ENERGISE

EUROPEAN NETWORK FOR RESEARCH, GOOD PRACTICE AND INNOVATION FOR SUSTAINABLE ENERGY

LIVING LAB COUNTRY REPORT – UNITED KINGDOM

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SUMMARY

This national country report describes the two living labs run in the United Kingdom for the pan-European ENERGISE (European Network for Research, Good Practice and Innovation for Sustainable Energy) project funded by the European Commission Horizon 2020 framework programme for 36 months (December 2016-November 2019). The report discusses the main findings arising from the living labs. It also considers some of the implications for policy-making and future research of the project.

The UK ran two of the 16 ENERGISE living labs (ELLs) conducted in eight European countries in which are based ENERGISE consortium partners. The preparatory work for implementing the ELLs in the UK began early in 2018; prior to that much of 2017 involved extensive thinking across the project about the concept of and design of the living labs.

ELL1 focused on individual households. ELL1 comprised 20 households with some variety with respect to socioeconomic group, located in Hastings and St Leonards on Sea (south coast of England). ELL2 was a collective living lab, involving 13 households, including some from lower income households in Hastings and St Leonards on Sea. All 13 ELL2 participants belonged to the same faith group and attended the same local mosque. ELL2 was a faith-based community. The two ELLs were active in overlapping time periods. For ELL1 this was between 17 September and 2 December, 2018; for ELL2 the active living lab period was between 24 September and 9 December, 2018.

Considering the location of the ELL sites within the borough of Hastings, it is not surprising that some homes were sea front properties. Others, however, were a few miles inland. Most homes were old and poorly insulated or had problems with damp, due to their proximity to the sea. Most participants owned their homes or were paying mortgages on them.

The ELL participants undertook two four-week challenges. The challenges were: a) to reduce indoor temperatures to 18°C or, if participants did not agree to this common challenge, to achieve another agreed individual target temperature; and b) to cut the number of laundry cycles by half or achieve a target related to an individual laundry challenge agreed between the household and the research team.

Turning to the main findings from the living labs, it is clear that participation in the ELLs led to significant changes in heating awareness and practices of the UK households that took part. Most of them were able to reduce indoor temperatures and still feel comfortable and warm enough. As a result of the laundry challenge the average number of weekly wash cycles and the average temperature of these washes went down. Participants started to assess what needed washing more carefully. Some participants pointed to the time-saving benefits of the laundry challenge. The use of washing machines changed in some households (e.g. more use of shorter or energy-efficient programmes, lower temperatures, doing full loads). Many participants committed to continuing with the new practices as the benefits were obvious to them.

There is some evidence of sufficiency or ruptures due to the ELLs. Most participants continued with their routine heating and laundry practices during the baseline period and made no changes prior to the start of the challenges. However, households reported that they started taking notice of their

routines in these domains, thinking more about energy use as they became more aware of relevant issues. Households reported that visits from the implementation team, the interviews, filling in the diaries and surveys, the challenge kits, the incentives/veg boxes, and the measuring equipment all helped reinforce their commitment to laundry and heating challenges. Moreover, the measuring and monitoring equipment and diaries made people more aware of, for example, the indoor temperatures in their dwelling. There was some evidence of a spillover effect, with participation in the ELLs influencing other practices, such as reducing the number of showers or baths taken and in the ways participants used electric appliances. In addition, some participants talked about their involvement in the project to friends, family and work colleagues (though not so much with neighbours or on social media). There is more sophisticated analysis still to be done on the myriad data generated by the ELLs.

In relation to policy implications and future research directions, an important consideration for future research into this topic concerns how to engage effectively with so-called 'harder to reach' groups that are significant consumers of energy, as was the case with UK ELL2. Presumably, projects like ENERGISE should address high-energy users, and they do not only reside in majority socio-economic and cultural groups in society. Considering the complexity and resource intensity of the ELLs, replication mindful of local context may be more effective rather than national policy-driven 'upscaling' based on a universal template. Further, learning might be facilitated by using findings from the ELLs to inform other initiatives or programmes, and/or integrating living lab elements into other projects. Localised amplification of project activities and findings might be achieved through collaborations of local stakeholders and other relevant actors, and by bringing policy makers, citizens, energy utilities and researchers together in a co-creative process of learning and action. This is based on a view of public engagement, which emphasises practices and active energy citizenship, rather than nudging of individual consumer choices and over-reliance on energy efficient technology. (Elsewhere, in the policy work package of the ENERGISE that they lead the Kingston University team refer to the need for a new 'imaginary' of active citizen engagement with energy and climate change policy, research and practice).

1. ELL DESCRIPTION

The UK ELLs were located in the Borough of Hastings, which includes the adjacent towns of Hastings and St-Leonards-on-Sea in East Sussex, on the south coast of England. Households were recruited with the help of a local partner, Energise Sussex Coast (ESC). The recruitment methods for ELL1 were based on non-probabilistic purposive sampling. Here, researchers use their judgment to recruit participants who may be able shed light on the particular topic or research questions at issue. For ELL2, convenience sampling was employed, exploiting the existing connections between ESC and the local Hastings mosque.

Recruitment advertisements were placed in a local newspaper and on the ESC website, the project was advertised through the Transition Town network – i.e. Transition Town Hastings – and posters and flyers were put up or circulated around the area. A recruitment stand at the popular St Leonards festival was run by ESC at the end of June 2018. Recruitment to ELL1 was achieved using the preceding methods. Existing contacts with the leader and active members of one of the faith groups in the area were used to recruit members of the Islamic community to ELL2. The recruitment started in June 2018 and was completed in August 2018. KUL received 41 responses to the recruitment questionnaire for ELL1, from which 20 households were selected; for ELL2 13 participants

completed the recruitment survey. A total of 33 households were recruited to the ELLs. However, participation rates varied throughout the study, so the number of responses/participants is indicated in each table of data in this report.

This section first presents the socioeconomic and demographic characteristics of the UK ELL participants. Then the characteristics of their dwellings and living environments are presented, and finally, their prior engagement with energy initiatives. These data are based on a survey used when recruiting participants (n=33) and are complemented with observations made when visiting the households for the first time.

1.1 SOCIODEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF THE ELL PARTICIPANTS

Given the purposive and convenience sampling approaches taken, the research team aimed to select households to reflect, as far as possible, the sociodemographic and socioeconomic composition of the UK population. However, compared with the UK as a whole, ELL1 had a higher percentage of home-owners, people with higher education qualifications, white participants, people in employment or other sources of stable income and in higher socioeconomic groups. The cultural diversity in our sample was achieved in large by the thirteen participants from a particular faith group (Islamic community) which comprised ELL2.

Among the households participating in the UK, 21% consist of only one person (Table 1) – all but one of them single females. All bar one of the two-person households (15% of our participants) were couples; the other was one of the two families of single (female) parents with school-age children. Seventeen of our households (52%) included children aged under 18. Six had a child of less than five, and two had babies. In the three examples of couples without children, all were aged between 40 and 62. There was only one example of a household consisting entirely of over 70s. Our sample included four families of four or more children and one example of a person living with their children and grandchildren. The key household types not represented were young single males, retired single males and young couples without children.

The second characteristic displayed in Table 1 is the age of the contact person. Households where our primary contact was aged 29 or less make up only 3% of our participants (one family in ELL1), while the majority (59%) is between the age of 30-49, and 34% are aged 50-69, with only one single household where the participant is aged over 70.

In terms of employment status (Table 1), our ELL participants are primarily full-time employed or entrepreneurs/business owners (52%). Our sample also include those working part-time (24%), as well as unemployed and students (9%), and retirees (6%). In terms of education (Table 1), our participants include a large share of people with tertiary/higher education (university degree), and fewer people with only primary education (63% vs. 9%), whereas the share of participants with secondary or vocational education is around 25% of the sample.

Table 1 Sociodemographic and socioeconomic characteristics of participating households Source: recruitment survey

Household size (n= 33)	**1 member**	**2 members**	**3 members**	**4 members or more**
%	21	15	12	52
Age of contact person (n=32)	**29 or younger**	**30-49**	**50-69**	**70 or older**
%	3	59	34	3
Employment status of contact person (n=33)	**Full-time employed or entrepreneurs**	**Part-time**	**Students, Unemployed**	**Retired**
%	52	24	9	6
Educational level of contact person (n=32)	**Higher/Tertiary**	**Secondary/vocational/ training/apprenticeship**	**Primary**	**Other or unknown**
%	63	25	9	3

1.2 REASONS FOR PARTICIPATING AND PRIOR EXPERIENCE OF ENERGY INITIATIVES

Our primary method for recruiting people was via local and social networks with the help of ESC, and local media. Many ELL2 participants decided to take part in the study because others in their faith group, including the Imam, signed up for the project. For ELL1 participants, both economic and environmental reasons were important. Some had previous connections with ESC staff and were curious about the living lab experiment.

It was felt that offering incentives for participation helped to attract attention and gain interest of different groups, including people who are not regularly involved in energy or environmental initiatives. Only a small number of households had been involved in information campaigns, had made use of incentives for energy investments, or had previously participated in a challenge or discussion to change every-day routines (Table 2). Overall, most of the participants were new to this kind of energy initiative.

Table 2 Number of participants having prior experience of energy initiatives (n=19)
Source: recruitment survey

	At home	At work	At school
Information campaign, tips for saving energy	5	3	-
Incentive to buy efficient appliances (including light bulbs)	2	6	1
Incentives to invest in renewable energy	-	-	-
Incentives or support for energy efficiency	5	1	-
Challenge/discussion to change habits and everyday routines	2	2	1
Other/don't know	4	5	9

1.3 CHARACTERISTICS OF DWELLINGS OF ELL PARTICIPANTS

Table 3 displays the main characteristics of the ELL participants' dwellings. Among our participants, 21% are tenants and 79% own their dwelling or have a mortgage on it. Table 3 also shows the period in which participants' dwellings were constructed and reveals that the majority are at least 100 years old and only 12% were built after 1980. A number of participants live in homes that are poorly insulated and draughty. Some, in addition, have open-plan interiors that limited their ability to heat particular rooms in isolation. According to one participant, high levels of air-born moisture from the sea affect residents' ability to dry washing outside and increase the need for the airing of homes. However, the homes in our study are spread over a fairly large area of the Borough of Hastings, including St Leonards-on-Sea, the town of Hastings and the Hastings suburb of Ore. Hence, although some are sea front properties, others are a few miles inland. According to the recruitment survey data, the number of rooms in participants' homes typically varies between 4 and 10, only two participants indicated that there are more than 10 rooms in their homes (including kitchens, living area, bathrooms, toilets, bedrooms, and other rooms, but excluding hallways, corridors and storage space).

Table 3 Characteristics of the participants' dwellings
Source: recruitment survey

Type of dwelling (n=33)	Flat/apartment	Terraced/semi-detached	Detached	Other
%	18	23	12	0

When dwelling built (n=31)	before 1920	1920s-1970s	1980s-2000	After 2000
%	68	19	6	6

The dominant source of heating was central heating – mostly fuelled by gas (91%) but also by electricity (3%). Two households reported in the baseline survey that they relied on biomass for their main source of heat. Many (85%), however, had secondary heaters that they used when it was particularly cold, to heat colder rooms in the house, when the central heating broke down or when a cosy ambience was desired. Indeed, the distinction between primary and secondary sources of heat was not always clear. For example, two households that recorded central heating as primary in the survey subsequently reported in the interviews that although they relied on central heating in the mornings and when the weather was particularly cold, their normal heat source in the evenings was a biomass heater in their front room. Table 4 shows the distribution of heating types and fuels among the UK participants.

Table 4 Heating sources in ELL participants homes (n=33)
Source: recruitment survey

	Primary heating source, %	Secondary heating source, %
Gas	91	12
Oil	-	-
Coal	-	3
Electricity	3	61
Biomass	6	9
Solar collectors	-	-
Heat pump	-	-
District heat	-	-
Other/don't know	-	-

The ability to adjust one's room temperature was one of the criteria for recruitment. Of the participants in the UK ELLs, all but one were able to control temperature settings for their entire home and 55% also had separate controls for individual rooms.

Another recruitment criteria was that participants should own a washing machine. Although some of our participants reported in the interviews and focus groups that they sometimes used launderettes, in the baseline survey none described this as being "regular". (Table 5). Eighteen percent of the

households had a separate tumble-dryer and one used a dehumidifier when they hung their washing to dry inside. 85% reported having an energy-saving programme or eco-programme option on their washing machine. Only half the participants knew the energy rating of their washing machine; of these, a quarter reported having one with an A++ rating.

Table 5 Laundry equipment owned or used by the households
Source: recruitment survey and baseline survey[1].

	Households with this equipment, feature or service, %
Tumble dryer or drying cabinet (n=33)	18
A++ rated washing machine (n=17)	24
Washing machine with eco-programme (n=20)	85
Regular use of public launderettes (n=33)	0

1.4 TOOLS AND APPROACHES USED FOR ELL1 AND ELL2 ENGAGEMENT

Depending on the recruitment channel, people were able to get involved by filling a recruitment survey online or by contacting the research team or ESC and having a face-to-face meeting. During the recruitment process households were invited to fill in surveys (recruitment and baseline) thatincluded filtering questions based on the requirements for participation e.g. about the ownership of a washing machine and an ability to regulate indoor heating. All received information about the project, and about benefits of joining the challenges. These benefits included challenge kits for heating and laundry; a consultation from an energy expert; vegetable boxes delivered fortnightly during the challenge period; the freedom to keep equipment used during the ELLs for measuring indoor temperatures and the electricity consumption of washing machines; and ideas and information related to energy use in everyday living.

Following the overall research design, all the households were visited for the installation of the metering equipment (a meter for a washing machine, thermometers and temperature logger), as well as at the beginning of the 'deliberation phase' that consisted of interviews in ELL1 and group discussions in ELL2 (two focus groups conducted on the same day but at different venues). In these meetings, the households discussed their laundry and heating practices, determined their challenges and received the challenge kits. During the challenges, the households were asked to fill in weekly surveys and diaries (for laundry and indoor temperature). The ELL2 participants had an opportunity to discuss their experiences with the challenges alongside their regular interactions with each other informally and in a specially created WhatsApp group. After the challenges, the research team met the participants again for interviews (ELL1) and focus groups/group discussions (ELL2) to discuss their experiences during the challenges. At these meetings the diaries and logging thermometers were also collected for subsequent analysis. Households were asked to complete a baseline survey

[1] AA+ rated washing machine and washing machine with eco-programme are from the baseline survey

before the challenges, a closing survey after the challenges, and a follow-up survey three months after the end of the challenges.

The ELL design included heating and laundry challenges, for which the challenge kits were provided. The challenge kits included materials and tips to support achieving the target that the households set themselves, either at the deliberation phase individual interviews or at the deliberation phase focus groups. The challenge kit for heating included a pair of woollen socks, two packs of tea (black and green), a Yahtzee game and a brochure including tips for keeping warm at a lower indoor temperature. The laundry kit included a stain remover, a clothes brush, a rack, an apron and a brochure including tips for energy efficient laundry and keeping clothes cleaner for longer. Photograph 1 shows the contents of the challenge kits for laundry and heating. Our participants universally reacted positively to the kits and some reported a measure of excitement. The socks were always appreciated (though sometimes used as gifts for others); the tea rarely prompted behaviour change but was always well received. The game was less often used, with participants sometimes reporting that they gave it away or had not yet opened it. The apron prompted lots of comment in the interviews due to its quality and the hanger was normally put to good use in some manner. The clothes brush was probably received least positively, with some participants hinting that they associated it with a by-gone age of personal valets, or else with the kinds of clothes worn by particularly wealthy people.

Some participants reported that the kits prompted them to reflect on, and change, their practices. This is illustrated by the comments made by two male participants from ELL2:

> *"My wife opened and it was exciting and get idea from them things"* (UK24)

> *"It raised up some ideas, some questions, 'why do we have this? Why do we have this?' and got us talking the first day we opened the stuff. It was my daughter who was reading all the challenges and whatever we decided, she was in charge of these things so it was, it raised awareness, made us all talk about it and see how can we benefit from this. We see socks, okay, we're all going to wear socks now, this kind of stuff."* (UK31)

Photograph 1 Challenge kits for heating and laundry

2. PRACTICES BEFORE THE CHALLENGES BEGAN

This section examines the practices existing in the households before the challenges. It is based on a survey sent to participants and on one-to-one (ELL1) or group (ELL2) interviews conducted before the start of the challenge. The section first discusses practices related to thermal comfort, before moving on to laundry practices.

2.1 PRACTICES RELATED TO THERMAL COMFORT

Responsibility for managing space heating was shared fairly equally between men and women in the mixed-gender households in ELL1. In half of all households with male and female adults, women had the main responsibility for controlling the household temperature and in a further 17% this responsibility was shared between adults from both genders. In ELL2 (where all households included at least one adult male and one adult female), the situation was rather different, with women looking after temperature regulation in 54% of households, men in 23% and responsibility being shared equally in 23%.

All the UK ELL participants had central heating systems that allowed temperature settings to be varied automatically on a daily programme. However, only 32% used this facility (and only 9% of ELL2 participants) – some because they claimed not to know how to use it and others because they preferred to turn their system on/off and up/down manually. More than 80% turned down their heating when they were away from home but only half did so overnight and only 39% did so in unused rooms. Airing of rooms by keeping windows open is not a familiar practice in the UK and was only reported by a quarter of our participants.

Preferred wintertime indoor daytime temperatures were significantly higher in ELL2 than ELL1 (Table 6): by 3ºC in living areas and adult bedrooms, and by 2.5 ºC higher in children's bedrooms. However, participants in both ELLs felt that adult bedrooms should be heated to lower temperatures than main living areas and that children's bedrooms should be warmer than adult ones.

Table 6 ELL participants' perceptions of desirable temperatures in the winter during daytime before taking part in the ENERGISE challenges
Source: baseline survey

	Average ELL1	Average ELL2	Average all	Highest ELL1/ELL2	Lowest ELL1/ELL2
Living area, °C (n=28)	19.2	22.2	20.1	23/27.5	15/18.5
Bedroom, °C (n=26)	17.4	20.5	18.8	20/27.5	15/16.5
Child's bedroom, °C (n=23)	19.1	21.6	20.2	25/30	15/17.5

In the interviews and group discussions, participants tended to be preoccupied with evening temperatures rather than daytime temperatures. Evenings were felt to be times when people became sedentary and therefore less resilient to cold spaces; when people in multi-occupant homes spent time together, often watching TV; when tiredness set in, and when 'coziness' (real fires; warmer

temperatures or “snuggling” under blankets) was more important. Participants sometimes switched off their heating entirely during the day and sometimes felt unjustified in having daytime heating on even if they were working at home and being sedentary.

The use of heating timers was not always favoured, with some feeling that they would save more by switching the pump off whenever they no longer needed the heating. While some did rely on thermostats to regulate the temperature, others did not. This was sometimes because the thermostat was in the wrong part of the house for it to regulate the temperature in the room that they wanted to regulate. For others, it was because they had no notion of the temperature within their home and only switched off/on the heating when they experienced subjective sensations of hot or cold. 61% of participants felt their indoor temperatures in their homes were just right. However, the figure was far higher in ELL2 (82%) than in ELL1 (45%), where 55% felt it was too low. Nine in ten felt that other household members shared their views on the indoor temperature.

Some ELL1 participants reported that they raised the target temperature in their homes if they had guests. In some cases, this seemed to be about the physical needs of the visitors – e.g. when the guests were older and perceived to be more vulnerable to the cold. In other cases, it appeared to be motivated by anxiety about contravening injunctive norms (e.g. when relatives were in the home in order to do the family some kind of favour and so ‘deserved’ to be kept warm) or descriptive norms (it being ‘a bit embarrassing’ if the house was cold):

> *“I have a lot of friends who say, 'oh we're going to [name of participant]’s, house [so] we're going to wear our slippers, we're going to bring slippers with us and bring a cardigan.' It's sort of almost a bit of a joke really.”* (UK13)

Sometimes, the extra heat provided for visitors was designed to create a more welcoming/cozy atmosphere – both to embellish the reputation of the hosts and to create an atmosphere conducive to positive social interaction.

Some members of family households were reluctant to have much heating on when they were at home alone – whether engaged in salaried work or not. This reluctance seemed to be driven by a sense that they did not deserve to be comfortable and that it was appropriate to subject oneself to a degree of suffering. One male participant, for example, described sitting in his home office wearing a hat, scarf and coat, and only switching the heating on when his children/wife returned home. Another suggested that she was reluctant to spend a lot of money on heating when her partner was away earning money and she was at home not generating any income; instead, she worked in the conservatory, using an electric heater or running the central heating with only the conservatory radiator turned on. In fact, generally speaking, participants typically felt more entitled to heat their homes during the evenings when people gathered together and were less physically active, and less entitled to do so during the day when people tended to operate as individuals and be more physically active.

While most said they turned the heating off/down while on holiday, one participant reported leaving the settings unchanged regardless of what they were doing and where they were located.

Table 7 Frequency of various heating-related practices among the ELL participants in winter-time before participating in the ENERGISE challenges
Source: baseline survey

	Share of households, %
Turn down heating for the night (n=31)	55 (ELL2: 45)
Turn down heating when not at home (n=31)	81 (ELL2: 73)
Turn down heating in unused rooms (n=31)	39 (ELL2: 27)
Has programmed the system to automatically turn down heating at certain times (n=31)	32 (ELL2: 9)
Air rooms for more than a few minutes per day (n=29)	28 (ELL2: 36)
Turn down heating when airing rooms (n=27)	52

Notably few of the participants programmed their heating systems to vary automatically temperatures throughout the day, 31% of ELL1 and 9% of ELL2 (Table 7). This, the interviews suggest, was either because they did not trust this feature of their heating system to work effectively or else because they felt it was more efficient to adapt heating patterns to their actual use of the home rather than to average patterns of occupation and behavior. The majority (70-80%) reported reducing target temperatures when not at home. Only around half reduced them during the night.

Over a quarter of participants reported regularly airing the rooms in their homes (Table 7) but few, if any, gave any indication in the interviews of this being part of their heating practices. Indeed, the practice of 'airing' was generally unfamiliar and prompted some puzzlement when introduced:

> *"Isn't that the kind of thing your grandma did? I don't get it. I think if a room is stuffy in the summer, fair enough. I can't, no it's just not something that occurs to me actually at all."* (UK21)

Commonly, participants reported using electric heaters, wood burners and open fires to boost temperatures in particular rooms when they did not want to heat the whole home. Wood burners and open fires not only provided heat, but also created a more desirable ambience for visitors and collective family times. In fact, open fires were sometimes used with ambience as the primary or sole aim, or because they were considered to provide a preferable type of heat:

> *"[the heat from an open fire is] more like the sunshine isn't it. It's more of a natural. It's a nice dry heat that's what I like about wood burners."* (UK11)

> *"We had [the wood burners] because it feels cosy and we like to look at them."* (UK07)

> *"We're thinking about converting [our log burner] back to an open fire actually so we can use it just, more fun. But obviously it's supposed to be 70% less efficient isn't it if you use an open fire than a wood burner. So that seems a bit silly really doesn't it, makes it less efficient. But, as we kind of only use it when we want it to be nice and cosy, it might be a good thing to do."* (UK04)

Keeping warm with additional clothing and footwear was common, but symbolic/identity issues were taken into account when deciding about this, and not just questions of warmth. For example, there was a feeling that additional clothing could stifle physical mobility, leading to sedentary behaviour that contradicted a self-identification as physically active. Similarly, one participant argued that he would not wear slippers because they were "for kids and old people", and one associated the wearing of extra clothes with "being very hair shirt" (a reference to an erstwhile practice of penitents and ascetics, who would wear course, scratchy undergarments as a form of mortification of the flesh). One ELL2 participant suggested that it was a custom in the country of his birth for people to be barefoot when at home. For others, additional clothing contributed positively to identity:

> *"We do sit in the front room with blankets round us because it's kind of something that we always did and it's quite nice and snuggly anyway. […slippers etc. are] functional but it's also nice and cosy […] hygge"* (UK19)

Some participants reported using less heating in their kitchens because of the heat generated by cooking activities. Apart from that, there was little evidence of any association between cooking practices and heating – although hot foods were associated with wintertime, this appeared to be a performance of a cultural identity or a means of emotion regulation rather than a practice intended to heat bodies or spaces:

> *"I think you would be [having more hot food] anyway don't you because there's winter food isn't there? You have more soups and you know you have less salads, so it's you know you are doing that naturally I think."* (UK10)

> *"I would never relate having hot meals or hot drinks to help keep you warm."* (UK17)

This section examines the practices existing in the households before the challenge. It is based on a survey sent to participants and one-to-one (ELL1) or group (ELL2) interviews conducted before the start of the challenge. The section first discusses practices related to thermal comfort, before moving on to laundry practices.

What people like / don't like about heating devices in the home

Participants expressed an aversion to the "stuffy" feeling resulting from the use of heating devices such as gas fires and central heating and felt that the kind of heat provided by real fires provided a more comfortable kind of heat. Some complained of the over-intensity of the heat provided by central heating. For one, under-floor heating was preferable because it "heats the room nice and gently". Log-burners were not only considered more cosy, but also (by some) more efficient: one participant argued that it gave him a third of the gas consumption of an equivalent sized family; another preferred using logs because he got them free of charge and argued, in addition, that burning logs was better for the environment. Log-burners also had the advantage of providing intense heat to one room while simultaneously providing gentle heat to the whole home; central heating, in contrast, was sometimes considered insufficiently flexible to heat different rooms to very different temperatures. In addition, some considered alternatives to central heating as essential back-ups for those occasions when the central heating broke down or was disabled by power cuts.

Some complained about not being able to use thermostats: because they were tied to rooms whose temperature was irrelevant to their comfort or because they were too complicated to use, unfamiliar or either didn't function properly or else could not be trusted to do so:

"We've had [new boiler] now for over a year, we don't quite know quite how to use it. I think it does switch itself off; it goes back to 16 [degrees] after a while because obviously it turns off but we can learn how to use it properly. It's just on some kind of timer, we don't know quite what." (UK02)

Areas in the home that are more or less comfortable

Rooms that received no direct sunlight were described as cooler and, sometimes, as too cold; so too were rooms with three outside walls. Amongst our sample, these rooms tended to be living rooms, bedrooms and studies. This lack of sunshine was not always considered a problem for bedrooms, where a cooler night-time temperature was preferred; but it was sometimes problematic for living rooms and studies, where people were awake but practices involved little physical exertion. Some rooms were cold because of faulty, leaking windows or doors. On occasion, increasing the temperature of a particularly cold room led to the overheating of other parts of the home.

Rising damp, condensation and the damp sea air encouraged some people to provide more heat in some rooms than they would otherwise have done. For example, one family used under-floor heating to keep their damp, poorly ventilated kitchen at a permanent 18 degrees, and one family described using space heating to protect the fabric of the home from damp. Open plan interior designs also caused difficulties. In poorly insulated homes, they made it difficult for central heating systems to provide enough warmth for draughty living spaces because so much of it was lost to other parts of the home – including to upstairs bedrooms, where it was not wanted. As a result, people with this type of home sometimes preferred the more intense heat produced by wood burners, whose heat can be shared throughout the home without compromising thermal comfort in the main living space.

How windows are used in winter

The use of windows varied enormously amongst ELL1 participants, suggesting the absence of any clear social norm. Some only opened windows if there was tangible evidence of it being necessary – e.g. if it was "too warm, smelly or a backdraft brings smoke into the flat". Others opened windows regularly: because they "like[d] the feeling of fresh air"; in order to "get oxygen into rooms"; to "let air in" or to deal with the dampness that comes with living by the sea. ELL2 participants, in contrast, were in agreement about the importance of regular airing and fresh air.

The data from ELL2 suggests a culture of wearing little in the home and heating accordingly. Wearing little was described as generating a "good feeling" and as "normal and light". It was considered "relaxing" to take off most of your clothes when you got home and just wear a t-shirt – and there was resistance to doing otherwise (possibly because the shedding of clothes symbolises the end of the working day for those who work away from home). Homes should not be heated to the point where you become "sweaty", it was argued, but neither should you need to put on more clothes in order to keep warm.

ELL1 participants provided a broader range of perspectives than those in ELL1. Some felt it was illogical (e.g. "silly") to spend lots of money on heating, if there was the option of wearing extra clothing. This implies (as some argued explicitly) that they would nonetheless opt for wearing less clothing if money were no object, energy cheaper or houses better insulated:

"If a building is efficient you can do that, but if this person is spending a ridiculous amount of money on keeping, but it looks like a very modern building that she's in and it just looks like it could be quite energy efficient. So, I can't see any problem with that." (UK10)

"I think with all the things we've got like insulation we're probably not using much more than we were because before a lot of the heat was going out whereas now it's not." (UK12)

"Silly, really silly…. My point in a way is not so much the use of the energy, it's the cost of the energy." (UK13)

"Not wrapping up is very nice, but I'm aware that it's a luxury. But yes I would rather not wear lots of clothes because I do [physically active] things and it hinders you. If you're very packed-up you're more likely to sit down and watch television than if you are lightly dressed. [… Home should be] "not too warm because it makes you too lazy, but not so that you become inactive from the cold. I do know that last week one evening it was quite cold and i just went to bed because it was too early in the year to put the heating on, but it made me warm." (UK06)

Interviewer: "Would you like ideally to be walking around in say t-shirts and shorts or are you happy with…?" Participant interrupts: "I'd love to!" (UK07)

Participants drew different conclusions from their memories of childhoods spent in cold homes. For some, this signaled the profligacy of much current energy use, while for others it helped them appreciate contemporary heating systems:

"I do think, why don't people just put up with the cold. We all grew up in houses without any heating didn't we? You probably did too. There was no heating. We used to put jumpers on." (UK17)

"[If it's too cold when you get ready for bed] the clothes get flung over and actually I'd prefer to do it a little bit more orderly and not feel that I'm rushing into getting warm again." (UK19)

Other ELL1 participants, however, considered dressing lightly in winter as immoral, because it was "bad for the environment"; or else they preferred to be dressed in a "cozy" manner that was appropriate to the season.

ELL1 participants struggled with the concept of heating people instead of spaces. They tended to argue that it was fine to heat spaces if they were actually being used and that it would be uncomfortable to live in a home where the spaces were not heated because, as one woman put it:

"there's only so much you can do to feel warm like with putting all the layers on; you [will] still feel cold if you're in a cold space" (UK16).

Again, participants sometimes wanted to account for the nature of the building when considering this question. For a participant who lived in a particularly house, there was no alternative to wearing lots of clothes, so although undesirable, this "makes sense"; for another, the more important issue was whether homes were now being designed and built to eradicate the need for warm indoor clothes altogether.

In addition to the use of the central heating, our ELL participants used several other strategies for keeping warm prior to the start of the challenges. Some used open fires, wood burners or electric heaters either to supplement the central heating or to provide a more “cozy” warmth and atmosphere in one or two rooms (usually the front room). Indeed, for some wood burners/fires provided the main/only heating for the whole house during the evenings. Most participants reported that they already wore extra clothes, slippers/extra socks and warm covers on their beds – all ways of heating the person rather than the space in the colder months. In contrast, just over a third of participants (36%) said they took baths/shower for this purpose (54% of ELL2s; 25% of ELL1s). Only 15% of ELL2s used draft excluders to keep the house warm, compared to 45% of ELL1s.

The ELL2 focus group deliberation meetings revealed several categories of routine in relation to indoor comfort. These included setting the central heating to come on either once or twice per day at set times (e.g. in the morning, or morning and evening). Another practice was to turn the heating on or off manually according to the weather outside that day and, again, not rely on the thermostat or timer. For the last of these the temperature could be turned up, say, to 25°C on a cold winter’s day. A variety of strategies are used to keep warm. Focus group participants mentioned wearing slippers, shawls and blankets, drinking hot drinks, keeping doors closed and using small heaters.
In terms of the material element, some focus group members did not find their boilers or radiators easy to use. One commented on the old age of their boiler. There was consensus regarding the (beneficial) practice of airing rooms by opening one or more windows.

2.2 PRACTICES RELATED TO LAUNDRY

Laundry appeared to be a gendered practice among our ELL participants, with women being the main residents taking responsibility for it in 83% of households that included male and female adults. Men were the main person responsible in just 8.5% of ELL households and the responsibility was shared in the remaining 8.5%. Length of wear was the criteria most commonly used to determine when an item of clothing needed to be washed (71% of participants) but smell and stains were also each mentioned by a quarter of participants. Participants did an average of four washes per week. However, this average hides a great deal of variation. For example, smaller households tended to do less (as few as half a wash per week) and five of the larger households did seven or more (Tables 8a, 8b). The largest household (8 residents) reported doing only 2.5 washes per week. 41% regularly used a tumble dryer, or (in one household) hung clothes indoors and used a dehumidifier to take the moisture out of the air. The use of tumble dryers seemed to be more common amongst larger households. Participants from ELL2 did more ironing (only 16% did little or none) than those from ELL1 (where 60% did little or none) but there was no evidence of any relationship between amount of ironing and household size.

Table 8a Laundry practices in different types of households before participating in the ENERGISE challenges – ELL1
Source: baseline survey

	Number of household members			
	1 (n=7)	**2 (n=4)**	**3 (n=4)**	**4+ (n=5)**
Average laundry cycles/week	1.5	2.3	5.0	5.8
Share using clothes dryer regularly	14%	0%	33%	40%
Share ironing regularly	57%	25%	50%	20%

Table 8b Laundry practices in different types of households before participating in the ENERGISE challenges – ELL2
Source: baseline survey

	Number of household members			
	1 (n=0)	**2 (n=1)**	**3 (n=0)**	**4+ (n=12)**
Average laundry cycles/week	-	1.5	-	4.3
Percentage using clothes dryer regularly	-	no data	-	42%
Percentage ironing regularly	-	100%	-	85%

Households most commonly washed their clothing and bed linen at 40°C. However, there was much variation, particularly for whites and bed linen (Table 9).

Table 9 Washing temperatures among the ELL participants before participating in the ENERGISE challenges
Source: baseline survey

	Mode	Mean	Lowest	Highest
Dark clothing, °C (n=31)	40	38	30	60
White clothing, °C (n=32)	40	46	30	90
Bed linen, °C (n=31)	40 (ELL2: 55)	55 (ELL2: 64)	30	93

Prior to the laundry challenge, two-thirds of participating households already kept clothes clean in ways other than machine-washing them. There were notable differences, however, between ELL1 and ELL2. While half of ELL1 used other ways to keep clothes clean, 92% of ELL2 did so, with a far greater proportion of ELL2s washing out stains (69%, compared to 20% in ELL1) and airing clothes (69%, compared to 10% in ELL1). 42% of all participants reported using aprons to keep clothes clean, while only 12% reported using a clothes brush. In the interviews, several participants mentioned changing out of their work-wear when arriving home, and having separate clothing for "dirty" activities (gardening, repairs).

Further, the laundry practices were discussed in detail during the deliberation interviews with ELL1 participants and during the focus group meetings with ELL2.

How people determine what is clean or dirty

According to interviews with the ELL1 participants, the length of wear and smell are the most frequently mentioned criteria for determining whether an item of clothing is clean or dirty and needs a wash. The length of wear varies between households and different members of each household; it also differs depending on the type of garment and the activities for which it is used (e.g. sport activities, gardening, crafts, office wear). Smell is seen as another important factor and mentioned by many. Visible stains (e.g. food or ink stains on school uniforms), although less common as a reason, are seen as a clear signal for putting something in the wash. Clothes losing 'shape' was mentioned once as a reason for washing (knees on leggings, elbows on cardigans, skinny jeans to tighten them up). Clothes can be put in the wash even if not considered dirty, just as a way of tidying up or filling up the load. There are some assumptions about how frequently the washing needs to be done for certain things such as underwear; this was often reported as a habit or routine without any particular indication of their being 'dirty'. Another habit, which is not necessarily shared by all household members, is of washing clothes after a single wear, e.g. parents were critical about their children's habit of putting their clothes in the wash (or laundry basket) every time they took them off.

ELL2 participants reported a number of routines that govern when the laundry needs to be done. For instance, a number of them do the laundry periodically (e.g. three times daily; twice a week; on Saturdays). Others do the laundry when the wash basket is full or check the state of the clothes of family members to see if a wash needs to be done. There was some reference to the need to wash clothes that smell or are stained or sweaty and to this becoming more of an issue depending on the occupation of the person concerned (e.g. whether it was 'customer facing'). A number of participants

referred to the need to wash ‘whites’ and ‘colours’ or clothes of different material separately from each other.

How washing frequency differs in relation to varying occasions

ELL1 participants reported that work clothes get washed more often, e.g. household members doing customer facing work or who are in professional or senior managerial positions require freshly washed clothes daily. Some participants in ELL1 with children noted that they started doing more washing since having kids. School uniforms/school shirts are typically washed once a week. Sports clothing is usually washed after each wear because it ‘stinks’ and for hygiene reasons. T-shirts can be worn for 1-3 days, dresses for up to three days. Jumpers, ‘woollies’ and jeans are usually worn for longer. One interviewee mentioned doing more washing in summer for dresses and beach towels (a rinse cycle rather than proper wash); another suggested that less washing is done in winter because it is not so visible when wearing coats and they are of darker colour. Many reported that they do not deliberately do washing for special occasions and wear some types of clothes more than once (e.g. church clothes or party clothes). It is a common practice to change underwear and socks daily. The frequency of washing bed linen varies: some said they do it every 3-4 weeks, some every two weeks; one household changes bed linen every week. Bed linen is washed more often when having guests to stay over (when guests stay over, bed linen is washed after each visitor leaves). Towels are washed when they get ‘smelly’, on average every two weeks. People also reported that they do less washing when they go camping.

> *“When I do sports my stuff has to be washed quite a lot because it stinks. I cycle. And I cycle a lot and so it gets very hot and very sweaty. And just for hygiene because you don’t want to be putting back on dirty stuff because it makes you sore.”* (UK20)

Notable changes from how laundry was done in the past

Participants reported that they began to do more laundry once they had children or when they got married. Some participants had previously, and sometimes still did, use a dryer/washer-dryer. Buying a new washing machine (with bigger capacity and greater efficiency) had an impact on people’s laundry practices. Previous life-style (nomadic, mostly outdoors) and geography (e.g. the participant who had previously lived in East Africa) also affected the way some did laundry in the past and may affect current practices. One interviewee mentioned doing more hand washing while unemployed and washed less when they lived in a flat – because there was less space for drying laundry. For those who had previously worked in an office, the washing was done more frequently in the past (in order to look ‘smart’). (Long-term) illnesses of family members had resulted in doing more washing in the past. Some said that they used to iron more than they now did, but also could see a difference between their own current practices and their parents’/childhood (parents used to wash and particularly iron more).

It was noted in ELL2 that in ‘the old days’ clothes washing was done by hand.

Who takes care of what in relation to laundry, and comparison across households and ELLs

With a substantial number of single person households in ELL1 (7), the question about roles taken in relation to laundry was not relevant to all 20 households. Although it is still common for the females in multi-adult households to take responsibility for doing the laundry, the roles are sometimes divided, e.g. a female doing washing and a male doing ironing (or ironing his own shirts), or each doing their own laundry, as in case with grown up children. In one case, involvement in the project resulted in a male partner doing more laundry.

The discussions with ELL2 revealed that in participating households the females do the laundry.

Strategies for keeping clothes clean and tidy
For ELL1 participants, wearing an apron (e.g. for 'messy baking' or craft work) is a common strategy; they also remove stains sometimes. Another strategy is to wear dark clothes so that dirt doesn't show so easily. Several participants stated that they don't buy or wear clothes that need ironing. Many people have different sets of clothes for home wear, work and/or going out (e.g. smart, scruffy and casual) and change clothes when they come home; some also have special gardening or allotment clothes.

Not everyone in ELL1 uses stain removers or has other stain removing strategies. Those who use stain removers tend to do it before the wash and put things into the washing machine anyway (this can be a stage in a laundry routine rather than a separate strategy). Only a couple of participants said they would do spot clean or remove a stain sometimes (e.g. food on the children's clothes).

Strategies for keeping clothes clean among ELL2 households included wearing an apron and changing out of (work) clothes after getting home. There was some reflection that less washing would need to be done if stains could be removed from clothes by hand. Some participants iron clothes for school wear or special occasions.

Spaces people use for putting clothes that have been worn
Many in ELL1 have space to put their clothes that have been worn but do not need a wash yet (e.g. over a chair, outside of the wardrobe, on the door or even in a pile on bedroom floor) as people have concerns about moths, although few participants put everything back in the wardrobe.

Spatiality of laundry
There are no problem with the access to laundry machines reported in ELL1 (typically, machines were situated in the kitchen or utility room), and people have enough space to dry their laundry (indoors and/or outdoors), although in some households this space can be limited for one wash load. People prefer to dry their laundry outdoor if there is an opportunity (e.g. a garden) and when the weather allows. Having clothes hanging around indoors makes the house look 'messy', although some mentioned a problem with drying clothes outdoors, such as gulls and sun damage, and one pointed to humidity being an issue in a seaside town. One participant is planning to get a new tumble dryer. Drying laundry indoors can be conditioned by heating time – a few participants do their laundry deliberately at the time when the radiators are on so the laundry can dry quicker on the radiators.

> *"Only because we'll end up having clothes hanging around the house for days trying to get them dry and then they smell musty. But whilst the weather's like this then everything goes outside. Even in winter."* (UK20)

Some participants in ELL2 use a launderette for drying their laundry; others have a dryer that they use when the weather is too bad to hang the washing up.

Washing at 30 C, eco-buttons and information on the use of different programs
ELL1 participants generally prefer doing washing at 40°C, sometimes 30°C; a quick wash is the most frequently used wash cycle.

"…usually I'll do 30 degrees for darker colours and 40 degrees for whites. I imagine heat might keep them a bit white, which might not be true, I don't know." (UK27)

Not every washing machine has an eco-button, and some ELL1 participants were not aware of this option on their machines. Some confused quick cycles and cold washes with eco-programmes (a quick/speedy cycle is often seen as the 'eco' option and as the most economical). The eco-cycle in most cases seems to take much longer and is therefore perceived as less convenient. Some machines have eco-cycles that do not allow users to vary the temperature of the wash and that prevent washing at 30ºC.

"Do you know what I realised after I spoke to you? Actually that it has got this eco-perfect and I honestly have no idea what it does or what it means and it's probably one of the reasons why I bought it but now I honestly probably just use 1 or 2 settings and don't really even think about it." (UK02)

Use of laundry machine at a specific day/night to save energy

Only several participants in ELL1 have a special (Economy 7) tariff that makes it more economical to do washing at night. However, this did not affect their routines because doing laundry in the evening or night makes too much noise. Only one participant stated that she used to do it when she had a special tariff.

"When I had Economy 7, which is cheaper during the night, I used to set, there's a timer on it. So I used to set it to go in the middle of the night. But now that I've got just a normal tariff, the same day and night, so I just do it whenever I think about it." (UK27)

Collective conventions and social norms around clean clothes

ELL1 participants were concerned to ensure that their level of clothing cleanliness was socially acceptable. This concern was especially salient when engaged in salaried office work and for children when going to school.

"I guess for my husband in his work because he's the boss and he has to wear a suit, you know shirt and tie, so it is important that he doesn't smell sweaty or looked crumpled or have dinner on his clothes. I like to send kids to school giving the appearance of being well looked after and you don't want them to be teased if they're sweaty or dirty." (UK13)

It might be needed sometimes to wear sparkling clean clothes for special occasions; it also feels good to wear nice fresh clothes ('a nice psychological feeling to it'). The reactions to the idea of 'sparkling white clothes' among ELL1 were mixed.

"I don't care if my whites look less white than somebody else's'" (UK01)

"Just ignore it. Not interested." (UK03)

"I mean you expect people to be clean, don't you? And if I'm wearing something white I want it to look white, I don't want it to look grey." (UK12)

"If you're going to wear a white shirt or a white t-shirt then I think it should be white, properly white." (UK09)

Some argued that they were unresponsive to societal pressure and that feeling clean was less linked to having freshly washed clothes than it was to regular and thorough washing of the body.

> *"I am really not bothered by peer pressure at all… if it's clean enough for me, it's clean enough."* (UK01)

> *"I am not big on social pressures. I really don't care what people think of me very much."* (UK11)

However, a distinction was sometimes drawn between undergarments and shirts, and garments that came into less contact with the skin – with more stress being laid on the cleanliness of the former. The common view is that wearing clean underwear is important for issues of hygiene and health.

Time-consuming aspects of laundry

Laundry is seen by ELL1 as part of the routine and usually not as a 'problem'; doubts were often expressed about saving significant (if any) time by doing less laundry as not spending much time on it anyway.

> *"I spend about 5 minutes. I just look in the basket and sort the whites from the coloureds, which how long does that take when you've got a pile."* (UK27)

Most of our ELL1 sample feels quite 'relaxed' or 'neutral' about it, some even enjoy doing laundry finding it 'satisfying'. Only few see it as a 'chore' (e.g. people with children) and would like to do less laundry or less ironing at least. The following quotation exemplifies the latter view:

> *"I find it frustrating the amount of washing there is that I end up doing."* (UK03)

3. PRACTICES DURING AND DIRECTLY AFTER THE CHALLENGES (FROM WEEKLY AND EXIT PHASE)

This section describes the changes that occurred in the participating households during and directly after the two four-week challenges. These challenges were either the 'common' challenges: to reduce indoor temperatures to 18°C and halve the number of wash cycles, or else participants' own, individually defined, challenges. Table 10 shows the share of households signing up to the common challenge, and provides examples of individually defined challenges.

Table 10 Share of households signing up for common or/and individual challenges Source: interviews and closing survey

	Common challenge, %	Individual challenge, %	Examples of individual challenges
Laundry challenge	70% (11 ELL1; 12 ELL2)	30%	• Reduce some washes to 30ºC • Reduce washes by 1/3 • Limit tumble dryer cycles to 2pw
Heating challenge	73% (11 ELL1; 13 ELL2)	27%	• Use thermostat to keep temp more steady • Reduce to 21.5ºC and buy/use heated throw • Reduce temp in empty rooms; reduce by an hour the time for which the heating is on • Keep rooms slightly cooler than normal (main heating not thermostatically controlled) • Only using the wood-burner, not the central heating (two participants) • 19ºC • Cut down no of logs used on wood-burner (which is mainly used for aesthetic purposes)

The following starts by discussing changes in heating practices, before moving on to changes in laundry practices. The data for this section is from weekly surveys sent to households during the study, a concluding survey at the end of the challenge periods, and closing interviews. The text also presents data on indoor temperatures collected by a temperature logger installed in participants' homes. Where access to power sockets was possible, data on the electricity used by washing machines was also collected.

3.1 CHANGES IN HEATING PRACTICES

During the heating challenge, households in ELL2 typically began to wear extra clothes (especially socks) and in some cases used a hot water bottle. Items from the challenge kit, such as the tea and the game prompted increased reflection and awareness, with one ELL2 participant (UK31) stating that having the thermometers alerted them to 'the fact' that their home was sometimes much warmer than they had realised. This same participant noted that subsequent to the challenge, he felt comfortable with a lower room temperature range (19-21ºC), where previously he had 'struggle[d] with the low temperatures' because he came originally from a tropical country and was acclimatised to 'maybe 23-24 [degrees] in the house'.

Figures 1a-1e present the temperatures in participants' main living spaces, as measured by the temperature loggers, during the baseline period (September 17th to October 14th 2018 for ELL1; 24th September to October 21st 2018 for ELL2) and the challenge period (November 5th to December 2nd for ELL1; November 5th to December 9th for ELL2).

Figure 1a ELL1 changes in indoor temperatures before and after the heating challenge – °C (starting September 17th 2018) (n=20)
Source: logging thermometers

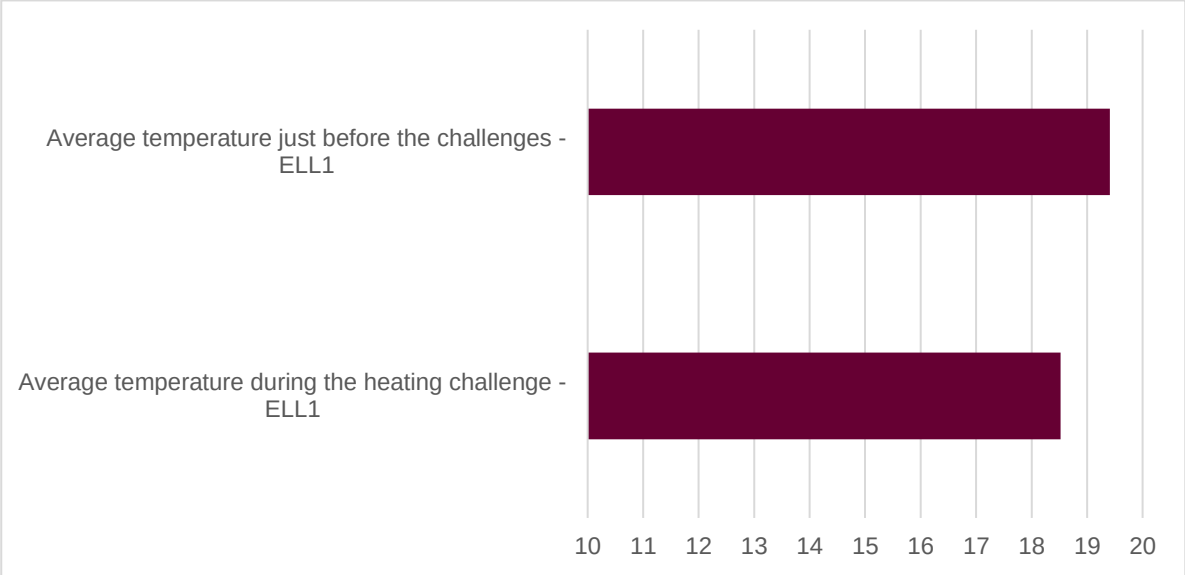
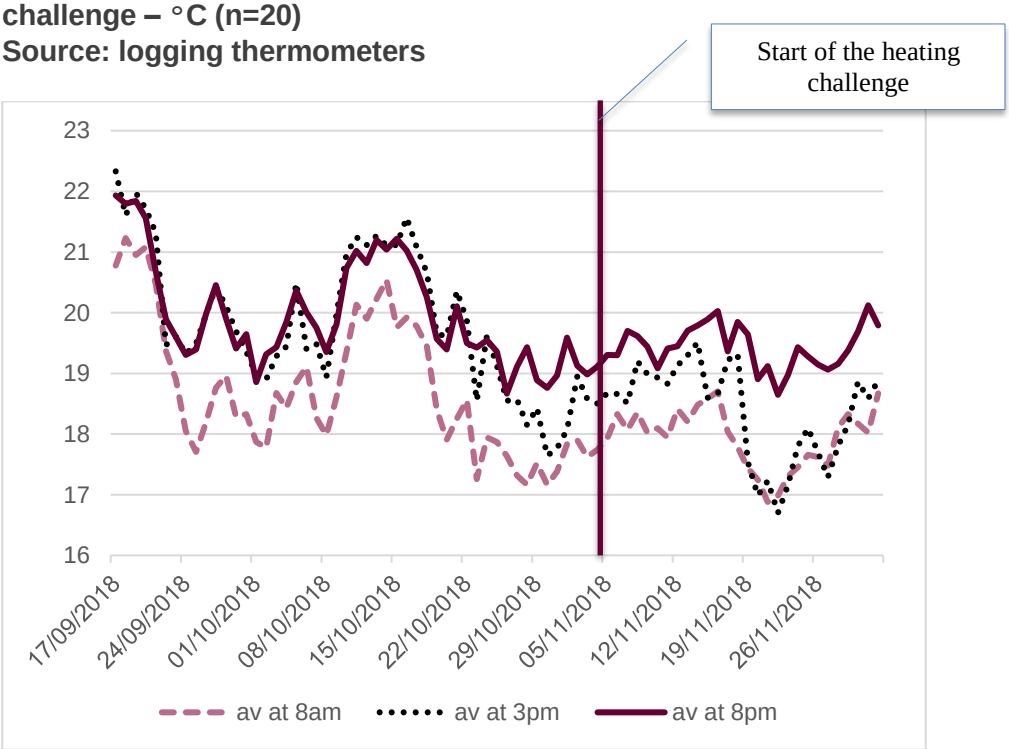


Figure 1b ELL1 average temperatures at 8am, 3pm and 8pm – before and during the heating challenge – °C (n=20)
Source: logging thermometers



As seen in Figure 1a, average temperatures amongst ELL1 participants fell from 19.4°C before the challenge to 18.5°C during the challenge. However, this change is not necessarily explained by the heating challenge for Figure 1b shows indoor temperatures falling before the heating challenge began. A more sophisticated data analysis is required before the impact of the challenge on ELL1 can properly be determined.

Figure 1c ELL2 changes in indoor temperatures before and after the heating challenge – °C (starting September 24th 2018) (n=8)
Source: logging thermometers

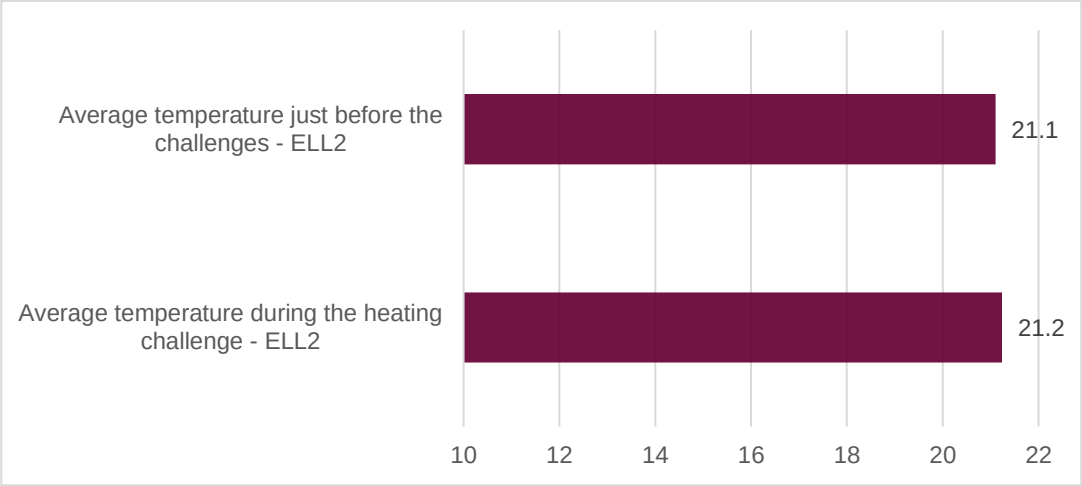
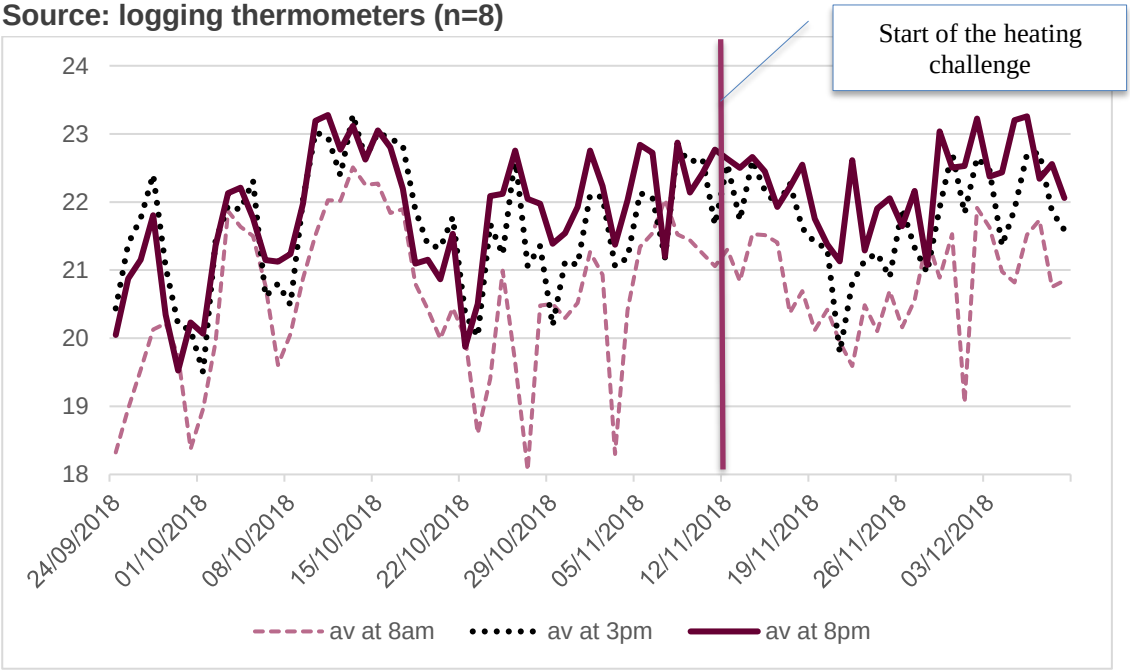


Figure 1d ELL2 average temperatures at 8am, 3pm and 8pm – before and during the heating challenge – °C
Source: logging thermometers (n=8)



For ELL2, Figures 1c and 1d suggest that the heating challenge had no impact on indoor temperatures. Overall temperatures averages were the same before and during the challenge (21°C) and there is no sign of changes in average temperatures at 8am, 3pm or 8pm.

There are some notable difference in temperature data between ELL1 and ELL2. There was more day-by-day variation in temperatures in ELL2 (Figure 1e), with the striking variation in averages perhaps reflecting the fact that most ELL2 participants controlled their heating manually, rather than by thermostat or timer. ELL2 participants also kept their homes 2-3°C warmer on average than did those in ELL1 (Figure 1f).

Figure 1e Comparison of average 8pm indoor temperatures in ELL1 and ELL2 –°C

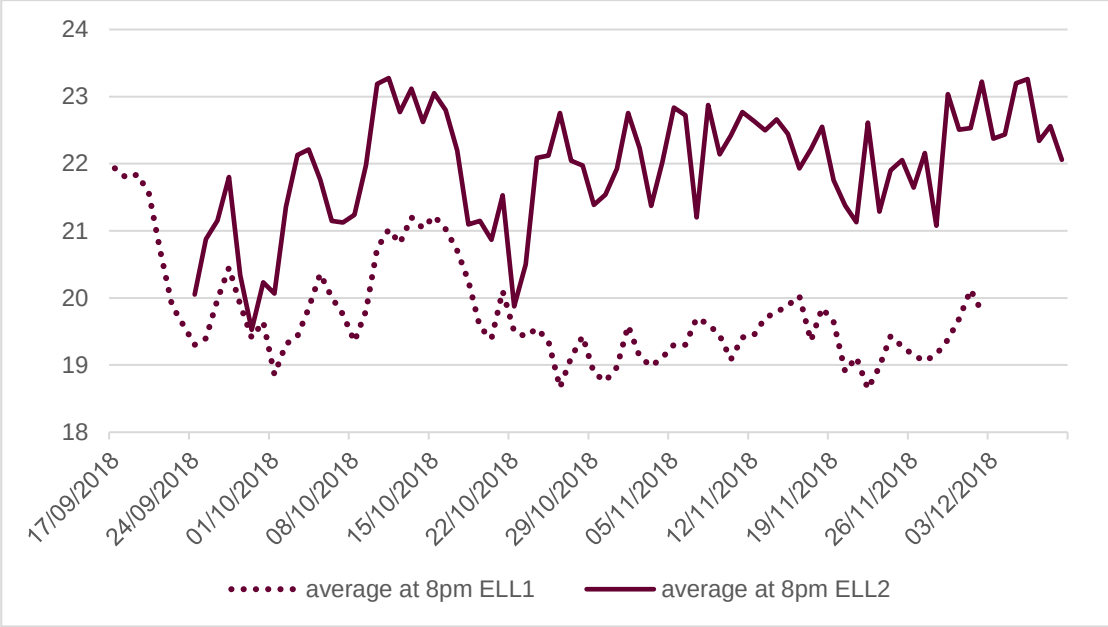


Figure 1f Temperature averages before (dotted lines) and during (solid lines) the heating challenge throughout the daily cycle – °C (n = 26; 20 ELL1, 6 ELL2)

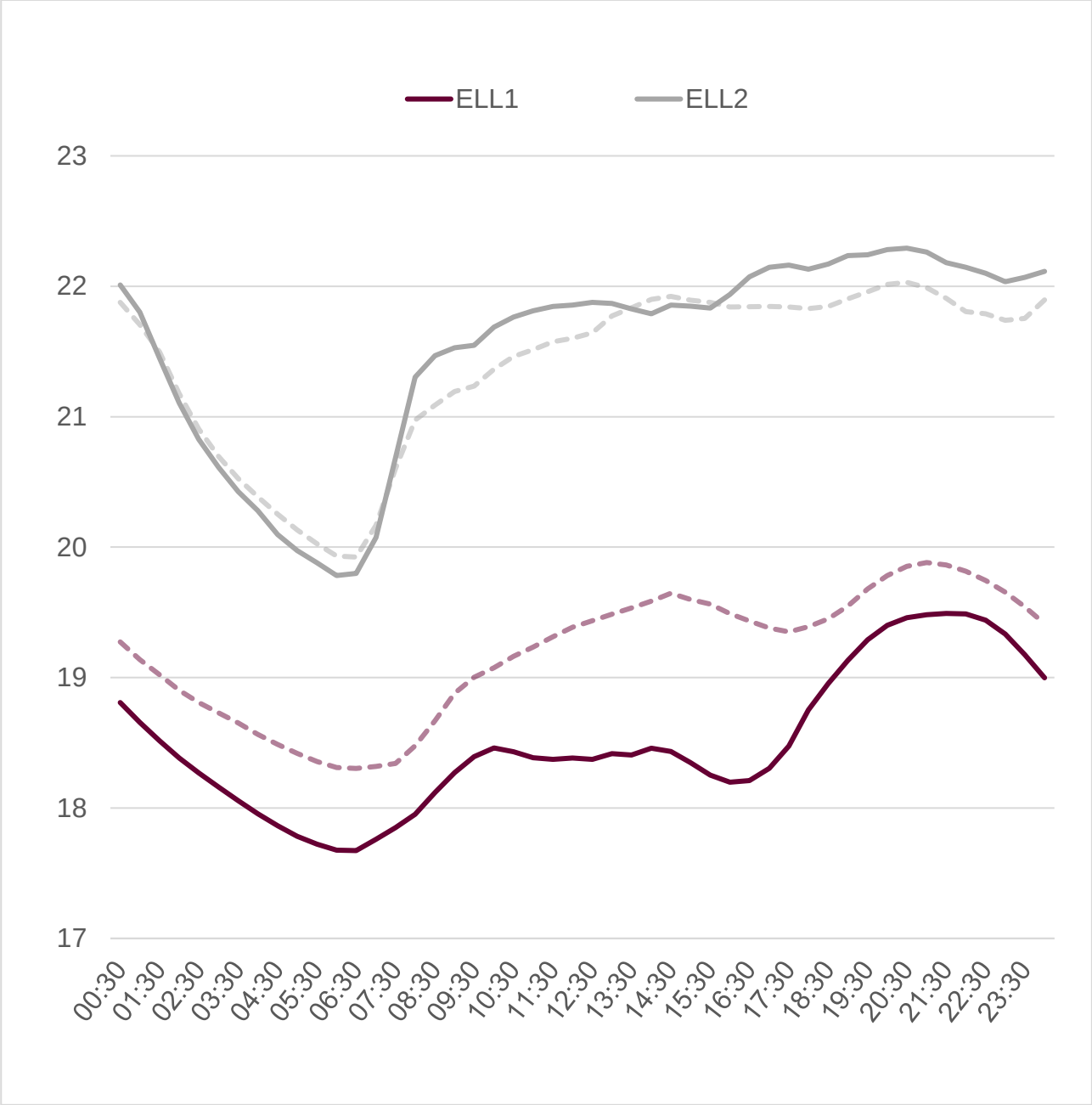


Figure 1f shows, further, that the most significant change in average temperatures was that in average daytime temperatures amongst ELL1 – i.e. between 9.30am and 5pm. This concurs with the tendency in the interviews for people to express greater willingness to reduce daytime temperatures than evening temperatures.

What participants did differently during the heating challenge

Few ELL2 participants provided data on changes they had made regarding heating, but those that did indicated that they began to wear more clothes during the challenge, and to use other means of keeping warm – e.g. skipping or using hot water bottles. The following quotation from a male participant (UK31) shows how greater awareness of heating and its consequences helped overcome barriers related to social identity:

"[before the study] that was not me but now, I see the benefit of [using hot water bottles] and also with this because I'm aware now of the whole issues on heating so I'm using it and I'm feeling… I enjoy it definitely [… Previously] I felt like [hot water bottles] made myself look old or something, that's old people thing." (UK31)

Use of thermostatic controls did not increase amongst ELL2, however. Participants' confidence in their ability to save them money remained low, and they continued to control their central heating by switching it on and off at the pump:

"To see the boiler on all the time makes you feel that it's working all the time and therefore feeling that maybe you'll pay more. So I'm not sure if that's the case or not so we feel, I feel better switch it off; when I want it then I put it on." (UK31)

In at least one ELL2 household, participation in the study led to significant changes in heating awareness and behavior, with a participant saying that the thermometers provided for the study made him confront his cultural norm and realise that he would be more physically comfortable if he broke that norm by heating his home to a lower temperature:

"It is good idea to reduce the temperature of the house because sometimes the temperature is too high but you don't feel it but you feel you're not comfortable but you don't know what's the reason. Then when you become aware, it's because you were now on 27 degrees inside your living area… That's the reason; that's why I don't feel comfortable. And then you start to think of the ways of reducing: maybe switching off or whatever you decide to do at that time […] Our temperature [was] maybe 23-24 in the house, that was the temperature that we were on. Now we're comfortable with 20, we can go to 21 or 19. We're comfortable in that range. I don't know, it could be me; I am coming from tropical country where the temperatures are always high; I studied in [country] where it is desert. So I'm used to those high temperatures and I struggle with the low temperatures. I struggle with that. So yes, but now living and understanding and feeling, trying to absorb that kind of things the environment that I'm in now so I can be comfortable at 18-19-20, I'd be comfortable with that. Maybe I prefer my own 25+ [temperatures] but it feels more comfortable at this." (UK31)

Some ELL1 participants did little or nothing new to keep warm (arguing, for example, that there was nothing more they could/should do) during the heating challenge. Some, indeed, had strong arguments for limiting the scale of the changes. UK06 wore an extra gilet during the challenge but argued that wearing any more than that would make her less active by restricting her physical movement and that "huddling" under blankets would have prevented her from maintaining what an "open heart centre" (a term taken from her yoga practice). She also argued that:

"I don't want that lifestyle yet. […] Being wrapped in a blanket during the daytime is like giving up to me." (UK06)

Others were more ambivalent about the idea of warming their bodies and keeping the house cooler, finding the target temperature of 18 achievable but not "comfortable":

"18 degrees is just far too cold […] But actually, if you dress up, it is okay. It's not the most comfortable but it is okay." (UK19)

Participants with families were sometimes particularly protective of having higher temperatures in the evenings, when warmth was represented as an essential ingredient for sociability and cosiness.

UK18, for example, used sarcasm to counter the implication that his family should be keeping their bodies warm in the evenings instead of heating their lounge with their wood burner:

> *"Yes, I mean we could have, like it suggested, snuggled on the sofa under a blanket or something and not had the wood burner going; we could have done that but we didn't try that. We could have sat there with the Horlicks under a blanket…"* (UK18)

Some ELL1 participants were content to make changes however. These included wearing socks instead of going barefoot at home; wearing extra jumpers; wearing thermal underwear; substituting woollen socks for those made of synthetic materials; keeping more physically active, and wearing slippers. Where the challenge coincided with other developments, changes were sometimes particularly marked. UK02's baby allowed them to put him in a growbag for the first time during the challenge, so they were able to turn the heating off at night, put extra blankets on the marital bed and wear pyjamas instead of sleeping naked. UK14 used the challenge as a prompt to review her domestic practices in the light of her husband's recent death. As a result, she reorganised her domestic chores to keep herself more active; reduced the length of time for which she had the heating on; drew her curtains earlier in the evenings and kept rooms warmer by closing internal door more.

Material arrangements

The challenge prompted some ELL1 participants to review their material heating arrangements. The heating challenge was "a bit of a boot" for UK11, who had long been dissatisfied with having her thermostat in the hall and was prompted by the challenge to find out how to move it to the front room, where she felt able to use it for the first time. Similarly, the act of measuring the temperatures in her upstairs rooms prompted UK19 to realise how cold they were and, hence, to install loft insulation. UK07 draft-proofed their doors and windows, having been intending to do this for the previous three years.

Similarly, some of those (including UK11) that had been using their thermostats as off/on switches began, instead, to use them to set the temperature of their home, and did so carefully rather than simply turning thermostats up high enough for the heating to come on.

> *"Sometimes we would not even look at the dial and just flick it round."* (UK03)

> *"I might have been one to just whack the heating if it was cold but not really think about where the thermostat was set at so then I'd whack it on and it would get too hot then we'd turn it off again whereas actually now, I'm much more up for having it on a set amount of time for a lower temperature."* (UK04)

This reduced overheating and wild swings in temperature.

Social norms

In ELL1, some participants took the recommendation of an 18ºC in-door temperature as an authoritative pronouncement of a prescriptive norm ("You're obviously environmental experts and so there must be something about 18 ºC that is environmentally friendly" – UK03). Sometimes this led to reductions in temperatures, but where participants had been unsure whether it was acceptable for them to heat to as high as 18ºC in particular circumstances, 18ºC was taken as a minimum temperature and the prescriptive norm led to more use of heating.

Some reported that they no longer simply adjusted the heating according to whether they believed themselves to be hot or cold, and now tempered such beliefs with evidence from their thermometers:

> *"I go by feeling. I don't say "oh it's cold today because it's 17 degrees". I think "I feel cold, it's 21 degrees, sorry I feel cold". It's a feeling but now I pay more attention. I'm obsessed with looking: "God, it feels hot! Oh, it's 19.3. Oh, it feels warmer." Yes, I've really paid attention to it at least 5 times a day."* (UK06)

> *"[knowing the actual temperature] shows that just whacking the heating up a bit or whatever isn't going to make any difference, doesn't it? It shows that you've got to address your own coldness, as it were, I think. If I'm feeling freezing but the thermometer is telling me it's 19 degrees in here then I have to find another way to get warm, don't I?"* (UK11)

Some ELL1 participants reported that they had never before had a thermometer in their homes. As indicated by the above quotes, the provision of thermometers therefore had a substantial impact on perceptions of what constituted a 'warm' or 'cold' home:

> *"It was interesting having the thermometers and actually seeing the temperatures of the different rooms. Because I've never sort of like thought about or had anything that's read the actual temperature of a room. And seeing what the cut-off is I suppose for me – as to when it feels too cold and when it feels just right."* (UK08)

> *"So for instance, if we're sitting down, often I feel a bit cold but we'd look at the thermostat and it would say 18 or something so it would be like actually, it's not that cold. So it's more like a psychological thing: so you think you're cold. So I just put a blanket on if we're watching the TV. That's it really."* (UK02)

The need for living spaces to be cosy was, however, a barrier in some cases to reducing temperatures in the evenings. This is because warm rooms represented, for some, safety and security for them and their families:

> *"it's not always about the temperature that you want the heating on; I think it's comfort and feeling safe and all that."* (UK06)

In other cases (e.g. UK02) warm spaces seemed to have been replaced by the use of extra clothes as signals of cosiness and safety.

Continuity of practice changes

Most ELL1 participants said in the exit interviews that they would continue with the changes made during the challenges. Some explained this by saying that they had learnt that 18ºC was a comfortable indoor temperature, while some intended to acclimatize to what initially seemed to not be comfortable:

> *"I'll keep it low, I think it's healthy. […] I'll keep it as low as possible because it's very do-able and it's also a question of getting used to it […] You can break through [the discomfort], definitely."* (UK06)

Others, however, said they would discontinue some of the changes they had made. UK19 concluded during the challenge that 18ºC was “far too cold” and subsequently set her thermostat back to 22ºC, while UK21 had moved it back to 21ºC. For some, the focus on temperature and heating prompted them to consider changes that might increase consumption: i.e. the woman who reported that she was considering having her heating on permanently as a way of combating the problem of damp).

3.2 CHANGES IN LAUNDRY PRACTICES

All the data showed average falls in the number of weekly washes, but the scale of this fall differed between the diary dataset and the data from the weekly surveys because some participants completed one and not the other.

1. Diary data (Figure 2a). Our analysis of this data excluded people who completed diaries for either the baseline or the challenge period but who did not do both (n=20). Of the eighteen ELL1 households that completed diaries for both the baseline and laundry challenge periods, about a fifth halved their number of weekly washes during the laundry challenge; the average reduction was 16%. Of the two ELL2 households that completed diaries for the entirety of the two periods, one recorded more washes during the challenge than during the baseline period, the other recorded a reduction, and the overall change was negligible.
2. Survey data (Figure 2b). The data that was analysed from the weekly surveys included all records of wash cycles, made no adjustment for missing data and was therefore more vulnerable to distortion than the analysis of the diary data. This analysis shows about the same reduction for ELL1 as was shown by the diary analysis (14%). In ELL2, however, analysis of the 28 data-points (out of a potential total of 40) suggested a reduction of 25% – a very different result from that of the diary data analysis.

Figure 2a Weekly number of laundry cycles during baseline and challenge periods
Source: diary data (only fully completed diaries included: n=18 ELL1; n=2 ELL2)

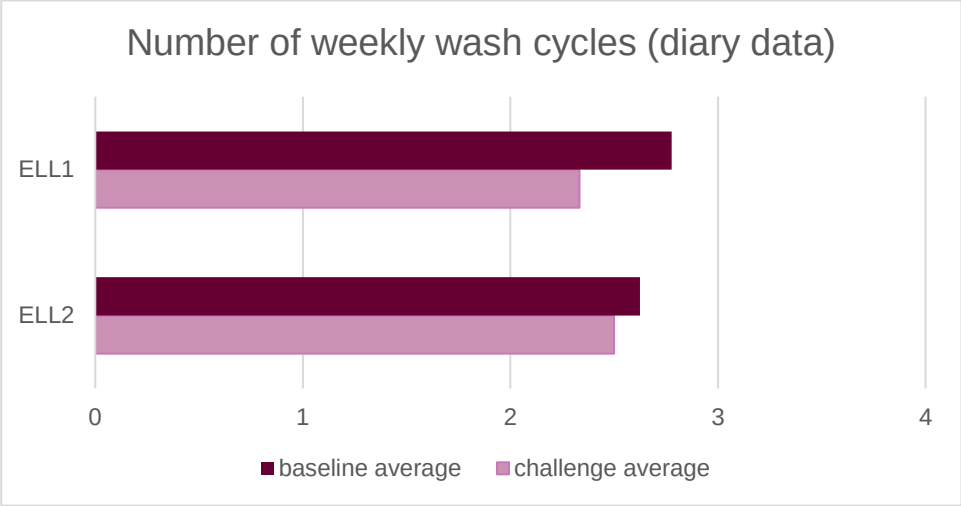
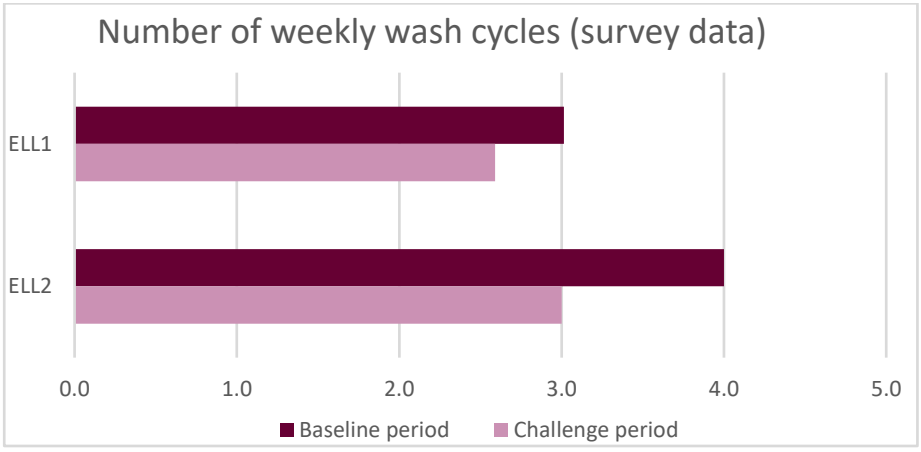


Figure 2b Weekly number of laundry cycles during baseline and challenge periods
Source: survey data; no corrections for missing data



Our analysis of the data recorded by participants in their diaries suggests a reduction in the average wash temperature amongst those in ELL1 but not those in ELL2. Amongst the seventeen ELL1 participants that completed the diaries, the average temperature of all the washes diarized prior to the laundry challenge was 38.7ºC and the average of all those diarised during the challenge was 33.4ºC. This rose slightly to 34.2ºC in the period after the challenge. Amongst the two ELL2 participants that completed diaries, the average temperature of all the washes prior to the challenge was 36.4ºC and the average rose to 37.0ºC during the challenge and 37.5ºC in the period after the challenge.

Meanwhile, Table 11 shows an increase in consumption during the challenge period for those participants who were able to monitor the electricity used by their washing machines. For both ELL1 and ELL2, the electricity used for washing machines increased by 6%. These averages mask significant variations between participating households. Two of the 14 households reduced their measured consumption by over 50%, one increased by 50% and in one it more than doubled. Some of these aberrations may have been the result of one-off phenomena such as extended absences from the home or the increased demand resulting from periods of bed-wetting. For example, the household whose consumption doubled had two sets of visitors during the challenge period and bought a new, larger, washing machine. The impacts of such phenomena on the overall findings will have been exacerbated on the small sample size. Due to problems accessing power points for washing machines in some fitted kitchens, the data sample for this analysis was particularly small: n=11 for ELL1 and n=2 for ELL2.

Table 11 Weekly electricity consumption for laundry appliances during baseline and challenge periods
Source: laundry diaries

Power consumption for laundry appliances, kWh/week	Mean	Lowest	Highest
Baseline	5.3	2.1	12.0
Challenge	5.6	1.8	22.4

After the laundry challenge	5.4	1.6	26.4

The figures in Table 11 are not consistent with the practice changes reported by some participants. The analysis of interview data (ELL1) and focus group data (ELL2) provides a deeper understanding of changes that occurred in relation to laundry practices, and people's perceptions and interpretations of those changes.

What laundry routines changed?

In ELL1 many participants opted for personal challenges rather than the common ENERGISE challenge (which was to halve the number of washes).[2] This is explained partly by the perceptions the participants hold – some believe they were already doing the necessary minimum of washing and could not reduce (or reduce significantly) the number of wash cycles. Examples of individual challenges are: to reduce the number of wash cycles by one third, to wash at lower temperature (30ºC) or do cold washes and to wear clothes for longer (e.g. 2-3 times rather than 1). Thus, there were significant variations among households in terms of setting the challenges and the changes to laundry routines.

> *"I did wear some of my clothes longer, not all of them but dependent what I was doing and how I felt really, and I did drop the temperature on quite a few washes down to 30."* (UK12)

It became obvious during the exit interviews that most ELL1 participants struggled with the challenge, especially when the target was to halve the laundry – hardly anyone managed to meet this target. Even with the personal challenges, which were adapted to household's circumstances, some struggled to achieve the set target. In one case the husband was interviewed at the deliberation stage when the challenge to reduce laundry by a third was agreed, however, the wife who is mainly in charge of laundry but could not take part in that discussion, felt 'stressed' and found it 'tough'. Nevertheless, most of the households in ELL1 actively experimented with their laundry practices; only four participants said that there was no (significant or notable) change in relation to their laundry routines.

Interestingly, one person (in a single person household) deliberately did more laundry during the baseline period as she did not want to look like a 'lazy person' in the eyes of the research team. She reported that it was easy for her to reduce her laundry cycles by half (one wash per week) because this meant going back to her normal routine. Nonetheless, a small change occurred for her in relation to washing temperature and using a rinse cycle instead of washing for a yoga shirt (UK27).

In relation to ironing, there was only small notable change reported by ELL1 (four household participants said that they had started ironing less) probably because the ELL1 participants were trying to avoid ironing as much as possible before the challenge (normal routine). Drying behaviours remained unchanged for most people; one reported using the tumble dryer less but that she had been unable to stop using it entirely because her heating had broken down, so she was unable to dry clothes on radiators. The ELL2 participants accepted a common challenge to halve the number

[2] In ELL1, 11 households accepted the common challenge to halve the number of wash cycles (UK20, UK13, UK17, UK19, UK03, UK02, UK04, UK06, UK07, UK09 and UK14). The other nine opted for a personal challenge (UK27, UK12, UK01, UK10, UK16, UK18, UK21, UK08 and UK11).

of wash cycles. However, only some ELL2 participants reduced the number of washes, as reported at the focus group meetings.

Skills, competencies and strategies for reducing laundry

Most of ELL1 tried to wear clothes (tops, t-shirts, jeans, cardigans, skirts) for longer (11 people said that in the exit interviews), e.g. for 2-3 days in a row rather than once, or by letting something sit for a day before wearing it again 'so you had the variety'. Several participants said that they reflected more carefully about what needed washing. Only two households admitted that there was no difference regarding the length of wear.

> *"I am thinking a lot more before I wash things and I'm wearing things for longer."* (UK16)

Various strategies were used to help people wear clothes for longer: e.g. one participant changed clothes when arriving home and did not cook in work clothes, another extended the life of work-wear by subsequently wearing it at home (this person was more reluctant to re-wear her work clothes). Several people started wearing an apron or using aprons more often.

> *"The apron [provided in the challenge kit], that apron's brilliant because it's plastified and I've been using it more definitely because I am not very good at putting an apron on so I do that much more."* (UK10)

Five participants described 'airing' as a new practice with which they experimented. Five interviewees explained why and how they started airing some of their clothes instead of washing them (e.g. on radiators or hangers). The reason for airing clothes is the smell, e.g. one participant works in social care and visits people's houses often, which means her clothes can smell unpleasant e.g. with tobacco sometimes. One of the participants tried to adopt this practice but gave up as it didn't really work for her. Not having enough space for airing clothes was mentioned as a reason for not doing airing more.

Several ELL1 participants came up with new ideas how to reduce laundry after the challenge started (i.e. they hadn't thought about it before, it was a novelty). For example, one woman bought 'crystals' to put in the wardrobe to fight damp and wash clothes less; in another household they put men's ties in the freezer in a plastic bag to get rid of the smell; one person started buying less but better quality clothes.

In many cases there were differences within individual ELL1 households in terms of the willingness of family members to change their routines and learn new ways to reduce laundry – this ranged from members of the same household being actively involved and fully supportive in doing the challenge to not changing their habits at all, or even demonstrating strong resistance.

> *"My husband won't play, he won't play at all but he wants to wear a clean work shirt every day so that's 5 shirts."* (UK13)

> *"[X] would say 'No! they can't wear that again! What are you doing? You're putting that stuff that she's worn all day and been outside in and been rolling around on the floor' or even inside floor."* (UK03)

One interesting approach discussed in ELL1 was giving children, who did not want to change their habits, their clothes back as 'washed' without washing them.

"I've told the children to but I don't think they have taken it on board quite as much but I have been putting their clothes out when they're not actually dirty and giving them back without them realising." (UK20)

Many of the ELL1 participants tried to extend the use of bed linen and towels; some reported a problem with damp that made it difficult. One said that she started airing bedding by opening the bedding up and opening the window at the same time.

As discussed at the focus group meetings, some ELL2 participants reduced the number of washes (e.g. from daily to three times a week), wore clothes for longer if not stained or smelly, separated only colours and dark clothes or did fuller loads; others did not change frequency of washes. One participant referred to the use of a bib for one of their children, to reduce the need for washing clothes.

There was a common view that, in this ELL2 community, men do not engage in domestic matters like laundry – for cultural reasons, but also because of long working hours.

Material arrangements

The use of washing machines changed in some households: while a few participants stopped overfilling the washing machine, others made sure it was a full load every time they used a washing machine or avoided partial loads. One participant stopped using an additional spin before hanging clothes up to dry. For one household there was no big change except to make sure the that the load is always a full one. They also started adding soda crystals for removing stains when washing at lower temperature.

"Something that changed as well I made sure that the loads were full. So I hate doing the washing with a half load anyway; I don't really do it very often unless it's jumpers or things like that but this time I really made sure it was full every time" (UK10)

In one household, a new, more energy efficient washing machine with a bigger drum capacity was bought during the challenge. Another family is considering buying a more energy efficient washing machine with an eco-cycle (possibly as a result of their involvement in the project). Several participants started doing hand washing occasionally.

Participants in ELL1 reported using aprons to protect their clothes (particularly when cooking) and brushes to clean clothes (e.g. to brush the mud off gardening clothes) more often. One family even bought a new 'bib' to protect baby's clothing. Several people used a stain remover sometimes instead of washing the whole piece. Hanging clothes between wears and when drying e.g. jumpers helps to avoid creases and reduced ironing. A few participants mentioned using baby wipes to get rid of marks on clothes.

"[washed] only when it was really dirty because it doesn't really get that dirty. I wiped it down a few times, her uniform, rather than washing it." (UK18)

Changes in wash cycle programmes, wash temperatures and use of metering
Many households in ELL1 started using 30ºC cycle or a quick wash (e.g. 30 minute cycle), or using them more often; one started using 40ºC degree wash for towels instead of 60ºC; one started using cold wash:

> *"I've been experimenting with the cold button and it's really amazing how I can do, and you can see here [in the diary], I can do a full wash, full load on cold and it only takes a tiny amount of electricity; it's really really really dropped the electricity down for doing a cold wash."* (UK13)

However, one participant reported that the 30ºC wash did not work for her or her family as some clothes came out and still 'stunk' of sweat and possibly didn't kill the bacteria, and the stains weren't coming out either (UK04). Another one noticed that using 30ºC wash does not work well for dark clothing, which was coming out with powder marks on it (UK11).

The discussion about the use of an eco-cycle, which few participants used during the challenge, raised issues about economic and environmental benefits of eco wash. Interestingly, that people came up with different, quite opposite conclusions supported by the meter data (this probably depends on the type of the washing machine). For example, in one case using the meter to compare the energy use for eco-cycle (40ºC) with the normal 30ºC wash helped to understand which one was more economical - the latter uses less energy. Another household worked out with the meter that eco-40 uses less power than normal 30ºC; they now use eco-40 instead of normal 40ºC or 30ºC wash.

Overall, the vast majority of ELL1 tried to experiment with different programmes and wash cycles. It was also noted by one participant that their water bill went down (as the result of doing less laundry perhaps). Only two ELL1 participants continued using their washing machines in the same way as they did prior to the challenge.

In ELL2, some participants were sceptical of using eco settings (this provoked laughter among the group) or of not using tumble dryer (in winter). One ELL2 household mentioned having worked out how to do shorter machine washes and reported that they now use this shorter cycle.

Representations of social norms
The expectations regarding children being presentable at school and an 'office look' at work did not change for many in ELL1, although people seem to be more relaxed about personal standards in other, more informal situations. For many families it was particularly important to make sure that their children wore clean clothes ('more social pressure'), and this did not change for some of them:

> *"Puberty kicking in. Yes, I don't think she's at that stage yet but it's just, I don't know, it's just not fresh, it didn't feel fresh for her [9-year old] to put on and I understand that."* (UK03)

It seems that clean clothes can mean different degrees of cleanliness, different standards, depending on the circumstances and the purpose of wearing them, and 'clean for home wear' is not the same as 'clean for away/work wear'. As such, it is seen as reasonable to have different sets of clothes, e.g. as one participant described it, two sets of clothes on the go each week, one for 'dirty work' and one for 'public use'. Some are happy to wear home clothes for longer and be a bit 'smelly'

at home ("at home […] I don't mind if you smell a bit") but not at work (e.g. for an office job, client-facing job, or other type of work which implies working in close contact with people):

> *"If I wear them at home and they smell a bit smelly then I can still wear them and then put it in the wash whereas I wouldn't want that at work, to put it on and then feel like I'm a bit smelly in front of with children and at work"* (UK18)

Those who tried to wear work clothes for longer were questioning the length of wear and potential smell sometimes, and worried about the thoughts and reaction of colleagues when wearing the same outfit for more than once, and that 'there is an element of depriving yourself'. The limits were defined by referring to the issues of hygiene, other people's judgements (event if they are only imagined), self-perceptions, and even a sense of indulgence, becoming one of the key themes in the interviews with ELL1 participants. ("Yes, like tramps. There's a limit. [laugh]" (UK27)) For example, clothes that are close to skin need more frequent washing. It was also recognised by some participants that it 'feels' very nice and enjoyable to wear fresh clothes or have fresh bedding.

Usually the participants in ELL1 felt clean during the laundry challenge when wearing clothes for longer; taking shower regularly helps to feel clean. As one participant put it, changing clothes every day before entering the challenge was a matter of habit, it was done automatically and was not needed. One participant was 'amazed' that she did not smell bad wearing a pair of trousers for a week. One participant reported feeling 'dirty' during the challenge as they tried to wear clothes for longer ("I felt dirty but I was determined to do it…[…] getting a shower in the morning and then put on dirty clothes, it's horrible"). Her husband also asked her to change her clothes, as "he's sick of seeing me in the same outfit probably" (UK21).

Time-saving benefits of changing laundry practices

Many participants pointed to the time-saving benefits of the laundry challenge, saying that it (must have) saved time by e.g. having one less wash to sort out in the week or doing less ironing which means more time for other, more interesting things. One mentioned reduced drying as a 'big benefit', which reduced stress over how or when to get things dry as it depends on the weather.

> *"It's definitely, definitely really positive thing, it's saved me some time which is good"* (UK13)

> *"I suppose it's less time really with less washes. It was quite nice in some ways not having to be folding up laundry and putting it out and stuff, not that I was doing it loads before anyway."* (UK16)

> *"It's not something I miss. I can spend my Sunday afternoons doing something more constructive than ironing."* (UK14)

For a few households, there was no time saving benefit (e.g. two households had the same frequency of washes, but at lower temperatures) or it was not significant. One participant felt like she was spending more time on laundry because it takes extra time (and creates extra work) to change the established routine they had.

Continuity of good practices, following the challenges

ELL1 participants' commitment to new laundry practices varied. This probably depends on what the challenge was, how difficult it was for them and what they managed to achieve (e.g. to halve the

number of wash cycles or only to do all washing at 30ºC). Around half of ELL1 participants (9) clearly stated that they would continue with the new practices as the benefits are obvious and they had adapted to the change, and it had become routine.

> *"…we just got used to wearing them longer and not bothering."* (UK17)

Some sounded more hesitant, saying that they would continue with some of the changes and would be more mindful about laundry. One person stated that he will try to continue with the changes but might slip back, while his wife is more confident about new practices because they save her work (less laundry and drying). Another participant felt that she might continue with the new practices but was still not sure about washing at 30ºC and needed to do some research about it. Only one participant said that she would not continue with the changed; although she had completed the challenge, she said she would have given up if it had continued for longer.

3.3. POTENTIAL RUPTURES AND SUFFICIENCY POTENTIAL

This section is concerned with the effect of ruptures - disruptions of or challenges to 'normal' practices and is based mostly on ELL1 exit interview data. It first considers the effect on participants of pre-challenge activities (i.e. during the baseline period), before moving on to discuss the relevance to the challenge to other domains of home energy use not included in the study and the impact of the challenge on participants emotionally and on heating and laundry practices for sufficiency (i.e. not wastefulness).

Most participants did things as normal during the baseline period (UK13, UK01, UK27 re heating); no changes were made before the challenge but participants started taking notice of their routines (UK10), thinking more about energy use as become 'more aware' of relevant issues (UK12). One person (UK27) was doing more laundry during the baseline period than normal (for her). She was concerned with what the researchers would think about her practices (i.e. not doing the laundry often enough).

Starting the diary made some participants more aware of the laundry being done and energy used. It was recognised that all elements of the ELL design (visits, interviews, the diaries and surveys, the challenge kits, the incentives/veg boxes, the measuring equipment) contributed to making participants more committed to the challenges. A few participants pointed to the interviews as being the biggest initiator of new awareness or a desire to change existing practices.

Most participants in ELL1 were happy to receive the challenge kits that helped them to find the way to feel clean and stay warm during the challenges; the products were 'lovely' (UK10), 'good' and useful (UK20), 'very nice', 'a little motivation thing' (UK04); the information/tips were found useful too (UK13), the information leaflets seem to be a key driver of change in some cases (UK16, UK18). The gifts prompted some people to start drinking hot drinks more consistently (every evening) and buy more warm socks (UK02). Although a few people did not use (some of) the products from the challenge kits; one person felt confused and did not use most of the products (UK27).
The measurement process was very important for our participants; the measuring and monitoring equipment and diaries made people more aware of, for example, the temperature in the dwelling. Participants consulted the thermometers regularly (they were 'very useful', provided 'hard evidence');

the thermometers had a big impact on some people's awareness of how perceived temperature relates to actual temperature. The thermometers also made them think about, for example, the use of radiators or how good the insulation of the house was. Doing diaries helped to monitor and reflect on laundry practices particularly (UK13); it was useful and informative, but sometimes it was 'a bit of a pain' (UK10). A meter and diaries provided good visualisation of energy consumption reduction, which was noticeable. (UK13) The meter showed how little energy was used by the washing machine (UK20).

The influence of the challenge on other practices

In several cases the challenges did not affect other energy consumption practices at home (UK13, UK01, UK27). One of the participants turned the boiler down, so hot water is colder. They also think more about changes in the house in ecologically-friendly way and do more recycling and reusing (UK20).

> *"We've turned the boiler onto economy setting so our hot water is cooler as well so we're using less gas heating that so it doesn't come out as hot and in theory then I don't think the central heating is as hot because the water's not as hot coming from the boiler."* (UK20)

> *"So I think we were already quite minded like that [recycling/reusing] anyway but we're just now being a lot more aware of what there is out there that's going to have less of an impact on the environment so different types of packaging like bees' wax packaging rather than cling film so wrap the kids' sandwiches up in that and they just take it home and wash it and re-use it, stuff like that."* (UK20)

Some started thinking more about energy (and water use) and reflect generally on how to reduce their environmental impact. One of the impacts of the study was on showering and bathing in one household which were reduced to save energy; they also started recycling bath water by using it to flush the toilet (UK17). In contrast, one participant reported having an extra bath because of feeling cold (UK06), and another said he was showering a bit more as tried to wear clothes for longer (UK18). Thinking more about different elements of laundry practices was also mentioned e.g. which detergent is the most environmentally friendly (UK16). A few started thinking about the use of other electric appliances (UK12) or car/petrol use (UK19). One family got a more energy efficient kettle (UK17). Another household reported that they try to cook more than one dish at a time when the oven is on (UK10):

> *"There's really every-day things like I know when I cook now, if the oven goes on then there'll be 2 dishes going on because the oven is warm anyway and that's something my Gran used to do actually, but isn't it interesting because the oven is warm so why don't you use that or you plan differently."* (UK10)

A common view was that taking part in the living lab experiment had a wider impact on people's lives and consumption practices.

> *"The whole thing made you generally much, much more aware in the wider context. So, it made you more aware of consumption, of waste, of all things right from trying to use less fuel, washing less, doing alternative things."* (UK07)

Some of our participants think that they are already quite energy efficient and do not waste energy. This may be why there was no big change in other energy-related practices at home beyond the heating and laundry domains.

> *"I mean I'm fairly good, I tend to have the lights on in the house like now because it does get quite dark when it's dark but I'm quite good at switching things off when I'm not in rooms and all that sort of thing. I don't have a house that looks like a Christmas tree."* (UK12)

For ELL2 there was one mention was made of a change in a practice in a different domain that was inspired by the project. This related to turning off lights and the use of other appliances.

Impact of the Challenges on Participants and Practices

At weekly intervals during the challenges, participants were asked how they felt about them (Figures 3a and 3b). Two of the options offered in the survey were entirely positive: "excited" and "relaxed", while a third, "more or less fine" was intended to suggest some ambivalence and both "worried" and "annoyed" some negative feelings. Figures 4a and 4b show that more participants were ambivalent at the start of the laundry challenge than at the start of the heating challenge. People were more likely to be relaxed about changing heating practices than about changing laundry practices and generally were more likely to be "relaxed" about the challenges as they neared an end. At the same time, more people became annoyed with the laundry challenge as it went on – perhaps, the interviews suggest, because of concerns about being perceived as dirty or smelly and/or the inconvenience associated with reducing the number of washes.

Figure 3a How participants felt during the laundry challenge: % of survey participants with different feelings (n=between 19 and 22)
Source: weekly surveys

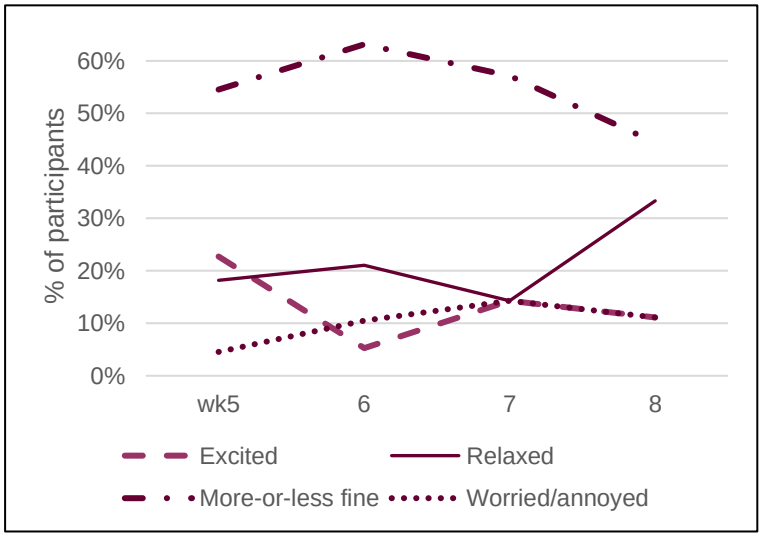
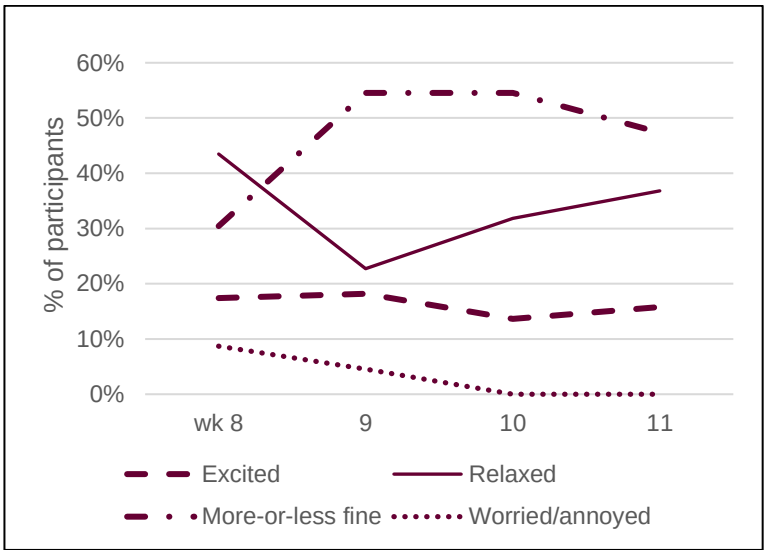


Figure 3b How participants felt during the heating challenge: % of survey participants with different feelings (n=between 20 and 21)
Source: weekly surveys



Figures 4 and 5 show changes in the number of ways in which participants warmed bodies instead of spaces, and the number of different steps they took to reduce their use of washing and drying machines. The data on heating indicates a reduction in the number of tactics participants reported for keeping down the consumption of energy for space-heating. Fewer reported using four, five or six different tactics and more reported using just three, two or one. This finding was not reflected in the interviews, where participants generally described trying out new approaches. It may be, however, that a greater mental focus on the issue of staying warm led to participants to identifying their preferred tactics more clearly and rejecting some of those that they had previously considered helpful.

Figure 4 Changes in the number of adaptive practices of thermal comfort (%) amongst those completing both the baseline survey and the closing survey (n=23) (use of heaters not included – e.g. open fires, electric heaters)

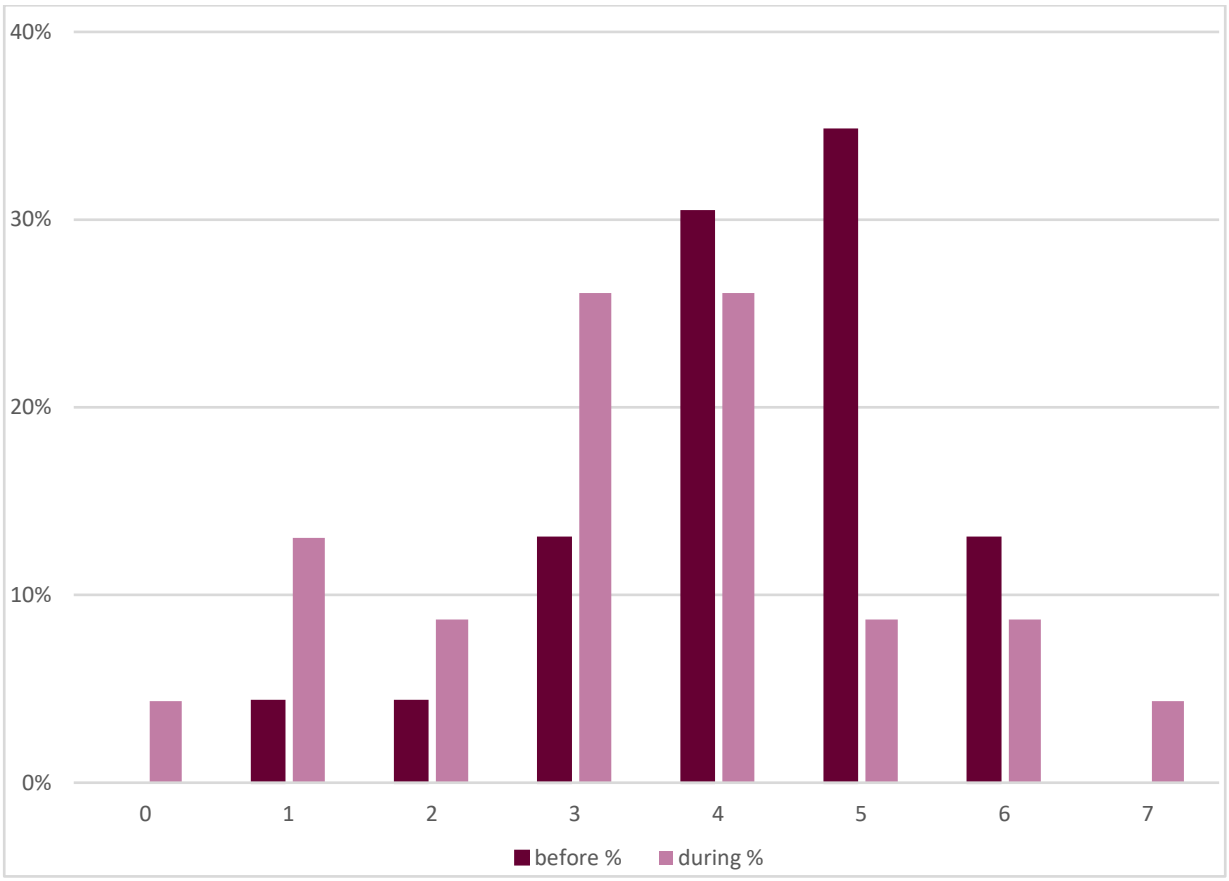
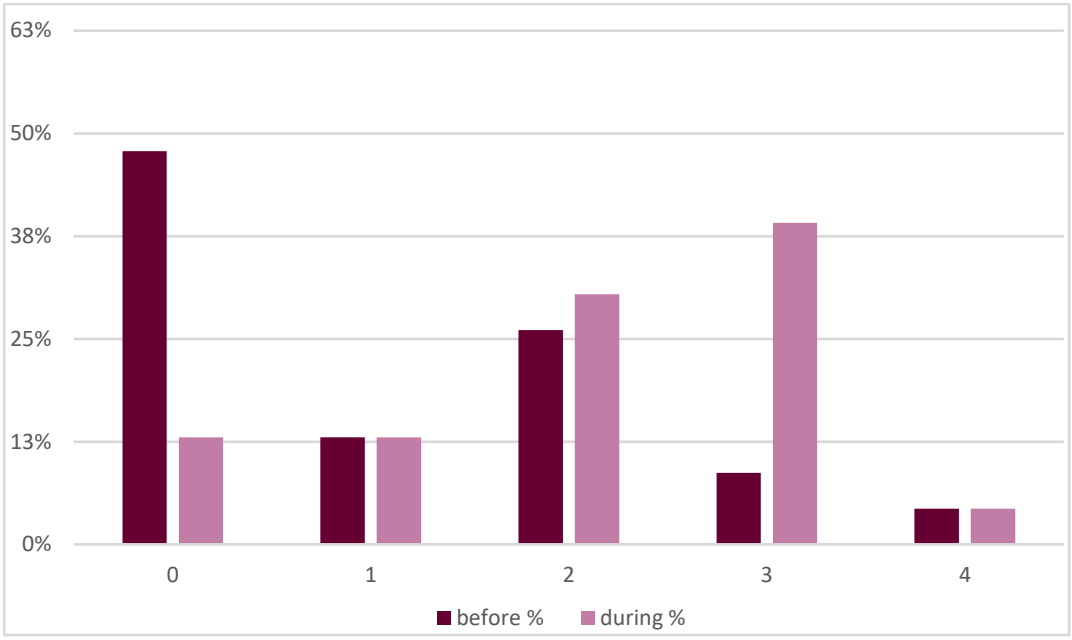


Figure 5 shows an increase in the number of tactics participants used to reduce their laundry during the laundry challenge. There are clear reductions in the numbers using no such tactic and increases in those using two or three.

Figure 5 Changes in the number of ways in which participants kept their clothes clean aside from using the washing machine amongst those completing both the baseline and the closing survey (n=23)



4. PRACTICES A FEW MONTHS AFTER THE CHALLENGE

This section explores the extent to which changes in practices introduced during the challenges persisted beyond them. It does so by comparing the baseline and closing surveys. It also presents data from a follow-up survey administered three months after the end of the challenges, in which participants were asked which practices they had retained, and which explored any rebound effects.

4.1 PERSISTENCE OF CHANGES IN HEATING PRACTICES

Table 12 examines the persistence of potential changes in expectations toward indoor comfort. This suggests a small but sustained (1°C) reduction in desired living room temperatures; no change in ideal temperatures for adult bedrooms, and some reduction in ideal daytime temperatures for children's' bedrooms. Note, however, that the high dropout rate makes throws into question the reliability of any comparisons between the three columns of data in the table.

Table 12 ELL participants' perceptions of desirable winter daytime temperatures before and after the challenge
Source: baseline, closing and follow-up surveys

	Mean before (n=33)	Mean directly after (n=23)	Mean 3 months after (n=20)
Living area, °C	19.2	18.6	18.2
Adult's bedroom, °C	17.4	17.4	17.2
Child's bedroom, °C	19.1	18.0	Not asked

4.2 PERSISTENCE OF CHANGES IN PRACTICES OF CLEANLINESS

Table 13 examines the persistence of reduced laundering cycles. The clearest change here is in the mean number of cycles done by participants from ELL1, which reduced from 3.3 before the challenge to 2.5 after the challenge. We disregard the data from ELL2, where the 69% dropout rate prior to the second of the surveys renders any comparison unreliable. Being based on estimated figures rather than taken from participant diaries, comparisons with the third column are not advisable.

Table 13 Average number of laundry cycles before and after the challenge
Source: baseline, closing and follow-up surveys

	Mean recorded before (n=33)	Mean recorded directly after (n=23)	Mean estimates cycles 3 months after (n=20)
Number of laundry cycles ELL1	3.3	2.5	2.1
Number of laundry cycles ELL2	4.0	3.5	3.3
Number of laundry cycles – both ELLs	3.6	2.7	2.3

Table 14 examines the persistence of alternative practices of keeping clean. This suggests large and lasting increases in the proportion of ELL1 participants that used techniques to postpone the washing of garments. Interestingly, the removal of stains was far more popular than airing of clothes, which was reported by just 40-50% of people after the challenge. While around 60% reported using an apron, it is worth noting that some of these participants reported in the qualitative interviews that although they had begun using aprons, this remained an infrequent part of their domestic practices.

Table 14 Persistence of alternative practices of keeping clothes clean – ELL1
Source: baseline, closing and follow-up surveys

	% of participants taking these measures, before (n=20)	% of participants taking these measures immediately after (n=19)	% of participants taking these measures, three months after (n=17)
Removing stains (washing or brushing) without washing the whole garment	20	68	94
Airing out clothes	10	47	41
Using an apron	40	63	59
No use of other methods for keeping clothes clean	50	16	12
Other	0	5	0

Table 15 examines potential changes in norms related to laundering by exploring changes in how households decide when an item requires washing. Growth in the use of smell rather than length of wear suggests the replacement of heuristic decision-making with a more empirical approach to judging when an item needs washing.

Table 15 Persistence of changes in criteria for deciding when items require washing – ELL1
Source: baseline, closing and follow-up surveys

	Share of households "most frequently" using this criterion, %		
	Before (n=20)	**Directly after (n=19)**	**3 months after (n=17)**
Stains	15	11	0
Smell	10	32	59
Length of wear	65	58	41
Don't know or other	10	0	0

4.3 POTENTIAL EFFECTS: CALCULATED CO2 SAVINGS, SPILLOVER EFFECTS, REBOUND EFFECTS AND POTENTIAL FOR SCALING UP

This section explores the potential effects of the ELL challenges, based on data collected in the follow-up survey sent out three months after the end of the challenge. It considers the potential spillover effects, which can magnify the effectiveness of the ELLs. It also explores potential monetary and time savings, as well as potential rebound effects that might undermine energy savings

achieved, if the case is that money or time is consequently spent for more energy-intensive activities. The section also explores the potential for scaling up on the basis of how participating households have communicated and are willing to communicate with others about the ELLs. It has not yet been possible to calculate achievable CO2 savings from the ELL challenges, though it is anticipated that this will be done before the end of the project.

In addition to possible CO2 savings achieved in laundry and heating, it was expected that experimentation with new practices in the ELLs might also encourage households to engage more widely with energy and climate issues. Table 16 explores spillover effects from the ELLs into broader engagement with energy, as well as the persistence of these changes three months after the end of the challenge. A change in the question wording after the first survey renders the reliability of the final column a little dubious (see footnotes). However, a comparison of the third and fourth columns suggests that the weeks and months after the challenge saw some increases in the proportion of the sample that engaged in these different ways – particularly raising energy and climate issues at work and actively searching for information on the subject.

Table 16 Spillover effects: changes in general engagement with energy and climate issues[3] – ELL1
Source: baseline, closing and follow-up surveys

	T1 : Before challenge, % (n=20)[4]	T2 : Directly after challenge, %[5] (n=19)	T/3, three months after challenge, %[6] (n=17)	Change, T3/T1
Raise energy and climate issues at home or with friends	70	53	59	-11
Raise energy and climate issues at work	25	11	29	+4
Raise energy and climate issues in NGOs or other groups of which I am a member	5	0	6	+1
Actively search for news or information on energy and climate issues	30	32	47	+17
Consider energy and climate issues when voting	75	16	41	-34

[3] This table combines data from the baseline and closing surveys.
[4] Note that the question asked in this survey differed from that in the others: "Do you engage with energy and climate issues? (several answers possible)"
[5] Note that the question wording here may have been read as referring to NEW forms of engagement rather than existing forms: "Since the start of the challenge, have you engaged with energy and climate issues in addition to your participation in ENERGISE? (select all relevant answers)"
[6] "Since the end of the challenges (in December) have you engaged with energy and climate issues? (select all relevant answers)"

Consider energy efficiency when buying electrical appliances/devices	75	37	41	-34
"Not specifically" any of the above	5	21	0	-5

The potential social and financial impacts of the ELLs were evaluated on the basis of money saved over the previous six months and time saved (see Table 17):

- Of the twenty participants that completed a survey three months after the challenges ended, three (15%) said they had made no financial savings and eleven (55%) said they did not know the scale of their financial savings. Of the six that did feel able to estimate financial savings, two-thirds estimated these at between £20 and £50.
- 8 of the 20 respondents said they had not saved any time. Of the 12 that thought they had, half said they did not know how much time they had saved, one reported saving less than an hour and five said they had saved between one and two hours.

It is, of course, possible that the money and time saved on laundry and heating will be spent on other, more energy intensive activities (see Heiskanen et al. 2018, D3.5). Table 17 explores households' reflections on their plans for how to use the financial savings and their thoughts on how they had spent the time saved.

Table 17 What are/will savings be used for: most common responses amongst those that claimed they had made savings
Source: follow-up survey

Money saved will be used for (n=17)		**Time saved has been used for (n=11)**	
Don't know yet	71%	Other housework	45%
Every-day running costs	24%	Cooking	36%
Savings	6%	Home maintenance	36%
		Cultural/religious activities	27%
		Social activities	27%
		Don't know	27%

The only clear evidence of potential negative rebound on energy consumption comes from the four respondents that suggested they would use the extra time for cooking. Cultural, religious and social activities may involve car travel and might, if scaled up, lead to increased supply of energy intensive services such as theatre and film. However, as social/cultural activities are collective in nature, some of this additional consumption will be less energy-intensive than home-based activities. None of the respondents reported an intention to spend their financial savings on the most immediately energy-intensive areas that were given as options in the survey: eating out, the purchase of new equipment and travel.

The broader impacts of the ELLs on everyday practices depend on the dissemination of the new norms beyond the immediate participants. As shown in Table 18, out of those that completed the survey three months after the challenges, the majority talked about the challenges with friends and

one-in-four mentioned it to colleagues. However, only 5% mentioned it to neighbours and only 10% shared their experiences on any form of mass/social media.

Table 18 Percentage of households that shared their experiences of the challenges (n=20) Source: follow-up survey

In personal interactions in the three months following the challenges – with:	
Friends	55%
Family and other relatives	70%
Colleagues	25%
Neighbours	5%
Groups/associations	0%
On any of these mass/social media	
Facebook/Twitter	10%
Blog post	0%
Newspaper article	0%

5. FEEDBACK FROM PARTICIPANTS AND IMPLEMENTATION TEAM ON ELL IMPLEMENTATION

Overall, ELL1 participants regarded the project as useful, interesting and enjoyable.

> *"We actually really enjoyed it. I think because […] we thought we were really good with our heating and our washing but it shows we had a lot of room for improvement and we just kind of enjoyed it being a bit like a test but now it's just what we do so for us it was great in that regard."* (UK02)

Taking part in the study made people 'feeling being useful', and the fact that their way of living is of interest to researchers gave them 'quite a nice feeling'. (UK13) Some admitted that they were pleased and 'quite honoured' to be part of the project. (UK27) It was also interesting and even enjoyable for people to put themselves through a 'trial' or a 'test' and managing/surviving it. Importantly, the project made people more aware of their energy use and habitual behavior, and will potentially have a long-term impact on their energy use in everyday life, including other domains e.g. using a car.

It was very useful for participants to have an actual target e.g. temperature ("actually gave us like a goal" (UK02)).

The participants appreciated the challenge kits (even if not using some of the items), and particularly the veg boxes delivered fortnightly as an incentive.

> *"It was really exciting having the parcels I'll be honest, even though the things in them were beautiful and lovely but just not quite for me; I wasn't disappointed about that, so that was*

nice. And the veg boxes were brilliant […] that has introduced me to some different veg which is quite satisfying." (UK13)

"It was fun opening the boxes like the boys were really excited about opening the challenge boxes and we had a good laugh over them…" (UK08)

The ELL1 participants regarding the design, timescale and the information support for the project made a number of suggestions. For example, it was noted that the temperatures were still mild in November and it would be better to do the challenges during colder months. Another suggestion was made regarding the duration – the challenges should run for longer e.g. for a year to account for different seasons. Although for most participants filling in the diaries was not taking much time and was easy to do ("It wasn't as time consuming as I thought it would be" (UK14)), few people found this task quite tedious:

"It's been good, it's been interesting. I have got a bit frustrated and bored perhaps with filling in the thing. I was glad when it ended actually." (UK04)

Some households wish they had more information and practical advice about energy use in homes (from an energy expert perhaps). Few participants think that it would be useful to have more information about what the most energy efficient way of doing things is:

"It's the whole thing isn't it? It's almost like you need to know when you're talking about a water bottle but it takes energy to heat the water to have the hot and you wonder how efficient that is. […] we need to know these things because at the moment we're just guessing." (UK10)

Only one participant was rather sceptical about the aims and the design of the project, for whom the study has not made much difference, assuming that people's washing and heating behaviour are driven by perfect rationality (UK09). Arguably, the project involved people who were already environmentally minded and did not reach others. However, the project has had an impact even on those who were previously mindful of consumption, care for the environment and/or try to save energy:

"I suppose what the study's really done is it has reinforced in me things that I knew I should be doing or that I would temperamentally I'm inclined to do, but sometimes you just forget." (UK07)

Some households found the living lab experience very challenging and tough, for others changing their practices was relatively easy. Interestingly that reducing laundry was often found more challenging and harder to achieve for most people than reducing indoor temperature; in some houses the ability to regulate indoor temperature (and to complete the challenge) was conditioned by the state and type of the heating system.

Survey feedback from ELL1 participants was also mainly positive:

"It was so worth our time. The time, money and energy we will now save will live with us for our future!" (UK02)

"I enjoyed thinking about it all. It's actually made me think more seriously about buying a Hybrid car to reduce petrol usage." (UK19)

"it was really useful thank you so much" (UK07)

"live frugally..." (UK06)

The feedback provided by few ELL2 participants in the survey at the end of the living lab was generally positive:

"It was really good experience." (UK31)

"It was good to see how we could reduce the number of washing machine loads per week and how we coped with the temperature of the house being lower. We enjoyed the challenge!" (UK24)

The study did not make much difference to ELL2 participants in terms of energy saving (possibly) but they were happy to take part as it might help them to save money in the longer term.

Influence of challenge participation on others

ELL1 participants talked about the project and their living lab experiences to relatives, friends and colleagues, usually those who were 'a little bit more like-minded in that kind of thing'. Some even mentioned having 'good discussions' with friends and family:

"They thought it was a good idea. I mean a lot of my friends are quite conscientious and they're quite aware of how much energy people are wasting so they found it interesting that there was actually a study being done. So, yes, we had quite a few good discussions around it." (UK20)

Those people were sometimes very surprised/'shocked' when learning about the challenges and targets set, particularly for heating (e.g. in case of one individual challenge not to have any heating on). The idea of washing at 30 degrees was also seen as problematic for those who were not involved in the study.

Although it was noted that not so many people showed interest as 'it's not so common for people to want to be bothered about saving energy' (UK13) and 'this is a bit ordinary to be having a conversation about. A bit day-to-day.' (UK01)

6. CONCLUSIONS/REFLECTION

Within the ENERGISE project, energy living labs are initiatives that aim to improve understanding of how to reduce energy use in households and communities, mindful of the social, economic and cultural contexts in which the initiatives are being implemented. The two UK ELLs were located in the borough of Hastings, on the south coast of England. The site is about two hours by train from the homes and offices of researchers from Kingston University, the UK consortium partner. This was not by design. The aim initially was for the ELL sites to be within easy reach of Kingston upon

Thames, to enable close working and engagement between the research team, participating households and implementation partners. The distance between the research team and the local site and participants likely affected recruitment to and collaboration during the ELLs and possible feedback during and post-ELLs. The Kingston team were fortunate, though, to have made contacts during previous projects with representatives of Community Energy England and Community Energy South. This facilitated linking up with the organisation that was to become the main local implementation partner: Energise Sussex Coast (ESC).

Without the support of ESC, it would have been very difficult to find and settle on a suitable site in a timely way and eventually to recruit sufficient and suitable participants to the ELLs. Having said this, the selection of the faith group as the basis for recruitment to ELL2 was partly due to the demographic imbalance present in the list of candidates already enlisted for possible participation to ELL1 and partly due to a lack of available options for the collective (i.e. community) lab and time and resources in which to complete recruitment.

The findings on the impacts of this study on energy consumption amongst participating UK households will remain inconclusive until further and more sophisticated analysis is undertaken. If one is to believe participants' reports, changes to practices certainly occurred. However, as is often the case with efforts to render domestic practices more environmentally sustainable, significant changes to practices do not always result in measurable changes to energy consumption – and in this study the power of the statistical analysis is negatively affected by the small sample size.

On heating, the data from the temperature loggers needs to be analysed more carefully to see whether people used less heating during/after the challenge than they would otherwise have done. This analysis will require a longitudinal analysis of change over time that controls for external temperatures. In addition, it might be more useful to focus on those participants that reported changes to their practices, rather than including ALL participants in the analysis. The interview and survey data provides clearer evidence of reductions in energy use but – being based on participants' subjective reports – is less reliable than the datalogger readings. Nonetheless, some participants spoke of learning, for the first time, that they felt more (or equally) comfortable when their homes were heated to lower temperatures; this strongly suggests that they will reduce their use of heating in future. The reported changes to material infrastructure (additional insulation, the relocation of thermostats) although only made by a minority of participants, also promise long-lasting reductions in heating. Less concrete, but perhaps even more promising, are the changes to awareness and understanding wrought by the introduction of thermometers into participants' homes. This, the interviews suggest, introduced some participants for the first time to the problematic relationship between objective and subjective temperature and the notion that the latter should not be allowed to determine indoor heating practices. The reductions in participants' estimation of ideal indoor temperatures suggest that this has had a positive impact. This positive result is offset, however, by the possibility that there was a rebound effect amongst some of those that felt their homes to usually be too cold prior to the challenges and by the poor reception generally given in the interviews to the idea of heating bodies rather than spaces.

In the analysis of laundry practices, the quantitative estimation of the impacts on energy use relied on three measurements: frequency of laundering and temperature of washes (as recorded by participants in the diaries/surveys), and the monitor data on the energy consumed by washing machines. These datasets suggest contradictory conclusions. Participants' records of wash frequency and wash temperature show clear overall reductions, whereas the monitor data suggest

a small increase. Many issues hamper the interpretation of this contradiction – not least of them, the inability of many households to install the monitors and the consequences of this for the comparability of the two samples. However, our conclusions should be informed by data showing that some participants simultaneously reduced their number of washes while also increasing their electricity consumption. Further analysis would show how common this was, but it is possible that some participants reduced the number of washes by more often washing with fuller loads that increased the energy consumption per load. In addition, the qualitative data suggests that it was more common to extend length of wear for lighter items (such as shirts) more than for heavier items (such as jeans); this, too, would have increased the weight, and hence energy consumption, of the wash cycles done during the challenge.

As in the heating challenge, however, the ambiguous measurement data in the laundry challenge are balanced by encouraging qualitative findings. Rather than using norm-based heuristics to decide when to wash items, participants increased their use of smell, which is an empirical test. This rendered length of use more flexible and allowed tactics such as airing to prolong the period between washes. Anxieties about stigmatising impacts of malodourous clothes limited this change however. This is evidenced by the frequent refusal to extend the wear of clothes worn on more formal occasions such as school, work and parent-child groups. Fear of stigma might explain the higher levels of anxiety reported regarding the laundry challenge and explain why few participants reported washing formal clothes less often. There was some suggestion, also, that anxieties about stigma caused participants to use more energy in other ways – e.g. by showering more often to compensate for the increased social risk inherent in wearing clothes for longer. In contrast, the benefits of using stain remover encounter no challenges from the social realm: their dramatically increased use and the reduction in stains as a trigger for washing can only have benefits for energy consumption levels.

It appears that ruptures within the ENERGISE living lab approach prompted the changes that participants reported. Within ELL1, some participants enjoyed the challenges and mentioned this as the feature of the study that most motivated them to change their practices. The level at which the heating challenge had been set led them to assume that not only was an 18°C indoor temperature desirable from an environmental point of view, but that this was also achievable and normalisable. Hence, they felt that they were being challenged to achieve something reasonable, that they should be able to do it and that it would be personally rewarding to try to meet the challenge.

The laundry challenge was somewhat different to the heating one in that the level of the challenge was set relative to the household's existing practice – i.e. they had to halve their existing number of washes. This challenge was troubling for some because it implied that they had previously been doing unnecessary washing – an implication that was not consistent with their notion of themselves as effective maximisers of time and money, and that, as a result, challenged their self-concept. The laundry challenge set out to change people's understanding of what they did "need" to do in order to remain socially accepted, healthy members of society. The most stubborn resistance to the challenge was presented by those who anticipated experiencing stigma or social rejection as a result of re-wearing clothes, or who had strongly held (normative) beliefs about the frequency with which one should launder items – particularly underwear, towels and bed linen, but also clothes that they feared would emit an unpleasant odour if washed less often. Indeed, perhaps because of issues related to shame, participants seemed less likely to consider changes to the laundering frequency of towels, underwear and bed linen.

Alongside the challenges and the authority and expertise perceived as undergirding them, the interviews also had an important motivating and enabling effect. This was in several regards. First, the reflective space provided by the interviewers enables participants to focus on aspects of their lives to which they usually awarded little attention. Second, the interviewers' probing and prompting challenged their assumptions about what was normal and allowed them to see that there might be alternatives to their current practices. Thirdly, because they constituted a social commitment to the challenges, participants' face-to-face verbal agreement to the challenges gave them a greater impetus to make the necessary sacrifices and efforts.

As mentioned above, there was less willingness to consider reductions in evening indoor temperatures than daytime temperatures. The concept of *cosiness* was important here, but this theme was insufficiently explored for there to be much certainty on its provenance or social meaning. The interviews suggest, however, that *cosy* is a core element of some social representations of 'home' and that the sacrifice of *warm spaces* therefore constitutes a threat to the ability of a home to be considered a caring, safe and emotionally secure place in the world. In fact, the notion of the self as the provider of a cosy home was just one of several ways in which the challenges threatened the social identities of some participants. For others, the domestic, individualised assumptions behind ENERGISE threatened their self-image as political rather than domestic actors; for others, as alluded to above, it seemed to threaten their place as a respected and decent member of society.

It is likely that similar (probably more profound) issues of social identity affected participants in ELL2. However, ELL1 and ELL2 differ in certain regards. ELL2 participants were recruited differently from ELL1, came from very different ethnic, cultural and religious milieu, and were overall linguistically less able to engage with the research. Nevertheless, participants in the two ELLs undertook roughly similar challenges in the same practice domains, were asked to complete similar tasks with respect to reporting on heating and laundry practices, had the same kinds of monitoring equipment installed in their homes and were supported by the same implementation team partners. Clearly, this was an opportunity to learn about how similar interventions worked differently between and within the ELLs, remembering that the project took a household rather than individual consumer perspective. Having said this, with regard to ELL2 a future similar project might need to consider the use of native researchers and interpreters, as well as rejecting the idea of a standard research design and standard research tools and, instead, creating/co-creating a research design specifically for each minority population. The budget for the ELL would need to be greater than was the case here to cater for this. Or, the implementation team would have to be stricter about the language capability requirement needed for households to take part, which would have the effect of making the project less inclusive, or run the risk of not recruiting sufficiently to the ELL in question.

This is an important consideration for future research into this topic – especially if, as in this study, the 'harder to reach' group are also the greater consumers of energy. ELL2 participants used more heating, made more use of tumble dryers and less use of draft excluders, did more ironing and washed clothes at higher temperatures than their ELL1 counterparts. Hence, while ELL1 is likely to be representative of early adopters of pro-environmental practices, ELL2 is more like the later-adopting majority of the population. Furthermore, ELL2 participants are probably more typical in their attitudes to environmental issues: whilst in the living labs ELL1 participants were likely to be motivated to commit to the challenges by environmental benefits, these had little visibility in ELL discourses, where saving money and time were depicted as of greater importance.

The ELLs were very demanding of various kinds of resources. Considering their relatively small scale, they required a significant investment of finance, time, personnel and equipment over a period of more than six months if one includes the pre-ELL formation and work with the local implementation team and 12 months including the closing event activities. The many points and types of participation engagement, data collection and analysis and general management and coordination made for a complex undertaking, requiring depth and extensive expertise and experience. It is not suggested that one can easily scale up such an exercise or that the UK should adopt a national policy for so doing. However, if deeper learning is to occur regarding the possibilities and challenges of changing individual and connected household energy practices, this may in future require funding for longer-term or parallel energy living lab projects (e.g. in the form of a 'lab of labs'). Replication allowing for subtleties of local conditions may be more effective rather than 'upscaling'. Further, learning might be facilitated by using findings from the ELLs to inform other initiatives or programmes, and/or integrating living lab elements into other projects.

There is a certain viral effect that allows for the spreading of ideas underpinning and knowledge of living lab activities. Thus participants in the ELLs shared news and thoughts among family, friends and colleagues at work, though not so much with neighbours it appears, nor through social media. This points to some localised amplification of project activities and findings. There may be a role for local stakeholders including, for example, the local authority in further amplifying the findings and impact of the ELLs specifically and the ENERGISE project in general. The effectiveness of such action may benefit from close working across agencies and actors (citizens, policy-makers, researchers, energy businesses and civil society organisations). The possibilities for collaborative working has already been demonstrated in the UK ELLs and may be further developed in future in an alternative 'imaginary' of co-created knowledge and experimentation around reducing household energy use through changing everyday practices.

Acknowledgments

The Kingston University team would like to thank colleagues at Energise Sussex Coast, Community Energy England, Community Energy South and in the home energy and clean growth units of the Department for Business, Energy and Industrial Strategy for their support during the project.

Appendix 1 Photographs from UK Living Labs

Photograph A1 Professor Audley Genus (right), with a participant in UK ELL1

Photograph A2 The washing line in the garden of a UK ELL1 participant

Photograph A3 Laundry domain challenge cards of a UK ELL1 participating household

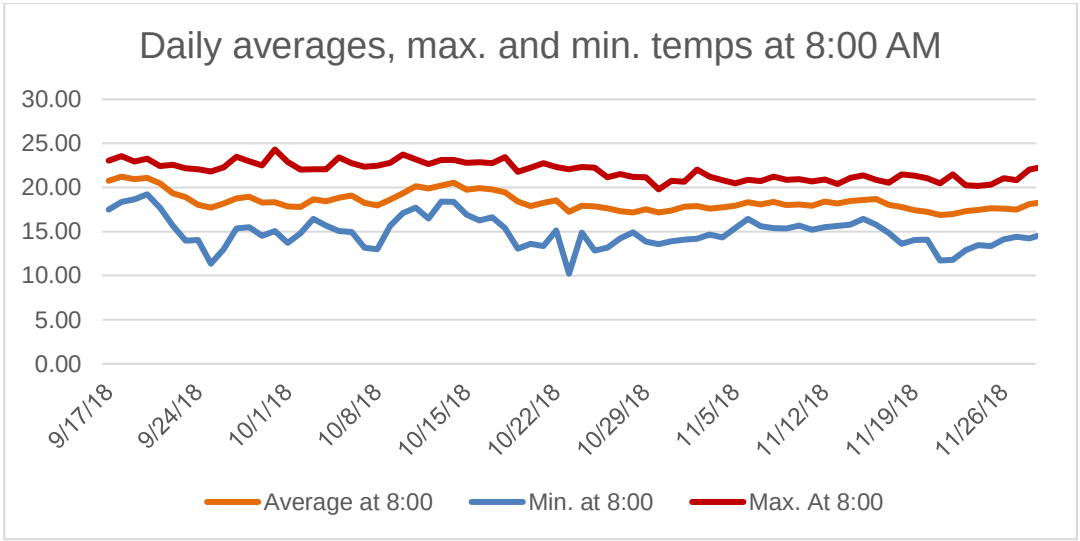
Photograph A4 A boiler in the home of a UK ELL participant

Photograph A5 A washer/dryer in the home of a UK living lab participant

Appendix 2 Changes in indoor and outdoor temperatures before and after the heating challenge

Figure A1 provides details on indoor temperatures in ELL1 at 8 am and 3 pm each day. Figure A2 provides details on indoor temperatures in ELL2 at the same times, all data from temperature loggers placed in the participants‘ living rooms.

Figure A1 Indoor temperatures in ELL1 households at 8 am and 3 pm each day



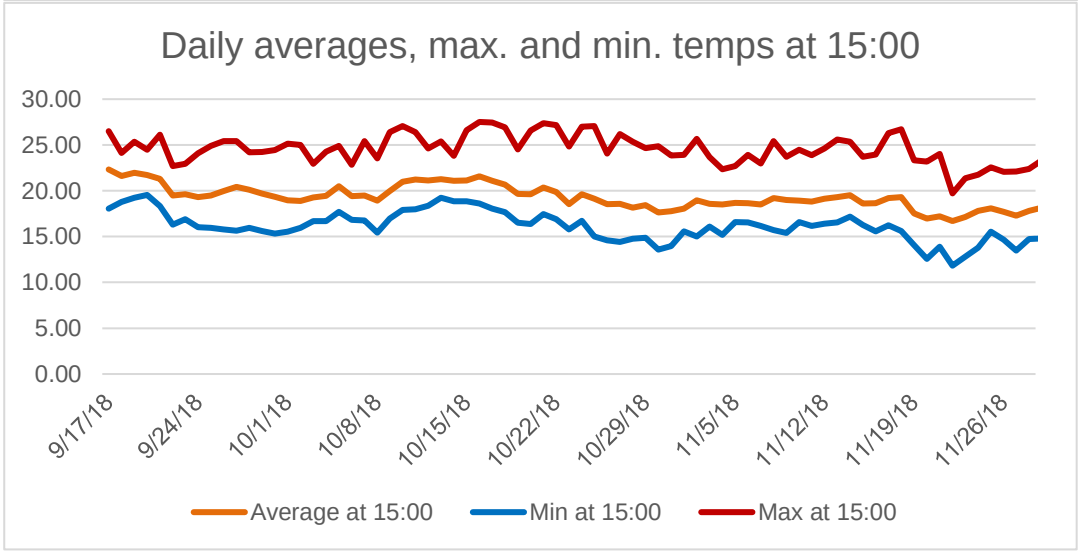


Figure A2 Indoor temperatures in ELL2 households at 8 am and 3 pm each day

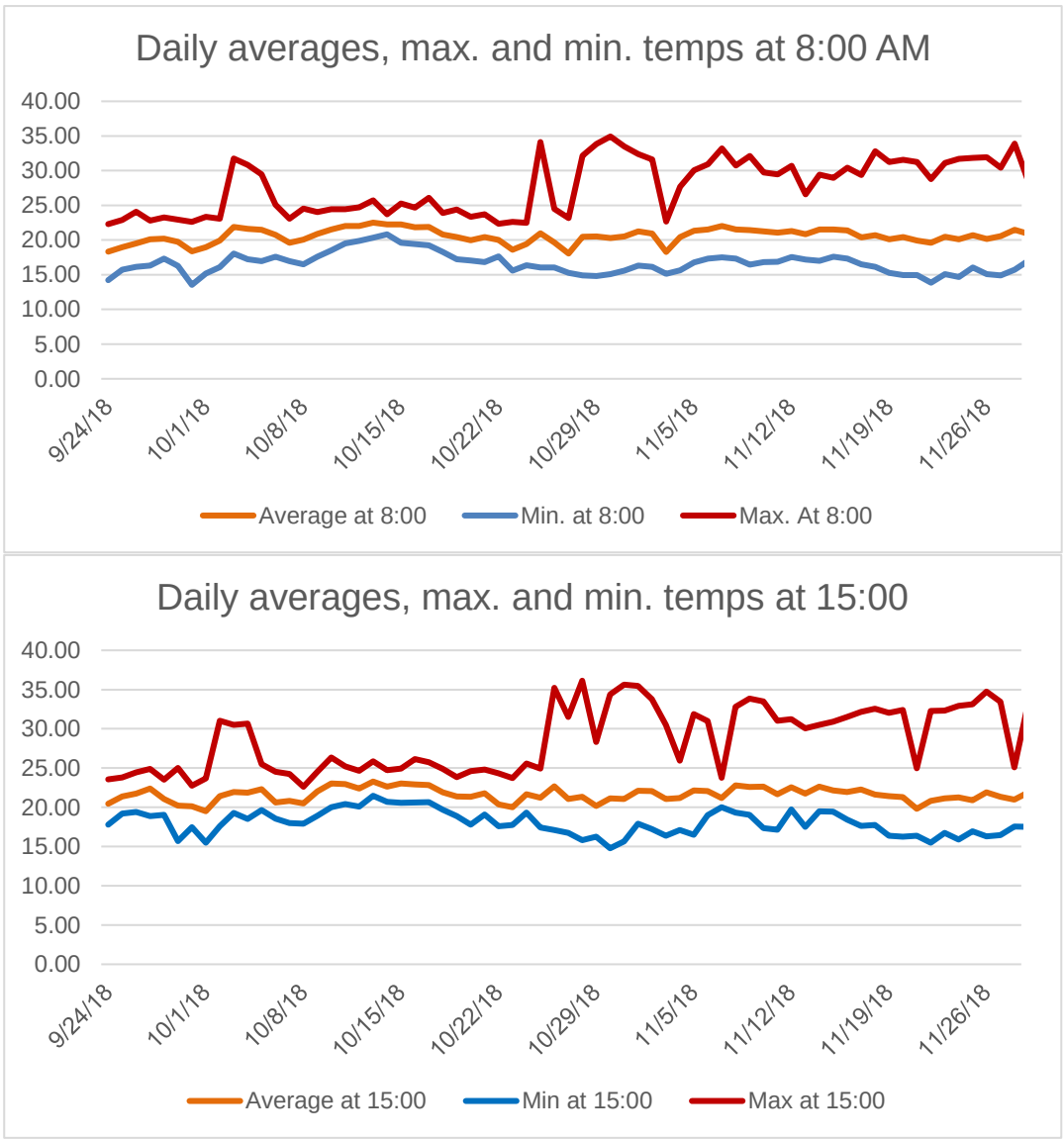
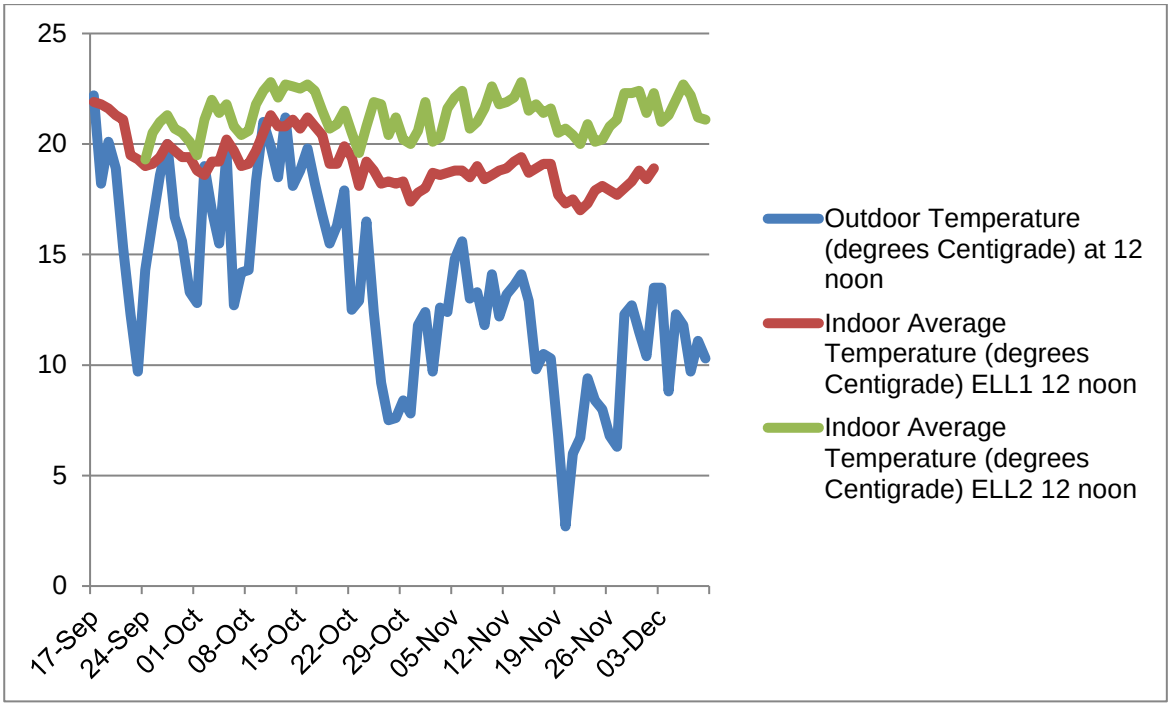


Figure A3 Comparing outdoor temperatures with indoor temperatures in ELL1 and ELL2 households



Source: Met Office daily weather data from Herstmonceux weather station available at: https://digital.nmla.metoffice.gov.uk