jacqueline would prefer him not to as he 'does it wrong'. Jacqueline claims that he never checks pockets or labels, sticks everything into the washer and dryer together and can't hang anything 'correctly' - failing to pull out creases or put shirts on hangers.

limitations of stuff
- Although Jacqueline heavily relies on the technology of the laundry process, she is very much aware of the limitations. Through experience, she has learnt to de-fluff the tumble dryer regularly and not to put certain articles in as they will shrink, and also that she can't put too many heavy items into the washing machine in one go as the machine will stop working.

laundry services
- None of the family are enamoured with ironing, preferring the bought in, biweekly, service of a cleaning lady to tackle Stephen's work shirts whilst also cleaning the rest of the house. The rest of the family tend to wear clothes that don't need ironing. Usually, these clothes only need to be folded out the dryer and then distributed per person in baskets to be put away.

winter laundry day

the ironing of clean laundry [steam iron]

the drying of clean laundry [airers]

the drying of clean laundry [tumble dryer]

the washing of dirty laundry [washing machine]

the collection of dirty laundry
7.2 Design concepts

Here are a few of our concept designs. They are deliberately directed towards future homes, although they can be created using technology available today.

7.2.1 KAIROS

In a future world where everything and everybody is digitally networked, the home increasingly becomes more complex and connected. Kairos is a concept that could run on a mobile tablet or smartphone. It allows you to schedule all your activities in relation to one another and your family routines.

The concept has been developed so far using the washing machine as an example. The endpoint of the wash cycle can, for example, be ‘snapped’ to the start or end points of other activities, (e.g. adjusting the washing machine spin cycle to avoid waking a lightly sleeping baby or synchronising the wash to finish when you arrive home from work). These examples could be achieved by using a sensor on the baby’s cot or by using live information from your smartphone and calendar to calculate when you are likely to arrive home.

By setting a delayed end time, the washing machine can also determine the most efficient settings to complete the task, adjusting dynamically to the anticipated activities and the energy load of the home/and wider supply grid. This will become increasingly important as more and more of our home’s energy is supplied from renewable sources such as wind and solar power. Additionally, KAIROS promotes conscious decision making and planning, especially relating to potential activity conflicts (for example, no one being home when the washing ends), thereby increasing the likelihood that washing can be hung out when the weather is fine and reducing the need to rewash when it has been left in the machine too long. it can learn your preferences and routines and thus over time make life more convenient.
7.2 Design concepts

7.2.2 HINTERLAND

Energy is often described as being invisible and intangible, masking the consequences of our desire to consume and to be consumed by technology. Who decides what energy consuming activities are acceptable and what is the yardstick for comparison?

Hinterland is an augmented reality app that makes the invisible, visible. Using a smart tablet as a viewing portal (with an underlying network of smart plugs and tags), the app illustrates in real-time the energy consumed as a series of industrial cloud plumes which will appear to be omitted from the energy consuming devices. Used in conjunction with a smart tablet based app, in which these clouds cause explicit damage to a virtual world, game mechanics elements are used to encourage reflection on and considered management of energy consumption.

If you are interested in visualising how your home performs, more can be found in Chapter 5 (page 37) which contains images generated from data, which could drive an app like Hinterland.

7.2.3 ANIMA

This concept is inspired by insights relating to ‘making the home feel right’. A family home is a living, breathing entity with its own unique signature, something that can be thought of as an energy and activity heartbeat that if left unchecked is prone to stress. This led us to consider whether the home can self-diagnose to save energy and improve a family’s well being?

Anima represents a heartbeat of the home, designed to draw the household into considering the energy use of the home in terms of its ‘health’ or ‘fitness’, rather than using unfamiliar energy measures such as Kilowatts or monetary savings which research has shown does not engage people in the long term with their energy use. The app would reside on a mobile tablet device and possible also on a communal, shared space such as the fridge door. The app incorporates a shared family calendar where schedules can be manually added or synchronised for each person.
The default screen of the app is of the combined heartbeat of the home, visualised as a dynamic ‘anima’ (meaning ‘soul’ or ‘psyche’), that pulses at a regular calm rate when the home’s combined energy use and levels of activity are below pre-agreed targets. As energy consumption or activity levels rise above their respective targets, the anima will give the illusion of stress through an exaggerated, irregular or frenetic pulse. In contrast to static representations of energy use such as bar graphs, the user is encouraged to interact with the display by pulling, twisting, and bouncing the anima for an engaging three dimensional experience with their living and shape shifting energy data.

The family can also choose to display the house’s energy consumption and their activities independent of one another. For the energy only anima, the shape reflects the homes’ gas and electricity data and the user can receive, by clicking on the facets of the anima, details of their consumption and also cost information. The other view is the activity anima, a visual amalgamation of a family’s busyness represented in an alternative colour scheme. Activity data can be drawn from the family calendars and from the technology of a modern, smart home environment. Movement sensors within the home and activity tracking through smartphones and wearable fitness devices will be able to detect a level of activity from movement in and out of rooms to personal fitness tracking. Again, by clicking on the anima’s tessellated surface, the family can drill down for further information and explore the busyness of the home.

The data from the calendars and of the family’s activity levels can also be used as an input into an automated home management system. For example, research has shown that people feel less cold when active so a house or smart thermostat could automatically reduce local temperature when the activity rating is high. Similarly, the calendar data can be used so that the system offers to switch the heating off when the data available suggests that the home is empty. At all levels, the data presented can be acted upon or ignored according to the family’s preference.
7.2 Design concepts

7.2.4 ASTITCHIN

We might waste a lot of energy in our homes through not having the time to plan more efficient ways of doing things. Although time is a tangible resource its usage is often reactive and poorly planned, giving the illusion of little time to reflect and take stock. We have therefore been asking ourselves: can we buy time for the things we enjoy and at the same time change our energy heavy lifestyles? Embracing the idiom ‘a stitch in time saves nine’, we propose ‘Astitchin’ time, can save the weekend’.

Astitchin is an app concept that ties energy saving with personal life goals, visualised as a family calendar that distorts and restores a treasured family photo depending upon your scheduled (or routine) use of energy and time. The app would be embedded within a communal family area, such as on the fridge door in the kitchen, synchronising with the families existing calendars (possibly through Microsoft Office or Facebook) where the user will be stepped through a process to enable them to earmark resources for the things that they want to do. The focus of Astitchin is to help users to plan time in advance for both themselves and for family time whilst also encouraging the development of energy saving habits and routines.

Astitchin will automatically synchronise with a weather app and also monitor the homes energy and water usage. If, for example, the weather is likely to be sunny on a particular day of the week, the app will prompt the user to put the washing on overnight so that it can be hung out to dry first thing the next day or the app could prompt the user to the availability of solar photovoltaic activity for using the washing machine at a reduced energy/financial cost. The emphasis would be on temporal savings, suggesting that you can ‘buy’ or ‘save’ time, like any other consumable and finite resource and use it when you want to, such as on the weekend with the family.

By extension, the app will encourage periods of reflection on time, resources and what the family wants from life. Do they want to be free on the weekends and what does this freedom look like? If the family want to spend time together outside of the home on a weekend, and have blocked this out in their calendar, then the app would suggest actions (such as the previously mentioned laundry load shifting) to help facilitate this. Also, going beyond load shifting the app could also prompt and motivate other savings, such as suggesting what could be done with the savings from a reduction of time in the shower; or suggesting what the money could be spent on from a change in heating system settings.
7.2.5 **FINITE**

Electricity, gas, water; resources are often presented as being limitless irrespective of ‘real world’ realities. Finite is a goal setting app and investigative tool for the family, shifting the conversation from the infinite, ‘how much have I consumed?’, to the finite, ‘how much do I have left?’ As people we are often motivated to save resources when something is scarce therefore the finite app is designed to help us to consider energy resources as limited rather than boundless resources.

Encouraging the family to make a commitment to save (a target derived from their current consumption), the app focuses and motivates the family towards long term investigation of their energy use and challenges them to make savings. As the ‘digital well’ begins to empty, ‘scarcity’ comes into play hopefully encouraging the family to use resources more carefully.

7.3 **Enuf! Shower length feedback device**

From our design, social science and engineering teams’ research, the LEEDR identified showering as an opportunity to save energy in the home. Hot water is interesting because although it’s not the biggest proportion of our energy use (See Chapter 3 and Figure 3.3a on page 26 in particular), as we begin to reduce our space heating, the energy required for hot water production will increase, relatively speaking and so not wasting hot water is important.

The device, called Enuf (Figure 7.6), used a range of audio and visual feedback methods to try and make people more aware of how long they spent in the shower and to try and motivate them to be quicker where possible. As well as just being informative, it was hoped the different levels of sounds and lights would be persuasive to the participants and that they would try to aim for the shorter times; either because they wanted to be congratulated by the device with cheerful sounds, or because they didn’t want to have to experience the increasingly dramatic sounds and colours!
This type of approach is quite new and untested, and we knew that only by giving the device to real families for an extended period of time could we ever hope to find out what elements were successful, and what need to be changed. We also wanted to see if the technology was suitable for the job, and could this type of device be a viable means of reducing the amount of energy and water used in the home. For us it was just as important to see what parts of the design were unsuccessful in the real world, as it was to see what parts really had positive effect on consumption.

The results of the trial as a whole were very positive overall, and there was huge variation in how successful the device was in reducing shower times. In some households, people more than halved the length of their showers and others changed their routine to try and shave a few minutes off or to finish into the green or orange sections. However, other participants were already very efficient, or unimpressed with the way device worked, or had routines that didn’t map well with the device, and didn’t reduce their time as much. Sometimes the technology wasn’t up to the job, and gave inaccurate information or flitted on and off; in these cases the device didn’t have a big effect on consumption. One of the most interesting aspects of the trial was the emotional reaction some participants had to the device; some really liked it and missed it when the trial finished, others were annoyed by it after a while, and some even a little fearful of it!

7.4 Summary

Design is an important part of our future because well designed products and services and useful to us, poor design is at best undesirable. The design work presented here has developed tools and techniques that can be applied by designers to create things that help us reduce our energy consumption.

Try this... 7.1 Reflect on the concepts and your energy analysis (pages 23, 35 and 37): what would help you reduce energy? Can you think of your own smart phone App and how it would work?
The LEEDR project team were all based at Loughborough University. LEEDR was a collaboration between individuals based in Schools and Departments across the university: Building Energy Research Group, School of Civil and Building Engineering; Centre for Renewable Energy Systems Technology and the Advanced Systems, Modelling and Simulation group in the School of Electronic, Electrical and Systems Engineering; Loughborough Design School; Department of Social Sciences; and the Department of Computer Science. And quite apart from the research, the team has produced no less than 3 weddings and 3 babies in the course of the project!

The investigators, through the grant award that funded the project, we were able to employ a number of Research Associates (RAs) to undertake the work. There was a core research staff who worked throughout the project and then a number who worked for shorter periods, or part time, to bring special skills as they were required. Through these posts, we were able to help the careers of 14 RAs which included: the first RA post for graduating PhD students; continuing employment; bridge to a first academic position as lecturer; and returning to research after career break.

The project was also able to support 4 PhD students by providing grants to fund the fees for study and to allow financial support during the 3 years. For these individuals, the project has given them the data to support the fascinating topics they have been studying, but also an environment that has had the support of more experienced researchers and allowed them to gain a unique perspective of how different research disciplines work, which will be a key skill as the frontiers in energy research progress over the coming years.

The Research Councils UK who funded the research do so to ‘...advance knowledge and generate new ideas which lead to a productive economy, healthy society and contribute to a sustainable world.’. A key part of this process is training and developing people to make a positive contribution in whatever field they work in. Thanks to your participation in the LEEDR project our whole team has benefited through advances in understanding energy use in the home and importantly has had a significant impact on the careers of our researchers and PhD students. Presented here in alphabetical order are the people who worked on the project to introduce you to the wider team who worked alongside the ones you know well.
8.1 The investigators

**Richard Buswell (Principal Investigator)** is a Senior Lecturer in Building Services Engineering in the School of Civil and Building Engineering and part of the Building Energy Research Group. His project work in both industrial and academic settings has been multi-disciplinary and his research has focused on understanding the performance of buildings, their energy systems and how people interact with them.

**Tracy Bhamra** is a Professor of Sustainable Design and the Dean of Loughborough Design School. A Chartered Engineer, Member of the Institution of Engineering and Technology and the Institution of Engineering Designers, and a Fellow of the RSA, she has over 20 years of research experience in sustainable design and is the founder of the UK Sustainable Design Network.

**Roy Kalawsky** is a Professor of Human-Computer Integration & Systems Engineering and the Director of Research School of Systems Engineering. Roy also led the DTI Centre for the Integrated Home Environment which ran extensive smart home technology trials in homes in the Leicestershire area. This work included automatic control of domestic appliances as well as the provision of services into the home.

**Val Mitchell** is a Senior Lecturer in the Loughborough Design School. She has over 15 years multidisciplinary research experience specialising in the development of user centred design methodologies for eliciting user requirements for future technologies and services. She was the lead human factors researcher in the Services Aggregation Trials for the DTI under ‘The Application Homes Initiative’.

**Sarah Pink** is a Professor of Design and Media Ethnography. She is an international authority in visual, digital and sensory research methodologies. Her research expertise is in everyday life and sustainability in domestic dwellings; analysing local authority sustainability agendas; UK construction industry work practices; and everyday digital media use. Sarah now works from RMIT in Melbourne, Australia.
Murray Thomson is a Senior Lecturer in Electrical Networks and Systems, in the Centre for Renewable Energy Systems Technology (CREST). His research focuses on electricity networks and grid balancing, particularly so that wind and solar power can be fully utilised in the future. An important aspect of this is ‘flexible demand’ whereby consumers at home and work may time-shift their activities in order on help reduce our reliance on fossil fuels.

Shuang-Hua Yang is a professor of networks and control and is a wireless sensor network specialist with an interests in their applications in; remote control, building fire safety, home security and energy saving, and military services. He is currently leading projects concerned with emergency response, RFID for road traffic control, and energy harvesting for wireless electronics in collaboration with UK industries.

8.2 The researchers

Sandy Brownlee completed a Computer Science BSc(hons) in 2005 at Robert Gordon University in Aberdeen, Scotland. He studied for his PhD in Multivariate Markov Networks for Fitness Modelling in an Estimation of Distribution Algorithm, which covered a range of applications for evolutionary algorithms. He focused on the construction of fitness models to support the evolutionary process. On LEEDR, Sandy helped us manage data communications and processing for the energy monitoring work. He is now a research Fellow at the University of Stirling.

Carolina Escobar-Tello has an MSc degree in Sustainable Product Design allied to a first degree in Industrial Design. Her PhD looked at understanding the way in which design can contribute in a holistic way to sustainability and in this way investigated, identified and proposed the design methods and characteristics of sustainable products, services or systems capable of contributing to our happiness. On LEEDR she lead the design based research and she is now a lecturer in the Loughborough Design School.

William Godfrey was an undergraduate studying Industrial Design at Loughborough. He worked with us on his placement year, having worked for 3D systems. He joined the LEEDR team for the summer before returning to student life for his final year and was based in the Design School. He helped us explore the project data to develop novel approaches to the use of digital systems to help lower energy use in the home and is now a design consultant for OgilvyOne in London.
Graham Jackson worked for Plessey & Lucas briefly before spending 35 years at 3M, prior joining the project. His background was in Ceramics and on the project he worked with Richard in the Building Energy Research Group developing and carrying out the initial survey material.

Kerstin Leder-Mackley worked as a Research Fellow on the TOTeM project (Tales of Things and Electronic Memory) in the School of Engineering and Design at Brunel University, prior to LEEDR. Her research background is in media and cultural studies, specifically qualitative audience research. On LEEDR she worked alongside Sarah, producing visual and sensory ethnographies of domestic energy consumption and everyday digital media use.

Xin Lu worked with Shuang-Hua in Computer sciences on the development of sensor technologies. Prior to Loughborough he studied at Beijing Institute of Technology in Electronics Science and Technology. He completed a MSc in Electronic & electrical Engineering before working for Shanghai Flight and Telecommunication Institute. He successfully completed his PhD in Wireless Sensor Network design and energy harvesting technologies while contributing to the monitoring programme on LEEDR. He is now a Research Fellow at Coventry University.

Dashamir Marini is a graduate of University Polytechnic of Tirana, where he obtained his master’s degree in Mechanical Engineering. He worked for two years as an engineer at Petcor International Company before he was awarded a PhD degree from Building Environment Science and Technology, University Polytechnic of Milan with on optimization and techno-economical performance evaluation of HVAC systems in a low energy residential building. Dashamir joined LEEDR in 2011 and has been working on modelling and data analysis.

John O’Brian worked with Roy in Systems Engineering on a number of projects prior to joining LEEDR. On the project he was involved in setting up monitoring databases. His skills included model based systems engineering, advanced interactive rendering, loosely coupled distributed systems, scalable systems, control systems, quality-of-service driven computing, grid/cloud computing.
8.2 The researchers

Katalin Osz has a multidisciplinary social science background. She is a final year PhD student at the department of Civil and Building Engineering and is partly supervised by Sarah. She took a short break from her studies to help us understand more about the links between the ethnographic and monitoring data.

Ian Richardson is a software architect with many years experience in implementing data systems. He completed his PhD at Loughborough in Crest which looked at assessing the impact of domestic low-carbon technologies on the electricity distribution network. The work focused on the development and use of a high-resolution integrated model that simulates both existing domestic electricity use and low voltage distribution networks. Following his PhD he worked part time on the LEEDR project before moving back to industry.

Dan Quiggin is a physicist who has just completed his PhD in modeling future energy scenarios. He is also director of Demand Energy Equality which aims to educate low income householders in PV panels. Dan joined the project in its later stages to help out with numerical analysis of the data.

Lynda Webb has a BA(Hons) in Home Economics and Education and Pg.Dip. in Design of Equipment for Disability. She completed her PhD, ‘Activity Diaries in Small Community Homes for People With Learning Disabilities’, in 1992. Since then she has worked in a variety of research projects working with both quantitative and qualitative data and their associated collection methods. On LEEDR Lynda manages participant liaison, installation and maintenance of the monitoring equipment analysis of the monitoring data.

Wendy Wang has just completed her PhD at Loughborough in the Building Energy Research Group. Although her work has not been directly related to LEEDR, Wendy helped out at some busy times helping us to organise the data we have collected from you.
Garrath Wilson is a doctoral researcher focusing on the role design plays in influencing sustainable behaviour. Combining a user-centred approach with the emerging field of Design for Sustainable Behaviour, the aim of his research is to influence a sustainable change in energy using comfort behaviours within the context of social housing. Garreth took over from Carolina when she gained her academic position.

8.3 The PhD students

Daniel Barry completed a degree in Physics and Communications BSc (Hons) at Lancaster University and a degree in Ergonomic Design and Human Factors BSc (Hons) at Loughborough University. Following graduation, he worked for BAE Systems as part of the design and engineering teams at the companies naval site in Barrow-in-Furness. He is currently studying for his PhD in Systems Engineering.

Paula Cosar-Jorda completed a degree in Building Engineering at UPV (University Polytechnic of Valencia), Spain. She carried out her final dissertation within the LEEDR project achieving the grade of ‘Outstanding’. She continues her work in LEEDR studying for her PhD which focuses on understanding the likely effectiveness of energy demand reduction measures in homes.

Marcus Hanratty After gaining a degree in Industrial Design in NCAD, Dublin, Marc worked as a designer for a number of years before completing an MSc in Sustainable Product Design in Loughborough. His PhD investigates domestic practice as it relates to energy use as well as the current role of digital media and its potential as an agent of behaviour change.

Roxana Morosanu completed a degree in Cultural Anthropology and Communication at the University of Bucharest in 2006 and an MSc in Social Anthropology and Community Development at the National School of Political Science and Public Administration, Bucharest. She worked for several years in journalism, marketing and she taught at the University of Bucharest, before moving to Loughborough to start her PhD. Her doctoral research focused on domestic time and digital media and she was awarded a PhD with distinction for her thesis titled ‘Presents of the Midlands: Domestic Time, Ordinary Agency and Family Life in an English Town’.
8.4 Behind the scenes

Barry Carnell Helped us with electrical matters in particular the safety testing of all the equipment we installed in your home. He retired earlier this year.

Steve Grieve is the IT systems manager in the School of Civil and Building Engineering and together with John Salisbury, supported the data servers used on the project and in particular set up the equipment necessary for the gas measurement system.

Matt Little Worked for us to develop the water measurement equipment and the cameras used in the gas measurement.

John Salisbury Works with Steve in the School, supporting the data acquisition servers.
**Duttons** Carried out the installation and removal of the water flow meters for us and there were a couple of guys from Duttons who helped us. Robert J. Dutton Ltd. are based in Shepshed and their contact details are: www.robertduttonltd.co.uk, Tel: 01509 XXX XXX.

**Unwins** carried out the installation of the CT clips in the distribution boards and installed additional power sockets as they were needed. John Unwin Electrical Contractors Ltd. are based in Loughborough and their contact details are: www.john-unwin.co.uk, Tel: 01509 XXX XXX.

**Mark** Did a great job for us by carrying out any remedial work that was required as we decommissioned your house. His contact details are: Tel: 07772 XXX XXX.
9.1 **Academic text**

Most academic research is disseminated to the research community through books, journal articles and conference papers. A list of those produced on LEEDR (so far) are given here. If you are interested in finding out more, then links to the full papers can be found on our website www.leedr-project.co.uk. All papers are stored on Loughborough University’s institutional repository and can be downloaded free of charge.

9.1.1 **Journal articles**


‘Current Issues and Future Directions in Methods for Studying Technology in the Home’ (2013), Coughlan, T., Leder Mackley, K., Brown, M., Martindale, S., Schlögl, S., Mal-
9.1.2 Conference papers


9.2 Presentations


9.1.3 Book chapters


9.2 Presentations


‘ ENERGY IN THE HOME: Everyday life and the effect on time of use’. BS2013, Savoie Technolac, France, Paula Cosar. 27/8/2013
‘Potential reduction in home energy demand, efficiency, control and lifestyle change’. Future Build, Bath University, Paula Cosar. 6/9/2013

‘Potential reduction in home energy demand, efficiency, control and lifestyle change’. Future Build, Bath University, Paula Cosar. 6/9/2013

‘Domestic Energy use and Everyday life in 2050’ Doctoral seminar. Loughborough University, UK Paula Cosar. 26/6/13

‘The future of domestic energy demand: how are we going to achieve domestic CO2 energy targets?’. DesRes, Loughborough University, UK, Paula Cosar. 2/4/2014

‘Knowing the world through your body: children’s sensory experiences of place’. K. Leder Mackley and S. Pink, Scaling Borders, Walls and Keys: Children’s Spatialities Symposium, Centre for the Study of Childhood and Youth, University of Sheffield. 15.05.13.

‘The meaning of media in everyday life routines’, Invited speaker, Centre for Cultural Research, Griffith University, Australia (May 2013)


‘Invited speaker Public Domestic symposium, RADAR Arts Centre, Loughborough University, UK talk by video, and discussion by skye (April 2013)

‘The meaning of media in everyday life routines’, Invited speaker, Contemporary Societies and Cultures seminar series, University of Melbourne, Australia (April 2013)

‘Beyond Ethnographic Film’, Invited Speaker, Public Lecture, Ethnographic Film Workshop, Non-Fiction Research Group, RMIT University, Australia (April 2013)

‘Going forward through the world: Thinking about first person perspective digital ethnography’, Invited speaker at ESRC seminar on First Person Perspective Digital Ethnography, at London School of Economics (January 2013)

‘Movement and Digital Media in Everyday Life and Ethnographic Practice’, Invited speaker at Seminar on Youth Street Politics in the Media Age at The Finnish Institute in London, as part of the Youth Street Politics in the Media Age: Helsinki and London Compared Project, University of Helsinki (January 2013)


‘Situating digital media now for an imagined future’, K. Leder Mackley and S. Pink, Digital Ethnography Research Centre, RMIT University, Melbourne, 15.11.12.

‘LEEDR: Low Effort Demand Reduction: Multidisciplinary research’. MEGs Christmas, Nottingham University, UK, Paula Cosar and Daniel Barry. 14/12/12


‘Consuming, moving, sensing: a sensory ethnography approach to movement, media and lighting’, S. Pink and K. Leder Mackley, Making Sense of Consumption, NCCR 2012, Gothenburg, 31.05.12.


‘Exploring the boundaries and interrelations of domestic energy practices’, K. Leder Mackley and S. Pink, Making Sense of Consumption, NCCR 2012, 31.05.12.

‘Situating everyday practices in the place event of home’, K. Leder Mackley, CaMARG: Culture and Media Analysis Research Group, Loughborough University, 03.05.12.
9.3 Web dissemination

There are two websites: one gives additional information about the project (www.leedr-project.co.uk) and the other is an access porthole that presents video clips from the project as a resource for others (we have sought consent from all involved in the clips presented, if you haven’t been approached, then your video footage will not appear there). This can be found at www.energyanddigitalliving.com.

9.4 Embedding findings in organisations

The work undertaken on LEEDR has also helped other organisations develop new ways of thinking about energy use in the home and demand reduction and in particular, we have spent time working with Forum of the Future. Forum are a charitable organisation set up by Johnathan Porritt to help organisations solve complex sustainability challenges. They work with people like Pepsico, Nike, Unileaver and Tescos and so are in a position to have a significant influence on the thinking that informs high level management decisions. We worked with Forum to develop new ways of thinking about energy consumption in family homes now and in the future. These ideas have then been developed into new engagement and workshop methods that are deployed by Forum.

9.5 Public engagement

We took part in universities week in 2014: our design team ran a futures workshop at the Natural History Museum on the 11/6/14.

9.6 Thesis and dissertations

9.6.1 PhDs

Paula ‘Evaluating whole-house energy reduction in family homes’, which utilises the monitoring data and modelling techniques to estimate the reduction potential tailored to a particular home. The work also employed interviews to understand the likely issues, or acceptances in undertaking the reductions with families. The work underpinned the energy savings analysis reported in Chapter 4, page 31.

Roxanna ‘Presents of the Midlands: domestic time, ‘ordinary agency’ and family life in an English town’. The work contributes to anthropological debates on the topics of human agency, time, domesticity, mothering, and kinship. The field work examined people’s relationship with time, and contributed to the work in Chapter 6, page 53.
Marc ‘Digital Design for Sustainable Behaviour: a framework and selection model for changing behaviour through cognitively aligned contextual intervention’, which used the data from the shower intervention (Chapter 7, page 63) that some homes participated in to develop understanding how to design products that help us to use less energy.

9.6.2 Postgraduate dissertations


9.6.3 Undergraduate dissertations


9.7 New research

Research projects form a continuum of investigation where the work that has gone before informs new ideas. LEEDR has supported the successful ‘Hothouse: Hot water provision in homes; consumption, storage and lifestyle’ project. Which will support three RAs and continue the investigation into hot water provision in homes in the future.
10.1 **Project funding**

This work was funded through the UK Research Council’s ‘Transforming Energy Through Digital innovation’ initiative, organised through the Energy and Digital Technology programmes. The LEEDR was based at Loughborough University, UK and the funding managed through the Engineering and Physical Sciences research Council; Grant Number EP/I000267/1).

10.2 **Authors**

This book is based on the work of the whole LEEDR team. The individuals who have contributed to the preparation of this book are acknowledged here:

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10.3 Contributors

This report is based on the work of the whole LEEDR team and technical support staff are acknowledged here in alphabetical order: Daniel Barry, Tracy Bhamra, Sandy Brownlee, Barry Carnell, Paula Cosar-Jorda, Carolina Escobar-Tello, William Godfrey, Steve Grieve, Marcus Hanratty, Graham Jackson, Roy Kalawsky, Kerstin Leder-Mackley, Matt Little, Xin Lu, Dashamir Marini, Roxana Morosanu, John O’Brien, Sarah Pink, Dan Quiggin, Ian Richardson, John Salsbury, Murray Thomson, Wendy Wang, Lynda Webb, Garrath Wilson and Shuang-Hua Yang. Thanks also to our contractors and partners for their support: Mark, Unwins, Duttons, EON, O2 and Alertme.

10.4 Production of the book

The formatting of the book was carried out using LaTeX www.latex-project.org, distributed under a GNU license. The template used for formatting the book is the ‘Legrand Orange Book’, from www.latextemplates.com, distributed under a Creative Commons License. Printing work was carried out by Design and Print Services, Loughborough University.

10.5 Analysis tools used

A range of software has been used in the collection of the data and in the analysis on the project. Video footage was edited using Final Cut Pro, Graphics generated using a combination of Microsoft Powerpoint and Adobe Illustrator, Photoshop, InDesign and plots using Octave.

Monitoring data was downloaded through a combination of bespoke Java code and LogMeIn (https://secure.logmein.com). Data servers were run in the School of Civil and Building Engineering. Data Storage were via Synology Rackstation 810 RP+ and Synology RX410.

The pre-processing of the monitoring data was carried out in two stages using Java Script and Octave. The gas data was pre-processed using Matlab and then Octave. The analysis of the data was carried out using a combination of Octave and Matlab, both on Apple and Windows based workstations.

10.6 Images

All images in this report have been created by Loughborough University. Images of staff and participants are reproduced here with permission, but may not be reproduced without consent.

10.7 On-Line Survey

On-line surveys on the LEEDR project were carried out using the Bristol on line service www.survey.bris.ac.uk.
11 — Keep track of LEEDR

11.1 Project website

The LEEDR project came to an end in November 2014, however the resources created and publications based on the research continue to be released. The best places to keep track of these are on our main website:

www.leedr-project.co.uk

11.2 Energy and digital living website

Our practice and routine related work has led to the development of a unique on-line resource for people interested in energy and digital living and is available at:

www.energyanddigitalliving.com

We hope you will keep track of us, the research continues at Loughborough University, where the majority of the project staff are still working to further the knowledge in the energy area.
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