Consultation Paper: CONSP:03

STORAGE HEATER SECONDARY FRACTION DISCUSSION

Issue 1.0

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1. INTRODUCTION

A storage heater system is generally designed such that it should be able to supply around 90% of the space heating requirement of a dwelling using off-peak electricity. The rest of the space heating requirement (referred to here as the secondary fraction) is usually supplied by separate direct acting electric heaters using on-peak electricity.

SAP ratings are based on the cost of meeting a standard assumption for the energy demands of a dwelling. Thus, the large difference between the cost of on-peak and off-peak electricity means that the assumptions about the secondary fraction are quite critical to the rating that is achieved.

SAP assumes that for a “standard” storage heater system (one which, like most currently installed, lacks fan assistance) the secondary fraction is 0.15. This means that 15% of the space heating demand is assumed to be met by on-peak electricity and 85% by off-peak electricity. It has been suggested that this fraction, which is meant to represent what can typically be achieved in a system that is being used broadly as intended, might be too high (i.e. that a figure of around 0.1, consistent with the design principle noted above, might be more appropriate). A figure of 0.1 is already used in SAP for fan assisted and high heat retention storage heater systems, and also for integrated storage/direct heaters, which it is recognised ought to be better than standard storage heaters in this respect.

This consultation paper aims to examine the secondary fraction of “standard” storage heater systems. It does this by using data from several homes with such storage heater systems and extracting the secondary fractions that were achieved in practice.

2. DATA ANALYSIS

The data that is used for the analysis is quite old - it was collected between 1990 and 1992. However, the homes formed a part of the Milton Keynes Energy Park, built to standards that exceeded the Building Regulations of the day. Thus, the data is actually representative of more recent practice, although certainly not up to current Building Regulations standards. However, it is probably a good representation of what can be achieved with standard storage heater systems in existing dwellings (bearing in mind that the existing stock has undergone significant energy efficiency improvements since the early 1990s).

More recent data of a similar nature was sought from the trade association BEAMA and other contacts - but nothing useful was provided. This is not surprising since the monitoring that would be required to replicate the level of detail in the Milton Keynes data is very considerable.

The available data encompasses several built forms of different sizes as summarised in Table 1. Altogether there are 60 dwelling-years of data available. Table 1 shows the off-peak and on-peak figures that were achieved in each case. The overall average secondary fraction, 0.22, is shown underneath the main table.

However, it will be noted that there are some systems that appear not to have been used in the manner for which they were designed. In particular, if a storage heater system is providing less than half of the space heating requirement (i.e. the secondary fraction is greater than 0.5) this is a clear indication that the occupants were not using it as intended. Indeed, in certain cases, there was evidence of individual storage heaters being turned off during the heating season (see the appendix for more on this).

Thus, Table 1 also shows the same data filtered to remove those cases where the storage heater system was clearly not being used as anticipated (i.e. removing cases where the secondary fraction is greater than 0.5). Therefore, the data analysis sample size is reduced to 53 dwelling-years and yields an average secondary fraction of 0.16, which is close to the 0.15 assumption which SAP currently uses. Figure 1 also shows the frequency distribution of the secondary fraction for these 53 cases.

Table 1 - Measured on-peak and off-peak space heating in homes with storage heater systems

	Annual space heating consumption			SF > 0.5 excluded	SF > 0.3 excluded
Reference	Off-peak (kWh)	On-peak (kWh)	Secondary fraction (SF)	Secondary fraction	Secondary fraction
Site R plot 43 1990/91 end terrace (1 bed)	3154	36	0.01	0.01	0.01
Site R plot 44 1990/91 end terrace (1 bed)	207	1152	0.85		
Site R plot 49 1990/91 end terrace (1 bed)	4033	492	0.11	0.11	0.11
Site R plot 1 1990/91 end terrace (1 bed)	3394	1083	0.24	0.24	0.24
Site R plot 48 1990/91 mid terrace (1 bed)	1246	122	0.09	0.09	0.09
Site R plot 3 1990/91 mid terrace (1 bed)	2679	1433	0.35	0.35	
Site R plot 4 1990/91 mid terrace (1 bed)	254	1565	0.86		
Site R plot 45 1990/91 mid terrace (1 bed)	1445	705	0.33	0.33	
Site R plot 47 1990/91 mid terrace (1 bed)	2916	2	0.00	0.00	0.00
Site R plot 46 1990/91 mid terrace (1 bed)	1750	957	0.35	0.35	
Site R plot 17 1990/91 mid terrace (2 bed)	3030	1644	0.35	0.35	
Site R plot 18 1990/91 mid terrace (2 bed)	2259	1566	0.41	0.41	
Site R plot 19 1990/91 mid terrace (2 bed)	4513	568	0.11	0.11	0.11
Site R plot 20 1990/91 mid terrace (2 bed)	1204	2114	0.64		
Site R plot 25 1990/91 mid terrace (2 bed)	4263	1037	0.20	0.20	0.20
Site R plot 27 1990/91 mid terrace (2 bed)	232	125	0.35	0.35	
Site R plot 28 1990/91 mid terrace (2 bed)	5006	1275	0.20	0.20	0.20
Site R plot 50 1990/91 maisonette (2 bed)	3237	749	0.19	0.19	0.19
Site R plot 2 1990/91 maisonette (2 bed)	7431	402	0.05	0.05	0.05
Site R plot 43 1991/92 end terrace (1 bed)	1752	584	0.25	0.25	0.25
Site R plot 44 1991/92 end terrace (1 bed)	377	1615	0.81		
Site R plot 49 1991/92 end terrace (1 bed)	4129	496	0.11	0.11	0.11
Site R plot 1 1991/92 end terrace (1 bed)	3537	1052	0.23	0.23	0.23
Site R plot 47 1991/92 mid terrace (1 bed)	1542	143	0.08	0.08	0.08
Site R plot 3 1991/92 mid terrace (1 bed)	692	250	0.27	0.27	0.27
Site R plot 4 1991/92 mid terrace (1 bed)	1970	109	0.05	0.05	0.05
Site R plot 46 1991/92 mid terrace (1 bed)	2605	2047	0.44	0.44	
Site R plot 48 1991/92 mid terrace (1 bed)	2065	1026	0.33	0.33	
Site R plot 45 1991/92 mid terrace (1 bed)	2353	1659	0.41	0.41	
Site R plot 17 1991/92 mid terrace (2 bed)	4199	725	0.15	0.15	0.15
Site R plot 18 1991/92 mid terrace (2 bed)	2261	498	0.18	0.18	0.18
Site R plot 19 1991/92 mid terrace (2 bed)	3563	197	0.05	0.05	0.05
Site R plot 20 1991/92 mid terrace (2 bed)	4403	608	0.12	0.12	0.12
Site R plot 25 1991/92 mid terrace (2 bed)	5220	947	0.15	0.15	0.15
Site R plot 27 1991/92 mid terrace (2 bed)	3217	1387	0.30	0.30	
Site R plot 28 1991/92 mid terrace (2 bed)	2850	672	0.19	0.19	0.19
Site R plot 50 1991/92 maisonette (2 bed)	4215	629	0.13	0.13	0.13
Site 8 plot 14 1990-92 end terrace (1 bed)	5170	480	0.08	0.08	0.08
Site 8 plot 11 1990-92 end terrace (1 bed)	1004	0	0.00	0.00	0.00
Site 8 plot 11 1990-92 end terrace (1 bed)	2295	142	0.06	0.06	0.06
Site 8 plot 19 1990-92 end terrace (1 bed)	3196	2185	0.41	0.41	
Site 8 plot 19 1990-92 end terrace (1 bed)	1487	2185	0.60		
Site 8 plot 17 1990-92 end terrace (1 bed)	5372	245	0.04	0.04	0.04
Site 8 plot 17 1990-92 end terrace (1 bed)	4810	690	0.13	0.13	0.13
Site 8 plot 14 1990-92 end terrace (1 bed)	5150	57	0.01	0.01	0.01
Site 8 plot 18 1990-92 mid terrace (1 bed)	4058	447	0.10	0.10	0.10
Site 8 plot 13 1990-92 mid terrace (1 bed)	3250	326	0.09	0.09	0.09
Site 8 plot 18 1990-92 mid terrace (1 bed)	2802	134	0.05	0.05	0.05
Site 8 plot 12 1990-92 mid terrace (1 bed)	4247	70	0.02	0.02	0.02
Site 8 plot 2 1990-1992 semi detached (2 bed)	3298	147	0.04	0.04	0.04
Site 8 plot 2 1990-1992 semi detached (2 bed)	2022	2472	0.55		
Site 8 plot 3 1990-1992 semi detached (2 bed)	4673	50	0.01	0.01	0.01
Site 8 plot 3 1990-1992 semi detached (2 bed)	2743	620	0.18	0.18	0.18
Site 8 plot 16 1990-1992 semi detached (2 bed)	5837	581	0.09	0.09	0.09
Site 8 plot 15 1990-1992 semi detached (2 bed)	1691	2567	0.60		
Site 8 plot 15 1990-1992 semi detached (2 bed)	4778	751	0.14	0.14	0.14
Site 23 plot 15 1990-1992 semi detached (2 bed)	5272	383	0.07	0.07	0.07
Site 23 plot 15 1990-1992 semi detached (2 bed)	4749	1388	0.23	0.23	0.23
Site 22 plot 15 1990-1992 semi detached (2 bed)	6580	92	0.01	0.01	0.01
Site 4 plot 15 1990-1992 semi detached (3 bed)	4338	137	0.03	0.03	0.03
		Average	**0.22**	**0.16**	**0.11**
		Number of cases	**60**	**53**	**42**

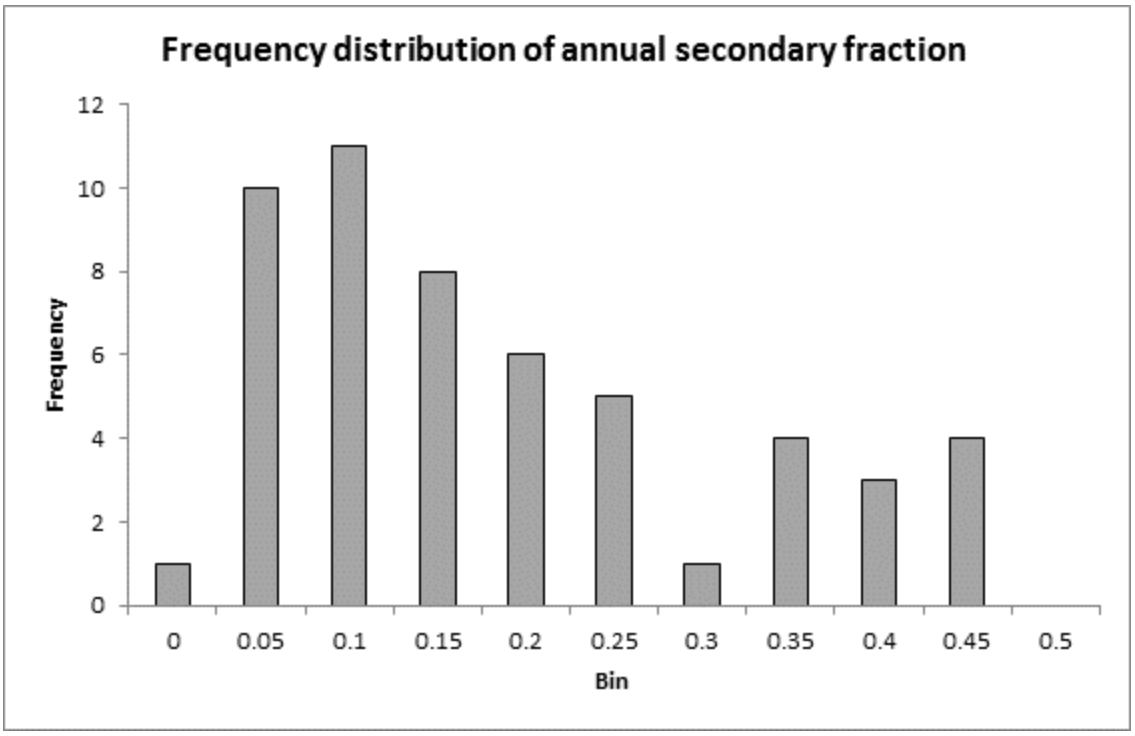

Figure 1 – Frequency distribution of annual secondary fraction

Of course, there is inevitably some uncertainty as to how the data should be filtered to remove the cases where the system is not being used as intended. A secondary fraction of 0.5 has been used, but it could also be argued, looking at Figure 1, that a lower secondary fraction of 0.3 might better mark the "dividing line" between an “intended” and “un-intended” usage pattern (such a fraction is also consistent with the original data analysis undertaken by NES for BREDEM testing purposes – see the appendix).

If this is done it reduces the number of cases to 42 and yields an average secondary fraction of 0.11, as shown in Table 1. Unfortunately, the determination of the "dividing line" position will always be somewhat arbitrary. Nevertheless, it should be borne in mind that SAP aims to represent what can typically be achieved in practice with such a system, and that the data does actually show what is achieved in practice by households (albeit not necessarily always using the system precisely as intended).

3. CONCLUSION

The overall conclusion of this analysis is that the SAP assumption of a secondary fraction of 0.15 is entirely consistent with the possible range of the average value (between 0.11 and 0.16) derived from the available (filtered) data. Therefore, in the absence of more recent monitored data, there is no justification for altering the assumption used in SAP.

4. APPENDIX – Considerations regarding the filtering of the data

The analysis presented in this paper has been strongly guided by the contents of an original report that NES Ltd provided to BRE in 1996[1]. That report was aimed at testing the BREDEM procedures for storage heater systems, rather than focusing on the secondary fraction. Nonetheless, it obviously contains relevant information on the secondary fraction and, perhaps most importantly, on the rationale behind the filtering of the data to eliminate cases where the storage heater system was not being used as intended.

The authors of the 1996 report thoroughly investigated the usage of the storage heaters in these dwellings and, being directly involved in the monitoring, they knew better than anyone what the data was actually showing. Unfortunately the full details of their deliberations are not in the report (it would have been impractical to include such detail), but there are nonetheless several remarks regarding the fact that some systems were simply not being used as intended. Examples of reasons included:

- “dwelling largely unoccupied”
- “storage heaters not used at all”
- “storage heating seems to have been intermittent at certain times in the heating season”
- “occupants …. stubbornly refused to use the storage heaters”.etc.

[1] BREDEM Storage Heater Procedure Development. Final Report May 1996. Prepared by Alan Horton and Neil Cutland, NES Ltd.

Based on this they filtered the data to focus on those systems that were being used as intended (and the filter that they ultimately applied was the secondary fraction of 0.3 that Figure 1 in the current paper strongly suggests – although it was expressed in the NES report in terms of the equivalent off-peak fraction – i.e. 0.7).

They said “removing dwellings with fractions less than 0.7 from the sample on the grounds that such a low fraction *must* be due to incorrect control settings, partial disablement of storage heaters altogether or a combination of both, give much better comparisons…” (between predicted and measured results).

Thus, the lower secondary fraction filter of 0.3 that has been applied in this paper, based on Figure 1, is not entirely arbitrary. The rationale for such a figure is fully supported by the analysis of those who were involved in the original monitoring exercise.