

Consultation Paper: CONSP:01

SAP HEATING REGIME

Issue 1.0

DOCUMENT REVISIONS

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DOCUMENT REVISION LOG

DATE	VERSION NO.	AMENDMENT DETAILS	APPROVED BY
28/06/16	1.0	First issue	Paul Davidson

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1. INTRODUCTION

A key principle of SAP is that a standard heating regime is used to calculate energy consumption. This is vital for energy rating purposes because it allows a fair comparison between different dwellings to be made. The assumed heating regime has not been amended since the first edition of SAP in the mid-1990s.

The Energy Follow-Up Survey (EFUS) 2011¹, published in January 2014, collected new data on domestic energy use to investigate aspects of energy modelling in need of review. This note examines the heating regime (temperature, heating hours, and proportion of house heated) indicated by the EFUS and compares this to the current SAP assumptions.

The heating pattern used in SAP needn't represent the true 'average'. Some households, for example those in fuel poverty, may use a heating regime which is unsatisfactory from a health point of view. Therefore, it is more suitable to assume what we might call a 'reasonable' or 'adequate' standard of heating (i.e. one that is unlikely to cause health issues), which may be somewhat better than the true average. However, it is still very useful to be able to ground this in the reality of a recent study of how occupants heat their homes. It is also useful to consider this in the context of other (non-rating) modelling purposes to which SAP is now put, where considerations of real occupant behaviour are more important, such as for Green Deal calculations of the savings for improvement measures.

SAP presently assumes:

- All the rooms of a house are heated
- A demand temperature of 21°C in the living area and 18°C elsewhere²
- A weekday heating pattern of 2 hr on, 7hr off, 7hr on, 8hr off
- A weekend heating pattern of 16 hr on, 8 hr off

¹ www.gov.uk/government/statistics/energy-follow-up-survey-efus-2011

² 18°C is the assumed *design* temperature. The *demand* temperature assumed by SAP is calculated from this base and will be between 18 and 21°C depending on the characteristics of the dwelling.

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EFUS Report 4 'Main heating systems' (in particular Table 52) includes analysis of:

- (a) 2616 household interviews about primary (main) heating system usage,
- (b) EFUS temperature monitoring data from 823 (of the above 2616) households to determine heating patterns.

In addition EFUS Report 5 'Secondary heating systems' provides analysis of household interviews on secondary heating system usage.

Relevant conclusions are as follows.

1.1 Central heating

- Approximately 90% of households are centrally heated, 10% non-centrally heated (predominantly electric storage heating).

1.2 Heating patterns

- Approximately 75% of centrally heated households heat regularly³, and of these:
 - o The householder interview data indicates that 69% have two heating periods during weekdays and 64% at weekends, while the temperature monitoring data indicates 53% (all days). For the first period both the householder data and temperature data indicates typically 2hrs. For the second period the householder data indicates 5hrs while the temperature data indicates 6hr.
 - o Both householder and temperature data indicate that the hours of heating during weekdays and the weekend are approximately the same (albeit with a shift of timing for approximately 25% of the households).
 - o The householder interview data indicates that 21% have one heating period during weekdays and 25% at weekends, while the temperature monitoring data indicates 34% (all days). The householder data indicates 14.5hrs while the monitoring data indicates just over 14hrs.

³ 'Heat regularly' means households stated that they heat their homes in a regular manner, turning their heating on and off at set times of the day, though the pattern can change for different days of the week and at weekends.

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- (In both sets of data the remainder have another number of heating periods).
 - The temperature data also indicates that the average (median) daily hours of heating increases by 1hr between November 2011 and December 2011, and in January 2012 remains the same as December. (For the timing of the heating patterns, January 2012 was used as representative of a typical winter month).
- 60% of centrally heated households that heat regularly using timer control reported that they additionally turn heating on for typically 1 to 2 hours at least once a week (not included in the above heating period times).
 - 60% of non-centrally heated households heat regularly, and of these:
 - 81% have one heating period.
 - 9% have two heating periods.
 - (10% have another number of heating periods).
 - The average (median) number of hours of heating on a weekday is 13.0 hours according to the householder interview data and 12.5 hours according to the temperature monitoring data. The average (median) number of hours of heating on a weekend day is 13.0 hours according to both datasets.

1.3 Extent of heating

- 65% of households (14.3 million households) have one or more rooms not heated by the main heating system. Of these, 26% (3.7 million households) use alternative heating to heat these rooms. Thus 48% of households (10.6 million households) have one or more rooms not heated.
- Initial bivariate analyses identified fuel poverty as relating to a significant difference in the likelihood of one or more rooms heated by the main heating system.
- 48% of households indicate that they have supplementary heating in one or more room that is, heating used in rooms that are also heated by the main heating system.

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1.4 Achieved temperatures

- Householder interview data indicated an average thermostat set temperature of 20°C. The temperature monitoring data indicated the average temperature achieved for the living room of 19.7 to 20.4, average 20.2°C, and an average temperature achieved for zone 2 of 18.7 to 19.4, average 19.1°C.

It should be noted that the monitoring data was collected during an unusually warm heating season, particularly in the autumn and spring. This may have had some impact, for example, shortening the lengths of time for additional heating. It is not thought that it would significantly affect the standard heating patterns (commonly set on the heating system timer), the extent of main heating, or the achieved temperatures.

It can be seen that the SAP assumptions are, in general, close to typical heating regimes found by the EFUS, although there are some differences as follows.

- 1) The most striking difference is that for centrally heated households that have two heating periods, the hours of heating during weekdays are similar to the weekend. SAP assumes two heating periods on weekdays and a single, longer heating period at weekends.
- 2) Of the centrally heated households that heat regularly, householder interviews indicate that 21% have one heating period all week. In addition, of non-centrally heated households that heat regularly, 81% also have one heating period. The dominance of central heating causes the combined value to be 28% of households that heat regularly have one heating period. This is discussed in the conclusions.
- 3) The overall length of time for both those who use two heating periods and those who use one heating period is 1 to 2 hours shorter than in SAP. However a majority of households use 1 to 2 hours of additional heating, so the total time is close to the SAP assumptions.
- 4) Of households with all types of heating 65% have one or more rooms not heated by the main heating system. This is also discussed in the conclusions.

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- 5) The average achieved temperature in the living room is around 20°C compared to 21°C assumed in SAP. The temperature elsewhere is within the range assumed in SAP.

2. IMPACT OF DIFFERENCES

The following considers 1) above, the difference in the result calculated by SAP if weekends were assumed to have the same 2 periods of heating hours as the weekdays. This has been carried out using BREDEM 2012 which is closely aligned with the SAP 2012 calculation, while allowing variation of variables such as heating hours, which are given set values in SAP. It can be seen that the difference, in terms of both kWh and percentage of space heating energy, is relatively small.

weekdays: 2 heating periods weekends: 1 heating period

Space htg. kWh/yr	Level of insulation		
	Poor	Typical	Good
Mid-terrace	16,585	9,016	5,982
Semi-det.	23,112	13,164	8,217
Detached	30,850	17,966	10,983

weekdays & weekends: 2 heating periods

Space htg. kWh/yr	Level of insulation		
	Poor	Typical	Good
Mid-terrace	15,816	8,745	5,844
Semi-det.	21,872	12,690	8,003
Detached	29,069	17,259	10,680

kWh/yr difference

kWh/yr	Level of insulation		
	Poor	Typical	Good
Mid-terrace	769	271	138
Semi-det.	1,240	474	214
Detached	1,781	707	303

% difference

	Level of insulation		
	Poor	Typical	Good
Mid-terrace	4.6%	3.0%	2.3%
Semi-det.	5.4%	3.6%	2.6%
Detached	5.8%	3.9%	2.8%

Space heating energy use and differences due to different heating periods

Calculations undertaken for gas central heating with responsiveness of 1.0.

For heating systems with lower responsiveness there will be a smaller difference.

3. CONCLUSIONS

Relevant results have been extracted from EFUS Report 4 'Main heating systems', and EFUS report 5 'Secondary heating systems'. SAP assumptions are found, overall, to be

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similar to typical heating regimes indicated in the EFUS report. However, there are differences which are discussed in the following.

3.1 Weekend heating periods

SAP assumes two heating periods (morning and evening) on weekdays and a single longer heating period at weekends. The EFUS results indicate that centrally heated households with two daily heating periods on weekdays also generally have a similar two heating period pattern at weekends. At first glance this appears to be at variance with the SAP assumption.

However, approximately 60% of the centrally heated households have two heating periods and approximately 30% have a single longer heating period. These two patterns thus cover a total of 90% of centrally heated households. The SAP assumption of five days of two heating periods and two days of a single heating period in a week therefore provides a reasonable representation *overall* of the approximate 5/7 (71%) of households with two heating periods all week, and 2/7 (29%) of households with a single heating period all week.

3.2 Length of heating periods

For centrally heated households (both those that use two heating periods and those that use one heating period) the EFUS results indicate that the total length of heating time each day is one to two hours shorter than assumed in SAP. However the majority of households use one to two hours of additional heating per day which are not included in this time, so the total time is very close to SAP assumptions.

3.3 Temperature

Living area: EFUS results indicate an achieved temperature for the living area which is around 1°C lower than the 21°C assumed in SAP.

Rest of the dwelling: the SAP non-living area assumed temperature is between 18 and 21°C depending on the heat loss coefficient and level of heating control. In a dwelling with typical to good levels of insulation and typical controls, the SAP calculated non-living area demand temperature is around 19°C. This agrees with the EFUS findings of an achieved temperature of around 19°C.

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3.4 Non-centrally heated households

81% of non-centrally heated households have one heating period, with an average heating time around 13hrs; this is between the times for one and two period centrally heated households. This differs from the heating pattern for centrally heated homes; however, only 10% of households lack central heating. Since SAP is a method for comparing dwellings using a single standardised heating regime regardless of the heating system, the use of the existing SAP pattern, found above to be representative of homes with central heating, should also continue to be used for non-centrally heated homes.

3.5 Extent of heating

SAP assumes that the whole house is heated. The EFUS results indicate that, considering households with all types of heating, just under half (48%) have one or more rooms not heated by the main or any secondary heating. In this respect the present SAP heating regime assumes a slightly better standard than is used in about half of homes.

3.6 Other studies

Huebner et al report⁴ a study which derived data from the Carbon Reduction in Buildings Home Energy Survey (CaRB HES), with interviews in 427 homes and monitored temperatures in a subset of 275 of these homes. The findings were similar to the EFUS results with a wide variety in heating patterns, and weekday and weekend heating patterns far more similar than assumed in SAP. Estimated demand temperature was about 20.6°C and average temperature during heating periods 19.6°C.

Kane et al⁵ also found a wide variety of heating patterns in a survey of 249 homes in the city of Leicester. Of the 93% of centrally heated homes, 51% were heated daily for two periods and 33% for one period; this may be compared with the EFUS results (69% and

⁴ Huebner, G.M., MacMichael, M., Shipworth, D., Shipworth M., Durand-Daubin, M., Summerfield, A. Heating patterns in English Homes: Comparing results from a national survey against common model assumptions. *Building and Environment* 70 (2013) 298-305.

⁵ Kane, T., Firth, S.K., Lomas, K.J. How are UK homes heated? A city-wide, socio-technical survey and implications for energy modelling. *Energy and Buildings* 86 (2015) 817-832.

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21%, respectively, for the weekday figures). Average winter temperatures were found to be higher in the in the homes of the elderly than in the homes of the under 30's, at 19.2°C compared to 16.4°C.

It is reassuring that these two studies provided similar findings to the EFUS.

3.7 Summary

SAP is a procedure for assessing the energy performance of dwellings. To fulfil this role it must use a single heating regime (demand temperature, timing, and proportion of house heated) for all dwellings.

The EFUS and other studies have provided us with a means to compare the heating regime used in SAP to the way UK householders actually use their heating. The key findings are as follows:

- The number of hours heating per day assumed in SAP represents the way in which UK householders operate their heating systems very well.
- SAP's assumption that dwelling living areas are heated to 21°C is slightly higher than the average figure in used in practice, of 20°C according to EFUS, or 20.6°C according to CaRB HES.
- The temperature assumed for the rest of the dwelling during heating periods is consistent with the way in which UK householders operate their heating systems.
- The assumption in SAP that houses are fully heated is a good representation of normal practice in the case of just over half of homes. In the other half, at least one room is normally unheated.

In addition to being used for assessing energy ratings, as for Building Regulations and Energy Performance Certificates (EPCs), SAP has more recently become used for assessing savings resulting from installed measures, again in EPCs and also in the Green Deal and ECO schemes. It has been recognised that parameters such as heating patterns and extent of heating vary considerably between households, and for this reason an Occupancy Assessment variant of the SAP methodology has been devised to provide a

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calculation which is adjusted as far as possible to the actual parameters of an individual household.

The heating regime in SAP of heating the whole house with a demand temperature of 21°C in the living area is considered to represent a level that is adequate in terms of health. This is an entirely reasonable position for energy rating, but evaluating savings brings in the issue of lower savings for less well heated homes and 'take back' where homes may be heated to a higher standard after measures are installed. This can be accounted for by applying a correction factor. The use of a fixed heating standard both before and after the installation of a measure is then also a reasonable position.

The assumptions in SAP are thus broadly supported by the EFUS and other studies. It would be possible to argue for some changes, such as heating less than the whole house and reducing the living area demand temperature. However the effects of such changes would be relatively small and the arguments for rating dwellings using an adequate rather than average heating regime remain. **On balance, we therefore propose leaving the existing SAP heating regime unchanged for SAP 2016, but would suggest inviting comments on this in the SAP consultation document.**

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