Department for
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& Industrial Strategy

Energy Follow Up Survey: Heating patterns and occupancy

Final report

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Contents

Executive Summary

The 'Heating Patterns and Occupancy' report is the first in a series of reports that present the findings from the Energy Follow-Up Survey (EFUS) 2017. These findings are based on interviews conducted during the autumn of 2017 (Interview 1: 2,632 households), the winter of 2017/2018 (Interview 2: 1,340 households) and the winter of 2018/2019 (Interview 3: 1,186 households), returning valuable information on how households reported using their main and secondary heating systems, their typical daytime occupancy patterns and their typical requirement for hot water.

Space heating systems and heating patterns

Since the EFUS 2011, some progress has been made towards low-carbon heat technologies, however the EFUS 2017 survey is still primarily an analysis of the heating patterns of households with traditional wet central heating systems (predominantly mains gas fuelled).

- **Main heating** While 92% of households reported using a central heating system (including communal heating and air source heat pumps) to heat the majority of their home in winter, around 8% of households used electric storage heaters or electric/gas/solid fuel room heaters. Households with non-central heating systems were more likely to be living in flats, smaller dwellings, and in dwellings with the lowest EPC rating bands (F or G). They were also more likely to be single person households, in the private rented sector and be fuel poor.
- **Central heating controls** Of households with central heating systems, almost half (46%) used a timer control; 87% had a main thermostat to control the temperature; and 79% had TRVs on all or most of their radiators. The median thermostat set point was 20°C - the same as reported in EFUS 2011.
- **Main heating season** The most commonly reported heating season was October to April (23% of households). The mean length for the 2017/18 heating season was 5.7 months; this has not changed significantly since EFUS 2011. Some 6% of homes were heated all year round; these were more likely to be associated with older households. There was no indication of any link between heating season and fuel poverty status.
- **Main heating patterns for households with central heating used at regular times of the day** Comparable with EFUS 2011, the majority (73%) of households with a central heating system had a regular heating pattern. A twice daily pattern was used by the majority of households in both 2011 and 2017, however in 2017, 23% of households reported using three or more heating periods on a weekday compared with 8% in 2011, with a corresponding lower proportion heating twice per day, suggesting a small shift towards more intermittent use of central heating systems. Similar to 2011, on the whole, households maintained similar heating patterns and heating hours all week with median daily hours of main heating during a typical weekday of 7.5 hours and 8 hours during a weekend day (excluding any boost heating). The most common regular heating pattern

for around a third of households (31%) with central heating was for the heating to come on in the morning for a 'short burst (less than 4 hours)' and then a second time later in the day for a sustained interval (4 to 10 hours).

- **Households without central heating** Some 60% had a regular heating pattern; of these the majority (67%) turned it on once a day during a typical weekday for a median of 7.5 hours and some 73% reported that they kept the same timings at the weekend.
- **Extent of main heating** The majority of households (62%) reported heating all the rooms in their home by the main heating system, while just over a quarter of households (27%) turned their main heating off in one or more habitable room types; the majority of those households (84%) did so in just one room type which was predominantly a bedroom. Just 6% of households that turned their main heating off in a bedroom reported using an alternative heater instead. This was predominantly an electric heater.
- **Unheated habitable rooms** Just under 5.5 million households (24%) reported leaving some of their habitable rooms unheated, typically a bedroom where around half of these were 'spare' bedrooms as the room was left unheated as 'it was not used/hardly ever used'. There was no clear relationship between having unheated rooms and a household's fuel poverty status, nor with the floor area. Extent of heating habitable rooms has not changed significantly since 2011, and re-analysis of the EFUS 2011 data indicated that 81% of households with unheated rooms left up to two habitable rooms unheated, almost three-quarters of which were bedrooms.
- **Supplementary heating** The use of supplementary heating in at least one room has decreased from 48% in EFUS 2011 to 39% in 2017. Supplementary heating was predominantly used in the living room and around a quarter of these households used this heater every day in the living room, for on average four hours on a typical weekday and five hours on a weekend day. The trend for solid fuel stoves being used for aesthetic purposes in addition to providing supplementary heat is supported by the reasons for use given, being more likely to report that they 'liked the look and feel of it'. There was no indication of a link between supplementary heating and fuel poverty status.

Occupancy and heating

Specific questions on a households' typical occupancy patterns have been collected and allowed for greater confidence in relating daytime occupancy to patterns of space heating use.

During a typical weekday 43% of households generally had someone at home 'all day' during the daytime (9am to 5pm); this was significantly higher at the weekend (60%). Just over a third of households reported 'variable' daytime occupancy for weekdays (39%) and weekends (38%).

Households were more likely to have someone in during the day on a weekday for the following groups: those with a pensioner present, all adults unemployed, the HRP or partner

was long-term sick or disabled, low incomes, households in fuel poverty and larger households.

Households that were in all day on a weekday, heated, on average, for more hours (median = 8hrs:30mins) than households that had variable daytime occupancy (median = 7hrs:00mins) or were out all day (median = 6hrs:00mins). For the 31% of households that reported someone being at home for more hours on a weekend than a weekday, approximately half of them (51%) reported also increasing their hours of heating.

Fuel poor households were more likely (57%) to have someone home all day during weekdays compared with non-fuel poor households (42%) but there was no difference in weekend daytime occupancy. Fuel poor households were also less likely to change their daytime occupancy across different weekdays. Affordability may preclude some fuel poor households from achieving the heating standard set in the fuel poverty methodology; fuel poor households that were in all day heated on average for 1 hour less (8 hours) than non-fuel poor households (9 hours).

Hot water systems and usage

Results obtained from EFUS 2017 on hot water systems are presented to provide up-to-date data to help to validate energy model algorithms in BREDEM, SAP and other models.

- **Use of immersion heaters** Around 8% of households had a dedicated immersion heater as their primary hot water source, mostly (90%) in households with non-central heating systems. Some 65% of households with non-central heating systems reported using their immersion ‘every day’ in the summer; this changed little in the winter (62%). Some 15% of households with central heating systems reported using their immersion ‘every day’ in the summer, decreasing to 6% in the winter.
- **Shower and bath ownership** Some 81% of households had both a bath(s) and a shower(s) in their home while 7% reported having no shower and 12% reported having no bath. Just over a third of showers were electric (37%) whilst the majority were supplied by the main hot water system (63%). For those fuel poor that had a shower, it was more likely to be an electric shower than a pumped shower.
- **Bath and shower use** In households with both bath and shower facilities, showers were used in preference to baths; with 41% not using the bath in a typical week. In 46% of households, total bath and shower use was less than one a day per person. Predictors of water consumption were: household size, presence of children and the age of the adult occupants.

1. Introduction

There is an ongoing requirement to keep our knowledge and understanding of domestic energy use up to date. This is essential to ensure that policies, and policy interventions, are directed in the most efficient and effective manner; that legislation and standards are based on principles and assumptions that reflect how people are actually using energy in their homes; and that models and statistics which provide the underpinning evidence base in this area are as accurate as possible. Of particular relevance at the moment are policies relating to fuel poverty, decarbonisation of heat, smart metering and minimising household energy bills.

The data presented here is from the 2017 Energy Follow-Up Survey (EFUS). This was a follow-up survey of a sample of respondents from the English Housing Survey (2014-2017) and provided more detailed information on use of heating, hot water and appliances. Similar Energy Follow-Up Surveys were carried out in 1998 and 2011.

Today the Department of Business, Energy and Industrial Strategy (BEIS) has several overarching aims which need to be addressed by this new EFUS. These are:

1. To determine current domestic energy consumption and heating patterns in England and to investigate how they change over time through timeseries comparisons.

2. To understand how and why there are variations in energy consumption between similar dwellings, and similarities in energy consumption between different dwellings.

3. To understand how households in fuel poverty use energy and how their energy consumption patterns and behaviours compare with non-fuel poor households.

The questions addressed in this report on ‘Heating patterns and Occupancy’ are:

- What are the main heating fuel types and systems? What are the secondary heating fuel types?
- What are households’ daily (weekday and weekend) heating patterns and heating seasons?
- What is the extent of use of the main heating system and in which room/s is secondary heating used?
- What are households’ occupancy patterns and how do these relate to their patterns of heating use?

The ‘Heating Patterns and Occupancy’ report is the first in a series of reports that present the findings from the EFUS 2017. The results presented here provide background information that underpins much of the analysis that is presented in the other reports in the EFUS 2017 series, in particular the reports on ‘Thermal Comfort’, ‘Energy Consumption’ and ‘Fuel Poverty’.

2. Methodology

Full details of the data collection and analysis methods used are set out in a separate methodology report, however, an outline is given below of the analysis, and the interview surveys upon which this report is based.

2.1 Surveys

The first of the householder surveys was undertaken in the autumn of 2017 and is referred to as Interview 1. A pilot survey of 94 households was carried out between May and June 2017, followed by the main survey of 1,867 households. This survey was conducted via a face-to-face interview conducted in the householders' home between August and October 2017. In order to boost the sample, an online version of the same survey was completed by a further 671 households between October and December, giving a total sample of 2,632.

The Interview 1 survey covered a number of areas including;

- Summer thermal comfort
- Cooling behaviours
- Hot water use
- Appliance use
- Lighting
- Energy tariffs and method of payment
- Dwelling improvements
- Changes to the household

The second of the householder surveys, a follow-up survey to Interview 1, was conducted between January and March 2018 and is referred to as Interview 2. To minimise disruption to the householders the survey was conducted via a telephone interview and 1,060 households completed the telephone survey. As with Interview 1, in order to boost the sample an online version of the Interview 2 survey was completed by a further 280 households giving a total sample of 1,340. Therefore almost 51% of the Interview 1 households also completed the Interview 2 survey.

The Interview 2 survey examined;

- Use of main, alternative and supplementary heating systems
- Winter thermal comfort
- Winter ventilation behaviours
- Damp and mould

- Winter appliance and hot water use
- Lighting
- Trade-offs made by households unable to afford to heat their homes
- Occupancy patterns

The third of the householder surveys, another follow-up survey to Interview 1, was conducted between February and March 2019 and is referred to as Interview 3. The survey was conducted via a telephone interview and online survey; 447 households completed the telephone survey and a further 739 households responded online, giving a total sample of 1,186. Some 80% of the Interview 3 surveys had an Interview 1 and Interview 2 survey (944 households), while the remaining 242 households had an Interview 1 survey only. The interview 3 survey collected information on:

- Use of main heating systems including the heating season
- Proportion of the house heated
- Occupancy patterns
- Smart technologies
- Method of payment and tariffs
- Changes to property and household

The results presented in this report are based on the householder responses to questions from all three Interview surveys. The respective survey is referenced within the text.

2.1 Weighting

The weighting factors for all three interview surveys were derived using a RIM weighting method and logistic regression, based on population targets so that the households in the EFUS dataset represent the number of households in England in 2017 (23.95 million) and 2018 (24.17 million). Further details are provided in the separate methodology report.

2.2 Analysis

Statistical analysis was used to measure the significance of the findings presented in this report. All statistical analysis was conducted on weighted data, and a design effect factor was used to account for the complex survey design. Further details on the analysis are provided in the full methodology report.

The key dependent variables used in each chapter have been analysed by the defined set of EFUS social demographic and dwelling characteristic variables (listed below). As a rule, only statistically significant results at the 99% level (where $p < 0.01$) have been included in the text, although there are some instances when results that are significant at the 95% level ($p < 0.05$) are reported.

Household characteristics: tenure, household composition, household size, presence of pensioner, presence of child, age of the HRP (household reference person), employment status of household, household income, daytime occupancy, anyone in the household designated long-term sick or disabled, under-occupying status, fuel poverty status.

Dwelling characteristics: dwelling type, house or flat, dwelling age, floor area, region, rurality, presence of central heating, main fuel used, wall type, insulated walls, loft insulation thickness, double glazing extent, number of insulation measures, Energy Performance Certificate (EPC) rating band.

Further details on these characteristics are located in the Glossary.

The following tests were used:

- The Chi-Squared (X2) test was used when comparing two categorical variables to determine if one differs from the other. Alongside this the Z-test for Proportions was used to determine where the differences occur, with a Bonferroni correction. Cramer's V test was used to analyse the effect size.
- Analysis of Variance (ANOVA) was used with continuous data to determine the impact of categorical variables, and the Tukey post-hoc test was used to determine where the differences occur. In addition, the effect size Eta-squared (η2) has been calculated. Where assumptions for homogenous variances are violated, the result of the Welch test has been reported, and post-hoc testing has been conducted by independent t-tests.
- McNemar's test was used when comparing two categorical variables, for a repeated measures design.
- The Kruskal-Wallis test was used for non-parametric analysis of discrete data, to determine the impact of categorical variables. The Mann-Whitney U test was used to determine where differences occur, and the effect size was approximated based on the r statistic.
- Paired T-tests were used when comparing two continuous variables, for a repeated measure. The Wilcoxon-signed rank test was used for non-parametric paired analysis.

All frequencies and percentages reported in the text have been rounded, with percentages rounded to the nearest percent.

Unless otherwise stated, where householders answered 'don't know' to an interview question, if the (unweighted) proportion of 'don't know' responses was less than 5% of the total valid responses then, for that particular question, the households that responded 'don't know' have been excluded from the analysis.

3. Space heating systems and heating patterns

Using information reported by households in Interviews 2 and 3, this chapter describes: the main heating systems being used by households; the control mechanisms in centrally heated households; the month that all households started and finished heating their home every day; and their heating patterns for a typical weekday and weekend day. In addition, this chapter looks at the extent of main heating use, the prevalence of unheated rooms and the use of alternative and supplementary heating systems[1].

3.1 Main heating systems

Approximately 89% of households reported that they use a central heating system to heat the majority of their home in the winter. The remaining households used either electric storage heaters (3%), electric room heaters (3%), a communal heating system (3%) or gas/solid fuel fires (1%). Although the survey picked up a few instances of households using the low-carbon heat technologies of air-source heat pumps (ASHP) and district heating (less than 1% combined), no households reported using ground source heat pumps (GSHP)[2]. Due to the small sample sizes for some heating types, further analysis has been carried out using two heating groups ('central heating' and 'non-central heating') where central heating, communal heating and heat pump systems (all fuel types) (less than 1%) have been designated as 'central heating' and storage heaters and room heaters (all fuel types) have been designated as 'non-central heating'. The central heating systems were predominantly fuelled by mains gas (90%) whereas the non-central heating systems were predominantly electric (83%).

Exploratory analysis of the main heating system type by socio-economic characteristics highlighted significant differences with the following household groups who were more likely to have a non-central heating system:

- **Household composition** Single person households under 60 (22%) compared with all other household types (ranging between 3% to 5%) except single person households aged 60 or over (12%)
- **Household size** One person households (17%) compared with 2 to 4 person households with (2% to 5%)
- **Fuel poverty** Fuel poor households (17%) compared with the non-fuel poor (7%)
- **Children present** Households without children (9%) compared with those with children (4%)

[1] Annex tables containing the underlying data for analyses by dwelling and household groups reported in this chapter can be found in 'Chapter 3 Annex Tables_dwelling and household.xls'.
[2] Annex tables containing the underlying data for this section can be found in 'Chapter 3 Annex Tables_Section3_1.xls'.

Similar analysis by dwelling characteristics highlighted significant differences between households living in different types of homes: the following were more likely to have a non-central heating system:

Dwelling type Households living in flats (21%) compared with households living in a house or bungalow (5%)

Floor area Households living in smaller dwellings, where 24% of dwellings less than 50m2 and 11% of dwellings 50 to 69m2 had a non-central heating system, compared with less than 5% for larger dwellings

EPC band Households living in dwellings with the lowest EPC bands (F/G) where 43% had a non-central heating system compared with households who lived in more energy efficient homes (ranging from 6% to 9% depending on EPC band, A to E)

3.2 Heating controls in centrally heated households

For households with central heating, the following were determined (Interview 2): the method used 'most often' to control when their heating turned on and off, whether a main thermostat was present and the mode of use, and the prevalence of thermostatic radiator valves (TRVs)[3].

3.2.1 Timing control

Households with central heating[4] most commonly reported (46%) using a timer to control their system, with a further 34% reporting that they controlled their heating manually using a thermostat. Additional information obtained in Interview 3 suggests that some of the latter group did have an underlying timer control for their boiler; in that survey 24% of households controlled their heating manually using a thermostat and had no timer for the boiler and a further 10% of households had a timer to control their boiler but used the thermostat to manually 'fine-tune' when their heating came on and off. Analysis of the timing control method by socio-economic and dwelling characteristics showed that there were differences between groups which are summarised below:

- **Tenure** Owner-occupiers were more likely to report using the timer to control their central heating than those in other tenures (53% compared with 41% private rented sector; 21% local authority and 24% housing association)
- **Employment status** Households with someone employed were more likely to report using the timer to control their central heating than households with no-one employed (49% compared with 40%)

[3] Annex tables containing the underlying data for this section can be found in 'Chapter 3 Annex Tables_Section3_2.xls'.
[4] Not including communal heating

- **Household composition** Couples over 60 years were more likely to report using the timer to control their central heating than single person households over 60 years (57% compared with 40%)
- **Income** Households in the highest income quintile were more likely to report using the timer to control their central heating than households in the lowest three income quintiles (61% compared with <40%). Whilst, the latter groups were more likely (ranging from 37-43%) to report using their thermostat manually to control their central heating than households in the highest income quintile (21%)
- **Under-occupiers** Households who were under-occupying their home were more likely to report using the timer to control their central heating compared with households not under-occupying (60% compared with 40%). Households who were not under-occupying were more likely to turn the thermostat up and down manually to switch the heating on and off (38% compared with 24%)
- **Floor area** Households in the smallest dwellings (under 50m2) were much less likely (19%) to use the timer than those living in the dwellings larger than 70m2 (ranging from 50-66% depending on floor area); instead they were much more likely (57%) to report using their thermostat manually to control their central heating than households in larger homes (18-30%)
- **Dwelling type** Households living in detached houses were more likely (64%) to use the timer than those in all other dwelling types (ranging from 31%-42%) except semi-detached houses (52%)

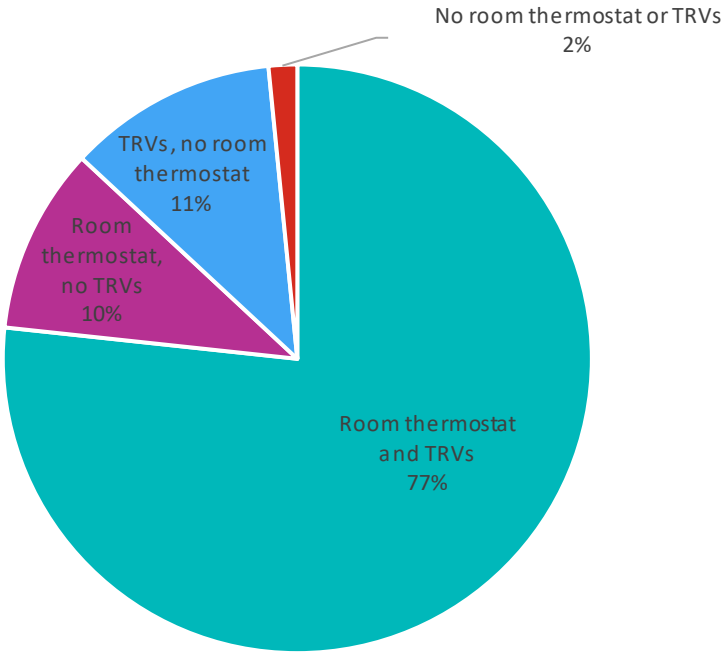
Some 13% of households in which the central heating system was controlled by a timer reported switching on their heating manually for an additional period of 'boost' heating every day during the winter of 2017. A further 53% used a period of boost at least once a week with the remainder (34%) using it infrequently or never.

3.2.2 Temperature control

The majority of households (87%) reported having a main thermostat to control the temperature of their home, a significant increase from the 73% reported in EFUS 2011. Around 79% of households had thermostatic radiator values (TRVs) on all or most of the radiators in the dwelling[5]. In combination, 77% of households had both a room thermostat and TRVs (Figure 3.1).

[5] It should be noted that the presence of TRVs does not necessarily mean that the household is actively using them to control the temperature of their home.

Figure 3.1: Central heating system temperature control



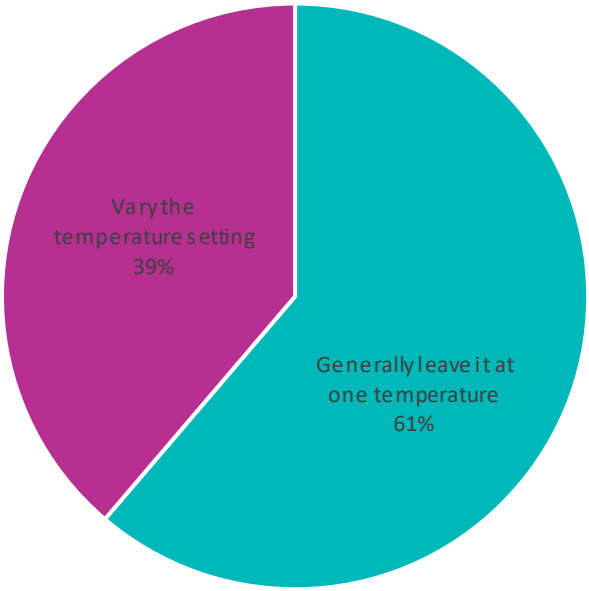
Base: all households with central heating (not including community heating or ASHP) (n=1,145), Interview 2.

Only one notable difference stood out in an analysis of the socio-economic and dwelling type characteristics of households and how they control the temperature of their heating; households with one or more pensioners present were less likely to have a room thermostat and TRVs (71%) compared with non-pensioner households (79%).

3.2.3 Thermostat settings

Of the 87% of households (18.2 million) with central heating who had a main thermostat controlling the temperature of the home, 61% reported having the heating set at one temperature when the heating was on and 39% reported that they varied the temperature setting, depending on how they were feeling or the time of day (Figure 3.2).

Figure 3.2: Use of the main room thermostat

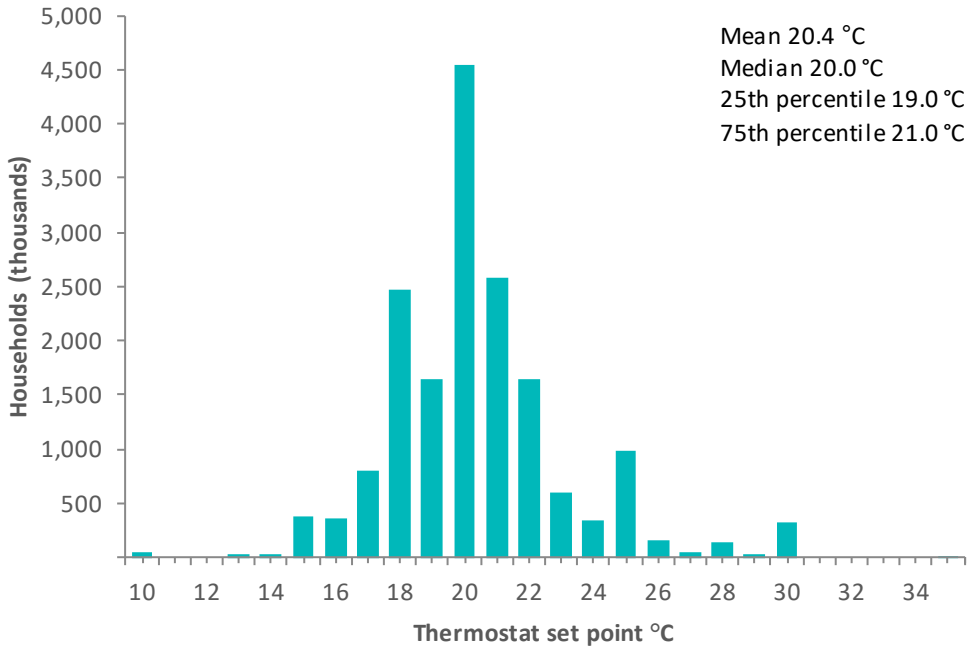


Base: all households with a main thermostat that controls the temperature of their home (n=1,008), Interview 2.

Figure 3.3 shows the distribution of reported thermostat set-points. The median temperature set point was 20°C, with a range of 10 to 35°C being reported. The interquartile range shows that 50% of households reported setting their thermostats to a temperature between 19 and 21°C. In EFUS 2011[6], the average reported set-point was also reported to be 20°C, although the interquartile range was slightly wider at between 18 and 21°C. It should be noted that in both EFUS surveys, no information was obtained on the location of the thermostat; this could have some effect on the chosen set-point.

[6] EFUS 2011, Mean Household Temperatures Report.

Figure 3.3: Reported thermostat set-points for centrally heated dwellings that have and use a thermostat



Base: all centrally heated households with a thermostat that set it to one temperature (n=957), Interview 2.

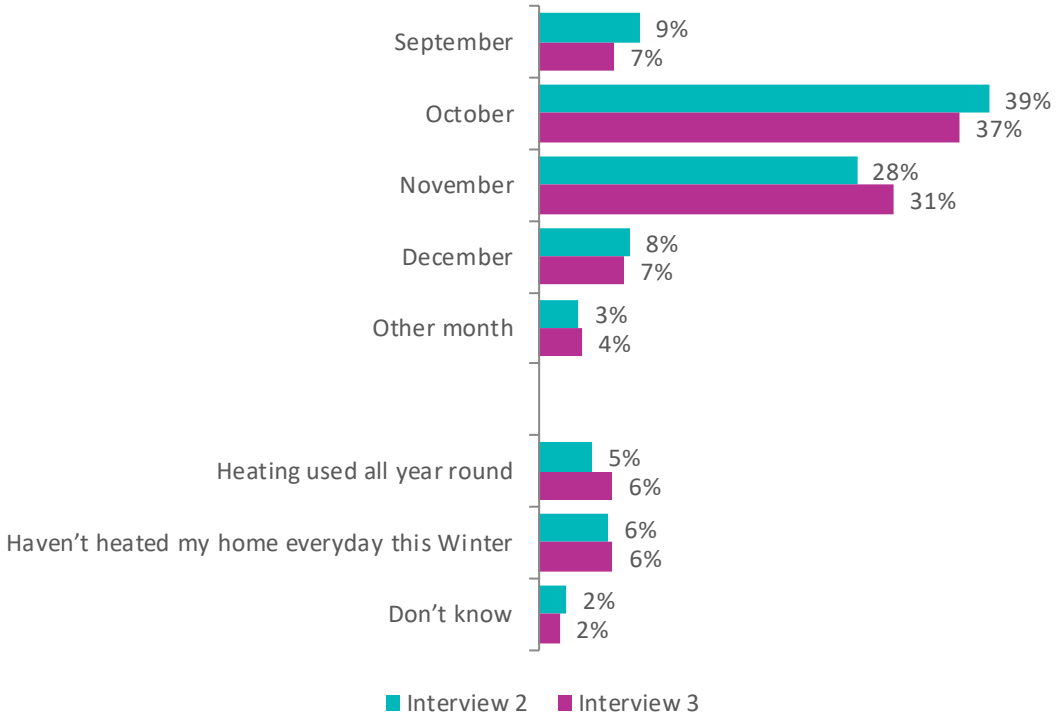
3.3 Main heating season for all households

Over a third of households (39%) reported that, for the 2017/18 heating season, daily heating started in October; similar responses were also reported for the 2018-19 heating season (Figure 3.4)[7]. Just over two-thirds of households (68%) reported that they stopped using their main heating system daily sometime in either March or April. The most commonly reported heating season was October to April (23% of households), with November to April, November to March and October to March being reported by a further 38% of households. The mean length reported for the 2017/18 heating season was 5.7 months; this has not changed significantly from the 5.6 months reported in the EFUS 2011[8] results.

[7] Annex tables containing the underlying data for this section can be found in 'Chapter 3 Annex Tables_Section3_3.xls'.

[8] For both EFUS, the length of the heating season has been calculated as being from the middle of the reported start month to the middle of the reported end month e.g. if the householder reported that they turned it on in October and off in April then the heating season is 6 months. The uncertainty of this is +/- 1 month as the reality could be that the heating goes on at the beginning of October and off at the end of April, or vice versa.

Figure 3.4: Month that daily heating started



Base: all households (n=1,340), Interview 2; (n=1,186), Interview 3.

Some 6% of households reported heating their home using their main heating system all year round. Households using a central heating system were no more likely to report this than those using a non-central heating system. There were no differences seen within groups for any of the other dwelling characteristics, nor did the type of main heating control used suggest any relationship between ability to control the heating system and having it on all year. There was a relationship between having the heating on all year and several socio-economic characteristics; households with someone over state pension age were more likely (11%) to have their heating on all year than those without (5%), as were households with no-one employed (11%) compared with those with at least one person employed (4%) and households considered to be under-occupying (11%) compared with those not (5%). There was no indication of any link between heating season length and fuel poverty.

The characteristics of the 6% of households that reported not heating their home every day in the winter are explored further in the section on non-regular heaters (section 3.4.3).

3.4 Main heating patterns

This section examines the daily space heating patterns used by households for a typical weekday and weekend day[9]. To aid timeseries comparisons, results follow the reporting structure used in the EFUS 2011 Main Heating Systems report, so that households with

[9] Annex tables containing the underlying data for this section can be found in 'Chapter 3 Annex Tables_Section3_4.xls'.

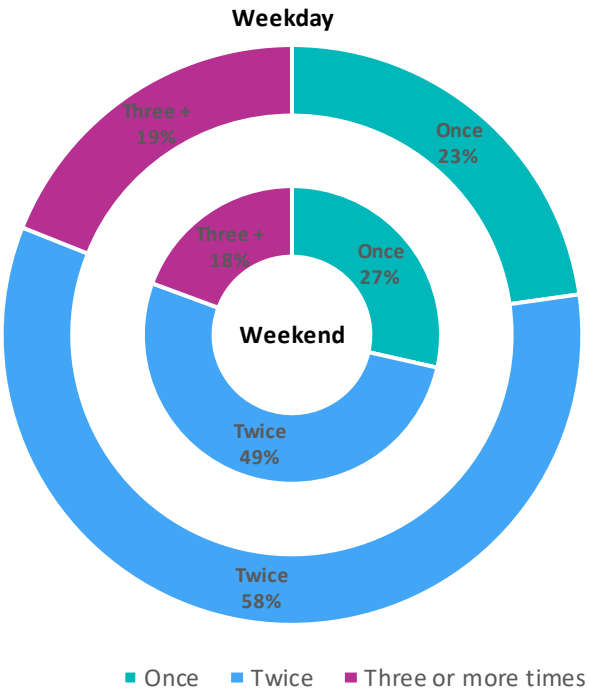
regular heating patterns (72% of all households) were analysed for centrally heated households (section 3.4.1) and non-centrally heated households (section 3.4.2) and all households with non-regular heating patterns (28% of all households) were analysed separately (section 3.4.3). There has been no change in the proportion of households heating in a regular manner since EFUS 2011 in which 73% of households reported heating their homes in a regular manner and the remaining 27% of households did not have set daily patterns for their heating[10]. Section 4.3 provides additional analysis on the patterns of space heating use by the households' occupancy patterns.

3.4.1 Centrally heated households using a regular heating pattern

The following section discusses the heating patterns for households with central heating systems reported to be used regularly (73% of centrally heated households, representing 16.2 million households). The majority (58%) of these households reported that on a typical weekday, they have their heating on twice per day, with a further 23% having it on once per day. Figure 3.5 shows that approximately 4% more households used their heating once a day at the weekend compared with a typical weekday. A similar result was reported in EFUS 2011[11]. Compared with EFUS 2011, a higher percentage of households reported using three or more heating periods on a weekday in 2017 (19% in 2017 compared with 8% in 2011) with a corresponding lower proportion heating twice per day in 2017 compared with 2011 (58% in 2017 compared with 69% in 2011)[12] suggesting that households' behaviours may have changed over the intervening years in this respect. Going forwards, it would be valuable to review whether this change in behaviour continues, and what impact it has on energy consumption.

[10] EFUS 2011 Report 4: Main heating systems, Section 3.2.
[11] EFUS 2011 Report 4: Main heating systems, Table 12.
[12] EFUS 2011 Report 4: Main heating systems, Table 5.

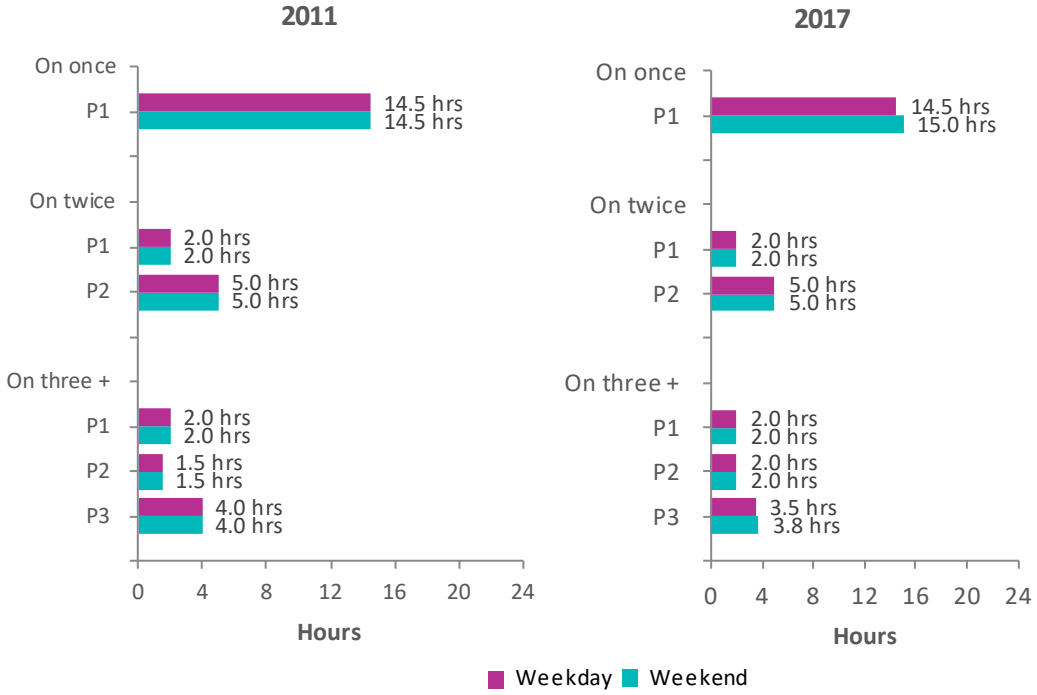
Figure 3.5: Number of periods heating is switched on and off on weekdays and weekend



Base: all households with central heating systems used regularly (n=773), Interview 3.

Figure 3.6 shows the reported median number of hours that the heating was on per time period, for a typical weekday and weekend for EFUS 2017, with the same results for EFUS 2011 shown for comparison. In both surveys, there was a small increase, from 7.5 hours to 8 hours, in the overall median number of hours at the weekend compared with a weekday and the length of heating periods were, on the whole, similar to those reported in EFUS 2011.

Figure 3.6: Median hours per heating period for weekday and weekend day, 2011 and 2017



Base: all households with central heating systems used regularly (n=768 weekday, n=727 weekend), Interview 3.

A 'timeframe' stereotype variable and 'time on' stereotype variable have been derived, using the cut-off points developed in the EFUS 2011 survey[13], to enable a timeseries comparison. Additionally, the EFUS 2011 'overall typical heating pattern' variable has been replicated to describe the heating patterns used by households with central heating that heat their homes in a regular manner. Results for the 2017 EFUS were generally consistent with those reported in the 2011 EFUS[14]:

For the 3.5 million households that reported using their central heating system once per day, 39% of them turned it on when they woke up and had it on for 11-16 hours, 19% turned it on in the evening and had it on for more than 17 hours, and 17% turned it on at home time and had it on for 4-10 hours. This distribution remains largely unchanged from that reported in EFUS 2011 (38%, 16% and 15% respectively)

For the 8.9 million households that reported using their central heating system twice per day, 89% turned it on for a period at 'wake up time' which was typically for 'less than 4 hours' (median = 2 hours), followed by a period at 'home-time' which was typically for a 'sustained interval' of 4 to 10 hours (median = 5 hours). The proportion, and median heating hours are unchanged from the results reported in EFUS 2011 (88%, period 1 median = 2 hours; period 2 median = 5 hours)

[13] Timeframe categories were <4 hours; 4 to 10 hours; 11 to 16 hours; >=17 hours. Time on categories were 'Wake up' 0500-0800; Daytime 0801-1459; Home time 1500-1900; Evening/night 1901-0459.
[14] EFUS 2011 Report 4: Main heating systems, Table 9, Table 10 and Table 11.

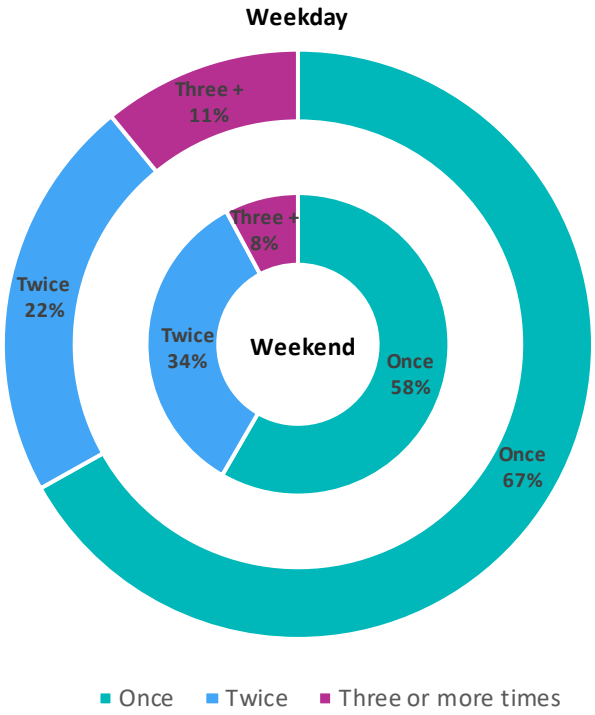
The most common heating pattern, describing 31% of centrally heated households heating in a regular manner, was one in which the heating came on twice daily, firstly at 'wake-up' for a 'short burst (less than 4 hours)' and then at 'home time' for a sustained interval (4 to 10 hours). This is slightly less than the 40% reported for EFUS 2011, the shift seemingly towards more households reporting 'other once daily pattern' and 'other number of periods' in 2017

Two fifths (40%) of households using central heating systems in a regular manner reported that they changed their heating times at the weekend, compared with a typical weekday. This is significantly more than the 24% of households using central heating systems in a regular manner that reported changing their heating times in EFUS 2011. However, further analysis showed that households that changed their heating times at the weekend increased their total heating time by 1.5 hours (from 7 hours on a weekday to 8.5 hours on a weekend). This is similar to the results reported in EFUS 2011 in which households that changed their heating times at the weekend increased their total heating time by 1 hour (from 7 hours on a weekday to 8 hours on a weekend). On the whole, most centrally heated households with regular heating patterns kept the same number of heating periods for weekdays and weekends (82%), with only 4% changing from heating twice per day on a weekday, to once per day at the weekend. There was, however, evidence of a shift towards a later turn on time for the first period of heating at the weekend, as 14% of the households that changed their heating times moved from turning it on between 0500-0800 to between 0801-1459.

3.4.2 Households without central heating using a regular heating pattern

For the 8% of households that reported using a non-central heating system as their main heating in winter, 60% reported that they used it in a regular manner. Of these, the majority (67%) turned it on for one period a day on a typical weekday (Figure 3.7), for a median of 7.5 hours. A further 22% of these households turned it on for 2 periods on a typical weekday, for an median of 7 hours (2 hours for the first period and 5 hours for the second period), although the small sample size (n=15) for the latter group means that these results should be interpreted with caution. Almost three-quarters of households (73%) using a non-central heating system reported that they kept the same timings at the weekend.

Figure 3.7: Number of heating periods used by households with non-central heating systems used in a regular manner



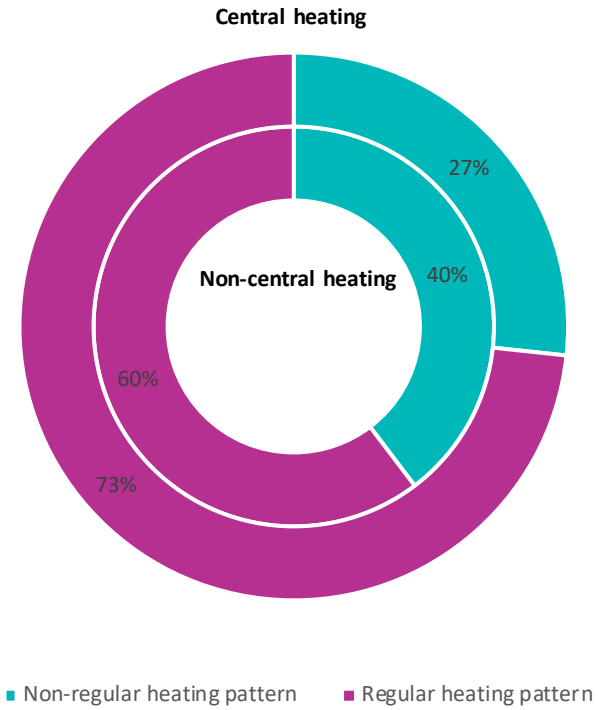
Base: all households with non-central heating systems used in a regular manner (n=63), Interview 3.

3..3 Households without a regular heating pattern

Approximately 28% (6.6 million) of households did not heat their homes in a regular way15 during the winter of 2018. This proportion has not changed significantly from the 27% reported in EFUS 2011. As was also seen in EFUS 201116, the prevalence of non-regular heating was higher for households with non-central heating compared with those with central heating (Figure 3.8).

[15] Non-regular heaters at Interview 3 were those that responded 'no' to whether they had the main heating system on at regular times of the day, plus households with a timed main heating system who responded 'no typical heating pattern' to the number of heating periods.
[16] EFUS 2011 Main Heating Systems, Table 23.

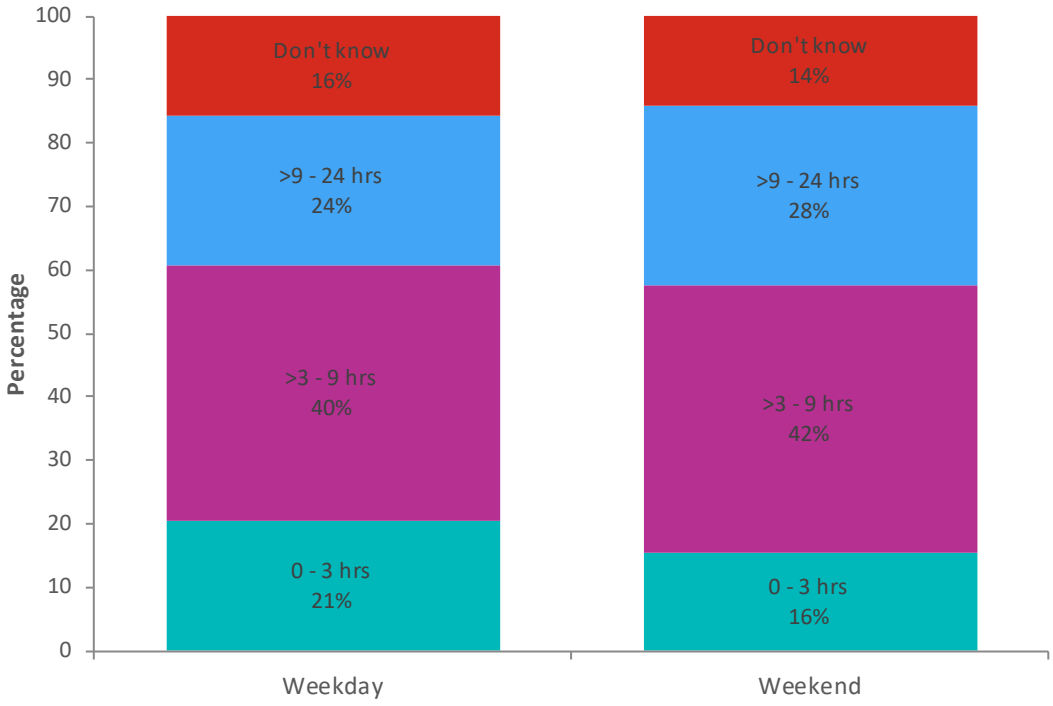
Figure 3.8: Prevalence of regular/non-regular heating patterns



Base: all households (n=1,181), Interview 3.

The distribution of the daily hours of heating, reported by households that heat their homes in a non-regular way, for a typical weekday and weekend day are shown in Figure 3.9. A notable proportion of households reported not knowing how many hours their heating was on for.

Figure 3.9: Daily hours of heating for non-regular heaters



Base: all households heating in a non-regular manner (n=332), Interview 3.

3.4.4 Total main heating hours for all households

The total daily hours of heating for all households have been calculated for a typical weekday and weekend day. Due to the uncertainty in the reported hours of 'boost' heating use in households with central heating systems controlled by a timer, any additional 'boost' hours have been excluded for this total so the figures will underestimate total heating time for these households[17].

Table 3.1 shows that the median daily hours of heating reported for a weekday was 7:00 hours and for a weekend day, 8:00 hours.

Table 3.1: Median number of daily hours of heating

	Sample size	Median (hrs:mins)	IQR for median (LQ, UQ)
Weekday day	1053	7:00	(5:00,10:00)
Weekend day	1009	8:00	(6:00,12:00)

Base: all households (n=1,186), Interview 3.

Analysis of the median weekday heating hours reported for different groups within the range of dwelling and socio-economic factors highlighted the following differences (median hours shown in brackets hh:mm):

- **Age of HRP** Broadly speaking, median heating hours increased with increasing age of the HRP
- **Household composition** Couples aged 60 or over with no dependant children heated the longest (9hrs:00mins) and single person households aged under 60 heated the least (5hrs:30mins)
- **Pensioner present** Households with a pensioner present heated for longer (9hrs:00mins) than those without a pensioner present (6hrs:15mins)
- **Weekday daytime** occupancy Households with someone in all day heated the longest (8hrs:30mins), those households with no-one in heated the least (6hrs:00mins) and those with variable occupancy were in between (7hrs:00mins) (see also Section 4.3)
- **Employment status** Households with no-one in employment heated longer (9hrs:00mins) than those with someone in employment (6hrs:30mins)
- **Tenure** Owner-occupiers heated longer (8hrs:00mins) than households in the private rented (6hrs:30mins) or RSL sectors (6hrs:00mins)

[17] Total main heating hours for all households was not reported in EFUS 2011 and so no direct comparisons can be made.

- **Under-occupiers** Households modelled to be under-occupying heated for longer (8hrs:00mins) than those not (7hrs:00mins)
- **Long-term sick or disabled** Households with someone in this category heated longer (8hrs:00mins) than households without (7hrs:00mins)
- **Income** Households in the lowest income quintile heated for fewer hours (6hrs:00mins) than households with higher incomes (7hrs:00mins to 7hrs:30mins)[18]
- **Dwelling type** Households living in detached houses heated for 2 hours longer on average (8hrs:00) than those in flats (6hrs:00). Interestingly, there was no difference found between flats and houses in EFUS 2011

Of the households with known heating hours, 69% reported keeping the same hours of heating on a weekday and a weekend day. Households that reported changing their hours, were typically those with no pensioners present, those without someone generally in all day on a weekday, those with at least one person employed, households not considered to be under-occupying and households with no-one long-term sick or disabled. Where a difference was reported, the median difference was two hours of extra heating on a weekend (IQR 1hrs:00mins to 4hrs:00mins). See Section 4.3 for further discussion of the relationship between heating patterns and household daytime occupancy.

3.5 Extent of main heating

Alternative heating systems are those used in rooms where the main heating system is present, but for whatever reason, is usually turned off and an alternative heater is used instead. In Interview 2, households were asked ‘Of the rooms that CAN be heated by your main heating system, which, if any, do you NOT normally heat using the main heating system in the winter?’. In Interview 3, a similar question was asked but with the intention of capturing information for rooms in which there was no main heating system installed.

This next section looks at all households that turned their main heating off in one or more rooms and whether or not the room was heated by an alternative heater (section 3.5.1) or was left unheated (section 3.5.2). Unless otherwise stated, the results presented are primarily those collected from Interview 2 as more comprehensive information for each room type was obtained[19].

Although the majority of households (14.2 million; 62%) reported heating all rooms by the main heating system, over a third of households (38%) (8.8 million households) reported turning it off in one or more rooms. In Interview 3, 57% of households reported heating all rooms by the main heating system and 43% (10.2 million households) reported at least one room not heated by the main heating system. Although this is not a statistically significantly different response (p=0.058), there is an indication that there may be an additional 5% of households

[18] Significant at 5% level; p=0.047.
[19] Annex tables containing the underlying data for this section can be found in ‘Chapter 3 Annex Tables_Section3_5.xls’.

(approximately 1.2 million) with at least 1 room not heated by the main heating system because no main heating was installed that are not represented in the following analysis.

Of those households that turned the main heating off in at least one room, over two-thirds (68%) were turning it off in just one type of room in their home and in total around 89% turned it off in either one or two room types. It should be noted that the total number of rooms in which the main heating was turned off may be an underestimate for dwellings with more than one of certain room types (most relevant to bedrooms)[20].

Rooms where the main heating system was most commonly turned off were; bedrooms (reported by 61% of households with at least 1 room not heated by main heating), kitchens (not used for dining) (20%), bathrooms with a WC (15%) and hallways/landings (12%).

For energy modelling purposes, it is more relevant to consider the heating behaviours in habitable rooms. The following analysis therefore focuses on households who turn their heating off in at least one habitable room. The definition of 'habitable rooms' has followed, as far as possible, that used in the SAP energy modelling methodology (see S9.1 in RdSAP 2012). Therefore the following EFUS room types were counted as habitable: kitchen diner, living room, dining room, combined kitchen and living room, combined living and bedroom, bedroom (including spare bedrooms) and study[21].

Just over a quarter of households (26%) (6.1 million households) turned their main heating off in one or more habitable room types (i.e 74% of households heated all their habitable rooms); 84% of those households turned it off in just 1 room type and a further 13% turned it off in two room types. For households where the main heating was turned off in one habitable room type only, in 87% of households this was in a bedroom. For those households turning it off in two habitable room types, 93% of them turned it off in a bedroom, with the second room typically being a living room (44%).

3.5.1 Use of alternative heating systems

Of the households that turned the main heating off in a bedroom, just 6% (341,000 households) reported using an alternative heater[22] in the room. This has decreased from the 12% reported in EFUS 2011. Although small sample sizes preclude a robust analysis of the use of alternative heaters in living rooms, the results presented in Table 3.2 show that the small proportion (3%) of households switching the main heating off in their living rooms, were much more likely to use an alternative heater compared with bedrooms. Similar results were reported in EFUS 2011 where 4% of households switched the main heating off in their living rooms, and 65% of those used an alternative heater. For all households, non-centrally heated

[20] Results from Interview 3, in which data on total numbers of rooms rather than by individual room types were collected, show that of the households that turned the main heating off in at least one room, 53% of households turned the main heating off in just one room, a further 28% in two rooms and the remainder (19%) in 3 or more rooms, however we do not know which types of rooms these were.

[21] Non-habitable rooms are kitchens (not used for dining), utility, bathrooms and toilets, hallway. Conservatories and 'Other' have also been designated as not habitable in this analysis. All results are from data collected in Interview 2, unless otherwise stated.

[22] As defined previously, an alternative heating system is one used in rooms where the main heating system is present, but for whatever reason, is usually turned off.

households were more likely to have used alternative heating in one or more rooms (20%) compared with those with central heating systems (3%) but this was the only statistically significant result from analysis by the socio-economic and dwelling characteristics.

Table 3.2: Summary of alternative heating use

	Households with room type		Main heating switched off in room	Alternative heater is used in that room		Percentage of those using alternative heater with central heating as main heating		Predominant type of alternative heater used (%)		
	Sample size	Number of households (thousands)	Percent (%)	*Sample size*	Percent (%)	*Sample size*	Percent (%)		*Sample size*	Percent (%)
Room								**Heater type**		
Bedroom	*1295*	**22,872**	**23.3**	*324*	***6.4***	*21*	***36.8****	Electric heater	*21*	***85.7****
Living room	*1276*	**22,357**	**2.6**	37	***57.8***	*22*	***76.1****	Encl. solid fuel fire	*22*	***28.8****

Base: all households (n=1,340), Interview 2. *Sample responses are very small and subject to large sampling errors.

3.5.2 Unheated habitable rooms

A little over three-quarters of all households (76% or 17.4 million households) reported that all habitable rooms in their home were heated (by either the main heating system or an alternative system); leaving just under 5.5 million households (24%) with some proportion of their habitable rooms unheated. Of those 5.5 million households, 89% reported only one unheated room type (the vast majority (91%) being a bedroom), a further 10% reported two unheated room types (predominantly a combination of a bedroom with either a study, kitchen diner, dining room or living room).

Where a bedroom was unheated, the propensity for 'spare' bedrooms to be left unheated was evident, as around half of households (48%) reported they did not heat the bedroom as the 'room [was] not used/hardly ever used'. For households in which the unheated bedroom was reported to be used 'every day', the main reasons for it being unheated were that they 'Don't like the room to get too hot' (46%) or the 'Room stays warm enough already' (30%).

Households with at least one habitable room left unheated were more likely to be:

- Living in non-centrally heated dwellings (44%) than centrally heated dwellings (23%)
- Households in which the HRP was 75 years or more (29%), compared with those where the HRP was aged between 16-34 years (14%)
- Single, or 2 person households (27-28%) rather than 4 person households (13 %)
- Households without children present (27%) compared with those with (16%)
- Households modelled to be under-occupying (32%) compared with those not (21%)

It is worth noting that there was no clear relationship between having unheated habitable rooms and a household's fuel poverty status, nor the floor area of the dwelling.

It is interesting to compare the results presented above for the EFUS 2017 data with those obtained from the 2011 EFUS. Re-analysis of the 2011 data to look at heating habits for habitable rooms only[23] has shown that 30% of households turned their main heating off in one or more habitable rooms (compared with 27% in 2017) and 26% of households had one or more habitable rooms left unheated (compared with 24% in 2017). Neither of these changes were significantly different which suggests that householders' behaviour regarding heating extent in habitable rooms hasn't changed over that time.

However, the structure of the EFUS 2011 data enables additional analysis on the total numbers of unheated habitable rooms, as information was collected on a room by room basis for all room types. In 2011, of those households that had at least one unheated habitable room, for 55% of households this was one habitable room only, for a further 26% of households it was two rooms and a further 14% it was three rooms. Analogous to the results found in EFUS 2017, the vast majority of unheated habitable rooms in 2011 were bedrooms; in 80% of households with one unheated habitable room, the room was a bedroom; in 73% of households with two unheated habitable rooms both rooms were bedrooms and the remaining 27% of households predominantly had one unheated bedroom plus either an unheated kitchen-diner, living room or dining room (although results are indicative only due to small sample size). The re-analysis of the 2011 EFUS data confirms that the EFUS 2017 results underestimated the total number of unheated rooms for those households that do leave a proportion of their home unheated, as households with more than one unheated bedroom were not represented in the EFUS 2017 data.

3.6 Supplementary heating

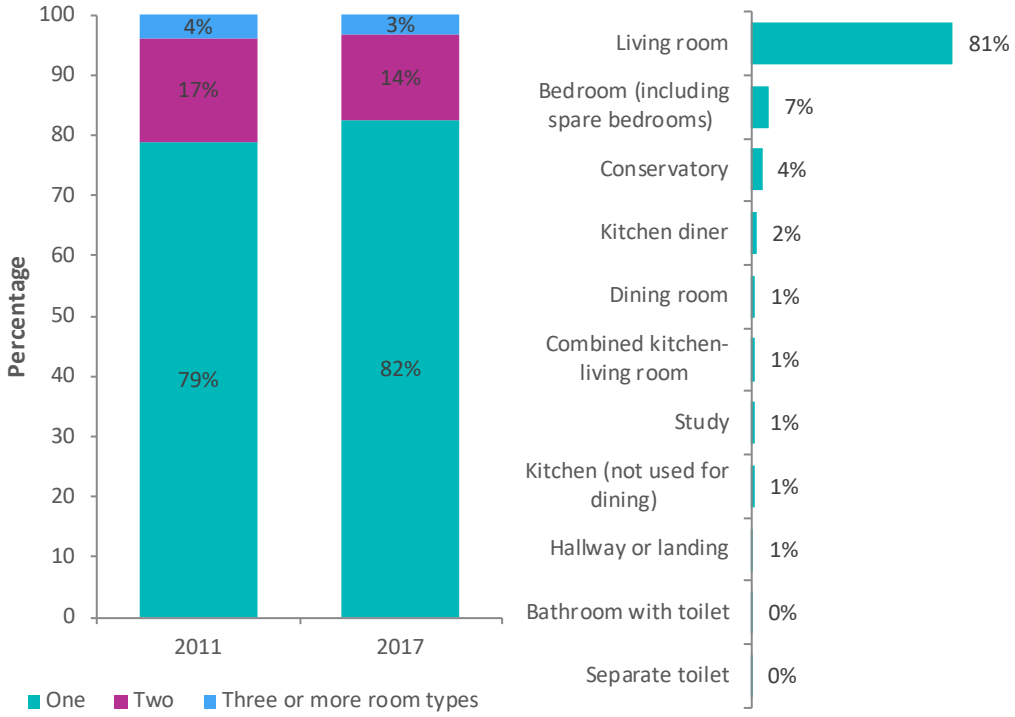
Supplementary heating systems are those used in addition to the main heating system i.e. to provide additional heat (either when the main heating is on, or as temporary ancillary heat when the main heating is not on)[24]. In Interview 2 around 39% of households (approximately 8.9 million households) reported using a supplementary heater in at least one room in addition to the main heating system in the winter. This proportion was similar in the EFUS 2017 Interview 3 data (38%). The use of supplementary heating has decreased since EFUS 2011 ($p<0.001$), when close to half of all households (48%) reported using supplementary heating in at least one room.

The majority of households using supplementary heating were only using it in one room type (82%); most of whom (81%) were using it in a living room. Those households reporting using supplementary heating in two room types were typically using it in a living room (92%) and then most commonly in a dining room or bedroom. The results for the numbers and types of

[23] Results presented for EFUS 2011 on main heating extent and unheated rooms (Report 4: Main heating Systems and Report 5: Secondary Heating Systems) are based on all rooms in the dwelling.
[24] Annex tables containing the underlying data for this section can be found in 'Chapter 3 Annex Tables_Section3_6.xls'.

rooms that supplementary heating is used in appears to have changed little since EFUS 2011[25] (Figure 3.10).

Figure 3.10: Number of room (types) where supplementary heating was used, 2011 and 2017 comparison. Types of room supplementary heating used in if used in 1 room only (2017)

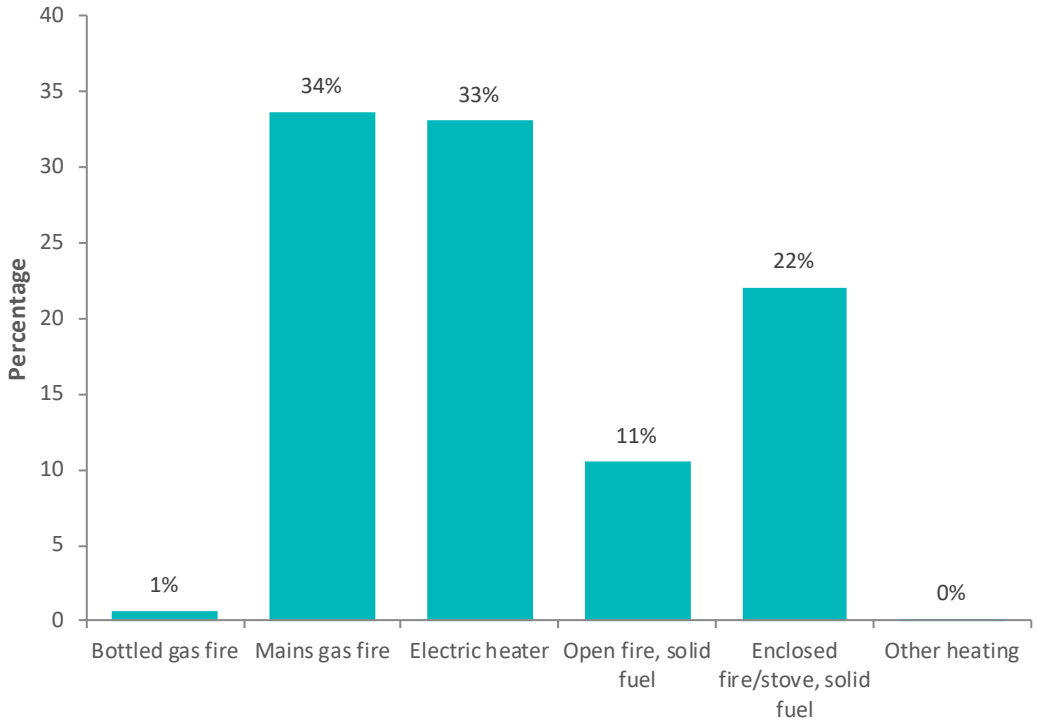


Base: all households using supplementary heating in at least one room, (n=473 , 2017), Interview 2.

Looking in detail at the 7.4 million households who used supplementary heating in the living room (33% of households with a living room present), these were split roughly evenly between a mains gas fire (34%), an electric heater (33%) or a solid fuel fire (33%), (Figure 3.11).

[25] EFUS 2011 Report 5: Secondary Heating. See section 3.3.1.

Figure 3.11: Living room: type of supplementary heater



Base: all households with supplementary heating in the living room (n=394), Interview 2.

Similarly to 2011, the majority of households that use supplementary heating in the living room do so relatively often, where some 60% of households with supplementary heaters use them at least once a week in winter (compared with 69% in 2011). Around a quarter of households (27%) were using these heaters every day.

Where households used supplementary heaters every day in the living room, the median number of hours that the supplementary heating was used was four hours on a weekday (IQR LQ=2.5 hours, UQ=6 hours) and five hours on a weekend day (IQR LQ=4 hours, UQ=8 hours).

The most common reasons[26] given by all households that used supplementary heating in the living room were:

- To heat the room being used rather than the whole house (46%)
- We like the look and feel of it (41%)
- The main heating is not able to make the room warm enough (31%)

The trend for solid fuel stoves being used for aesthetic purposes in addition to providing supplementary heat is supported by the contrasting reasons for use given. Households using gas or electric heaters were most likely to report using it to ‘heat the room in use’ rather than the whole house (48%), with a further 33% reporting that the living room ‘was not warm

[26] Multiple responses were allowed.

enough' using the main heating system. In contrast, households using a solid fuel fire/stove were most likely (80%) to report that they 'liked the look and feel of it'.

Analysis by socio-economic and dwelling characteristics suggests that the following were more likely to use supplementary heating in a living room compared with other categories within their group:

- **Tenure** Owner occupiers (40%) compared with all other tenures (local authority (17%), housing association (18%); private rented sector (23%))
- **Under-occupiers** Under-occupiers (45%) compared with those not under-occupying (28%)
- **Dwelling type** Households living in detached houses (53%) compared with all other dwelling types (14%-38%). Households in flats were the least likely to have used supplementary heating in the living room (14%) compared with all house types (37%). Related to this, households living in the largest dwellings (140m2 or more) were most likely to have used supplementary heating (55%) compared with dwellings less than 90m2 (20-27%)
- **Dwelling age** Households living in the oldest dwellings (pre 1919) (49%) compared with dwellings built after 1945 (19-32%)
- **Rurality** Households in rural areas (50%) compared with those in urban areas (31%)
- **Fuel type of main heating** Households who used a non-metered fuel (53%) as their main heating fuel compared with those using electricity or gas (24-32%)
- **EPC bands** Households living in dwellings with EPC bands D, E, F and G (36%-52%) compared with those living in dwellings with bands A, B and C (19%)

There was no indication of any link between the use of supplementary heating and fuel poverty status. Interestingly, repeating the above analysis on those households using supplementary heating in their living room, but excluding those that used it because they 'like the look and feel of it', many of the above differences were no longer evident and significant results only remained for houses compared with flats and those in the lower EPC bands compared with A/B/C.

Where supplementary heating was used in the bedroom (1.0 million households; 4% of households with a bedroom present), 93% of these heaters were electric. Around half of households that used supplementary heating in the bedrooms (55%) were using these heaters every day in the winter and a further 30% used only in unusual circumstances e.g. very cold weather. The most commonly reported reasons given by households for using supplementary heating in the bedroom were because the main heating system in the room was not able to keep the room warm enough (46%) and because it was the room in use (43%).

4. Occupancy and space heating patterns

This chapter examines households' reported occupancy patterns and how these relate to household and dwelling characteristics, space heating patterns and fuel poor and non-fuel poor households. All findings are based on the Interview 3 survey unless otherwise stated.

4.1 Occupancy patterns

Households were asked whether 'generally speaking' someone was at home during the morning (9am to 1pm), afternoon (1pm to 5pm), evening (5pm to midnight) and overnight (midnight to 9am) periods for weekdays, Saturdays, and Sundays (if different to Saturdays) during the winter (2018/19).

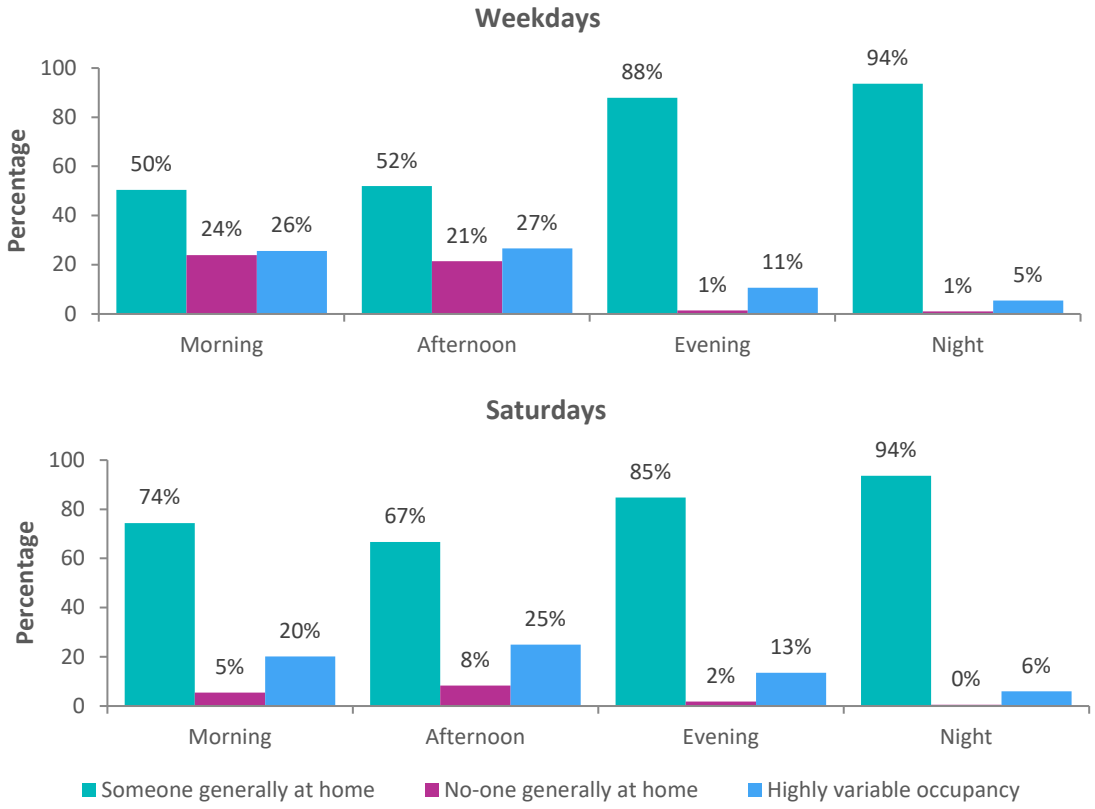
For weekdays, 88% of households reported that there was someone generally at home during the evening and 94% reported someone being at home overnight (Figure 4.1). During the daytime 50% of households had someone in during the morning and 52% had someone in during the afternoon. Some 24% and 21% of households reported that there was no-one generally at home during the morning and afternoon respectively, and 26% and 27% of households reported that their occupancy during these time periods was highly variable[27].

For Saturdays, 85% of households reported that there was someone generally at home during the evening and 94% reported someone being at home overnight. During the daytime this decreased to 74% of households having someone in during the morning and 67% having someone in during the afternoon. Between 5% and 8% of households reported that there was no-one generally at home during the morning and afternoon respectively, and 20% and 25% of households reported that their occupancy during these time periods was highly variable.

The difference between weekdays and Saturdays occupancy status for morning, afternoon and evening periods was significant for all of the yes or no categories, with the highly variable occupancy category only different for weekday mornings compared with Saturday mornings.

[27] Annex tables containing the underlying data for this section can be found in 'Chapter 4 Annex Tables_Section4_1.xls'.

Figure 4.1: Morning, afternoon, evening and overnight occupancy for weekdays and Saturdays



Base: all households (n=1,177 weekdays, n=1,179 Saturday), Interview 3.

Some 91% of households stated that someone was generally at home during the same periods on Sundays as for Saturdays. For the 9% of households that had different occupancy patterns on Saturdays compared with Sundays, households generally switched from being 'highly variable' on Saturday to being 'in' on Sundays.

To aid analysis relevant to energy modelling policy, simple occupancy derived variables were created for occupancy between 9am and 5pm (morning and afternoon combined) for a typical weekday and weekend[28], and is referred to going forward as 'daytime occupancy'.

During weekdays 43% of households generally had someone at home throughout the daytime; this was significantly higher on the weekend (60%) (Figure 4.2). Conversely, during weekdays 18% of households reported nobody home during the daytime; this was only 2% of households on the weekends. Interestingly, the same proportion (just over a third) of households reported variable daytime occupancy for weekdays (39%) and weekends (38%).

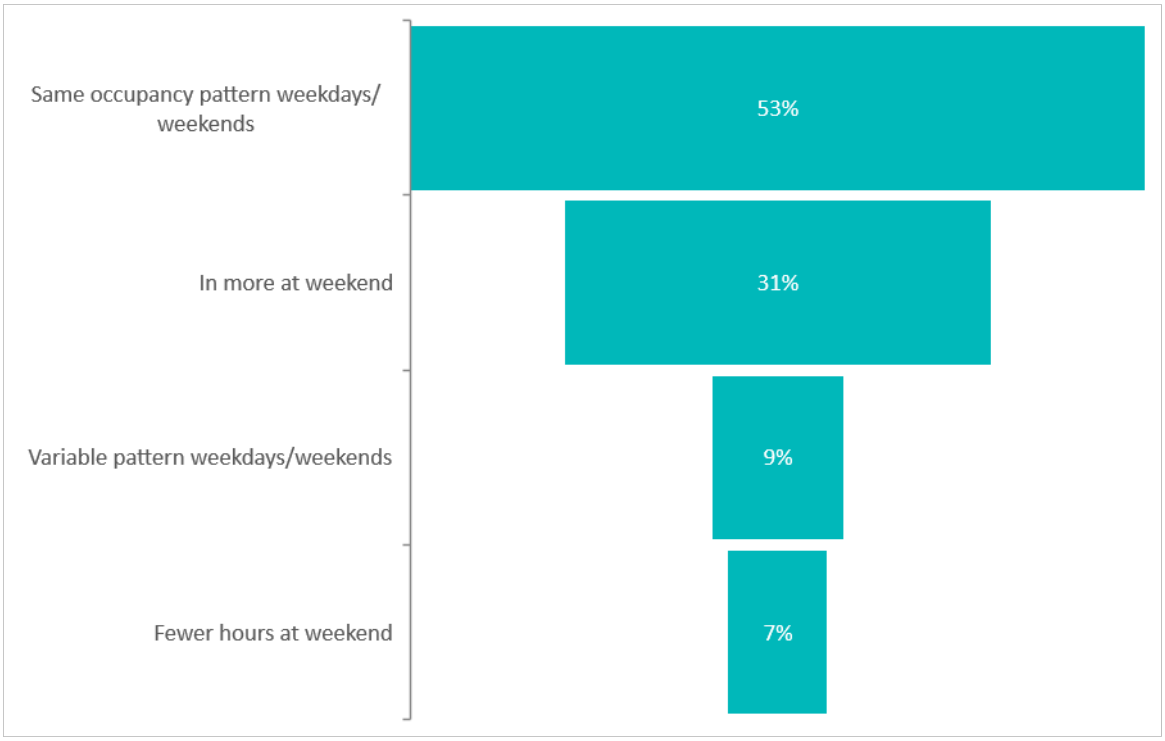
[28] Saturdays and Sundays were combined and averaged into a 'weekend' variable since some 91% of households reported being at home for broadly similar periods on both these days.

Figure 4.2: Daytime occupancy during weekdays and weekends

Base: all households (n=1,176 weekdays, n=1,178 weekends), Interview 3.

Analysis showed that just over half (53%) of all households did not change their daytime occupancy patterns between weekdays and weekends (Figure 4.3). A further 31% of households reported someone generally home for more time during the daytime at the weekend than during weekdays, while 7% of households reported being in for fewer hours during the daytime at the weekend compared with a weekday.

Figure 4.3: Daytime occupancy comparison between weekdays and weekends

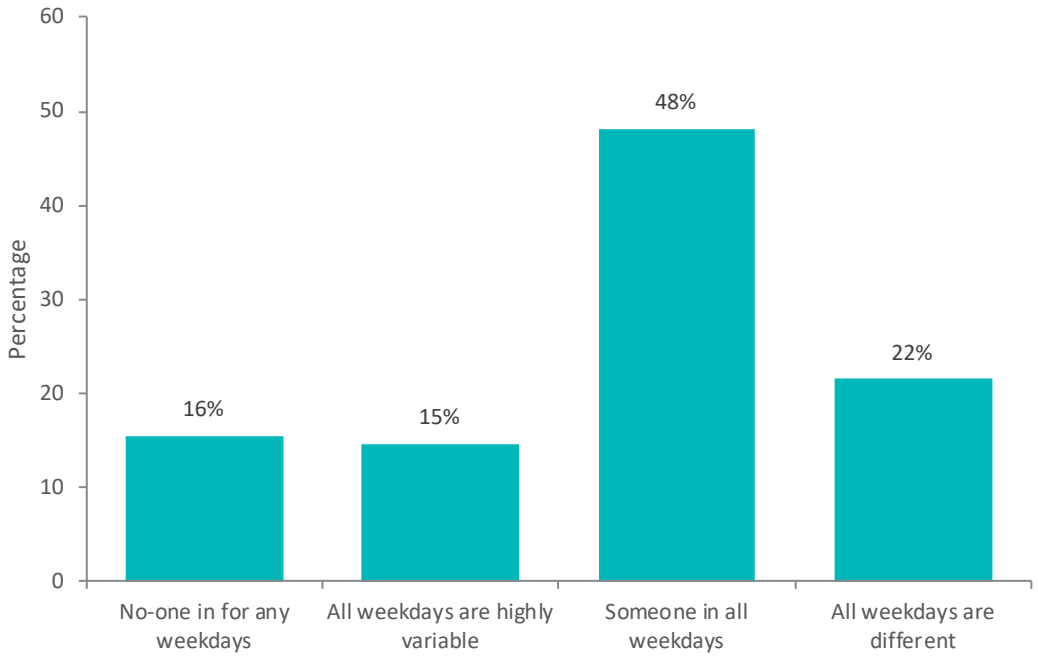


Base: all households (n=1,176), Interview 3.

In Interview 3, in addition to the 'typical weekday' occupancy question (Figure 4.1), households were also asked about their daytime occupancy for each week day individually (Monday to Friday)[29]. Responses were grouped across the weekdays and Figure 4.4 shows that around 22% of households changed their daytime occupancy on different weekdays.

[29] As a methodological point the same response categories were used (yes/no/highly variable/don't know) but it should be noted that specific timings for what 'daytime' referred to were not given to the respondent in this question.

Figure 4.4: Monday to Friday daytime occupancy



Base: all households (n=1,167), Interview 3.

4.2 Daytime occupancy and socio-economic and dwelling characteristics

The following findings suggest, perhaps unsurprisingly, that the key factors influencing daytime occupancy among households were the age of the occupants, their employment status, household size, and if the household had someone who reported having a long-term sickness[30].

Weekday occupancy

The following household groups were more likely to report having someone in during the daytime:

- **Pensioner present** Households with someone over the state pension age (63%) compared with those without (34%)
- **Employment status** Households with all adults unemployed (60%) compared with those households where someone was employed (35%)
- **Household composition** Couples aged 60 and over with no dependent children (67%) compared with any other types of households (ranging from 24% to 50%)

[30] Annex tables containing the underlying data for this section can be found in 'Chapter 4 Annex Tables_Section4_2.xls'.

- **Long-term sick or disabled** Households with either a long-term sick or disabled HRP or partner (as defined by EFUS) (56%) compared with other households (37%)
- **Income** Households in the lowest two income quintiles (52% to 55%) compared with those in higher income quintiles (36% to 37%)
- **Fuel poverty** Fuel poor households (57%) compared with non-fuel poor households (42%)
- **Household size** Households with five or more persons (67%) compared with single person households (37%)

The following household groups were more likely to report having no-one in during the daytime:

- **Pensioner** present Households under the state pension age (25%) compared with those with a pensioner present (2%)
- **Employment status** Households with someone employed (25%) compared with those with no-one employed (3%)
- **Age or HRP** Households with HRP aged under 35 (43%) compared with those where the HRP was older (24% or lower)
- **Household composition** Single person households under 60 (34%) and couples under 60 with no dependent children (32%) compared with single/couple households with someone over 60 (no dependent children) or couples with dependent children (15% or lower)
- **Long-term sick or disabled** Non long-term sick or disabled households (22%) compared with long-term sick or disabled households (9%)
- **Tenure** Households living in the private rented sector (27%) compared with households living in the social rented sector (12% or lower)

Interestingly, there were no significant differences across any of the socio-economic variables for those households that reported having highly variable daytime occupancy. Perhaps unsurprisingly daytime occupancy during the weekday was not related to any dwelling characteristics, including the dwelling's EPC band.

Weekend occupancy

The findings were different for weekend occupancy. Unsurprisingly, given that households were more likely to be in all day and only 2% of households had no one in during the daytime during the weekend, the differences in the proportion of each social demographic group were less. In fact, the only difference that remained for daytime occupancy at the weekend was that single person households were less likely (48%) to be in all day than all other household sizes (62% to 72%) and more likely to have variable occupancy (49%) than households with 2 to 4 persons (less than 37%).

Households changing weekday and weekend occupancy

As expected, the differences for households that changed their occupancy patterns between the weekdays and weekends were related to household composition, age and employment status of the households. The findings indicated that working couple households or single households with no one long-term sick or disabled were mostly likely to change their occupancy pattern.

Analysis by the socio-economic variables highlighted the following groups were more likely to change their occupancy between the weekday and weekend:

- **Household composition** Couples under 60 years with no dependent children (62%) compared with both couples (no dependent children) and single persons over 60 (25% and 38%). This was also seen in the analysis by age of HRP
- **Employment status** Households with someone employed (56%) compared with those with no-one employed (30%)
- **Long-term sick or disabled** Households with no-one long-term sick or disabled (53%) compared with households with someone long-term sick or disabled (35%).

4.3 Daytime occupancy and space heating

There was no difference in daytime occupancy patterns (for either weekdays or weekends) in households with central heating versus non-central heating, nor between households using different ways of controlling their main heating, nor between households that did, or did not use any secondary heating, nor between those reporting using any ‘boost’ heating. The findings suggest that those households that were at home more were no more likely to have more efficient or easier to manage heating systems or were managing their heating in a different way to those households that were at home less during the daytime[31].

There were some links between occupancy patterns and heating use. This section will explore occupancy patterns by the heating season, heating periods and heating hours.

There was no link between when a household started their heating season (section 3.3) or the duration of the heating season (section 3.3) and daytime occupancy patterns during a weekday or on the weekend.

For centrally heated homes with regular heating periods, on a typical weekday, households with no-one in during the day were more likely (77%) to have their heating come on twice a day compared with households that had variable (60%) or all day (48%) occupancy. The former were also less likely (6%) to have used three or more heating periods compared with both the variable and all day occupancy types (22%). Households that had someone in all day were more likely (30%) to have their heating come on once during the day compared with other

[31] Annex tables containing the underlying data for this section can be found in ‘Chapter 4 Annex Tables_Section4_3.xls’.

households. There were no significant differences in weekend heating periods and weekend occupancy.

Households that changed their daytime occupancy between a typical weekday and weekend day were also more likely (70%) to change their heating periods compared with those that kept the same weekdays and weekend occupancy patterns (30%).

While median weekday main heating hours for all households were 7hrs:00mins (see 3.3.4), households that were in all day heated, on average, for more hours (median = 8hrs:30mins) than households that had variable daytime occupancy (median = 7hrs:00mins) or were out all day (median = 6hrs:00mins) (Table 4.1).

On a typical weekend day, there were no significant differences in the median number of main heating hours between the three daytime occupancy groups; both those households with no-one in and those with someone in all day heated, on average, for 8hrs:00mins and those with variable weekend day occupancy heated, on average, for 7hrs:30mins. Note that the small sample size for households with no-one in during the day at the weekend means this result is indicative only.

Table 4.1: Median daily hours of heating by weekday and weekend daytime occupancy

	Weekday someone in between 9am and 5pm			Weekend someone in between 9am and 5pm		
	Sample size	Median	IQR	*Sample size*	Median	IQR
No	*131*	6:00	(4:00,7:30)	*22*	8:00	(5:00,9:00)
Variable	*392*	7:00	(4:30,9:30)	*351*	7:30	(5:30,10:30)
Yes all day	*525*	8:30	(6:00,13:00)	*631*	8:00	(6:00,13:30)
Total	*1048*	7:00	(5:00,10:00)	*1004*	8:00	(6:00,12:00)

Base: all households (n=1,186), Interview 3.

As shown in Table 4.2, all households that reported the same occupancy patterns for a weekday and weekend day also reported the same main heating hours, on average, for a weekday and weekend day. Households that reported being in their home, both for more hours at the weekend and those who had a variable pattern for all days, reported slightly higher weekend heating hours, on average, compared with a weekday. The difference in heating hours for households that were at home fewer hours at the weekend was not significantly different.

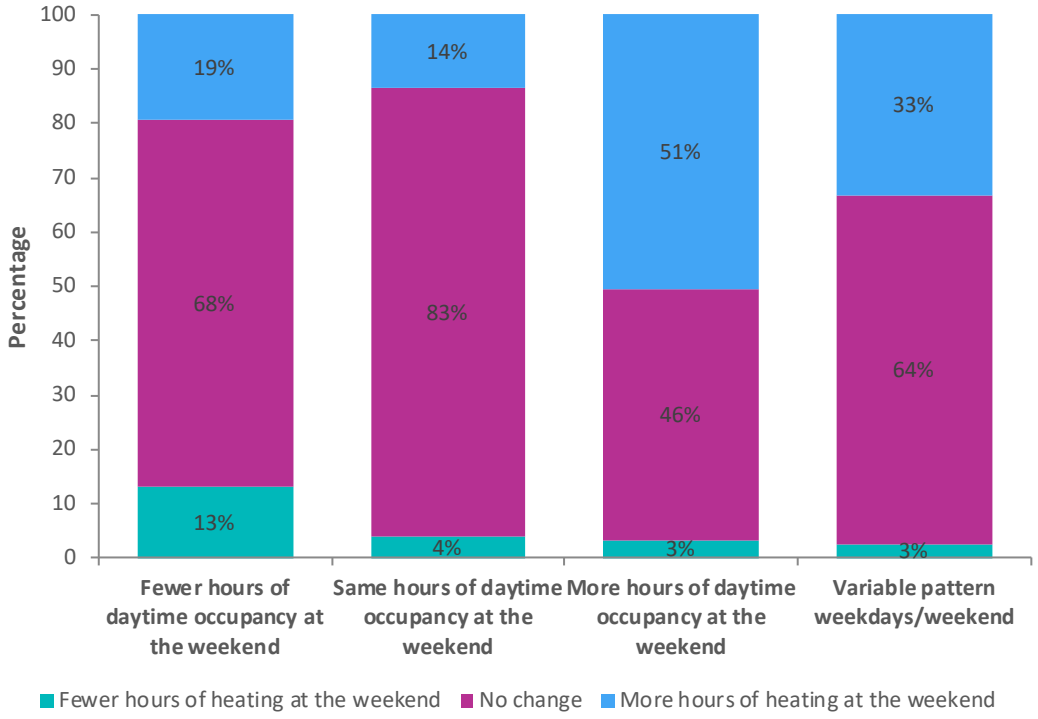
Table 4.2: Median weekday and weekend main heating hours by changing occupancy status

	Weekday main heating hours			Weekend main heating hours		
	Sample size	Median	IQR for median	*Sample size*	Median	IQR for median
Same hours	*611*	8:00	*(5:30,12:00)*	*593*	8:00	*(6:00,13:30)*
Fewer hours at weekend	*83*	8:30	*(6:00,11:00)*	*79*	9:00	*(7:00,12:00)*
More hours at weekend	*256*	6:00	*(4:00,8:00)*	*237*	7:00	*(5:00,10:00)*
Variable pattern weekdays/weekend	*98*	7:00	*(4:00,9:30)*	*95*	8:00	*(5:00,10:00)*
Total	*1048*	7:00	(5:00,10:00)	*1004*	8:00	(6:00,12:00)

Base: all households, Interview 3.

Households' reported changes between their weekday and weekend occupancy status were compared with their changes in weekday and weekend main heating hours. Figure 4.5 shows that for those households that reported someone being at home for more hours on a weekend than a weekday, approximately half of them (51%) reported also increasing their hours of heating at the weekend, whilst 46% mainly kept the same hours of heating as they did during a weekday.

Figure 4.5: Change in main heating hours between weekday and weekend day by changing weekday-weekend daytime occupancy status



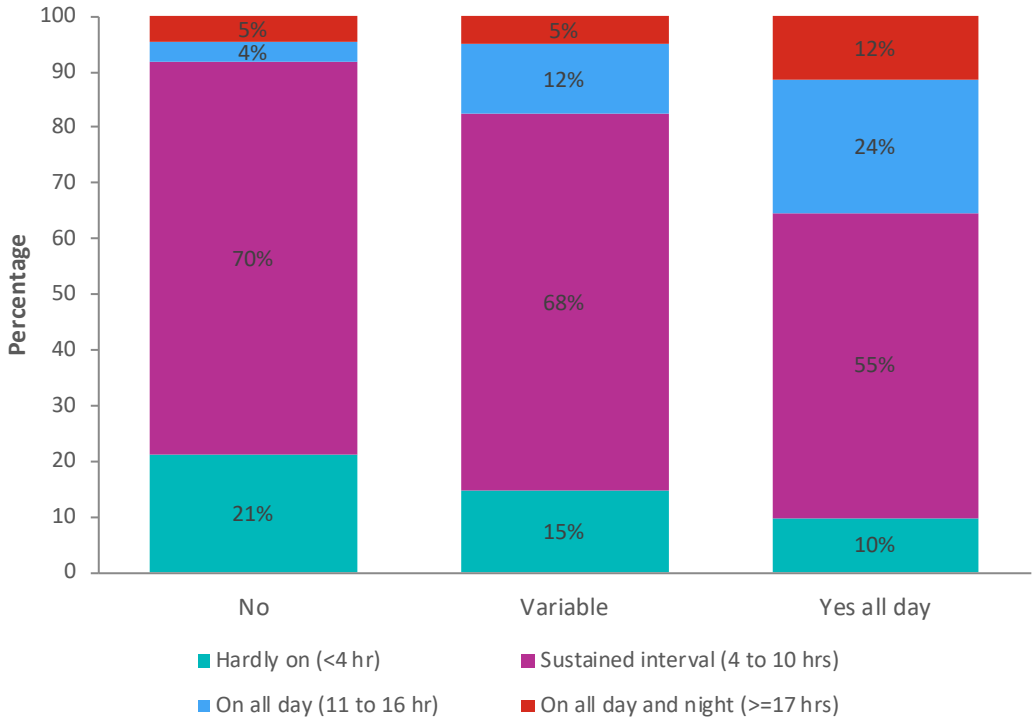
Base: all households (n=588), Interview 3.

Timeframe of main heating: Whilst the majority of households (63%) heat their homes for a sustained interval (4 to 10 hours a day)[32] during weekdays there was further evidence that

[32] See footnote 13 for a description of the timeframe variable.

longer heating hours were related to occupancy patterns. Households that reported someone in all day during weekdays were more likely to heat for more than 10 hours compared with those households that had no-one in, or had variable weekday daytime occupancy. The current fuel poverty modelling methodology assumes that households with someone generally at home during the weekday daytime, heat their home for 16 hours a day, rather than for 9 hours which is the SAP-based standard used for all other households. Whilst the EFUS data provides some evidence to support this assumption, it is worth noting that the majority of households that have someone in all day are not, in practice, heating for this extended length of time (Figure 4.6).

Figure 4.6: Timeframe of weekday main heating hours by weekday occupancy status



Base: all households (n=1,028), Interview 3.

4.4 Daytime occupancy, fuel poverty and space heating

As reported in Section 4.2, fuel poor households were more likely (57%) to have someone at home all day during weekdays (and subsequently less likely to have no-one in during the day) compared with non-fuel poor households (42%). However, weekend occupancy was more generic across households as almost all households either had someone in all day or were highly variable in their daytime occupancy. Fuel poor households were also less likely (14%) to change their daytime occupancy across different weekdays compared with non-fuel poor households (23%)[33].

[33] Annex tables containing the underlying data for this section can be found in 'Chapter 4 Annex Tables_Section4_4.xls'.

There was some evidence for a difference in the average (median) main heating hours for households that reported someone in all day (weekday), between those that were fuel poor and those that were not fuel poor. Fuel poor households that were in all day heated on average for one hour less (8hrs:00mins) than non-fuel poor households (9hrs:00mins), however, this difference was only significant at the 10% level[34]. Readers are referred to the EFUS 2017 'Thermal Comfort' report for analysis of the internal temperatures in these households.

There was no evidence of a difference in the use of supplementary heaters between fuel poor and non-fuel poor households that had someone in all day on a typical weekday.

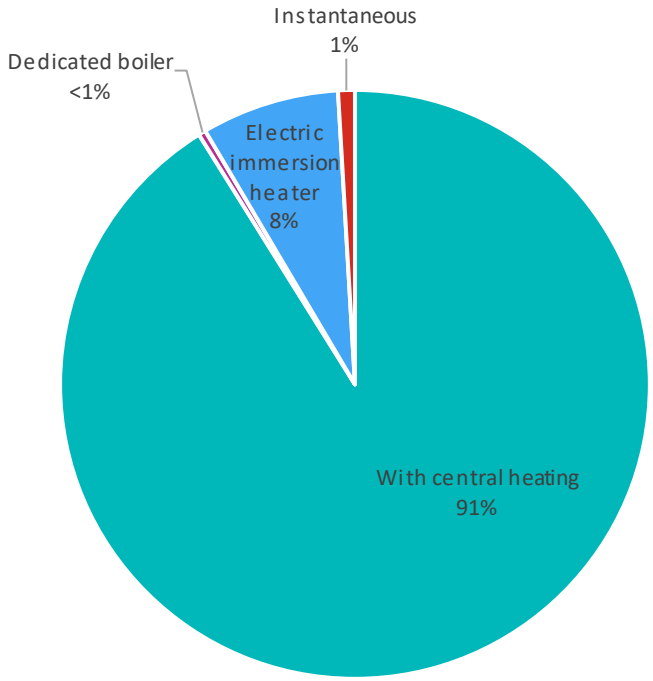
5. Hot water systems and usage

This section examines the use of immersion heaters for summer and winter water heating, along with an analysis of the ownership and use of baths and showers by households[35]. Data on the use of immersion heaters 'in a typical week in summer' and the types of shower used most often were collected during Interview 1; the use of immersion heaters in winter and the numbers of baths and showers taken were collected during Interview 2.

Figure 5.1 shows the main type of water heating system present in dwellings in the EFUS survey, based on information collected in the physical survey of the EHS[36]. Clearly, the heating of water by the central (space) heating boiler is the predominant system in use, with dedicated electric immersion heaters being used in 8% of households, and separate instantaneous water heaters in only 1% of households. The EHS 'Energy Efficiency, 2016' report showed that the proportion of dwellings with a hot water cylinder and immersion heater as the primary means of water heating had decreased steadily from 17% to 7% between 1996 and 2016[37].

[34] p=0.077
[35] Annex tables containing the underlying data for analyses by dwelling and household groups reported in this chapter can be found in 'Chapter 5 Annex Tables_dwelling and household.xls'.
[36] Annex tables containing the underlying data for this section can be found in 'Chapter 5 Annex Tables_Section5_0.xls'.
[37] https://www.gov.uk/government/statistics/english-housing-survey-2016-energy-efficiency

Figure 5.1: Types of water heating systems



Base: all households (n=2,632), Interview 1.

Of the 1.8 million households in EFUS 2017 that had an electric immersion heater as their primary source of hot water, the majority of these (89%) were households with non-central heating as their main space heating. Only a small number of households (193,000) with central heating had an electric immersion heater as their primary source of hot water (less than 1% of all households with central heating)[38]. Of course, some households with central heating systems will also have an electric immersion present as an auxiliary method of heating their water; those with either a standard boiler, back boiler or standard condensing boiler (38% of all boiler types) will have a hot water cylinder and therefore the potential to have an electric immersion heater as an additional water heating system. In contrast, households with combination boilers (either standard combi or condensing-combi, 62% of boiler types) heat water directly, generally without a separate cylinder. Between 49% and 60% of households with either a standard boiler, back boiler or standard condensing boiler reported that they had an immersion heater. To put into context, this means that around 22% of households with central heating had an immersion heater installed and 78% of non-centrally heated households had an immersion heater installed.

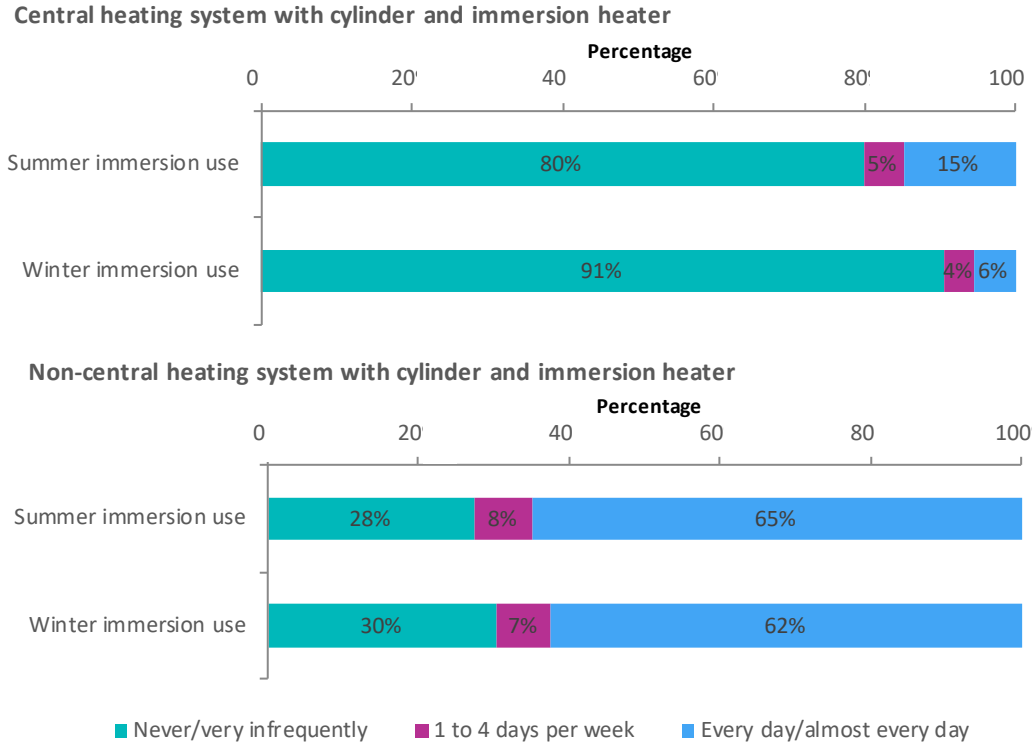
5.2 Use of immersion heaters

Figure 5.2 shows households' reported use of their immersion heaters in the summer and the winter, split by households with central heating systems (with cylinder and immersion) and

[38] Although the sample sizes of this group is too small to be reported (n=17), the data indicates that around a third have communal heating as their main space heating; it is not possible to state with any certainty, but the remainder may have a warm air system as these systems were included within the 'central heating' category.

non-central heating systems (with cylinder and immersion). Just 15% of households with central heating systems reported using their immersion 'every day' in the summer, decreasing to 6% in the winter. In comparison, 65% of households with non-central heating systems reported using their immersion 'every day' in the summer and this changed little for the reported winter use (62%)[39].

Figure 5.2: Immersion heater use in the summer and winter by main heating system



Base: all households that stated the use of their immersion heater in summer (n=367), Interview 1 and winter (n=669) Interview 2.

It is interesting that 28-30% of households without central heating reported never, or very infrequently, using their immersion in either summer or winter, even though this was purported to be their main source of hot water. However, the sample size was small for this group (n=31 winter; n=51 summer) which in itself represented less than 2% of all households.

Also of interest were the 15% and 6% of households with central heating (with cylinder and immersion) that reported using their electric immersion every day in the summer and winter respectively. Small sample sizes restrict reporting further analysis but there were indications that households in fuel poverty and those in social tenures may be more likely to use their immersion heaters every day in the winter than other groups. Further work in this area is recommended to determine if this is the case.

[39] Annex tables containing the underlying data for this section can be found in 'Chapter 5 Annex Tables_Section5_1.xls'.

5.3 Ownership and use of showers and baths

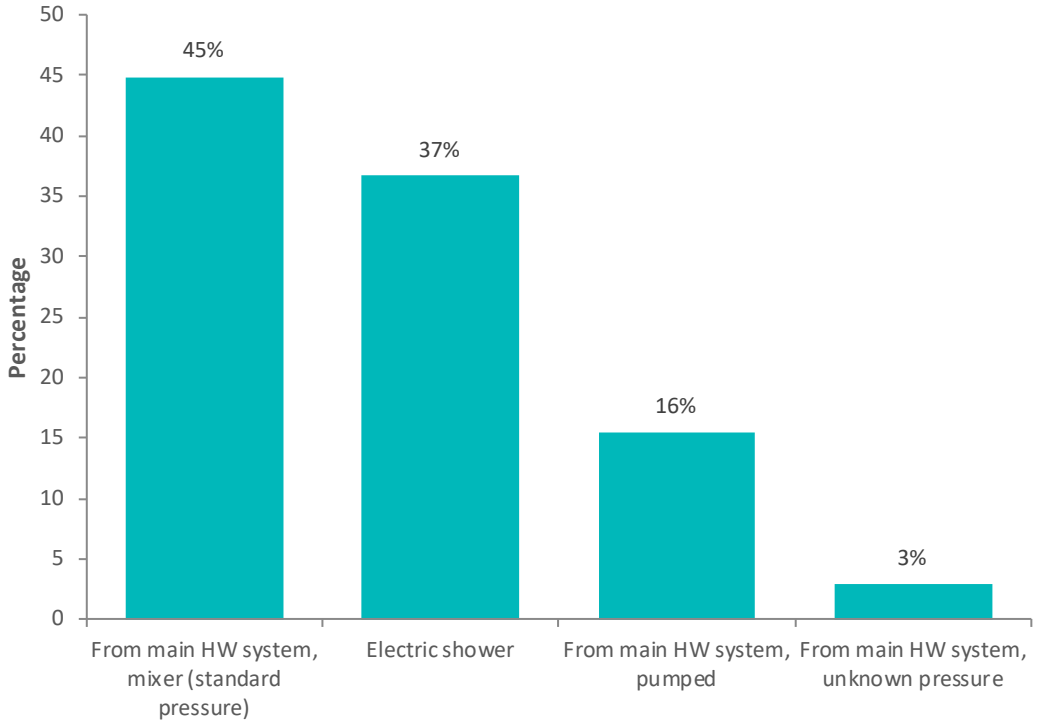
Some 81% of households had both a bath and a shower[40] in their home[41]. Some 7% (1.8 million households) reported having no shower and 12% of households (2.9 million households) reported having no bath in their home. The most significant differences in whether a household had both a shower and a bath installed, or either a bath or shower exclusively, were seen in the dwelling type and floor area of the dwelling, household size and tenure. Households in bungalows (61%) were the least likely to have both facilities compared with other dwelling types (72%-93%). While households in homes under 50m2 were more likely (30%) to have only a shower installed compared with larger homes (13% or less). Single person households (72%) were the least likely to have both facilities compared with households of two or more persons (83% to 91%) and they were most likely to have only a shower installed (21%) compared with households with two or more persons (12% or less). Owner-occupiers (86%) and private renters (82%) were more likely to have both a bath and a shower compared with local authority (60%) and housing association (68%) households, who in turn were most likely (21% and 16% respectively) to have only a bath (compared with owner occupiers 3% and private renters 7%).

There was some evidence that fuel poor households were more likely to have only a bath installed (13%) than non-fuel poor households (6%), but equally likely to have only a shower (11%) or both bath and shower (76%) installed compared with the non-fuel poor (12% and 82% respectively)[42].

Of the 93% of households with a shower installed, just over a third were electric showers (37%) whilst the majority were supplied by the main hot water system (63%); 16% of all showers were pumped (power) showers supplied by the main hot water system (Figure 5.3).

[40] Households were asked about the type of shower they used ‘most often’.
[41] Annex tables containing the underlying data for this section can be found in ‘Chapter 5 Annex Tables_Section5_2.xls’.
[42] Significant at the 5% level ($p<0.05$)

Figure 5.3: Shower type



Base: all households with a shower (n=2,357), Interview 1.

Exploring the shower type by the socio-economic and dwelling characteristics, it was found that dwelling characteristics such as floor area and dwelling type were better predictors of shower types than the socio-economic characteristics. The largest dwellings with a floor area of 140m2 or more (32%) were more likely to have pumped showers installed than smaller dwelling types (9% to 26%). Similarly, detached dwellings were more likely (30%) to have pumped showers installed compared with other dwelling types (11% to 17%). Linked to this, detached dwellings were least likely (25%) to have electric showers installed than other dwelling types (33% to 46%). The socio-economic characteristics, which were not as significant, nonetheless showed some interesting results; social renters (58%) were more likely to have electric showers than both private renters (37%) and owner occupiers (32%) and pumped showers were more likely to be installed in households in the highest income quintile (26%) than those in lower income groups (7% to 16%).

For households that did have a shower, fuel poor households were more likely to use an electric shower (47%) than non-fuel poor households (35%). Fuel poor households were also less likely to use a pumped shower from the main hot water system than non-fuel poor households (10% compared with 16%).

5.2.1 Bath and shower use

The current BREDEM 2012 modelling methodology uses equations to estimate the number of showers and baths taken per day dependent on the number of occupants; these feed into the estimation of the energy required to heat water. The equation for the number of baths taken per day depends on whether there is also a shower present in the dwelling or not. The type of

shower is also required in order to estimate a) the volume of hot water used per shower[43] and b) the energy required for electric showers. The forthcoming version of SAP, SAP 10[44], further differentiates the estimation of the number of showers taken per day so that two equations are used dependent on whether there is also a bath present in the dwelling or not.

Table 5.1 shows the median number of daily baths and showers taken per person for households that only had a bath, only a shower or had both a shower and a bath installed[45]. It highlights that in households where both a bath and a shower were installed the bath is used less frequently, as the median number of baths taken was lower than the number of showers taken (0.07 baths daily per person; 0.83 showers daily per person). A similar pattern was found when comparing households that had only bath/s (0.36 baths daily per person) with households that had only shower/s (one shower daily per person) – typically, baths were used less frequently than showers.

Table 5.1: Median showers/baths per person daily by ownership of baths and showers

	Number of baths taken daily per person			Number of showers taken daily per person		
	Sample size	Median	IQR for median	*Sample size*	Median	IQR for median
Bath/s only (no shower present)	*117*	0.36	(0.18,0.86)			
Bath/s and shower/s present	*1034*	0.07	(0,0.21)	*1034*	0.83	(0.5,1)
Shower/s present (no bath present)				*188*	1.00	(0.5,1)

Base: all households (n=1,340), Interview 2.

In households with both bath and shower facilities around 41% of them reported not using the bath in a typical week. Furthermore, in these same households, when the reported weekly household bath use was calculated as a daily use per person around 77% never, or very infrequently, used the bath. Showers appeared to be used in preference to baths in households with both facilities; 18% reported that the shower was used less than once a day by the whole household, which, when calculated as a daily use per person, resulted in 5% never, or very infrequently, using the shower.

For households that had either bath or shower facilities installed, some 58% of households showered daily per person (in households with only shower/s) compared with only 19% of households bathing daily per person (in households with only bath/s). Some 35% of households with only a bath did not/very infrequently used it daily per person compared with just 1% of households with only shower facilities.

In centrally heated households with a hot water cylinder and auxiliary immersion, there were no statistically significant differences in the shower and bath facilities available between those that reported using their immersion heater every day versus those that reported never using their immersion heaters. It was considered that perhaps households were having to use their

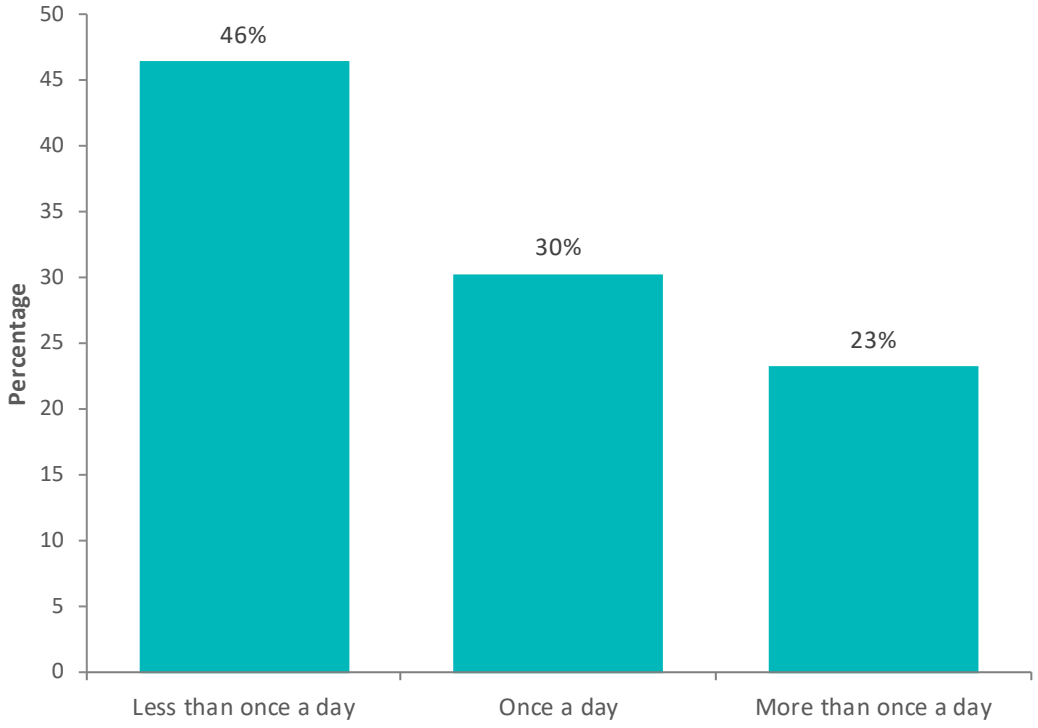
[43] Table 6 in BREDEM 2012: A technical description of the BRE Domestic Energy Model. Version 1.1.
[44] https://www.bregroup.com/sap/sap10/
[45] The number of baths and showers taken daily per person was calculated by dividing the number of baths or showers taken daily in the households by the number of occupants.

immersion to provide additional hot water if they only had a bath available for washing, however the evidence does not support this, for neither summer nor winter use of the immersion.

5.2.2 Water consumption

As a guide to water consumption, the total number of baths and showers taken daily per person in a household has been calculated. Figure 5.4 shows that in around half of all households (46%), each person used the bath and/or shower less than once a day, in a third of households once a day (30%) while in nearly a quarter of households (23%) these were used more than once a day per person.

Figure 5.4: Number of baths and showers taken daily per person in the household[46]



Base: all households (n=1,305), Interview 2.

Examining this by the socio-economic characteristics of the households, the following households were more likely to be taking less than one shower and/or bath per person per day:

- **Household size** Households with three or more persons (60%-80%) compared with two person households (44%) and single person households (26%)
- **Children present** Where the household had one or more dependent children (71%) compared with households that had no dependent children(38%)
- **Employment status** Households with someone employed (49%) compared with unemployed households (42%)

[46] Due to rounding the figure percentages do not add up to 100%.

- **Long-term sick or disabled** Households with someone with a long-term sickness or disability (52%) compare with household with no one with a long-term sickness or disability (43%)
- **Fuel poverty** Fuel poor household (60%) compared with non-fuel poor households (45%)
- **Under-occupiers** Households not under-occupying (49%) compared with under occupiers (40%)

The following households were more likely to be taking a shower/bath once a day:

- **Households size** Single person households (47%) compared with two person households (30%) and all other households (9% to 19%)
- **Children present** No dependent children present (36%) compared with households with dependent children present (13%)
- **Employment status** Unemployed households (40%) compared with households with someone employed (25%)
- **Pensioner present** Households with someone over the state pension age (38%) compared with those with no pensioners present (27%)
- **Fuel poverty** Non-fuel poor households (31%) compared with fuel poor households (21%)

The following household groups were more likely to be taking shower/baths more than once a day:

- **Children present** No dependent children present (26%) compared with those households with dependent children present (15%)
- **Employment status** Households with someone employed (26%) compared with unemployed households (17%)
- **Pensioner present** Households with no pensioners present (27%) compared with those with one or more pensioners present (16%)
- **Long-term sick or disabled** Households with no-one with a long-term illness or disability (27%) compared with those with a person with a long-term illness or disability (16%)

There was no difference between fuel poor households (20%) and non-fuel poor households(24%) using the bath/shower more than once a day.

The above findings highlight the importance of considering the socio-economic characteristics in any predictors of water consumption, especially those related to the size of the households, the presence of children in the household and the employment status of the household.

6. Conclusions

The ‘Heating patterns and Occupancy’ report is the first in a series of reports that present the findings from the EFUS 2017. These findings are based on interviews conducted during the autumn of 2017 (Interview 1: 2,632 households), the winter of 2017/2018 (Interview 2: 1,340 households) and the winter of 2018/2019 (Interview 3: 1,186 households). Almost 51% of the Interview 1 households also completed the Interview 2 survey and some 80% of the Interview 3 surveys had an Interview 1 and Interview 2 survey (944 households), while the remaining 242 households had an Interview 1 survey only.

The three EFUS 2017 interview surveys have returned valuable information on how households reported using their main and secondary heating systems, their typical daytime occupancy patterns and their typical requirement for hot water for bathing. These findings provide background information that underpins much of the analysis that will be presented in the other reports in this EFUS series, in particular the reports on ‘Thermal Comfort’, ‘Energy Consumption’ and ‘Fuel Poverty’.

Space heating systems and heating patterns

Analysis has been carried out to determine the reported heating seasons, weekday and weekend heating patterns, the extent to which the main heating system is used within dwellings, including the occurrence, frequency and reasons for leaving any rooms unheated, and the reported use of supplementary heating. These findings are based on information reported by the household and should be interpreted in this context as there is the potential for responses to be mis-reported or biased in some way; for example the starting month for heating may be reported less accurately by households interviewed towards the end of the survey period.

In general, the structure of the space heating systems and heating pattern data collected in EFUS 2017 was consistent with EFUS 2011 which has enabled timeseries comparisons to be made. The intervening six years have seen some progress towards low-carbon heat technologies, however the EFUS 2017 survey is still primarily an analysis of the heating patterns of households with traditional wet central heating systems (predominantly mains gas fuelled).

The main conclusions can be summarised as:

- Almost all households with central heating had either a main room thermostat and/or TRVs to control the temperature of their main heating, although 2% had neither. The median thermostat set point was 20°C; this has not changed since EFUS 2011.
- The most commonly reported heating season was October to April; this has not changed since EFUS 2011 (in which the household reported data was supported by

analysis of the internal temperature data). This is one month shorter than the standardised heating season used in SAP, which is October to May.

- A comparison of EFUS 2017 and EFUS 2011 provides initial evidence to suggest that heating patterns in households with central heating may be shifting towards more intermittent use of heating periods with an increase in the proportion of households that reported using three or more heating periods in a typical weekday. However, the most common heating pattern, in which the heating came on in the morning for a 'short burst (less than 4 hours)' and then for a second time later in the day for a sustained interval (4 to 10 hours) has not changed since EFUS 2011.
- EFUS 2017 confirms the 2011 EFUS results which showed that households typically used their heating for a similar amount of time on weekdays and weekend days.
- Approximately one-quarter of all households had one or more habitable rooms unheated; this has not changed since EFUS 2011. Unheated rooms were predominantly bedrooms. Additional modelling studies could explore the extent of rooms unheated in terms of dwelling floor area, which could then be aligned more usefully with BREDEM model inputs.
- Use of alternative heating systems was not particularly prevalent, particularly in households with central heating systems.
- The prevalence of supplementary heating has decreased since EFUS 2011, from almost half (48%) of all households in 2011 to just under 40% in 2017, although the numbers and types of rooms that it is used in has changed little over the intervening years. EFUS 2017 has shown evidence for solid fuel stoves being used for aesthetic purposes in addition to providing supplementary heat.

Occupancy and heating

Specific questions on a households' typical occupancy patterns have been collected for the first time in an EFUS survey – EFUS 2011 had relied on the information collected in the underlying EHS survey. The EFUS 2017 results allowed for greater confidence in relating daytime occupancy to patterns of space heating use, as households were asked slightly more detailed questions about their occupancy patterns.

- During a typical weekday 43% of households generally had someone at home 'all day' during the daytime; this was significantly higher on the weekend (60%). A low number of households reported nobody home during the daytime – 18% of households for a typical weekday falling to just 2% of households for a weekend day. A substantial proportion (almost 40%) of households reported 'variable' daytime occupancy both during the weekdays and on the weekend. Some 48% of households reported generally being in during the daytime every weekday.
- Analysis of daytime occupancy by social-economics characteristics was generally in line with expectations; households that were more likely to have someone in during the

daytime on a weekday were either pensioner households, unemployed or long-term sick households.

- There was a relationship between occupancy patterns and space heating use. Households with no-one in during the day on a weekday were more likely (77%) to have their heating come on twice a day compared with households that had variable (60%) or all day (48%) occupancy. Households that were in all day on a weekday heated, on average, for more hours (median = 8hrs:30mins) than households that had variable daytime occupancy (median = 7hrs:00mins) or were out all day (median = 6hrs:00mins). On a typical weekend day, however, there were no significant differences in the median number of main heating hours between the three daytime occupancy groups (median = 8hrs:00mins for all households).
- The current fuel poverty modelling methodology sets a standard for households with someone generally at home during the weekday daytime of 16 hours per day of heating, rather than the 9 hours used for all other households. It is recognised that the fuel poverty methodology sets a desirable standard for heating for households, rather than attempting to reflect actual usage. Affordability may preclude some fuel poor households from achieving this standard. Whilst the EFUS data provided some evidence to support this assumption of longer heating hours for households in all day, it is worth noting that the majority of households that had someone in all day were not, in practice, heating for this extended length of time.
- Around a half of all households did not change their occupancy patterns between the weekdays and weekends and these households also reported the same main heating hours, on average, for a weekday as for a weekend. For households that reported being home for more hours on the weekend, approximately half of them (51%) increased their heating hours on the weekend, whilst almost all of the remainder kept the same heating hours (46%).
- Fuel poor households (57%) were more likely to have someone home all day during weekdays and there was an indication that fuel poor households that were in all day, heated on average for one hour less (median = 8hrs:00mins) than non-fuel poor households that were in all day (median = 9hrs:00mins). This difference was significant only at the 10% level in this study; it is recommended that further research is undertaken to corroborate these findings.

Hot water systems and usage

Results obtained from EFUS 2017 on the use of electric immersion heaters for water heating, and the frequency of use of baths and showers by the household have been presented, with a view to providing up-to-date data to help to validate energy model algorithms in BREDEM, SAP and other models, and to provide supporting information to aid analysis of the EFUS 2017 energy consumption data.

- Some 65% of households with non-central heating systems used an electric immersion to provide hot water every day, all year round. A smaller proportion of households with

central heating systems also reported the daily use of their immersion heater (15% in summer, 6% in winter), even though this is unlikely to be the most cost-effective means of heating water for these households. There was some evidence to show that for dwellings with central heating systems with a cylinder and immersion, fuel poor households and those in social tenures were more likely to be using their immersion than other groups. Further research would be needed to determine if this is the case and to explore whether this was perhaps a consequence of being poorly informed about the most efficient/cost effective way of using the system in place, or perhaps due to an off-peak electricity tariff being used.

- Curiously, close to one-third of households with non-central heating systems reported never, or very infrequently using their immersion in either summer or winter, even though this was purportedly their main source of hot water. However this group does represent less than 2% of all households.
- It is also worth noting that around 62% of households with central heating systems had a combination boiler without a hot water cylinder and therefore no potential to have an electric immersion heater installed; upgrading these water heating systems to low carbon systems, such as solar hot water or air source/ground source heat pumps may be less appealing (and more costly) to householders.
- Some 81% of households had both a shower and a bath in their home, 12% had no bath and 7% had no shower. In just over a third of households with showers, an electric shower was used most often, the remainder being showers fed from the main hot water system. Some 16% of households with showers used a ‘pumped’ shower most often. In households with both shower and bath facilities, showers were typically used in preference to baths and 41% of households with both shower and bath facilities reported never using the bath in a typical week. In households with either a shower or a bath, baths were taken less frequently than showers.
- In future EFUS it may be useful to explore how many showers are available for use in households and the frequency and length of use of each shower, to obtain a more accurate picture energy consumption and water use in relation to household washing habits.

The processing and analysis of data for this report has highlighted some methodological issues that would be worth considering for a future EFUS:

- The manual use of a ‘boost’ of main heating by households with central heating was, as in EFUS 2011, difficult to ascertain from the interview responses; in all likelihood this practice is too spontaneous for respondents to be able to recall accurately and a different method of data collection is required to obtain a proper understanding of this behaviour. Similarly, given that approximately a quarter of all households heated their homes in a non-regular manner, an alternative method of collecting information on exactly how and when space heating energy is being used in these homes may be required e.g. smart meter data. It will be interesting to see whether more households report heating in this way as smart heating controls become more widespread.

- Obtaining detailed and accurate daytime occupancy data from households requires careful consideration of the question formats; the proportion of households that reported generally having some in all day during a typical weekday (with specific timings given) differed slightly when households were asked to report a generic ‘daytime’ occupancy for each individual weekday. To further our understanding of household occupancy patterns on heating requirements and other uses of energy it would be beneficial to ascertain responses for the specific timings of daytime occupancy for all weekdays. Determining whether any household members worked from home would also be a useful factor to relate to energy consumption.

Glossary

Term	Description
Age of dwelling:	This is the date of construction of the oldest part of the dwelling. Recorded by surveyors in the EHS physical survey.
Age of HRP:	The Household Reference Person (HRP) is the person in whose name the dwelling is owned or rented or who is otherwise responsible for the accommodation. In the case of joint owners and tenants, the person with the highest income is taken as the HRP. Where incomes are equal, the older is taken as the HRP. This procedure increases the likelihood that the HRP better characterises the household's social and economic position. The age of the HRP is derived from: variables obtained from the EHS Interview survey for households that had not changed since the earlier EHS interview. householder responses to questions 45-50 in EFUS Interview 1 and questions 41-45 in EFUS Interview 3 for new households.
Alternative heating:	Heating system present in a room (or rooms) used as an alternative to the main heating system.
After housing costs equivalised income – weighted quintiles:	This is calculated based on the fuel poverty income (from 2015 & 2016 fuel poverty datasets) and updated to account for any changes to income at Interview 1 and Interview 3 EFUS questionnaires. Validation of income based on reasons why household income had changed for the Interview 3 questionnaire provided increased confidence and reliability of the income.
Boiler type:	Derived from the EHS data.
Children Present:	Anyone in the household who is 16 years old or younger at the time of the EFUS interview. This is derived from; variables obtained from the EHS Interview survey for households that had not changed since the earlier EHS interview. householder responses to questions 45-50 in Interview 1 and questions 41-45 in Interview 3 in the EFUS questionnaires for new households
Daytime Occupancy	Derived from the EFUS survey. A household has been classified as being 'in during a weekday' if they indicated being generally in the house on weekdays during the winter, for both the morning and afternoon periods. A household is classified as 'not in during the day' if they responded as not being in for both the

Term	Description
	morning and the afternoon periods. Households who were in for either the morning or afternoon period were coded as 'Variable' occupancy.
Dwelling insulation:	The number of insulation measures (0 to 3) where positive responses for 'fully double glazed', 'insulated walls' and having loft insulation greater than 200mm count as insulation measures. EFUS Interview 1 and interview 3 questionnaires asked respondents about new insulation measures installed since the EHS survey. New windows installed since the EHS survey are excluded from the analysis as it cannot be assumed that this resulted in the dwelling being fully double glazed.
Dwelling type:	Classification of dwelling on the basis of the surveyors' inspections during the EHS physical survey.
Employment status of the household:	Derived from W1_q56 of EFUS Interview 1, and the modelling assumes responses are for all adults in the household (HRP, partner and any other additional adults in employment). 'Don't know' responses were coded as having no employment. Households either have at least one person employed, or all adults are unemployed.
Energy Performance Certificate (EPC) band:	Energy Performance Certificate band, also sometimes known as the Energy efficiency rating (EER) band (SAP 2012) of the dwelling. Bands from A to G that are used in the Energy Performance Certificate. 'A' is the most efficient and 'G' is the least efficient. Derived from the SAP 2012 methodology used for the 2016 EHS. SAP2012 was re-modelled for dwellings which have had improvements between the EHS and EFUS Interviews 1 and 3.
Fuel poverty (LIHC) status:	Based on the 'Low Income High Cost' (LIHC) definition, a household is considered to be fuel poor if: they have required fuel costs that are above average (the national median level); were they to spend that amount, they would be left with a residual income below the official poverty line. Each household's fuel poverty status has been updated using EFUS data on household changes, incomes and modelled fuel costs due to dwelling improvements.
Fuel poverty gap:	The difference in pounds between the required energy costs for each fuel poor household and the nearest fuel poverty threshold.
Fuel type of main heating system:	As recorded by surveyors in the EHS physical survey. Grouped into 'mains gas', 'electricity' and 'other', which includes bottled gas, bulk gas, solid fuels, oil and community schemes. The data

Term	Description
	was updated at Interview 2 and Interview 3 if a household reported using a different main heating system. Assumptions for households reporting having central heating but did not answer about fuel type: - Set to mains gas if a mains gas connection was recorded in the EHS - If not on mains gas set to EHS recorded main fuel - If reported not on gas in EFUS Interview 1, then categorised as 'other' gas (e.g. bottled).
Fully double glazed:	Derived from the 'dblglaz4' EHS variable as recorded by surveyors in the physical survey. Fully double glazed is defined as 'entire house double glazed'. Not fully double glazed is anything less than fully double glazed. New windows installed since the EHS survey were excluded from the analysis as it could not be assumed that this resulted in the dwelling being fully doubled glazed.
Heating season:	The months when there is a requirement for the main heating system to provide heat. For the EFUS 2017 survey this is calculated based on householder responses to a question in Interview 2 (what month heating began every day) and a question in Interview 3 (what month heating stopped every day), both asked in relation to Winter 2017/18.
Household size:	Number of persons in the household, banded into 5 groups, derived from the 'hhsizex' variable from the EHS Interview survey. The data was updated following any changes to household composition recorded in EFUS Interview 1 and Interview 3 questionnaires.
Insulated walls:	Derived from the 'wallinsx' variable as measured by surveyors in the EHS physical survey and refers to any insulation for the predominant wall type. The 'solid uninsulated' category includes non-cavity other wall types such as timber, steel or concrete framed. EFUS Interview 1 and Interview 3 questionnaires asked the household about the installation of wall insulation since the EHS survey and the 'wallinsx' variable was updated.
Loft insulation:	Banded variable of 'loftinsx', the level of loft insulation recorded by surveyors in the EHS physical survey. EFUS Interview 1 and Interview 3 questionnaires asked the household about the installation of loft insulation since the EHS survey and the 'loftinsx' variable was updated.
Long-term sickness or disability:	Whether anyone in household has long-term illness or disability that limits their activities. And/or whether anyone in the

Term	Description
	household is registered disabled. This is self-reported by EHS interview respondents.
Pensioner Present:	Anyone in the household who of state pension using data from the EHS Interview survey. Updates using responses to questions 45-50 in Interview 1 and questions 41-47 of Interview 3 EFUS questionnaires.
Region:	Government Office Region that the dwelling is located in. Obtained from the EHS.
Rurality:	Is the dwelling in a rural (village or isolated hamlet) or urban (urban or town or fringe) location. Derived from the 'rumorph' variable in the EHS.
SAP rating:	The energy cost rating as determined by Government's Standard Assessment Procedure (SAP) and is used to monitor the energy efficiency of dwellings. It is an index based on calculated annual space and water heating costs for a standard heating regime and is expressed on a scale of 1 (highly inefficient) to 100 (highly efficient with 100 representing zero energy cost). An updated SAP rating was modelled for dwellings which had improvements between EHS and EFUS Interviews 1 and 3.
Supplementary heating:	Heating systems used in addition to the main heating system to boost internal temperatures.
Tenure:	Derived from the EHS but updated from householder responses in EFUS to q52 in Interview 1 and Q51 of the Interview 3. Cases responding 'don't know' left as the original EHS category. The modelling assumes a response of 'renting' to be a household living in the private rented sector.
Type of (main) heating system:	Derived from the EHS but adjusted for EFUS Interview 2 and Interview 3 responses (question 02). Grouped into central heating or non-central heating categories. Non-central heating includes storage radiators, gas fires, electric heaters, coal/wood/ smokeless fuel fires or stoves and other less common systems.
Under-occupying:	A household is considered to be under-occupying if the dwelling is more than large enough for the number (and type) of occupants living there. For the full definition of under occupancy, see the fuel poverty methodology handbook, which is available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/829010/Fuel_Poverty_Methodology_Handbook_2019.pdf

Term	Description
	Derived from EHS data and updated based on age and household changes at EFUS Interview 1 and 3.
Useable floor area:	The total usable internal floor area of the dwelling as modelled for the EHS 'floorx', rounded to the nearest square metre. It excludes integral garages, balconies, stores accessed from the outside only and the area under partition walls. Grouped into 6 categories.
Water heating system	Derived from EHS data. Categories are: 'with central heating', 'dedicated boiler', 'electric immersion heater', 'instantaneous', 'other'.

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