SAP 2005

The Government's Standard Assessment Procedure for Energy Rating of Dwellings

2005 EDITION

Summary of Comments on SAP2005 reviewed by Solartwin.pdf

Page: 1

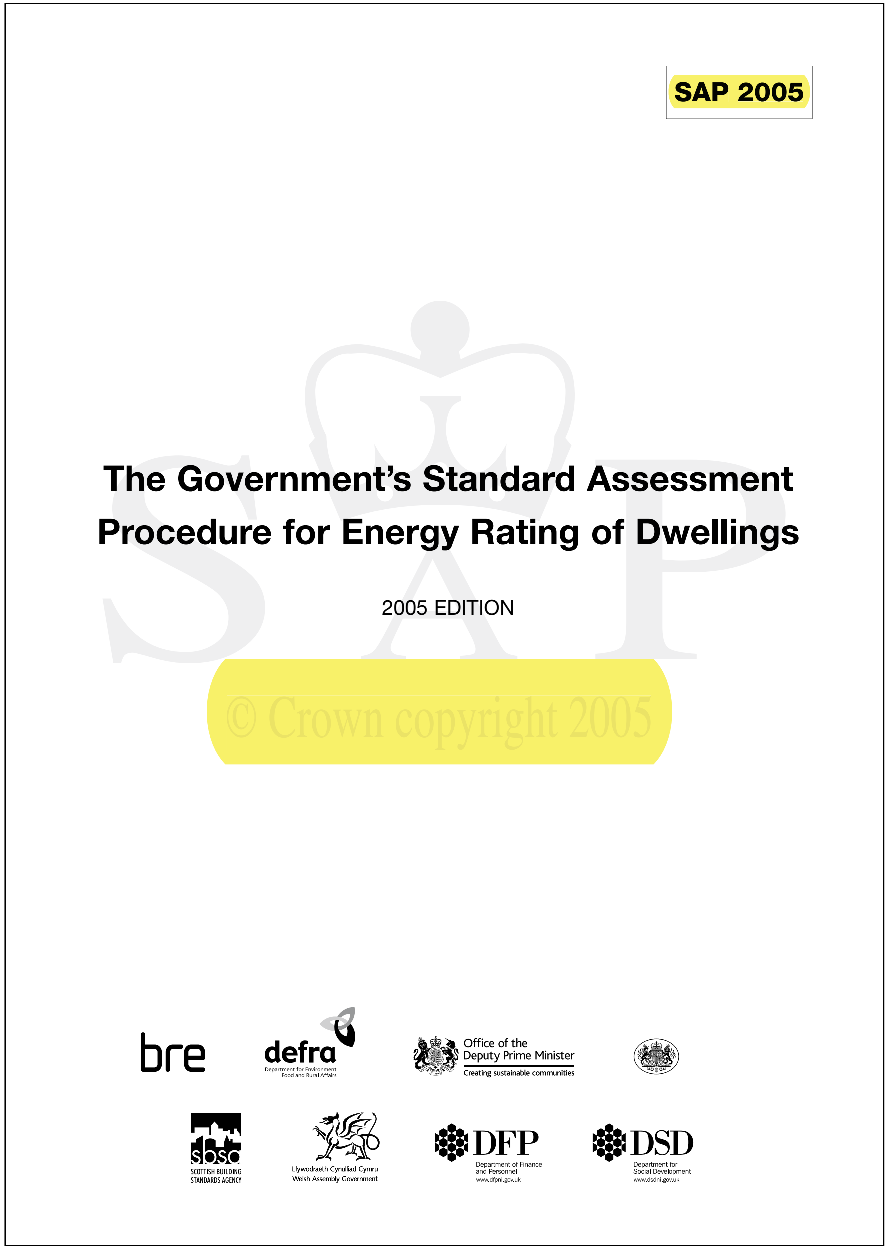
Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 16:17

February 07. This document is being published because the use of SAP 2005 in UK means that Solar Twin Ltd faces what it sees as significant and apparently unjustified market limitation. This has happened because it appears that SAP 2005 (2005 edition) has been written with too narrow a technological scope for the proprietary technology which we use. We have had productive discussions with DCLG concerning the content of documents relating to building regulations on solar thermal, however a timetable for action concerning updates is uncertain. Therefore it is important that designers, engineers, building control officers and regulators, among others, know about our concerns, which include:

1/ A limited scope definition of exclusive solar volume which does not adequately allow for exclusive solar volume in time, which we use

2/ An apparent PV pumping energy penalty for our technology

Comments from page 1 continued on next page


SAP 2005

The Government's Standard Assessment Procedure for Energy Rating of Dwellings

2005 EDITION

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which is not balanced by penalties which relate to conventional solar's several shortcomings such as fat pipes and stop-start pumping and the use of heat exchangers which reduce stratification and therefore also reduce pump-on time

3/ a need to offer in table H1 a fifth row: a flat plate double glazed default parameter with a lower No (say 0.5 to 0.6), a higher a1 (say 3) and aperture to gross ratio of about 0.9. These figures are similar to our panel's which is currently omitted as an option.

There are also several wider issues which we believe merit discussion including:

4/ an elevated Legionella risk which would be promoted by apparently dangerous plumbing diagrams which are included in fig H2, which is a potentially dangerous and outmoded twin full volume cylinder arrangement.

5/ a need for or and other technology's "dedicated in time" solar volume explanation or an illustration to replace the first diagram in H2, an approach which is currently omitted.

6/ a need for a heat store with a large mains pressure heat exchanger inside it to replace the third diagram in H2, this being much less of a Legionella risk, risk being best designed out, not treated later by heat as the current diagram proposes.

7/ the strange methodology of apparently basing hot water needs on floor size and not number of occupants, when it is people which use hot water, not floors, an error which is perverse and which will result in noncompliant but clearly logical installations in

Comments from page 1 continued on next page

SAP 2005

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bre defra Office of the Deputy Prime Minister sbsa Llywodraeth Cynulliad Cymru Welsh Assembly Government DFP DSD

large homes of low occupancy.

7/ the failure of SAP to offer higher solar fractions at the expense of total annual performance per square metre for winter optimised wall mounted south facing panels. This constraint does not properly allow for façade mounted panels and the flatter and more useful solar delivery that they offer annually. It results in a bias towards evacuated tube technology and a general underestimation via SAP of the effectiveness of solar thermal overall.

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 16:20
Portions of this document have been copied for fair comment because they contain material which may be inaccurate, misleading, or market limiting. if read from the perspective of new solar water heating technology such as, but not exclusively, Solartwin.

The working principle of solar hot water systems is shown in Figure H1: examples of arrangements are given in Figure H2.

Water from the cold supply is either fed (directly or via a cold feed cistern) to the preheat zone where it is heated by solar energy. Then the water passes to the domestic hot storage (separate hot water cylinder or upper part of combined cylinder) which is heated to the required temperature by a boiler or an electric immersion.

There are three main types of solar collector:

- unglazed: the overall performance of unglazed collectors is limited by high thermal losses
- glazed flat plate: a flat plate absorber (which often has a selective coating) is fixed in a frame between a single or double layer of glass and an insulation panel at the back
- evacuated tube: an absorber with a selective coating is enclosed in a sealed glass vacuum tube.

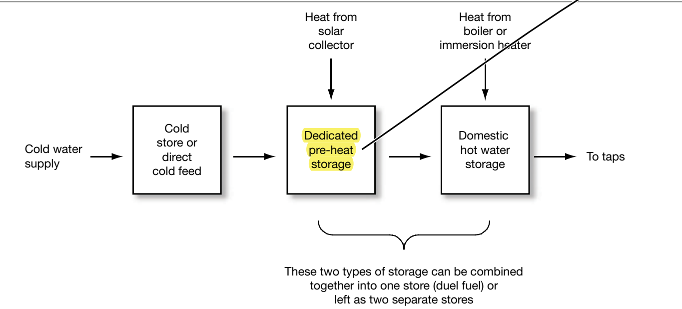
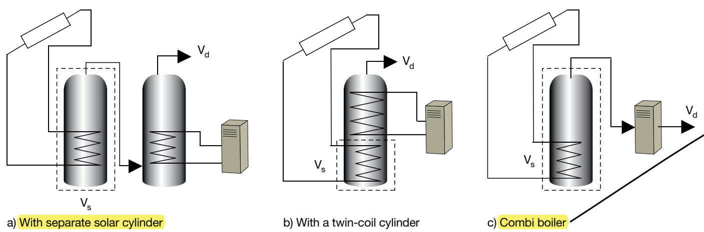


Figure H1 Working principle of solar water heating



V_s (indicated by the dashed line) is the dedicated solar storage volume
See text opposite concerning the effective solar volume
V_d is the daily hot water demand

Figure H2 Schematic examples of arrangements for solar pre-heating

Page: 2

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 16:00

Restrictive dedicated solar storage volume definition. Standard Assessment of Performance (SAP) calculation methodology excludes Solartwin by not accepting dedicated solar volume (DSV) in time. t is not stated here that a dedicated volume can also be in time as well as in space, as shown here. It should be. In addition, a diagram should be provided to show this. Solartiwn uses dedicated solar volume in time. Not to explicitly state this anywhere in this document may be market limiting. This Standard Assessment of Performance (SAP) calculation methodology excludes Solartwin by not accepting dedicated solar volume (DSV) in time. See also the effective solar vol bullets on next page plus calcs H11, H12: and calcs dependent on these. Also DHCG Table 31 g on page 64: on storage of solar pre-heated water. This approach ismarket limiting. We usually have a backup heater positioned at the bottom of the cyl and switch it on after sunset. This gives a big dedicated solar volume in TIME not SPACE. Benefits: full not part cyl of hot water at night & better Legionella control. Time based DSV is proven, with over 2000 installations. Its exclusion attacks our technology. It must not be outlawed on a whim. While both space & time DSV's have pros & cons, our approach was specifically allowed by Clearskies. Solution is to Allow 100% consideration of solar vols in TIME in SAP. Say: "In well stratified low flow systems with with backup heating coming on after 90% of the solar energy is delivered then the full cylinder volume can be treated as dedicated solar volume." As stated earlier, this will be our working assumption.

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 13:51

Legionella promotion by SAP diagram. There are safer combi options available. That of using a heat store. This should be shown. Solution: Replace with a heat store diagram. Its large surface area heat exchanger still means the solar volume remains small, only the volume of a heat exchanger rather than the volume of a cylinder.

Comments from page 2 continued on next page

This small volume plus its much faster turnover is much safer.

The working principle of solar hot water systems is shown in Figure H1: examples of arrangements are given in Figure H2.

Water from the cold supply is either fed (directly or via a cold feed cistern) to the preheat zone where it is heated by solar energy. Then the water passes to the domestic hot storage (separate hot water cylinder or upper part of combined cylinder) which is heated to the required temperature by a boiler or an electric immersion.

There are three main types of solar collector:

- unglazed: the overall performance of unglazed collectors is limited by high thermal losses
- glazed flat plate: a flat plate absorber (which often has a selective coating) is fixed in a frame between a single or double layer of glass and an insulation panel at the back
- evacuated tube: an absorber with a selective coating is enclosed in a sealed glass vacuum tube.

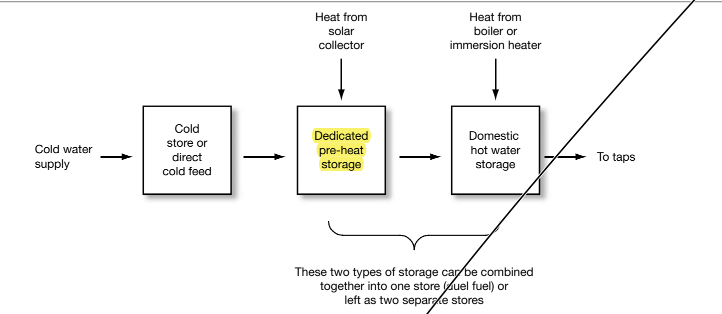


Figure H1 Working principle of solar water heating

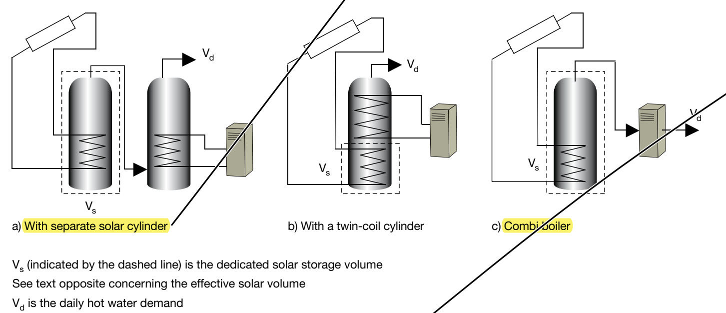


Figure H2 Schematic examples of arrangements for solar pre-heating

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 15:58

Omission of direct solar plumbing diagram leads to its marginalisation. We have a valid and different technology. It should be shown in a typical diagram. Plus, if this twin cylinder series design can not be removed from the document, at least it should come with a safety warning. Plumbing approaches like this offers a Legionella risk which may be unacceptable unless this cylinder is regularly heated throughout to approx 60C. This diagram does not show any heater apart from solar. In such a case it may not exceed 40C for weeks or even months in winter and thus allow Legionella bacteria to proliferate. This diagram should be replaced with a typical low pressure open vented direct diagram. On it, dedicated solar volume in time should be labelled, indicating the whole of the cylinder. Delete diag a. Replace with a typical diagram of a direct low flow pumped system with a backup heater at the bottom. Plus show a 24h timeline with a graph of typical sunlight levels and a bar to show when the backup heating comes on. We have a far higher market penetration than diagram (a) and we should be illustrated. I offer to supply this diagram.

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 14:16

It must be asked why there are no penalties for a range of avoidable design features (all of which hamper the performance old solar): fat pipes, high thermal masses, stop-start controllers, high delta T and poor stratification. Conversely it must be asked why are there no extra credits for more effective designs such as Solartwin's use of microbore pipes, low thermal mass, variable speed pumping, low delta T and high levels of stratification

Comments from page 2 continued on next page

The performance of a solar collector is represented by its zero-loss efficiency (proportion of incident solar radiation absorbed in the absence of thermal loss) and its heat loss coefficient (heat loss from collector to the environment per unit area and unit temperature difference).

The solar contribution to domestic hot water is given by

$$Q_s = S \times Z_{panel} \times A_{ap} \times \eta_0 \times UF \times f(a_1/\eta_0) \times f(V_{eff}/V_d) \qquad (H1)$$

where

Q_s	=	solar input, kWh/year
S	=	total solar radiation on collector, kWh/m²/year
Z_{panel}	=	overshading factor for the solar panel
A_{ap}	=	aperture area of collector, m²
η_0	=	zero-loss collector efficiency
UF	=	utilisation factor
a_1	=	linear heat loss coefficient of collector, W/m²K
$f(a_1/\eta_0)$	=	collector performance factor $= 0.87 - 0.034 (a_1/\eta_0) + 0.0006 (a_1/\eta_0)^2$
V_{eff}	=	effective solar volume, litres
V_d	=	daily hot water demand, litres
$f(V_{eff}/V_d)$	=	solar storage volume factor $= 1.0 + 0.2 \ln(V_{eff}/V_d)$ subject to $f(V_{eff}/V_d) <= 1.0$

The collector's gross area is the projected area of complete collector (excluding any integral means of mounting and pipework). The aperture area is the opening through which solar radiation is admitted.

The preferred source of performance data for solar collectors is from a test on the collector concerned according to BS EN 12975-2, *Thermal solar systems and components – Solar collectors – Part 2: Test methods*. The aperture area, and the performance characteristics η_0 and a_1 related to aperture area, are obtained from the test certificate. If test data are not available (e.g. for existing installations), the values in Table H1 may be used.

The effective solar volume is:

- in the case of a separate pre-heat tank (such as arrangements a) or c) in Figure H2), the volume of the pre-heat tank
- in the case of a combined cylinder (such as arrangement b) in Figure H2), the volume of the dedicated solar storage plus 0.3 times the volume of the remainder of the cylinder
- in the case of a thermal store (hot water only or integrated as defined in Appendix B) where the solar coil is within the thermal store, the volume of the dedicated thermal storage.

Calculation of solar input for solar water heating

Aperture area of solar collector, m² *If only the gross area can be established reliably, multiply it by ratio in Table H1*			(H1)
Zero-loss collector efficiency, η_0, from test certificate or Table H1			(H2)
Collector heat loss coefficient, a_1, from test certificate or Table H1			(H3)
Collector performance ratio a_1/η_0	(H3) ÷ (H2) =		(H4)
Annual solar radiation per m² from Table H2			(H5)
Overshading factor from Table H3			(H6)
Solar energy available	(H1) × (H2) × (H5) × (H6) =		(H7)
Solar-to-load ratio	(H7) ÷ [(39) + (40)] =		(H8)
Utilisation factor if (H8) > 0, 1 - exp[-1/(H8)], otherwise enter '0' in box (H9) *If the cylinder is heated by a boiler and there is no cylinderstat, reduce the utilisation factor by 10%*			(H9)
Collector performance factor	0.87 - 0.034 × (H4) + 0.0006 × (H4)² =		(H10)
Dedicated solar storage volume, V_s, litres *Volume of pre-heat store, or dedicated solar volume of a combined cylinder*			(H11)
If combined cylinder, total volume of cylinder, litres			(H12)
Effective solar volume, V_{eff} *If separate pre-heat solar storage, or a thermal store, (H13) = (H11)* *If combined cylinder, (H13) = (H11) + 0.3 × [(H12) – (H11)]*			(H13)
Daily hot water demand, V_d, (litres) from Table 1			(H14)
Volume ratio V_{eff}/V_d	(H13) ÷ (H14) =		(H15)
Solar storage volume factor $f(V_{eff}/V_d)$	1 + 0.2 × ln(H15) =		(H16)
Solar input Q_s	(H7) × (H9) × (H10) × (H16) =		(H17)

Note: (39) and (40) are box numbers of the main worksheet

Enter (H17) in (50) of main worksheet. If separate figures for solar input are required for the heating season (8 months) and summer (4 months) take 50% of Q_s as applying during the heating season and 50% during the summer.

Page: 3

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 19:26

This performance test is not appropriate for collectors which are low flow such as ours. Nor is it appropriate for collectors whose performance equation cannot be approximated to a quadratic equation of the form y = a + bx + cxx. Any collector with a step change in performance such as one using thermostatic air vents or thermotropic materials cannot be characterised by such an equation.

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 19:26

Not always 0.3. SAP needs to credit the use of solar volume in time properly and here is a solution. This 0.3 allowance is too small and should increase to 0.9 or 1 in the case of solar water heating systems which use dedicated solar volume in time solutions. Explanation: The particular SAP technical detail concerns how much hot water storage volume can be allocated to a solar panel, in circumstances when the backup heating is timed to come on in the evening, having been left off all day, as we usually do with Solartwin. The problem is that SAP does not allow for this operational feature properly, perhaps because it has not seem to fully anticipated its general use. So SAP allows only 30% of the cylinder volume to be credited instead of a realistic figure of 80% to 100%. While a figure of 30% may be appropriate for older solar technologies such ones which use twin coil cylinders, where the upper (backup) coil is heated during the day, it is inppropriate for our technology. The effects of applying this 30% inflexibly are market limiting. These effects include (a) a very low (or even zero) square metre solartwin panel area being allowed by the calculations in most domestic circumstances, these being smaller than our standard 2.8 sqm panel, so that it would impose an unreasonably small panel area when in our experience, a larger one is proven to work well, as well as safely and (b) unrealistically low energy delivery calculations, even if a

Comments from page 3 continued on next page

2.8 sqm panel were to be fitted, with the damaging consequence to us that few buyers would choose our technology if these flawed calculations were to be taken seriously. In the absence of any guidance on SAP, and given the delays we have encountered, we will be working on the basis that 90% of the cylinder's volume can used as the equivalent of a dedicated solar volume.

The performance of a solar collector is represented by its zero-loss efficiency (proportion of incident solar radiation absorbed in the absence of thermal loss) and its heat loss coefficient (heat loss from collector to the environment per unit area and unit temperature difference).

The solar contribution to domestic hot water is given by

$$Q_s = S \times Z_{panel} \times A_{ap} \times \eta_0 \times UF \times f(a_1/\eta_0) \times f(V_{eff}/V_d) \qquad (H1)$$

where

Q_s = solar input, kWh/year
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a_1 = linear heat loss coefficient of collector, W/m²K
$f(a_1/\eta_0)$ = collector performance factor
$= 0.87 - 0.034 (a_1/\eta_0) + 0.0006 (a_1/\eta_0)^2$
V_{eff} = effective solar volume, litres
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$f(V_{eff}/V_d)$ = solar storage volume factor
$= 1.0 + 0.2 \ln(V_{eff}/V_d)$ subject to $f(V_{eff}/V_d) <= 1.0$

The collector's gross area is the projected area of complete collector (excluding any integral means of mounting and pipework). The aperture area is the opening through which solar radiation is admitted.

The preferred source of performance data for solar collectors is from a test on the collector concerned according to BS EN 12975-2, *Thermal solar systems and components – Solar collectors – Part 2: Test methods*. The aperture area, and the performance characteristics η_0 and a_1 related to aperture area, are obtained from the test certificate. If test data are not available (e.g. for existing installations), the values in Table H1 may be used.

The effective solar volume is:

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- in the case of a combined cylinder (such as arrangement b) in Figure H2), the volume of the dedicated solar storage plus 0.3 times the volume of the remainder of the cylinder
- in the case of a thermal store (hot water only or integrated as defined in Appendix B) where the solar coil is within the thermal store, the volume of the dedicated thermal storage.

Calculation of solar input for solar water heating

Aperture area of solar collector, m² *If only the gross area can be established reliably, multiply it by ratio in Table H1*			(H1)
Zero-loss collector efficiency, η_0, from test certificate or Table H1			(H2)
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Annual solar radiation per m² from Table H2			(H5)
Overshading factor from Table H3			(H6)
Solar energy available	(H1) × (H2) × (H5) × (H6) =		(H7)
Solar-to-load ratio	(H7) ÷ [(39) + (40)] =		(H8)
Utilisation factor if (H8) > 0, 1 - exp[-1/(H8)], otherwise enter '0' in box (H9) *If the cylinder is heated by a boiler and there is no cylinderstat, reduce the utilisation factor by 10%*			(H9)
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Solar input Q_s	(H7) × (H9) × (H10) × (H16) =		(H17)

Note: (39) and (40) are box numbers of the main worksheet

Enter (H17) in (50) of main worksheet. If separate figures for solar input are required for the heating season (8 months) and summer (4 months) take 50% of Q_s as applying during the heating season and 50% during the summer.

Table H1 : Default collector parameters

Collector type	η_0	a_1	Ratio of aperture area to gross area
Evacuated tube	0.6	3	0.72
Flat plate, glazed	0.75	6	0.90
Unglazed	0.9	20	1.00

Table H2 : Annual solar radiation, kWh/m²

Tilt of collector	Orientation of collector				
	South	SE/SW	E/W	NE/NW	North
Horizontal			933		
30°	1042	997	886	762	709
45°	1023	968	829	666	621
60°	960	900	753	580	485
Vertical	724	684	565	427	360

Table H3 : Overshading factor

Overshading	% of sky blocked by obstacles.	Overshading factor
Heavy	> 80%	0.5
Significant	> 60% - 80%	0.65
Modest	20% - 60%	0.8
None or very little	< 20%	1.0

Note: Overshading must be assessed separately for solar panels, taking account of the tilt of the collector. Usually there is less overshading of a solar collector compared to overshading of windows for solar gain (Table 6d)

Page: 4

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 13:47

Double glazed matt black flat plates are not given typical performance figures, despite significant market share. Our exclusion is market limiting. It stops people knowing about our panels as being part of the SAP picture. There is a need to offer in table H1 an extra row: a flat plate double glazed default parameter. The solution is to add a fifth row with a lower No (say 0.5 to 0.6), a higher a1 (say 3) and aperture to gross ratio of about 0.9. These figures are similar to our panel's which is currently omitted as an option.

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 16:05

Market limitation for all solar thermal because sensible use of steep wall mounted panels do not get enough credit via SAP for their much flatter (less peaky) annual performance across the year. This is a serious error. It does not properly allow for façade mounted S facing panels and the flatter and more useful solar delivery that they offer annually. Fails to offer high solar fractions here. Bias to evacuated tubes. Understates the potential of solar thermal. Solution is to use better calculation methodology for wall mounted panels. Don't just reduce annual output. SAP MUST allow for possible increase in solar fraction with steep panels! Current the performance based assumption appears that roofs are where panels go. This is too limiting. In less backward countries than UK, facade mounted panels are the way towards maximising carbon displacement from homes.

Comments from page 4 continued on next page

Table H1 : Default collector parameters

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None or very little	< 20%	1.0

Note: Overshading must be assessed separately for solar panels, taking account of the tilt of the collector. Usually there is less overshading of a solar collector compared to overshading of windows for solar gain (Table 6d)

Table 1: Hot water energy requirements

Floor area TFA (m^2)	(a) Hot water usage V_d (litres/day)	(b) Energy content of water used (kWh/year)	(c) Distribution loss (kWh/year)
30	63	1146	202
40	71	1293	228
50	79	1437	254
60	87	1577	278
70	95	1713	302
80	102	1846	326
90	109	1976	349
100	116	2102	371
110	123	2225	393
120	129	2344	414
130	136	2460	434
140	142	2572	454
150	148	2681	473
160	154	2787	492
170	159	2889	510
180	165	2987	527
190	170	3082	544
200	175	3174	560
210	180	3262	576
220	185	3347	591
230	189	3428	605
240	193	3506	619
250	197	3581	632
260	201	3652	644
270	205	3719	656
280	209	3783	668
290	212	3844	678
300	215	3901	688

Note:

Alternatively, the hot water usage and the distribution loss may be calculated from the total floor area of the dwelling (TFA), using the following steps:

1) *Calculate* $N = 0.035 \times TFA - 0.000038 \times TFA^2$, *if* $TFA \leq 420$
   $N = 8$ *if* $TFA > 420$

   Hot water usage $= (25 \times N) + 38$
2) *Energy content of water used* $= [(61 \times N) + 92] \times 0.85 \times 8.76$
3) *Distribution loss* $= [(61 \times N) + 92] \times 0.15 \times 8.76$

Table 2: Hot water storage loss factor (kWh/litre/day)

If the manufacturer's declared loss is available, see Table 2b. In the absence of manufacturer's declared cylinder loss, the loss factor L from Table 2 is multiplied by the cylinder volume in litres, by the volume factor from Table 2a, and by the appropriate temperature factor from Table 2b, to obtain the loss rate. These data apply to cylinders heated by gas, oil and solid fuel boilers and by electric immersion, and to stores within combi boilers.

For community heating systems with no cylinder in the dwelling, use loss factor for 50 mm factory insulation and a cylinder size of 110 litres. For an electric CPSU, the loss is 0.022 kWh/litre/day.

In the case of a combination boiler:

1) the storage loss factor is zero if the efficiency is taken from Table 4b
2) the loss is to be included for a storage combination boiler if its efficiency is the manufacturer's declared value or is obtained from the Boiler Database (in which case its insulation thickness and volume are also to be provided by the manufacturer or obtained from the Database).

Insulation thickness, mm	Cylinder loss factor (L) kWh/litre/day	
	Factory insulated cylinder	Loose jacket
0	0.1425	0.1425
12	0.0394	0.0760
25	0.0240	0.0516
35	0.0191	0.0418
38	0.0181	0.0396
50	0.0152	0.0330
80	0.0115	0.0240
120	0.0094	0.0183
160	0.0084	0.0152

Note:

Alternatively the heat loss factor, L, may be calculated for insulation thickness of t mm as follows:

1) *Cylinder, loose jacket* $L = 0.005 + 1.76/(t + 12.8)$
2) *Cylinder, factory insulated* $L = 0.005 + 0.55/(t + 4.0)$

Table 2a: Volume factor for cylinders and storage combis

Volume V_c	Volume Factor VF
40	1.442
60	1.259
80	1.145
100	1.063
120	1.00
140	0.950
160	0.908
180	0.874
200	0.843
220	0.817
240	0.794
260	0.773
280	0.754

Note:

1) *When using the data in Table 2, the loss is to be multiplied by the volume factor.*
2) *Alternatively, the volume factor can be calculated using the equation* $VF = (120 / V_c)^{1/3}$
   Where:
   V_c *– volume of cylinder or storage, litres*

Page: 5

Author: barryjohnston
Subject: Highlight
Date: 02/02/2007 13:54

Why does SAP use a blunt stick when a fine one is available? People use hot water. Floors do not. Sap assumes that floors do when it comes to calculating hot water demand. This brings in errors. This is perverse. It will result in noncompliant but clearly logical installations in large homes of low occupancy. Solution is to Allow occupany to determine hot water load also if not already allowed elsewhere.

Table 4f: Electricity for fans and pumps and electric keep-hot facility

Equipment	kWh/year
Heating system	
Central heating pump (supplying hot water to radiators or underfloor system)	130 [a)]
Oil boiler [b)] - pump (supplying oil to boiler and flue fan) [c)]	100 [a)]
Gas boiler - flue fan (if fan assisted flue)	45
Warm air heating system fans [d)]	0.6 × V
Keep-hot facility of a combi boiler	
Electricity for maintaining keep-hot facility [e,f)] - keep-hot facility, controlled by time clock - keep-hot facility, not controlled by time clock	 600 900
Ventilation system	
Mechanical extract ventilation [g)]	SFP × 1.22 × V
Balanced whole house mechanical ventilation fans [g)]	SFP × 1.22 × V
Positive input ventilation (from loft space)	0
Positive input ventilation (from outside) [g)]	SFP × 1.22 × V
Solar water heating pump	
Solar water heating pump, electrically powered	75
Solar water heating pump, PV powered	0

Notes:

[a)] *Multiply by a factor of 1.3 if room thermostat is absent.*

[b)] *Applies to all oil boilers that provide main heating, but not if boiler provides hot water only.*

[c)] *The same motor operates both the pump and the flue fan.*

[d)] *If the heating system is a warm air unit and there is whole house ventilation, the electricity for warm air circulation should not be included in addition to the electricity for mechanical ventilation. V is the volume of the dwelling.*

[e)] *See notes to Table 3a for the definition of keep-hot facility.*

[f)] *In the case of an electrically powered keep-hot facility where the power rating of the keep-hot heater is obtained from the Boiler Efficiency database, the electricity consumed for maintaining the keep-hot facility should be taken as in footnote 3) to Table 3a.*

[g)] *SFP is specific fan power in W/(litre/sec), see paragraph 2.6 and Table 4g, V is volume of the dwelling in m³.*

Table 4g: Specific fan power for mechanical ventilation systems

Type of mechanical ventilation	SFP, W/(litre/sec)
Balanced whole house mechanical ventilation, with or without heat recovery	2.0
Mechanical extract ventilation, or positive input ventilation from outside	0.8

Table 5: Lighting, appliances, cooking and metabolic gains

Floor area (m^2)	Gains (W)	Floor area (m^2)	Gains (W)
30	230	**170**	893
40	282	**180**	935
50	332	**190**	978
60	382	**200**	1020
70	431	**210**	1061
80	480	**220**	1102
90	528	**230**	1142
100	576	**240**	1181
110	623	**250**	1220
120	669	**260**	1259
130	715	**270**	1297
140	760	**280**	1334
150	805	**290**	1349
160	849	**300**	1359

Notes:

Alternatively, gains may be calculated from the total floor area of the dwelling (TFA), using the following steps:

1) Calculate
$N = 0.035 \times TFA - 0.000038 \times TFA^2$ *if* $TFA \le 420$
$N = 8$ *if* $TFA > 420$

2) Calculate gains (W)
$= 74 + 2.66 \times TFA + 75.5 \times N$ *if* $TFA \le 282$
$= 824 + 75.5 \times N$ *if* $TFA > 282$

If there is low-energy lighting the gains should be reduced to take account of the reduced gains from lighting (see Appendix L).

Table 5a: Gains from fans and pumps

Function	Gains (W)
Central heating pump [a)]	10
Oil boiler pump, inside dwelling [b)]	10
Warm air heating system fans [a) c)]	0.06 × V
Balanced whole house mechanical ventilation fans	SFP × 0.06 × V

Notes:

[a)] *Does not apply to community heating*

[b)] *Only for boiler providing main heating. In addition to central heating pump, but not if oil pump is outside dwelling.*

[c)] *If the heating system is a warm air unit and there is whole house ventilation, the gains for warm air circulation should not be included in addition to the gains for mechanical ventilation. V is the volume of the dwelling.*

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Date: 02/02/2007 16:04

We welcome the acknowledgment of the "zero carbon" benefit here for PV pumped systems. Unfortunately the 75 kWh figure is far too high for some newer systems which use miniature low voltage low flow mains pumps. More than one figure, indeed realistic ranges of figures needs to be available in order to incentivise designers of low carbon mains power solar thermal to reduce its carbon clawback ratio, a figure which can exceed 20% for some evacuated tube technologies.