

## SAP WorkSheet: New dwelling design stage

### User Details

**Assessor Name:** Nicholas Jones **Stroma Number:** STRO000971  
**Software Name:** Stroma FSAP 2012 **Software Version:** Version: 1.0.4.10

### Property Address: Plot 26

**Address :** Plot 26, Pagham Road, Pagham, PO21 3PX

### 1. General dwelling dimensions

|                                                           | Area(m <sup>2</sup> ) | Av. Height(m)                      | Volume(m <sup>3</sup> ) |
|-----------------------------------------------------------|-----------------------|------------------------------------|-------------------------|
| Ground floor                                              | 63.69 (1a)            | 2.37 (2a)                          | 150.95 (3a)             |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 63.69 (4)             |                                    |                         |
| Dwelling volume                                           |                       | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | 150.95 (5)              |

### 2. Ventilation rate

|                              | main heating | secondary heating | other | total | m <sup>3</sup> per hour |
|------------------------------|--------------|-------------------|-------|-------|-------------------------|
| Number of chimneys           | 0            | 0                 | 0     | 0     | 0 (6a)                  |
| Number of open flues         | 0            | 0                 | 0     | 0     | 0 (6b)                  |
| Number of intermittent fans  |              |                   |       | 2     | 20 (7a)                 |
| Number of passive vents      |              |                   |       | 0     | 0 (7b)                  |
| Number of flueless gas fires |              |                   |       | 0     | 0 (7c)                  |

### Air changes per hour

|                                                                                                                                                        |                                          |               |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------|-----------|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =                                                                              | 20                                       | ÷ (5) =       | 0.13 (8)  |
| <i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>                              |                                          |               |           |
| Number of storeys in the dwelling (ns)                                                                                                                 |                                          |               | 0 (9)     |
| Additional infiltration                                                                                                                                |                                          | [(9)-1]x0.1 = | 0 (10)    |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction                                                               |                                          |               | 0 (11)    |
| <i>if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35</i> |                                          |               |           |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0                                                                          |                                          |               | 0 (12)    |
| If no draught lobby, enter 0.05, else enter 0                                                                                                          |                                          |               | 0 (13)    |
| Percentage of windows and doors draught stripped                                                                                                       |                                          |               | 0 (14)    |
| Window infiltration                                                                                                                                    | 0.25 - [0.2 x (14) ÷ 100] =              |               | 0 (15)    |
| Infiltration rate                                                                                                                                      | (8) + (10) + (11) + (12) + (13) + (15) = |               | 0 (16)    |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area                                                      |                                          |               | 4.5 (17)  |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)                                                               |                                          |               | 0.36 (18) |
| <i>Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used</i>                                |                                          |               |           |
| Number of sides sheltered                                                                                                                              |                                          |               | 3 (19)    |
| Shelter factor                                                                                                                                         | (20) = 1 - [0.075 x (19)] =              |               | 0.78 (20) |
| Infiltration rate incorporating shelter factor                                                                                                         | (21) = (18) x (20) =                     |               | 0.28 (21) |

Infiltration rate modified for monthly wind speed

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

Monthly average wind speed from Table 7

| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |
|--------|-----|---|-----|-----|-----|-----|-----|-----|---|-----|-----|-----|
|--------|-----|---|-----|-----|-----|-----|-----|-----|---|-----|-----|-----|

Wind Factor (22a)m = (22)m ÷ 4

| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |
|---------|------|------|------|-----|------|------|------|------|---|------|------|------|
|---------|------|------|------|-----|------|------|------|------|---|------|------|------|

## SAP WorkSheet: New dwelling design stage

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

|      |      |      |     |     |      |      |      |      |     |      |      |
|------|------|------|-----|-----|------|------|------|------|-----|------|------|
| 0.35 | 0.35 | 0.34 | 0.3 | 0.3 | 0.26 | 0.26 | 0.26 | 0.28 | 0.3 | 0.31 | 0.33 |
|------|------|------|-----|-----|------|------|------|------|-----|------|------|

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)) , otherwise (23b) = (23a)

0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) x [1 - (23c) ÷ 100]

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 0.56 0.56 0.56 0.55 0.54 0.53 0.53 0.53 0.54 0.54 0.55 0.55 (24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m= 0.56 0.56 0.56 0.55 0.54 0.53 0.53 0.53 0.54 0.54 0.55 0.55 (25)

### 3. Heat losses and heat loss parameter

| ELEMENT                    | Gross area (m²) | Openings m² | Net Area A ,m² | U-value W/m²K               | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K |
|----------------------------|-----------------|-------------|----------------|-----------------------------|-------------|-----------------|------------|
| Doors                      |                 |             | 2.01           | 1.2                         | 2.412       |                 | (26)       |
| Windows Type 1             |                 |             | 2.32           | $\times 1/[1/(1.4) + 0.04]$ | 3.08        |                 | (27)       |
| Windows Type 2             |                 |             | 4.26           | $\times 1/[1/(1.4) + 0.04]$ | 5.65        |                 | (27)       |
| Windows Type 3             |                 |             | 0.82           | $\times 1/[1/(1.4) + 0.04]$ | 1.09        |                 | (27)       |
| Walls Type1                | 40.28           | 7.4         | 32.88          | 0.24                        | 7.89        |                 | (29)       |
| Walls Type2                | 17.39           | 2.01        | 15.38          | 0.2                         | 3.04        |                 | (29)       |
| Roof                       | 63.69           | 0           | 63.69          | 0.13                        | 8.28        |                 | (30)       |
| Total area of elements, m² |                 |             | 121.36         |                             |             |                 | (31)       |
| Party wall                 |                 |             | 18.25          | 0                           | 0           |                 | (32)       |
| Party floor                |                 |             | 63.69          |                             |             |                 | (32a)      |

\* for windows and roof windows, use effective window U-value calculated using formula  $1/[(1/U\text{-value})+0.04]$  as given in paragraph 3.2

\*\* include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 31.43 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 12474.56 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K 10.32 (36)

if details of thermal bridging are not known (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 41.75 (37)

Ventilation heat loss calculated monthly (36)m = 0.33 x (25)m x (5)

|     |     |     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

## SAP WorkSheet: New dwelling design stage

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (36)m= | 28.01 | 27.89 | 27.77 | 27.22 | 27.12 | 26.63 | 26.63 | 26.54 | 26.82 | 27.12 | 27.33 | 27.55 | (38) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

Heat transfer coefficient, W/K

$$(39)m = (37) + (38)m$$

|                                            |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (39)m=                                     | 69.76 | 69.64 | 69.53 | 68.97 | 68.87 | 68.38 | 68.38 | 68.29 | 68.57 | 68.87 | 69.08 | 69.3  |      |
| Average = Sum(39) <sub>1...12</sub> / 12 = |       |       |       |       |       |       |       |       |       |       |       | 68.97 | (39) |

Heat loss parameter (HLP), W/m²K

$$(40)m = (39)m + (4)$$

|                                            |     |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------------|-----|------|------|------|------|------|------|------|------|------|------|------|------|
| (40)m=                                     | 1.1 | 1.09 | 1.09 | 1.08 | 1.08 | 1.07 | 1.07 | 1.07 | 1.08 | 1.08 | 1.08 | 1.09 |      |
| Average = Sum(40) <sub>1...12</sub> / 12 = |     |      |      |      |      |      |      |      |      |      |      | 1.08 | (40) |

Number of days in month (Table 1a)

|        |     |     |     |     |     |     |     |     |     |     |     |     |      |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|        | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |      |
| (41)m= | 31  | 28  | 31  | 30  | 31  | 30  | 31  | 31  | 30  | 31  | 30  | 31  | (41) |

### 4. Water heating energy requirement

kWh/year

Assumed occupancy, N

if TFA > 13.9,  $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

if TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day  $V_{d,average} = (25 \times N) + 36$

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

|        |       |       |       |       |       |       |       |       |       |       |       |       |  |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
|        | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |  |
| (44)m= | 92.06 | 88.71 | 85.36 | 82.02 | 78.67 | 75.32 | 75.32 | 78.67 | 82.02 | 85.36 | 88.71 | 92.06 |  |

Hot water usage in litres per day for each month  $V_{d,m} = \text{factor from Table 1c} \times (43)$

|                                     |       |       |       |       |       |       |       |       |       |       |       |         |      |
|-------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|------|
| (44)m=                              | 92.06 | 88.71 | 85.36 | 82.02 | 78.67 | 75.32 | 75.32 | 78.67 | 82.02 | 85.36 | 88.71 | 92.06   |      |
| Total = Sum(44) <sub>1...12</sub> = |       |       |       |       |       |       |       |       |       |       |       | 1004.29 | (44) |

Energy content of hot water used - calculated monthly =  $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$  kWh/month (see Tables 1b, 1c, 1d)

|                                     |        |       |        |        |        |       |       |       |       |        |        |         |      |
|-------------------------------------|--------|-------|--------|--------|--------|-------|-------|-------|-------|--------|--------|---------|------|
| (45)m=                              | 136.52 | 119.4 | 123.21 | 107.42 | 103.07 | 88.94 | 82.42 | 94.58 | 95.71 | 111.54 | 121.75 | 132.21  |      |
| Total = Sum(45) <sub>1...12</sub> = |        |       |        |        |        |       |       |       |       |        |        | 1316.78 | (45) |

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (46)m= | 20.48 | 17.91 | 18.48 | 16.11 | 15.46 | 13.34 | 12.36 | 14.19 | 14.36 | 16.73 | 18.26 | 19.83 | (46) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

Temperature factor from Table 2b

Energy lost from water storage, kWh/year

$$(48) \times (49) =$$

b) If manufacturer's declared cylinder loss factor is not known:

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

If community heating see section 4.3

Volume factor from Table 2a

Temperature factor from Table 2b

Energy lost from water storage, kWh/year

$$(47) \times (51) \times (52) \times (53) =$$

Enter (50) or (54) in (55)

Water storage loss calculated for each month

$$((56)m = (55) \times (41)m$$

|        |      |       |      |       |      |       |      |      |       |      |       |      |      |
|--------|------|-------|------|-------|------|-------|------|------|-------|------|-------|------|------|
| (56)m= | 22.1 | 19.96 | 22.1 | 21.38 | 22.1 | 21.38 | 22.1 | 22.1 | 21.38 | 22.1 | 21.38 | 22.1 | (56) |
|--------|------|-------|------|-------|------|-------|------|------|-------|------|-------|------|------|

If cylinder contains dedicated solar storage,  $(57)m = (56)m \times [(50) - (H11)] \div (50)$ , else  $(57)m = (56)m$  where (H11) is from Appendix H

|        |      |       |      |       |      |       |      |      |       |      |       |      |      |
|--------|------|-------|------|-------|------|-------|------|------|-------|------|-------|------|------|
| (57)m= | 22.1 | 19.96 | 22.1 | 21.38 | 22.1 | 21.38 | 22.1 | 22.1 | 21.38 | 22.1 | 21.38 | 22.1 | (57) |
|--------|------|-------|------|-------|------|-------|------|------|-------|------|-------|------|------|



## SAP WorkSheet: New dwelling design stage

|       |      |      |   |      |   |        |   |      |   |     |   |        |      |
|-------|------|------|---|------|---|--------|---|------|---|-----|---|--------|------|
| East  | 0.9x | 1    | x | 0.82 | x | 63.27  | x | 0.63 | x | 0.7 | = | 15.86  | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 92.28  | x | 0.63 | x | 0.7 | = | 23.13  | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 113.09 | x | 0.63 | x | 0.7 | = | 28.34  | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 115.77 | x | 0.63 | x | 0.7 | = | 29.01  | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 110.22 | x | 0.63 | x | 0.7 | = | 27.62  | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 94.68  | x | 0.63 | x | 0.7 | = | 23.73  | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 73.59  | x | 0.63 | x | 0.7 | = | 18.44  | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 45.59  | x | 0.63 | x | 0.7 | = | 11.42  | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 24.49  | x | 0.63 | x | 0.7 | = | 6.14   | (76) |
| East  | 0.9x | 1    | x | 0.82 | x | 16.15  | x | 0.63 | x | 0.7 | = | 4.05   | (76) |
| South | 0.9x | 0.77 | x | 2.32 | x | 46.75  | x | 0.63 | x | 0.7 | = | 33.15  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 76.57  | x | 0.63 | x | 0.7 | = | 54.29  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 97.53  | x | 0.63 | x | 0.7 | = | 69.15  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 110.23 | x | 0.63 | x | 0.7 | = | 78.16  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 114.87 | x | 0.63 | x | 0.7 | = | 81.45  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 110.55 | x | 0.63 | x | 0.7 | = | 78.38  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 108.01 | x | 0.63 | x | 0.7 | = | 76.58  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 104.89 | x | 0.63 | x | 0.7 | = | 74.37  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 101.89 | x | 0.63 | x | 0.7 | = | 72.24  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 82.59  | x | 0.63 | x | 0.7 | = | 58.56  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 55.42  | x | 0.63 | x | 0.7 | = | 39.29  | (78) |
| South | 0.9x | 0.77 | x | 2.32 | x | 40.4   | x | 0.63 | x | 0.7 | = | 28.64  | (78) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 19.64  | x | 0.63 | x | 0.7 | = | 25.57  | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 38.42  | x | 0.63 | x | 0.7 | = | 50.02  | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 63.27  | x | 0.63 | x | 0.7 | = | 82.38  | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 92.28  | x | 0.63 | x | 0.7 | = | 120.14 | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 113.09 | x | 0.63 | x | 0.7 | = | 147.24 | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 115.77 | x | 0.63 | x | 0.7 | = | 150.72 | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 110.22 | x | 0.63 | x | 0.7 | = | 143.49 | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 94.68  | x | 0.63 | x | 0.7 | = | 123.26 | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 73.59  | x | 0.63 | x | 0.7 | = | 95.81  | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 45.59  | x | 0.63 | x | 0.7 | = | 59.35  | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 24.49  | x | 0.63 | x | 0.7 | = | 31.88  | (80) |
| West  | 0.9x | 0.77 | x | 4.26 | x | 16.15  | x | 0.63 | x | 0.7 | = | 21.03  | (80) |

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

|        |       |        |        |        |        |        |       |        |        |        |       |       |      |
|--------|-------|--------|--------|--------|--------|--------|-------|--------|--------|--------|-------|-------|------|
| (83)m= | 63.64 | 113.94 | 167.39 | 221.42 | 257.02 | 258.12 | 247.7 | 221.36 | 186.49 | 129.33 | 77.31 | 53.72 | (83) |
|--------|-------|--------|--------|--------|--------|--------|-------|--------|--------|--------|-------|-------|------|

Total gains – internal and solar (84)m = (73)m + (83)m , watts

|        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (84)m= | 581.94 | 628.05 | 662.84 | 688.33 | 695.01 | 670.27 | 644.88 | 626.22 | 607.92 | 579.51 | 559.24 | 559.35 | (84) |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

### 7. Mean indoor temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)

21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

## SAP WorkSheet: New dwelling design stage

|        |      |      |      |      |     |      |      |     |      |      |      |      |      |
|--------|------|------|------|------|-----|------|------|-----|------|------|------|------|------|
| (86)m= | 0.99 | 0.98 | 0.96 | 0.91 | 0.8 | 0.63 | 0.46 | 0.5 | 0.72 | 0.92 | 0.97 | 0.99 | (86) |
|--------|------|------|------|------|-----|------|------|-----|------|------|------|------|------|

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

|        |    |    |    |    |    |    |    |    |    |    |    |    |      |
|--------|----|----|----|----|----|----|----|----|----|----|----|----|------|
| (87)m= | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | (87) |
|--------|----|----|----|----|----|----|----|----|----|----|----|----|------|

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

|        |    |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (88)m= | 20 | 20.01 | 20.01 | 20.01 | 20.02 | 20.02 | 20.02 | 20.02 | 20.02 | 20.02 | 20.01 | 20.01 | (88) |
|--------|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

|        |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| (89)m= | 0.98 | 0.97 | 0.95 | 0.88 | 0.75 | 0.54 | 0.36 | 0.39 | 0.64 | 0.88 | 0.97 | 0.99 | (89) |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|------|

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

|        |    |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (90)m= | 20 | 20.01 | 20.01 | 20.01 | 20.02 | 20.02 | 20.02 | 20.02 | 20.02 | 20.02 | 20.01 | 20.01 | (90) |
|--------|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

$$fLA = \text{Living area} \div (4) = 0.4 \quad (91)$$

Mean internal temperature (for the whole dwelling) =  $fLA \times T1 + (1 - fLA) \times T2$

|        |      |      |      |       |       |       |       |       |       |       |      |      |      |
|--------|------|------|------|-------|-------|-------|-------|-------|-------|-------|------|------|------|
| (92)m= | 20.4 | 20.4 | 20.4 | 20.41 | 20.41 | 20.41 | 20.41 | 20.41 | 20.41 | 20.41 | 20.4 | 20.4 | (92) |
|--------|------|------|------|-------|-------|-------|-------|-------|-------|-------|------|------|------|

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

|        |      |      |      |       |       |       |       |       |       |       |      |      |      |
|--------|------|------|------|-------|-------|-------|-------|-------|-------|-------|------|------|------|
| (93)m= | 20.4 | 20.4 | 20.4 | 20.41 | 20.41 | 20.41 | 20.41 | 20.41 | 20.41 | 20.41 | 20.4 | 20.4 | (93) |
|--------|------|------|------|-------|-------|-------|-------|-------|-------|-------|------|------|------|

### 4. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

Utilisation factor for gains, hm:

|        |      |      |      |      |      |      |     |      |      |     |      |      |      |
|--------|------|------|------|------|------|------|-----|------|------|-----|------|------|------|
| (94)m= | 0.98 | 0.97 | 0.95 | 0.89 | 0.77 | 0.58 | 0.4 | 0.43 | 0.67 | 0.9 | 0.97 | 0.99 | (94) |
|--------|------|------|------|------|------|------|-----|------|------|-----|------|------|------|

Useful gains, hmGm, W = (94)m x (84)m

|        |        |        |        |        |        |        |        |     |       |        |        |        |      |
|--------|--------|--------|--------|--------|--------|--------|--------|-----|-------|--------|--------|--------|------|
| (95)m= | 572.76 | 612.08 | 630.96 | 615.33 | 537.16 | 386.86 | 259.28 | 272 | 409.3 | 520.17 | 542.51 | 552.05 | (95) |
|--------|--------|--------|--------|--------|--------|--------|--------|-----|-------|--------|--------|--------|------|

Monthly average external temperature from Table 8

|        |     |     |     |     |      |      |      |      |      |      |     |     |      |
|--------|-----|-----|-----|-----|------|------|------|------|------|------|-----|-----|------|
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
|--------|-----|-----|-----|-----|------|------|------|------|------|------|-----|-----|------|

Heat loss rate for mean internal temperature, Lm, W = [(39)m x ((93)m - (96)m)]

|        |         |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (97)m= | 1123.16 | 1079.5 | 966.49 | 793.54 | 599.57 | 397.31 | 260.54 | 273.91 | 432.57 | 675.32 | 919.04 | 1122.8 | (97) |
|--------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

Space heating requirement for each month, kWh/month =  $0.024 \times [(97)m - (95)m] \times (41)m$

|        |       |        |        |       |       |   |   |   |   |        |       |        |      |
|--------|-------|--------|--------|-------|-------|---|---|---|---|--------|-------|--------|------|
| (98)m= | 409.5 | 314.11 | 249.63 | 128.3 | 46.44 | 0 | 0 | 0 | 0 | 115.43 | 271.1 | 424.64 | (98) |
|--------|-------|--------|--------|-------|-------|---|---|---|---|--------|-------|--------|------|

$$\text{Total per year (kWh/year)} = \text{Sum}(98)_{1..12} = 1959.15 \quad (98)$$

Space heating requirement in kWh/m²/year

$$30.76 \quad (99)$$

### 5a. Energy requirements: Individual heating systems including micro-CHP

#### Space heating:

Fraction of space heat from secondary/supplementary system

$$0 \quad (201)$$

Fraction of space heat from main system(s)

$$(202) = 1 - (201) = 1 \quad (202)$$

Fraction of total heating from main system 1

$$(204) = (202) \times [1 - (203)] = 1 \quad (204)$$

Efficiency of main space heating system 1

$$332.23 \quad (206)$$

Efficiency of secondary/supplementary heating system, %

$$0 \quad (208)$$

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | kWh/year |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|

Space heating requirement (calculated above)

|       |        |        |       |       |   |   |   |   |        |       |        |
|-------|--------|--------|-------|-------|---|---|---|---|--------|-------|--------|
| 409.5 | 314.11 | 249.63 | 128.3 | 46.44 | 0 | 0 | 0 | 0 | 115.43 | 271.1 | 424.64 |
|-------|--------|--------|-------|-------|---|---|---|---|--------|-------|--------|

$$(211)m = \{[(98)m \times (204)]\} \times 100 \div (206) \quad (211)$$

|        |       |       |       |       |   |   |   |   |       |      |        |
|--------|-------|-------|-------|-------|---|---|---|---|-------|------|--------|
| 123.26 | 94.55 | 75.14 | 38.62 | 13.98 | 0 | 0 | 0 | 0 | 34.74 | 81.6 | 127.82 |
|--------|-------|-------|-------|-------|---|---|---|---|-------|------|--------|

$$\text{Total (kWh/year)} = \text{Sum}(211)_{1..12} = 589.7 \quad (211)$$

## SAP WorkSheet: New dwelling design stage

Space heating fuel (secondary), kWh/month

$$= \{[(98)m \times (201)]\} \times 100 \div (208)$$

|                                                      |   |   |   |   |   |   |   |   |   |   |   |   |         |
|------------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---------|
| (215)m=                                              | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |         |
| Total (kWh/year) =Sum(215) <sub>1..5,10...12</sub> = |   |   |   |   |   |   |   |   |   |   |   |   | 0 (215) |

### Water heating

Output from water heater (calculated above)

|                            |        |        |        |        |        |        |        |        |        |        |        |        |              |
|----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
|                            | 181.88 | 160.37 | 168.57 | 151.32 | 148.43 | 132.84 | 127.78 | 139.94 | 139.6  | 156.9  | 165.65 | 177.57 |              |
| Efficiency of water heater |        |        |        |        |        |        |        |        |        |        |        |        | 133.85 (216) |
| (217)m=                    | 133.85 | 133.85 | 133.85 | 133.85 | 133.85 | 133.85 | 133.85 | 133.85 | 133.85 | 133.85 | 133.85 | 133.85 | (217)        |

Fuel for water heating, kWh/month

$$(219)m = (64)m \times 100 \div (217)m$$

|                                      |        |        |        |        |        |       |       |        |        |        |        |        |               |
|--------------------------------------|--------|--------|--------|--------|--------|-------|-------|--------|--------|--------|--------|--------|---------------|
| (219)m=                              | 135.88 | 119.81 | 125.94 | 113.04 | 110.89 | 99.24 | 95.46 | 104.54 | 104.29 | 117.21 | 123.75 | 132.66 |               |
| Total = Sum(219a) <sub>1..12</sub> = |        |        |        |        |        |       |       |        |        |        |        |        | 1382.73 (219) |

### Annual totals

Space heating fuel used, main system 1

kWh/year

kWh/year

Water heating fuel used

Electricity for pumps, fans and electric keep-hot

Total electricity for the above, kWh/year

$$\text{sum of (230a)...(230g) =}$$

Electricity for lighting

|  |              |
|--|--------------|
|  | 0 (231)      |
|  | 320.59 (232) |

### 12a Fuel costs - individual heating systems

|                                                                                                                          | Fuel<br>kWh/year | Fuel Price<br>(Table 12) | Fuel Cost<br>£/year |
|--------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------|---------------------|
| Space heating - main system 1                                                                                            | (211) x          | 13.19 x 0.01 =           | 77.78 (240)         |
| Space heating - main system 2                                                                                            | (213) x          | 0 x 0.01 =               | 0 (241)             |
| Space heating - secondary                                                                                                | (215) x          | 13.19 x 0.01 =           | 0 (242)             |
| Water heating cost (other fuel)                                                                                          | (219)            | 13.19 x 0.01 =           | 182.38 (247)        |
| Pumps, fans and electric keep-hot                                                                                        | (231)            | 13.19 x 0.01 =           | 0 (249)             |
| (if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a) |                  |                          |                     |
| Energy for lighting                                                                                                      | (232)            | 13.19 x 0.01 =           | 42.29 (250)         |
| Additional standing charges (Table 12)                                                                                   |                  |                          | 0 (251)             |

Appendix Q items: repeat lines (253) and (254) as needed

|                          |                                 |              |
|--------------------------|---------------------------------|--------------|
| <b>Total energy cost</b> | (245)...(247) + (250)...(254) = | 302.45 (255) |
|--------------------------|---------------------------------|--------------|

### 12a SAP rating - individual heating systems

|                                 |                                                    |      |       |
|---------------------------------|----------------------------------------------------|------|-------|
| Energy cost deflator (Table 12) |                                                    | 0.42 | (256) |
| Energy cost factor (ECF)        | $\frac{[(255) \times (256)] \div [(4) + 45.0]}{=}$ | 1.17 | (257) |
| <b>SAP rating (Section 12)</b>  |                                                    | 83.7 | (258) |

### 12a CO2 emissions - individual heating systems including micro-CHP

| Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |
|--------------------|-------------------------------|--------------------------|
|--------------------|-------------------------------|--------------------------|

## SAP WorkSheet: New dwelling design stage

|                                                   |                                 |                        |   |         |       |
|---------------------------------------------------|---------------------------------|------------------------|---|---------|-------|
| Space heating (main system 1)                     | {211} x                         | 0.519                  | = | 306.05  | {261} |
| Space heating (secondary)                         | {215} x                         | 0.519                  | = | 0       | {263} |
| Water heating                                     | {219} x                         | 0.519                  | = | 717.63  | {264} |
| Space and water heating                           | {261} + {262} + {263} + {264} = |                        |   | 1023.69 | {265} |
| Electricity for pumps, fans and electric keep-hot | {231} x                         | 0.519                  | = | 0       | {267} |
| Electricity for lighting                          | {232} x                         | 0.519                  | = | 166.39  | {268} |
| Total CO <sub>2</sub> , kg/year                   |                                 | sum of {265}...{271} = |   | 1190.08 | {272} |
| <b>CO<sub>2</sub> emissions per m<sup>2</sup></b> |                                 | {272} ÷ (4) =          |   | 18.69   | {273} |
| El rating (section 14)                            |                                 |                        |   | 85      | {274} |

### 13a Primary Energy

|                                                   | Energy<br>kWh/year              | Primary<br>factor      |   | P. Energy<br>kWh/year |       |
|---------------------------------------------------|---------------------------------|------------------------|---|-----------------------|-------|
| Space heating (main system 1)                     | {211} x                         | 3.07                   | = | 1810.37               | {261} |
| Space heating (secondary)                         | {215} x                         | 3.07                   | = | 0                     | {263} |
| Energy for water heating                          | {219} x                         | 3.07                   | = | 4244.97               | {264} |
| Space and water heating                           | {261} + {262} + {263} + {264} = |                        |   | 6055.34               | {265} |
| Electricity for pumps, fans and electric keep-hot | {231} x                         | 3.07                   | = | 0                     | {267} |
| Electricity for lighting                          | {232} x                         | 0                      | = | 984.22                | {268} |
| 'Total Primary Energy                             |                                 | sum of {265}...{271} = |   | 7039.56               | {272} |
| <b>Primary energy kWh/m<sup>2</sup>/year</b>      |                                 | {272} ÷ (4) =          |   | 110.53                | {273} |