

## 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 2

**Address :** Plot 2, Pagham Road, Pagham, PO21 3PX

### 1. General dwelling dimensions

|                                                           | Area(m <sup>2</sup> ) | Av. Height(m)                      | Volume(m <sup>3</sup> ) |
|-----------------------------------------------------------|-----------------------|------------------------------------|-------------------------|
| Ground floor                                              | 47.54 (1a)            | 2.37 (2a)                          | 112.67 (3a)             |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 47.54 (4)             |                                    |                         |
| Dwelling volume                                           |                       | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | 112.67 (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) =       | 0.18 (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                                                      |                                          |               | 5 (17)    |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)                                                               |                                          |               | 0.43 (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) =                     |               | 0.33 (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

|      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.42 | 0.41 | 0.41 | 0.36 | 0.36 | 0.31 | 0.31 | 0.31 | 0.33 | 0.36 | 0.37 | 0.39 |
|------|------|------|------|------|------|------|------|------|------|------|------|

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= 0.59 0.59 0.58 0.57 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.58 (24d)

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

(25)m= 0.59 0.59 0.58 0.57 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.58 (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             |                 |             | 1.5            | $\times 1/[1/(1.4) + 0.04]$ | 1.99        |                 | (27)       |
| Windows Type 2             |                 |             | 4.83           | $\times 1/[1/(1.4) + 0.04]$ | 6.4         |                 | (27)       |
| Windows Type 3             |                 |             | 0.52           | $\times 1/[1/(1.4) + 0.04]$ | 0.69        |                 | (27)       |
| Floor                      |                 |             | 47.54          | 0.15                        | 7.131001    |                 | (28)       |
| Walls                      | 46.23           | 8.86        | 37.37          | 0.19                        | 7.1         |                 | (29)       |
| Roof                       | 47.54           | 0           | 47.54          | 0.11                        | 5.23        |                 | (30)       |
| Total area of elements, m² |                 |             | 141.31         |                             |             |                 | (31)       |
| Party wall                 |                 |             | 22.53          | 0                           | 0           |                 | (32)       |

\* 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) = 30.95 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 2501.92 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Low 100 (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 12.17 (36)

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

Total fabric heat loss (33) + (36) = 43.13 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

|        | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| (38)m= | 21.91 | 21.78 | 21.65 | 21.06 | 20.95 | 20.43 | 20.43 | 20.34 | 20.63 | 20.95 | 21.17 | 21.41 |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

(39)m= 65.04 64.91 64.78 64.19 64.08 63.56 63.56 63.46 63.76 64.08 64.3 64.54 (39)

## SAP WorkSheet: New dwelling design stage

Heat loss parameter (HLP), W/m<sup>2</sup>K

$$\{40\}m = \{39\}m + \{4\}$$

|                          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| {40}m=                   | 1.37 | 1.37 | 1.36 | 1.35 | 1.35 | 1.34 | 1.34 | 1.33 | 1.34 | 1.35 | 1.35 | 1.36 |      |      |
| Average = Sum{40} / 12 = |      |      |      |      |      |      |      |      |      |      |      |      | 1.35 | {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

1st/1st year

Assumed occupancy, N

1.62

{42}

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)<sup>2</sup>)] + 0.0013 x (TFA - 13.9)

if TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36

72.63

{43}

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=                 | 79.89 | 76.98 | 74.08 | 71.17 | 68.27 | 65.36 | 65.36 | 68.27 | 71.17 | 74.08 | 76.98 | 79.89 |        |      |
| Total = Sum{44} / 12 = |       |       |       |       |       |       |       |       |       |       |       |       | 871.53 | {44} |

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

|                        |        |        |        |       |       |       |       |       |       |       |        |        |         |      |
|------------------------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|--------|--------|---------|------|
| {45}m=                 | 118.47 | 103.62 | 106.93 | 93.22 | 89.45 | 77.19 | 71.52 | 82.07 | 83.05 | 96.79 | 105.66 | 114.74 |         |      |
| Total = Sum{45} / 12 = |        |        |        |       |       |       |       |       |       |       |        |        | 1142.71 | {45} |

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

|        |       |       |       |       |       |       |       |       |       |       |       |       |  |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|------|
| {46}m= | 17.77 | 15.54 | 16.04 | 13.98 | 13.42 | 11.58 | 10.73 | 12.31 | 12.46 | 14.52 | 15.85 | 17.21 |  | {46} |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|------|

Water storage loss:

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

175

{47}

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):

1.32

{48}

Temperature factor from Table 2b

0.54

{49}

Energy lost from water storage, kWh/year

$$\{48\} \times \{49\} =$$

0.71

{50}

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

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

0

{51}

If community heating see section 4.3

Volume factor from Table 2a

0

{52}

Temperature factor from Table 2b

0

{53}

Energy lost from water storage, kWh/year

$$\{47\} \times \{51\} \times \{52\} \times \{53\} =$$

0

{54}

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

0.71

{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 x [(50) - (H11)] ÷ (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} |
|--------|------|-------|------|-------|------|-------|------|------|-------|------|-------|------|--|------|

Primary circuit loss (annual) from Table 3

0

{58}

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 x (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

|        |       |       |       |       |       |       |       |       |       |       |       |       |  |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|------|
| {59}m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 |  | {59} |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|------|

## SAP WorkSheet: New dwelling design stage

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

|        |   |   |   |   |   |   |   |   |   |   |   |      |
|--------|---|---|---|---|---|---|---|---|---|---|---|------|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |
|--------|---|---|---|---|---|---|---|---|---|---|---|------|

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

|        |        |        |        |        |        |        |        |        |        |        |        |       |      |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|------|
| (62)m= | 163.83 | 144.59 | 152.28 | 137.12 | 134.81 | 121.08 | 116.88 | 127.43 | 126.95 | 142.15 | 149.55 | 160.1 | (62) |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|------|

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRs and/or WWHRS applies, see Appendix G)

|        |   |   |   |   |   |   |   |   |   |   |   |      |
|--------|---|---|---|---|---|---|---|---|---|---|---|------|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |
|--------|---|---|---|---|---|---|---|---|---|---|---|------|

Output from water heater

|                                         |        |        |        |        |        |        |        |        |        |        |        |         |      |
|-----------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|------|
| (64)m=                                  | 163.83 | 144.59 | 152.28 | 137.12 | 134.81 | 121.08 | 116.88 | 127.43 | 126.95 | 142.15 | 149.55 | 160.1   |      |
| Output from water heater (annual): 1.12 |        |        |        |        |        |        |        |        |        |        |        | 1676.78 | (64) |

Heat gains from water heating, kWh/month  $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (65)m= | 75.68 | 67.23 | 71.84 | 66.11 | 66.03 | 60.78 | 60.07 | 63.58 | 62.73 | 68.47 | 70.25 | 74.44 | (65) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

### 5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

|        | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (66)m= | 97.08 | 97.08 | 97.08 | 97.08 | 97.08 | 97.08 | 97.08 | 97.08 | 97.08 | 97.08 | 97.08 | 97.08 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (67)m= | 31.89 | 28.33 | 23.04 | 17.44 | 13.04 | 11.01 | 11.89 | 15.46 | 20.75 | 26.35 | 30.75 | 32.78 | (67) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

|        |        |       |        |       |        |        |        |        |        |        |        |        |      |
|--------|--------|-------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (68)m= | 210.22 | 212.4 | 206.91 | 195.2 | 180.43 | 166.55 | 157.27 | 155.09 | 160.59 | 172.29 | 187.06 | 200.95 | (68) |
|--------|--------|-------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|------|

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (69)m= | 46.33 | 46.33 | 46.33 | 46.33 | 46.33 | 46.33 | 46.33 | 46.33 | 46.33 | 46.33 | 46.33 | 46.33 | (69) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

Pumps and fans gains (Table 5a)

|        |   |   |   |   |   |   |   |   |   |   |   |   |      |
|--------|---|---|---|---|---|---|---|---|---|---|---|---|------|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |
|--------|---|---|---|---|---|---|---|---|---|---|---|---|------|

Losses e.g. evaporation (negative values) (Table 5)

|        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (71)m= | -64.72 | -64.72 | -64.72 | -64.72 | -64.72 | -64.72 | -64.72 | -64.72 | -64.72 | -64.72 | -64.72 | -64.72 | (71) |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

Water heating gains (Table 5)

|        |        |        |       |       |       |       |       |       |       |       |       |        |      |
|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|------|
| (72)m= | 101.72 | 100.04 | 96.56 | 91.82 | 88.75 | 84.42 | 80.74 | 85.45 | 87.13 | 92.03 | 97.57 | 100.05 | (72) |
|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|------|

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

|        |        |        |        |        |       |        |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|------|
| (73)m= | 422.52 | 419.46 | 405.19 | 383.15 | 360.9 | 340.66 | 328.59 | 334.69 | 347.15 | 369.35 | 394.06 | 412.46 | (73) |
|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|------|

### 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: |      | Access Factor<br>Table 6d |   | Area<br>m <sup>2</sup> |   | Flux<br>Table 6a |   | g_<br>Table 6b |   | FF<br>Table 6c |   | Gains<br>(W) |      |
|--------------|------|---------------------------|---|------------------------|---|------------------|---|----------------|---|----------------|---|--------------|------|
| North        | 0.9x | 0.77                      | x | 4.83                   | x | 10.63            | x | 0.63           | x | 0.7            | = | 15.7         | (74) |
| North        | 0.9x | 0.77                      | x | 4.83                   | x | 20.32            | x | 0.63           | x | 0.7            | = | 30           | (74) |
| North        | 0.9x | 0.77                      | x | 4.83                   | x | 34.53            | x | 0.63           | x | 0.7            | = | 50.97        | (74) |
| North        | 0.9x | 0.77                      | x | 4.83                   | x | 55.46            | x | 0.63           | x | 0.7            | = | 81.87        | (74) |
| North        | 0.9x | 0.77                      | x | 4.83                   | x | 74.72            | x | 0.63           | x | 0.7            | = | 110.29       | (74) |

## SAP WorkSheet: New dwelling design stage

|       |      |      |   |      |   |        |   |      |   |     |   |        |      |
|-------|------|------|---|------|---|--------|---|------|---|-----|---|--------|------|
| North | 0.9x | 0.77 | x | 4.83 | x | 79.99  | x | 0.63 | x | 0.7 | = | 118.07 | (74) |
| North | 0.9x | 0.77 | x | 4.83 | x | 74.68  | x | 0.63 | x | 0.7 | = | 110.23 | (74) |
| North | 0.9x | 0.77 | x | 4.83 | x | 59.25  | x | 0.63 | x | 0.7 | = | 87.45  | (74) |
| North | 0.9x | 0.77 | x | 4.83 | x | 41.52  | x | 0.63 | x | 0.7 | = | 61.28  | (74) |
| North | 0.9x | 0.77 | x | 4.83 | x | 24.19  | x | 0.63 | x | 0.7 | = | 35.71  | (74) |
| North | 0.9x | 0.77 | x | 4.83 | x | 13.12  | x | 0.63 | x | 0.7 | = | 19.36  | (74) |
| North | 0.9x | 0.77 | x | 4.83 | x | 8.86   | x | 0.63 | x | 0.7 | = | 13.09  | (74) |
| East  | 0.9x | 1    | x | 0.52 | x | 19.64  | x | 0.63 | x | 0.7 | = | 3.12   | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 38.42  | x | 0.63 | x | 0.7 | = | 6.11   | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 63.27  | x | 0.63 | x | 0.7 | = | 10.06  | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 92.28  | x | 0.63 | x | 0.7 | = | 14.67  | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 113.09 | x | 0.63 | x | 0.7 | = | 17.97  | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 115.77 | x | 0.63 | x | 0.7 | = | 18.4   | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 110.22 | x | 0.63 | x | 0.7 | = | 17.52  | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 94.68  | x | 0.63 | x | 0.7 | = | 15.05  | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 73.59  | x | 0.63 | x | 0.7 | = | 11.69  | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 45.59  | x | 0.63 | x | 0.7 | = | 7.24   | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 24.49  | x | 0.63 | x | 0.7 | = | 3.89   | (76) |
| East  | 0.9x | 1    | x | 0.52 | x | 16.15  | x | 0.63 | x | 0.7 | = | 2.57   | (76) |
| South | 0.9x | 0.77 | x | 1.5  | x | 46.75  | x | 0.63 | x | 0.7 | = | 21.43  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 76.57  | x | 0.63 | x | 0.7 | = | 35.1   | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 97.53  | x | 0.63 | x | 0.7 | = | 44.71  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 110.23 | x | 0.63 | x | 0.7 | = | 50.53  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 114.87 | x | 0.63 | x | 0.7 | = | 52.66  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 110.55 | x | 0.63 | x | 0.7 | = | 50.68  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 108.01 | x | 0.63 | x | 0.7 | = | 49.51  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 104.89 | x | 0.63 | x | 0.7 | = | 48.09  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 101.89 | x | 0.63 | x | 0.7 | = | 46.71  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 82.59  | x | 0.63 | x | 0.7 | = | 37.86  | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 55.42  | x | 0.63 | x | 0.7 | = | 25.4   | (78) |
| South | 0.9x | 0.77 | x | 1.5  | x | 40.4   | x | 0.63 | x | 0.7 | = | 18.52  | (78) |

Solar gains in watts, calculated for each month

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

|        |       |      |        |        |        |        |        |        |        |       |       |       |      |
|--------|-------|------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|------|
| (83)m= | 40.25 | 71.2 | 105.74 | 147.07 | 180.92 | 187.14 | 177.26 | 150.59 | 119.68 | 80.81 | 48.66 | 34.17 | (83) |
|--------|-------|------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|------|

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

|        |        |        |        |        |        |       |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|------|
| (84)m= | 462.77 | 490.66 | 510.93 | 530.22 | 541.82 | 527.8 | 505.85 | 485.27 | 466.83 | 450.16 | 442.72 | 446.63 | (84) |
|--------|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|------|

### 7. Mean internal temperature (annual/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)

|        |      |     |      |      |      |      |      |      |      |      |      |      |      |
|--------|------|-----|------|------|------|------|------|------|------|------|------|------|------|
| (86)m= | Jan  | Feb | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  | (86) |
|        | 0.92 | 0.9 | 0.88 | 0.82 | 0.74 | 0.61 | 0.48 | 0.51 | 0.68 | 0.83 | 0.89 | 0.92 |      |

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) |
|--------|----|----|----|----|----|----|----|----|----|----|----|----|------|

## SAP WorkSheet: New dwelling design stage

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

|        |       |       |       |      |      |       |       |       |       |      |      |      |      |
|--------|-------|-------|-------|------|------|-------|-------|-------|-------|------|------|------|------|
| (88)m= | 19.79 | 19.79 | 19.79 | 19.8 | 19.8 | 19.81 | 19.81 | 19.81 | 19.81 | 19.8 | 19.8 | 19.8 | (88) |
|--------|-------|-------|-------|------|------|-------|-------|-------|-------|------|------|------|------|

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

|        |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| (89)m= | 0.91 | 0.89 | 0.86 | 0.79 | 0.69 | 0.53 | 0.37 | 0.41 | 0.61 | 0.79 | 0.88 | 0.91 | (89) |
|--------|------|------|------|------|------|------|------|------|------|------|------|------|------|

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

|        |       |       |       |      |      |       |       |       |       |      |      |      |      |
|--------|-------|-------|-------|------|------|-------|-------|-------|-------|------|------|------|------|
| (90)m= | 19.79 | 19.79 | 19.79 | 19.8 | 19.8 | 19.81 | 19.81 | 19.81 | 19.81 | 19.8 | 19.8 | 19.8 | (90) |
|--------|-------|-------|-------|------|------|-------|-------|-------|-------|------|------|------|------|

|                           |      |      |
|---------------------------|------|------|
| fLA = Living area ÷ (4) = | 0.43 | (91) |
|---------------------------|------|------|

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (92)m= | 20.31 | 20.31 | 20.31 | 20.32 | 20.32 | 20.32 | 20.32 | 20.33 | 20.32 | 20.32 | 20.32 | 20.32 | (92) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

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

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (93)m= | 20.31 | 20.31 | 20.31 | 20.32 | 20.32 | 20.32 | 20.32 | 20.33 | 20.32 | 20.32 | 20.32 | 20.32 | (93) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

### 9. Space heating calculation

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= | 0.91 | 0.9 | 0.87 | 0.81 | 0.71 | 0.57 | 0.42 | 0.46 | 0.65 | 0.81 | 0.89 | 0.92 | (94) |
|--------|------|-----|------|------|------|------|------|------|------|------|------|------|------|

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

|        |        |       |        |        |        |        |        |        |        |       |        |        |      |
|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|-------|--------|--------|------|
| (95)m= | 421.96 | 439.3 | 441.99 | 427.79 | 384.87 | 298.85 | 214.42 | 221.55 | 301.15 | 363.4 | 391.83 | 409.95 | (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= | 1041.25 | 1000.32 | 894.8 | 732.91 | 552.3 | 363.83 | 236.71 | 249.11 | 396.73 | 622.78 | 849.88 | 1040 | (97) |
|--------|---------|---------|-------|--------|-------|--------|--------|--------|--------|--------|--------|------|------|

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

|        |        |        |        |        |        |   |   |   |   |        |       |        |      |
|--------|--------|--------|--------|--------|--------|---|---|---|---|--------|-------|--------|------|
| (98)m= | 460.75 | 377.01 | 336.89 | 219.69 | 124.57 | 0 | 0 | 0 | 0 | 192.98 | 329.8 | 468.75 | (98) |
|--------|--------|--------|--------|--------|--------|---|---|---|---|--------|-------|--------|------|

|                                                         |         |      |
|---------------------------------------------------------|---------|------|
| Total per year (kWh/year) = Sum(98) <sub>1...12</sub> = | 2510.45 | (98) |
|---------------------------------------------------------|---------|------|

Space heating requirement in kWh/m<sup>2</sup>/year

|       |      |
|-------|------|
| 52.81 | (99) |
|-------|------|

### 9. Energy requirements for individual heating systems including micro-CHP

#### Space heating:

Fraction of space heat from secondary/supplementary system

|   |       |
|---|-------|
| 0 | (201) |
|---|-------|

Fraction of space heat from main system(s)

|                     |   |       |
|---------------------|---|-------|
| (202) = 1 – (201) = | 1 | (202) |
|---------------------|---|-------|

Fraction of total heating from main system 1

|                               |   |       |
|-------------------------------|---|-------|
| (204) = (202) × [1 – (203)] = | 1 | (204) |
|-------------------------------|---|-------|

Efficiency of main space heating system 1

|        |       |
|--------|-------|
| 329.14 | (206) |
|--------|-------|

Efficiency of secondary/supplementary heating system, %

|   |       |
|---|-------|
| 0 | (208) |
|---|-------|

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

Space heating requirement (calculated above)

|        |        |        |        |        |   |   |   |   |        |       |        |
|--------|--------|--------|--------|--------|---|---|---|---|--------|-------|--------|
| 460.75 | 377.01 | 336.89 | 219.69 | 124.57 | 0 | 0 | 0 | 0 | 192.98 | 329.8 | 468.75 |
|--------|--------|--------|--------|--------|---|---|---|---|--------|-------|--------|

|                                           |       |
|-------------------------------------------|-------|
| (211)m = {[(98)m x (204)] } x 100 ÷ (206) | (211) |
|-------------------------------------------|-------|

|        |        |        |       |       |   |   |   |   |       |       |        |
|--------|--------|--------|-------|-------|---|---|---|---|-------|-------|--------|
| 139.99 | 114.54 | 102.35 | 66.75 | 37.85 | 0 | 0 | 0 | 0 | 58.63 | 100.2 | 142.42 |
|--------|--------|--------|-------|-------|---|---|---|---|-------|-------|--------|

|                                                 |        |       |
|-------------------------------------------------|--------|-------|
| Total (kWh/year) = Sum(211) <sub>1...12</sub> = | 762.72 | (211) |
|-------------------------------------------------|--------|-------|

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

|         |   |   |   |   |   |   |   |   |   |   |   |
|---------|---|---|---|---|---|---|---|---|---|---|---|
| (215)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|---------|---|---|---|---|---|---|---|---|---|---|---|

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

## SAP WorkSheet: New dwelling design stage

### Water heating

Output from water heater (calculated above)

|        |        |        |        |        |        |        |        |        |        |        |       |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| 163.83 | 144.59 | 152.28 | 137.12 | 134.81 | 121.08 | 116.88 | 127.43 | 126.95 | 142.15 | 149.55 | 160.1 |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|

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 |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|

(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

|         |       |        |        |        |        |       |       |      |       |       |        |       |
|---------|-------|--------|--------|--------|--------|-------|-------|------|-------|-------|--------|-------|
| (219)m= | 122.4 | 108.02 | 113.77 | 102.44 | 100.71 | 90.46 | 87.32 | 95.2 | 94.84 | 106.2 | 111.73 | 119.6 |
|---------|-------|--------|--------|--------|--------|-------|-------|------|-------|-------|--------|-------|

Total = Sum(219a)<sub>1..12</sub> =

1252.68 (219)

### Annual totals

kWh/year

kWh/year

Space heating fuel used, main system 1

762.72

Water heating fuel used

1252.68

Electricity for pumps, fans and electric keep-hot

Total electricity for the above, kWh/year

sum of (230a).. (230g) =

0 (231)

Electricity for lighting

225.3 (232)

### 10a 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                    | 100.6 (240)         |
| Space heating - main system 2                                                                                            | (213) x          | 0                        | 0 (241)             |
| Space heating - secondary                                                                                                | (215) x          | 13.19                    | 0 (242)             |
| Water heating cost (other fuel)                                                                                          | (219)            | 13.19                    | 165.23 (247)        |
| Pumps, fans and electric keep-hot                                                                                        | (231)            | 13.19                    | 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                    | 29.72 (250)         |
| Additional standing charges (Table 12)                                                                                   |                  |                          | 0 (251)             |

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

### Total energy cost

(245)...(247) + (250)...(254) =

295.55 (255)

### 11a SAP rating - individual heating systems

|                                 |             |
|---------------------------------|-------------|
| Energy cost deflator (Table 12) | 0.42 (256)  |
| Energy cost factor (ECF)        | 1.34 (257)  |
| SAP rating (Section 12)         | 81.29 (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 |
|-------------------------------|--------------------|-------------------------------|--------------------------|
| Space heating (main system 1) | (211) x            | 0.519                         | 395.85 (261)             |
| Space heating (secondary)     | (215) x            | 0.519                         | 0 (263)                  |
| Water heating                 | (219) x            | 0.519                         | 650.14 (264)             |

## SAP WorkSheet: New dwelling design stage

|                                                   |                                 |       |   |         |       |
|---------------------------------------------------|---------------------------------|-------|---|---------|-------|
| Space and water heating                           | {261} + {262} + {263} + {264} = |       |   | 1046    | {265} |
| Electricity for pumps, fans and electric keep-hot | {231} x                         | 0.519 | = | 0       | {267} |
| Electricity for lighting                          | {232} x                         | 0.519 | = | 116.93  | {268} |
| Total CO <sub>2</sub> , kg/year                   | sum of {265} .. {271} =         |       |   | 1162.93 | {272} |
| <b>CO<sub>2</sub> emissions per m<sup>2</sup></b> | {272} ÷ (4) =                   |       |   | 24.46   | {273} |
| El rating (section 14)                            |                                 |       |   | 83      | {274} |

### 1.3a Primary Energy

|                                                   | Energy<br>kWh/year              | Primary<br>factor |   | P. Energy<br>kWh/year |       |
|---------------------------------------------------|---------------------------------|-------------------|---|-----------------------|-------|
| Space heating (main system 1)                     | {211} x                         | 3.07              | = | 2341.57               | {261} |
| Space heating (secondary)                         | {215} x                         | 3.07              | = | 0                     | {263} |
| Energy for water heating                          | {219} x                         | 3.07              | = | 3845.73               | {264} |
| Space and water heating                           | {261} + {262} + {263} + {264} = |                   |   | 6187.3                | {265} |
| Electricity for pumps, fans and electric keep-hot | {231} x                         | 3.07              | = | 0                     | {267} |
| Electricity for lighting                          | {232} x                         | 0                 | = | 691.67                | {268} |
| 'Total Primary Energy                             | sum of {265}...{271} =          |                   |   | 6878.97               | {272} |
| <b>Primary energy kWh/m<sup>2</sup>/year</b>      | {272} ÷ (4) =                   |                   |   | 144.7                 | {273} |