

## SAP WorkSheet: New dwelling design stage

### User Details

**Assessor Name:** Nicholas Jones      **Stroma Number:** STRO000971  
**Software Name:** Stroma FSAP 2012      **Software Version:** Version: 1.0.4.26

### Property Address: Plot 4

**Address :** Plot 4, Cinders Road II, Yaptan, BN18 0JJ

### 1. General dwelling dimensions

|                                                           | Area(m <sup>2</sup> )                     | Av. Height(m)                            | Volume(m <sup>3</sup> )                  |
|-----------------------------------------------------------|-------------------------------------------|------------------------------------------|------------------------------------------|
| Ground floor                                              | <input type="text" value="50.53"/> (1a) × | <input type="text" value="2.37"/> (2a) = | <input type="text" value="119.76"/> (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | <input type="text" value="50.53"/> (4)    |                                          |                                          |
| Dwelling volume                                           |                                           | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =     | <input type="text" value="119.76"/> (5)  |

### 2. Ventilation rate

|                              | main heating                   | secondary heating              | other                          | total                                 | m <sup>3</sup> per hour              |
|------------------------------|--------------------------------|--------------------------------|--------------------------------|---------------------------------------|--------------------------------------|
| Number of chimneys           | <input type="text" value="0"/> | <input type="text" value="0"/> | <input type="text" value="0"/> | <input type="text" value="0"/> × 40 = | <input type="text" value="0"/> (6a)  |
| Number of open flues         | <input type="text" value="0"/> | <input type="text" value="0"/> | <input type="text" value="0"/> | <input type="text" value="0"/> × 20 = | <input type="text" value="0"/> (6b)  |
| Number of intermittent fans  |                                |                                |                                | <input type="text" value="2"/> × 10 = | <input type="text" value="20"/> (7a) |
| Number of passive vents      |                                |                                |                                | <input type="text" value="0"/> × 10 = | <input type="text" value="0"/> (7b)  |
| Number of flueless gas fires |                                |                                |                                | <input type="text" value="0"/> × 40 = | <input type="text" value="0"/> (7c)  |

### Air changes per hour

|                                                                                                                                                        |                                          |               |                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------|----------------------------------------------------|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =                                                                              | <input type="text" value="20"/>          | ÷ (5) =       | <input type="text" value="0.17"/> (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)                                                                                                                 |                                          |               | <input type="text" value="0"/> (9)                 |
| Additional infiltration                                                                                                                                |                                          | [(9)-1]×0.1 = | <input type="text" value="0"/> (10)                |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction                                                               |                                          |               | <input type="text" value="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                                                                          |                                          |               | <input type="text" value="0"/> (12)                |
| If no draught lobby, enter 0.05, else enter 0                                                                                                          |                                          |               | <input type="text" value="0"/> (13)                |
| Percentage of windows and doors draught stripped                                                                                                       |                                          |               | <input type="text" value="0"/> (14)                |
| Window infiltration                                                                                                                                    | 0.25 - [0.2 × (14) ÷ 100] =              |               | <input type="text" value="0"/> (15)                |
| Infiltration rate                                                                                                                                      | (8) + (10) + (11) + (12) + (13) + (15) = |               | <input type="text" value="0"/> (16)                |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area                                                      |                                          |               | <input type="text" value="5.09999990463257"/> (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)                                                               |                                          |               | <input type="text" value="0.42"/> (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                                                                                                                              |                                          |               | <input type="text" value="2"/> (19)                |
| Shelter factor                                                                                                                                         | (20) = 1 - [0.075 × (19)] =              |               | <input type="text" value="0.85"/> (20)             |
| Infiltration rate incorporating shelter factor                                                                                                         | (21) = (18) × (20) =                     |               | <input type="text" value="0.36"/> (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

|      |      |      |      |      |      |      |      |      |      |     |      |
|------|------|------|------|------|------|------|------|------|------|-----|------|
| 0.46 | 0.45 | 0.44 | 0.39 | 0.39 | 0.34 | 0.34 | 0.33 | 0.36 | 0.39 | 0.4 | 0.42 |
|------|------|------|------|------|------|------|------|------|------|-----|------|

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= 0.6 0.6 0.6 0.58 0.57 0.56 0.56 0.56 0.56 0.57 0.58 0.59 (24d)

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

(25)m= 0.6 0.6 0.6 0.58 0.57 0.56 0.56 0.56 0.56 0.57 0.58 0.59 (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                      |                 |             | 2.09           | 1.2                         | 2.508       |                 | (26)       |
| Windows Type 1             |                 |             | 3.51           | $\times 1/[1/(1.4) + 0.04]$ | 4.65        |                 | (27)       |
| Windows Type 2             |                 |             | 4.35           | $\times 1/[1/(1.4) + 0.04]$ | 5.77        |                 | (27)       |
| Walls Type1                | 45.73           | 7.86        | 37.87          | 0.25                        | 9.47        |                 | (29)       |
| Walls Type2                | 21.69           | 2.09        | 19.6           | 0.15                        | 3.04        |                 | (29)       |
| Total area of elements, m² |                 |             | 67.42          |                             |             |                 | (31)       |
| Party floor                |                 |             | 50.53          |                             |             |                 | (32a)      |
| Party ceiling              |                 |             | 50.53          |                             |             |                 | (32b)      |

\* 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) = 25.43 (33)

Heat capacity Cm = S(A x k) ((23) ... (30) + (32) + (32a) ... (32e) = 3560.96 (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 11.11 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 36.54 (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= | 23.89 | 23.73 | 23.58 | 22.84 | 22.7 | 22.05 | 22.05 | 21.94 | 22.3 | 22.7 | 22.98 | 23.27 |

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

|                            |       |       |       |       |       |       |       |       |       |       |       |            |
|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------|
| (39)m=                     | 60.43 | 60.27 | 60.11 | 59.37 | 59.24 | 58.59 | 58.59 | 58.47 | 58.84 | 59.24 | 59.52 | 59.81      |
| Average = Sum(39) ... /12= |       |       |       |       |       |       |       |       |       |       |       | 59.37 (39) |

## SAP WorkSheet: New dwelling design stage

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

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

|                       |     |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------------------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|
| {40}m=                | 1.2 | 1.19 | 1.19 | 1.18 | 1.17 | 1.16 | 1.16 | 1.16 | 1.16 | 1.17 | 1.18 | 1.18 |      |      |
| Average = Sum{40}/12= |     |      |      |      |      |      |      |      |      |      |      |      | 1.18 | {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

Assumed occupancy, N

1.71

{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

74.71

{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=               | 82.18 | 79.19 | 76.2 | 73.22 | 70.23 | 67.24 | 67.24 | 70.23 | 73.22 | 76.2 | 79.19 | 82.18 |        |      |
| Total = Sum{44}/12 = |       |       |      |       |       |       |       |       |       |      |       |       | 896.53 | {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=               | 121.87 | 106.59 | 109.99 | 95.89 | 92.01 | 79.4 | 73.58 | 84.43 | 85.44 | 99.57 | 108.69 | 118.03 |         |      |
| Total = Sum{45}/12 = |        |        |        |       |       |      |       |       |       |       |        |        | 1175.49 | {45} |

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

|        |       |       |      |       |      |       |       |       |       |       |      |      |  |      |
|--------|-------|-------|------|-------|------|-------|-------|-------|-------|-------|------|------|--|------|
| {46}m= | 18.28 | 15.99 | 16.5 | 14.38 | 13.8 | 11.91 | 11.04 | 12.66 | 12.82 | 14.94 | 16.3 | 17.7 |  | {46} |
|--------|-------|-------|------|-------|------|-------|-------|-------|-------|-------|------|------|--|------|

Water storage loss:

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

200

{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= | 167.23 | 147.56 | 155.35 | 139.79 | 137.37 | 123.3 | 118.93 | 129.79 | 129.33 | 144.93 | 152.58 | 163.39 | (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=                                  | 167.23 | 147.56 | 155.35 | 139.79 | 137.37 | 123.3 | 118.93 | 129.79 | 129.33 | 144.93 | 152.58 | 163.39  |      |
| Output from water heater (annual): 1.12 |        |        |        |        |        |       |        |        |        |        |        | 1709.56 | (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= | 76.81 | 68.22 | 72.86 | 67 | 66.88 | 61.52 | 60.75 | 64.36 | 63.52 | 69.39 | 71.26 | 75.53 | (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= | 102.34 | 102.34 | 102.34 | 102.34 | 102.34 | 102.34 | 102.34 | 102.34 | 102.34 | 102.34 | 102.34 | 102.34 | (66) |

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

|        |       |       |      |    |       |       |       |       |       |       |      |       |      |
|--------|-------|-------|------|----|-------|-------|-------|-------|-------|-------|------|-------|------|
| (67)m= | 34.75 | 30.87 | 25.1 | 19 | 14.21 | 11.99 | 12.96 | 16.84 | 22.61 | 28.71 | 33.5 | 35.72 | (67) |
|--------|-------|-------|------|----|-------|-------|-------|-------|-------|-------|------|-------|------|

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

|        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (68)m= | 221.81 | 224.11 | 218.31 | 205.96 | 190.37 | 175.72 | 165.94 | 163.64 | 169.44 | 181.78 | 197.37 | 212.02 | (68) |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

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

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (69)m= | 46.94 | 46.94 | 46.94 | 46.94 | 46.94 | 46.94 | 46.94 | 46.94 | 46.94 | 46.94 | 46.94 | 46.94 | (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= | -68.23 | -68.23 | -68.23 | -68.23 | -68.23 | -68.23 | -68.23 | -68.23 | -68.23 | -68.23 | -68.23 | -68.23 | (71) |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

Water heating gains (Table 5)

|        |        |        |       |       |       |       |       |       |       |       |       |        |      |
|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|------|
| (72)m= | 103.24 | 101.51 | 97.93 | 93.06 | 89.89 | 85.44 | 81.65 | 86.51 | 88.23 | 93.27 | 98.97 | 101.52 | (72) |
|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|------|

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

|        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (73)m= | 440.85 | 437.54 | 422.39 | 399.08 | 375.53 | 354.21 | 341.61 | 348.04 | 361.33 | 384.82 | 410.89 | 430.31 | (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 | 3.51                   | x | 10.63            | x | 0.63           | x | 1.11           | = | 18.11        | (74) |
| North        | 0.9x | 0.77                      | x | 3.51                   | x | 20.32            | x | 0.63           | x | 1.11           | = | 34.6         | (74) |
| North        | 0.9x | 0.77                      | x | 3.51                   | x | 34.53            | x | 0.63           | x | 1.11           | = | 58.79        | (74) |
| North        | 0.9x | 0.77                      | x | 3.51                   | x | 55.46            | x | 0.63           | x | 1.11           | = | 94.44        | (74) |
| North        | 0.9x | 0.77                      | x | 3.51                   | x | 74.72            | x | 0.63           | x | 1.11           | = | 127.22       | (74) |

## SAP WorkSheet: New dwelling design stage

|       |      |      |   |      |   |        |   |      |   |      |   |        |      |
|-------|------|------|---|------|---|--------|---|------|---|------|---|--------|------|
| North | 0.9x | 0.77 | x | 3.51 | x | 79.99  | x | 0.63 | x | 1.11 | = | 136.19 | (74) |
| North | 0.9x | 0.77 | x | 3.51 | x | 74.68  | x | 0.63 | x | 1.11 | = | 127.15 | (74) |
| North | 0.9x | 0.77 | x | 3.51 | x | 59.25  | x | 0.63 | x | 1.11 | = | 100.88 | (74) |
| North | 0.9x | 0.77 | x | 3.51 | x | 41.52  | x | 0.63 | x | 1.11 | = | 70.69  | (74) |
| North | 0.9x | 0.77 | x | 3.51 | x | 24.19  | x | 0.63 | x | 1.11 | = | 41.19  | (74) |
| North | 0.9x | 0.77 | x | 3.51 | x | 13.12  | x | 0.63 | x | 1.11 | = | 22.34  | (74) |
| North | 0.9x | 0.77 | x | 3.51 | x | 8.86   | x | 0.63 | x | 1.11 | = | 15.09  | (74) |
| South | 0.9x | 0.77 | x | 4.35 | x | 46.75  | x | 0.63 | x | 1.11 | = | 98.66  | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 76.57  | x | 0.63 | x | 1.11 | = | 161.57 | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 97.53  | x | 0.63 | x | 1.11 | = | 205.81 | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 110.23 | x | 0.63 | x | 1.11 | = | 232.62 | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 114.87 | x | 0.63 | x | 1.11 | = | 242.4  | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 110.55 | x | 0.63 | x | 1.11 | = | 233.28 | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 108.01 | x | 0.63 | x | 1.11 | = | 227.93 | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 104.89 | x | 0.63 | x | 1.11 | = | 221.35 | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 101.89 | x | 0.63 | x | 1.11 | = | 215    | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 82.59  | x | 0.63 | x | 1.11 | = | 174.27 | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 55.42  | x | 0.63 | x | 1.11 | = | 116.94 | (78) |
| South | 0.9x | 0.77 | x | 4.35 | x | 40.4   | x | 0.63 | x | 1.11 | = | 85.25  | (78) |

Solar gains in watts, calculated for each month

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

|        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (83)m= | 116.76 | 196.17 | 264.61 | 327.05 | 369.62 | 369.47 | 355.08 | 322.23 | 285.69 | 215.46 | 139.28 | 100.34 | (83) |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

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

|        |        |        |     |        |        |        |        |        |        |        |        |        |      |
|--------|--------|--------|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (84)m= | 557.61 | 633.71 | 687 | 726.13 | 745.15 | 723.68 | 696.68 | 670.27 | 647.02 | 600.27 | 550.17 | 530.65 | (84) |
|--------|--------|--------|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

### 7. Mean internal 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 |      |
| (86)m= | 0.89 | 0.85 | 0.8 | 0.72 | 0.61 | 0.47 | 0.35 | 0.38 | 0.54 | 0.73 | 0.85 | 0.9 | (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= | 19.92 | 19.93 | 19.93 | 19.94 | 19.94 | 19.95 | 19.95 | 19.95 | 19.95 | 19.94 | 19.94 | 19.93 | (88) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

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

|        |      |      |      |      |      |     |      |     |      |      |      |      |      |
|--------|------|------|------|------|------|-----|------|-----|------|------|------|------|------|
| (89)m= | 0.87 | 0.83 | 0.77 | 0.68 | 0.56 | 0.4 | 0.27 | 0.3 | 0.48 | 0.69 | 0.83 | 0.88 | (89) |
|--------|------|------|------|------|------|-----|------|-----|------|------|------|------|------|

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

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (90)m= | 19.92 | 19.93 | 19.93 | 19.94 | 19.94 | 19.95 | 19.95 | 19.95 | 19.95 | 19.94 | 19.94 | 19.93 | (90) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

fLA = Living area ÷ (4) =

0.5 (91)

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

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (92)m= | 20.47 | 20.47 | 20.47 | 20.47 | 20.48 | 20.48 | 20.48 | 20.48 | 20.48 | 20.48 | 20.47 | 20.47 | (92) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

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

## SAP WorkSheet: New dwelling design stage

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (93)m= | 20.47 | 20.47 | 20.47 | 20.47 | 20.48 | 20.48 | 20.48 | 20.48 | 20.48 | 20.48 | 20.47 | 20.47 | (93) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

### 8. Space heating calculation

Set  $T_i$  to the mean internal temperature obtained at step 11 of Table 9b, so that  $T_{i,m} = (76)m$  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,  $h_m$ :

|        |      |      |      |     |      |      |      |      |      |      |      |      |      |
|--------|------|------|------|-----|------|------|------|------|------|------|------|------|------|
| (94)m= | 0.88 | 0.84 | 0.79 | 0.7 | 0.58 | 0.44 | 0.31 | 0.34 | 0.51 | 0.71 | 0.84 | 0.89 | (94) |
|--------|------|------|------|-----|------|------|------|------|------|------|------|------|------|

Useful gains,  $h_m G_m$ ,  $W = (94)m \times (84)m$

|        |       |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (95)m= | 491.2 | 533.25 | 540.43 | 508.47 | 434.13 | 316.33 | 218.87 | 227.92 | 330.53 | 426.97 | 460.49 | 473.08 | (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,  $L_m$ ,  $W = [(39)m \times ((93)m - (96)m)]$

|        |        |        |       |        |        |        |        |        |        |        |        |        |      |
|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (97)m= | 976.93 | 938.25 | 839.7 | 687.22 | 519.83 | 344.56 | 227.38 | 238.67 | 375.32 | 584.99 | 795.92 | 973.13 | (97) |
|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

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

|        |        |        |        |       |       |   |   |   |   |        |        |        |      |
|--------|--------|--------|--------|-------|-------|---|---|---|---|--------|--------|--------|------|
| (98)m= | 361.38 | 272.16 | 222.65 | 128.7 | 63.76 | 0 | 0 | 0 | 0 | 117.57 | 241.51 | 372.04 | (98) |
|--------|--------|--------|--------|-------|-------|---|---|---|---|--------|--------|--------|------|

Total per year ( $kWh/year$ ) =  $Sum(98)_{1..12} =$  1779.77

Space heating requirement in  $kWh/m^2/year$

35.22 (99)

### 9. Space heating: 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) =  $(202) \times [1 - (203)] =$

1 (204)

Efficiency of main space heating system 1

256.35 (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)

|        |        |        |       |       |   |   |   |   |        |        |        |
|--------|--------|--------|-------|-------|---|---|---|---|--------|--------|--------|
| 361.38 | 272.16 | 222.65 | 128.7 | 63.76 | 0 | 0 | 0 | 0 | 117.57 | 241.51 | 372.04 |
|--------|--------|--------|-------|-------|---|---|---|---|--------|--------|--------|

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

|        |        |       |      |       |   |   |   |   |       |       |        |
|--------|--------|-------|------|-------|---|---|---|---|-------|-------|--------|
| 140.97 | 106.17 | 86.85 | 50.2 | 24.87 | 0 | 0 | 0 | 0 | 45.86 | 94.21 | 145.13 |
|--------|--------|-------|------|-------|---|---|---|---|-------|-------|--------|

Total ( $kWh/year$ ) =  $Sum(211)_{1..12} =$  694.27 (211)

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 | (215) |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|-------|

Total ( $kWh/year$ ) =  $Sum(215)_{1..12} =$  0

#### Water heating

Output from water heater (calculated above)

|        |        |        |        |        |       |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|
| 167.23 | 147.56 | 155.35 | 139.79 | 137.37 | 123.3 | 118.93 | 129.79 | 129.33 | 144.93 | 152.58 | 163.39 |
|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|

Efficiency of water heater

176.98 (216)

|         |        |        |        |        |        |        |        |        |        |        |        |        |       |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| (217)m= | 176.98 | 176.98 | 176.98 | 176.98 | 176.98 | 176.98 | 176.98 | 176.98 | 176.98 | 176.98 | 176.98 | 176.98 | (217) |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|

Fuel for water heating,  $kWh/month$

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

|         |       |       |       |       |       |       |      |       |       |       |       |       |       |
|---------|-------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|
| (219)m= | 94.49 | 83.37 | 87.78 | 78.98 | 77.62 | 69.66 | 67.2 | 73.33 | 73.08 | 81.89 | 86.21 | 92.32 | (219) |
|---------|-------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|

Total =  $Sum(219a)_{1..12} =$  965.93

#### Annual totals

$kWh/year$

$kWh/year$

Space heating fuel used, main system 1

694.27

## SAP WorkSheet: New dwelling design stage

|                                                   |                          |        |       |
|---------------------------------------------------|--------------------------|--------|-------|
| Water heating fuel used                           |                          | 965.93 |       |
| Electricity for pumps, fans and electric keep-hot |                          |        |       |
| Total electricity for the above, kWh/year         | sum of (230a)...(230g) = | 0      | (231) |
| Electricity for lighting                          |                          | 245.49 | (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                    | x 0.01 = 91.57 (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 = 127.41 (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 = 32.38 (250)  |
| Additional standing charges (Table 12)                                                                                   |                  |                          | 120 (251)             |

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

|                          |                                 |        |       |
|--------------------------|---------------------------------|--------|-------|
| <b>Total energy cost</b> | (245)...(247) + (250)...(254) = | 371.36 | (255) |
|--------------------------|---------------------------------|--------|-------|

### 11a. SAP rating - individual heating systems

|                                 |                                  |       |       |
|---------------------------------|----------------------------------|-------|-------|
| Energy cost deflator (Table 12) |                                  | 0.42  | (256) |
| Energy cost factor (ECF)        | [(255) x (256)] ÷ [(4) + 45.0] = | 1.63  | (257) |
| <b>SAP rating (Section 12)</b>  |                                  | 77.22 | (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                         | = 360.33 (261)           |
| Space heating (secondary)                         | (215) x                         | 0.519                         | = 0 (263)                |
| Water heating                                     | (219) x                         | 0.216                         | = 208.64 (264)           |
| Space and water heating                           | (261) + (262) + (263) + (264) = |                               | 568.97 (265)             |
| Electricity for pumps, fans and electric keep-hot | (231) x                         | 0.519                         | = 0 (267)                |
| Electricity for lighting                          | (232) x                         | 0.519                         | = 127.41 (268)           |
| Total CO2, kg/year                                |                                 | sum of (265)...(271) =        | 696.37 (272)             |
| <b>CO2 emissions per m²</b>                       |                                 | (272) ÷ (4) =                 | 13.78 (273)              |
| EI rating (section 14)                            |                                 |                               | 90 (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              | = 2131.41 (261)       |

## SAP WorkSheet: New dwelling design stage

|                                                   |                                 |                        |   |         |       |
|---------------------------------------------------|---------------------------------|------------------------|---|---------|-------|
| Space heating (secondary)                         | {215} x                         | 3.07                   | = | 0       | {263} |
| Energy for water heating                          | {219} x                         | 1.22                   | = | 1178.44 | {264} |
| Space and water heating                           | {261} + {262} + {263} + {264} = |                        |   | 3309.84 | {265} |
| Electricity for pumps, fans and electric keep-hot | {231} x                         | 3.07                   | = | 0       | {267} |
| Electricity for lighting                          | {232} x                         | 0                      | = | 753.64  | {268} |
| 'Total Primary Energy                             |                                 | sum of {265}...{271} = |   | 4063.49 | {272} |
| <b>Primary energy kWh/m<sup>2</sup>/year</b>      |                                 | {272} ÷ {4} =          |   | 80.42   | {273} |