

# SAP WorkSheet: New dwelling design stage

## User Details

**Assessor Name:** Nicholas Jones **Stroma Number:** STRO000971  
**Software Name:** Stroma FSAP 2012 **Software Version:** Version: 1.0.4.18

## Property Address: Plot 2

**Address :** Plot 2, Cinders Road, Yapton, BN18 0JJ

## 1. General dwelling dimensions

|                                                           | Area(m <sup>2</sup> ) |   | Av. Height(m) |                                      | Volume(m <sup>3</sup> ) |
|-----------------------------------------------------------|-----------------------|---|---------------|--------------------------------------|-------------------------|
| Ground floor                                              | 49.86 (1a)            | x | 2.37 (2a)     | =                                    | 118.17 (3a)             |
| First floor                                               | 49.86 (1b)            | x | 2.55 (2b)     | =                                    | 127.14 (3b)             |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 99.72 (4)             |   |               |                                      |                         |
| Dwelling volume                                           |                       |   |               | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 245.31 (5)              |

## 2. Ventilation rate

|                              | main heating |   | secondary heating |   | other |   | total |        | m <sup>3</sup> per hour |
|------------------------------|--------------|---|-------------------|---|-------|---|-------|--------|-------------------------|
| Number of chimneys           | 0            | + | 0                 | + | 0     | = | 0     | x 40 = | 0 (6a)                  |
| Number of open flues         | 0            | + | 0                 | + | 0     | = | 0     | x 20 = | 0 (6b)                  |
| Number of intermittent fans  |              |   |                   |   |       |   | 4     | x 10 = | 40 (7a)                 |
| Number of passive vents      |              |   |                   |   |       |   | 0     | x 10 = | 0 (7b)                  |
| Number of flueless gas fires |              |   |                   |   |       |   | 0     | x 40 = | 0 (7c)                  |

## Air changes per hour

|                                                                                                                                                        |                                          |               |                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------|-----------------------|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =                                                                              | 40                                       | ÷ (5) =       | 0.16 (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                                                      |                                          |               | 5.09999990463257 (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)                                                               |                                          |               | 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                                                                                                                              |                                          |               | 2 (19)                |
| Shelter factor                                                                                                                                         | (20) = 1 - {0.075 x (19)} =              |               | 0.85 (20)             |
| Infiltration rate incorporating shelter factor                                                                                                         | (21) = (18) x (20) =                     |               | 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 |
|--------|-----|---|-----|-----|-----|-----|-----|-----|---|-----|-----|-----|

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

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

|  |      |      |      |      |      |      |      |      |      |      |     |      |
|--|------|------|------|------|------|------|------|------|------|------|-----|------|
|  | 0.45 | 0.44 | 0.44 | 0.39 | 0.38 | 0.34 | 0.34 | 0.33 | 0.36 | 0.38 | 0.4 | 0.42 |
|--|------|------|------|------|------|------|------|------|------|------|-----|------|

Calculate effective air change rate for the applicable case

If mechanical ventilation:

(23a)

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

(23b)

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

(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)m x 0.5]

|         |     |     |      |      |      |      |      |      |      |      |      |      |
|---------|-----|-----|------|------|------|------|------|------|------|------|------|------|
| (24d)m= | 0.6 | 0.6 | 0.59 | 0.58 | 0.57 | 0.56 | 0.56 | 0.55 | 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 | 0.59 | 0.58 | 0.57 | 0.56 | 0.56 | 0.55 | 0.56 | 0.57 | 0.58 | 0.59 |
|--------|-----|-----|------|------|------|------|------|------|------|------|------|------|

(25)

### 3. Heat losses and heat capacity 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                      |                 |             | 2.06           | 1.2                         | 2.472       |                 | (26)       |
| Windows Type 1             |                 |             | 5.68           | $\times 1/[1/(1.4) + 0.04]$ | 7.53        |                 | (27)       |
| Windows Type 2             |                 |             | 8.45           | $\times 1/[1/(1.4) + 0.04]$ | 11.2        |                 | (27)       |
| Floor                      |                 |             | 49.86          | 0.21                        | 10.4706     |                 | (28)       |
| Walls                      | 140.52          | 16.19       | 124.33         | 0.25                        | 31.08       |                 | (29)       |
| Roof                       | 49.86           | 0           | 49.86          | 0.11                        | 5.48        |                 | (30)       |
| Total area of elements, m² |                 |             | 240.24         |                             |             |                 | (31)       |

\* 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) = 68.24 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 6426.18 (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 18.97 (36)

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

Total fabric heat loss (33) + (36) = 87.21 (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= | 48.79 | 48.46 | 48.15 | 46.66 | 46.38 | 45.09 | 45.09 | 44.85 | 45.59 | 46.38 | 46.95 | 47.53 |

(38)

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

|        |        |        |        |        |        |       |       |        |       |        |        |        |
|--------|--------|--------|--------|--------|--------|-------|-------|--------|-------|--------|--------|--------|
| (39)m= | 135.99 | 135.67 | 135.35 | 133.87 | 133.59 | 132.3 | 132.3 | 132.06 | 132.8 | 133.59 | 134.15 | 134.74 |
|--------|--------|--------|--------|--------|--------|-------|-------|--------|-------|--------|--------|--------|

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

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

|                       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| {40}m=                | 1.36 | 1.36 | 1.36 | 1.34 | 1.34 | 1.33 | 1.33 | 1.32 | 1.33 | 1.34 | 1.35 | 1.35 |      |      |
| Average = Sum{40}/12= |      |      |      |      |      |      |      |      |      |      |      |      | 1.34 | {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 year

Assumed occupancy, N

2.74

{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

99.2

{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=               | 109.12 | 105.15 | 101.19 | 97.22 | 93.25 | 89.28 | 89.28 | 93.25 | 97.22 | 101.19 | 105.15 | 109.12 |         |      |
| Total = Sum{44}/12 = |        |        |        |       |       |       |       |       |       |        |        |        | 1190.42 | {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=               | 161.82 | 141.53 | 146.05 | 127.33 | 122.18 | 105.43 | 97.69 | 112.11 | 113.45 | 132.21 | 144.32 | 156.72 |         |      |
| Total = Sum{45}/12 = |        |        |        |        |        |        |       |        |        |        |        |        | 1560.83 | {45} |

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

|        |       |       |       |      |       |       |       |       |       |       |       |       |  |      |
|--------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|--|------|
| {46}m= | 24.27 | 21.23 | 21.91 | 19.1 | 18.33 | 15.81 | 14.65 | 16.82 | 17.02 | 19.83 | 21.65 | 23.51 |  | {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} |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|------|

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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= | 207.18 | 182.5 | 191.41 | 171.23 | 167.53 | 149.32 | 143.05 | 157.47 | 157.34 | 177.57 | 188.21 | 202.08 | (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=                                  | 207.18 | 182.5 | 191.41 | 171.23 | 167.53 | 149.32 | 143.05 | 157.47 | 157.34 | 177.57 | 188.21 | 202.08 |      |
| Output from water heater (annual): 1.12 |        |       |        |        |        |        |        |        |        |        |        | 2094.9 | (64) |

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

|        |       |       |       |       |       |       |       |       |       |       |      |      |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|------|
| (65)m= | 90.09 | 79.84 | 84.85 | 77.45 | 76.91 | 70.17 | 68.77 | 73.56 | 72.84 | 80.25 | 83.1 | 88.4 | (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= | 164.22 | 164.22 | 164.22 | 164.22 | 164.22 | 164.22 | 164.22 | 164.22 | 164.22 | 164.22 | 164.22 | 164.22 | (66) |

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

|        |       |       |       |       |       |       |       |       |      |       |      |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|------|-------|------|-------|------|
| (67)m= | 59.33 | 52.69 | 42.85 | 32.44 | 24.25 | 20.47 | 22.12 | 28.76 | 38.6 | 49.01 | 57.2 | 60.98 | (67) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|------|-------|------|-------|------|

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

|        |       |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (68)m= | 381.9 | 385.86 | 375.88 | 354.62 | 327.78 | 302.56 | 285.71 | 281.74 | 291.73 | 312.99 | 339.83 | 365.05 | (68) |
|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

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

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (69)m= | 54.16 | 54.16 | 54.16 | 54.16 | 54.16 | 54.16 | 54.16 | 54.16 | 54.16 | 54.16 | 54.16 | 54.16 | (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= | -109.48 | -109.48 | -109.48 | -109.48 | -109.48 | -109.48 | -109.48 | -109.48 | -109.48 | -109.48 | -109.48 | -109.48 | (71) |
|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|------|

Water heating gains (Table 5)

|        |        |       |        |        |        |       |       |       |        |        |        |        |      |
|--------|--------|-------|--------|--------|--------|-------|-------|-------|--------|--------|--------|--------|------|
| (72)m= | 121.09 | 118.8 | 114.04 | 107.57 | 103.37 | 97.46 | 92.43 | 98.87 | 101.16 | 107.86 | 115.42 | 118.81 | (72) |
|--------|--------|-------|--------|--------|--------|-------|-------|-------|--------|--------|--------|--------|------|

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

|        |        |        |        |        |       |        |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|------|
| (73)m= | 671.22 | 666.26 | 641.67 | 603.53 | 564.3 | 529.39 | 509.16 | 518.27 | 540.39 | 578.75 | 621.34 | 653.74 | (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                      | 8.45             | x | 10.63          | x | 0.63           | x | 1.11         | = 43.59 (74)  |
| North        | 0.9x                      | 0.77 | x                      | 8.45             | x | 20.32          | x | 0.63           | x | 1.11         | = 83.3 (74)   |
| North        | 0.9x                      | 0.77 | x                      | 8.45             | x | 34.53          | x | 0.63           | x | 1.11         | = 141.54 (74) |
| North        | 0.9x                      | 0.77 | x                      | 8.45             | x | 55.46          | x | 0.63           | x | 1.11         | = 227.35 (74) |
| North        | 0.9x                      | 0.77 | x                      | 8.45             | x | 74.72          | x | 0.63           | x | 1.11         | = 306.27 (74) |

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|       |      |      |   |      |   |        |   |      |   |      |   |        |      |
|-------|------|------|---|------|---|--------|---|------|---|------|---|--------|------|
| North | 0.9x | 0.77 | x | 8.45 | x | 79.99  | x | 0.63 | x | 1.11 | = | 327.87 | (74) |
| North | 0.9x | 0.77 | x | 8.45 | x | 74.68  | x | 0.63 | x | 1.11 | = | 306.11 | (74) |
| North | 0.9x | 0.77 | x | 8.45 | x | 59.25  | x | 0.63 | x | 1.11 | = | 242.86 | (74) |
| North | 0.9x | 0.77 | x | 8.45 | x | 41.52  | x | 0.63 | x | 1.11 | = | 170.18 | (74) |
| North | 0.9x | 0.77 | x | 8.45 | x | 24.19  | x | 0.63 | x | 1.11 | = | 99.15  | (74) |
| North | 0.9x | 0.77 | x | 8.45 | x | 13.12  | x | 0.63 | x | 1.11 | = | 53.77  | (74) |
| North | 0.9x | 0.77 | x | 8.45 | x | 8.86   | x | 0.63 | x | 1.11 | = | 36.34  | (74) |
| South | 0.9x | 0.77 | x | 5.68 | x | 46.75  | x | 0.63 | x | 1.11 | = | 128.82 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 76.57  | x | 0.63 | x | 1.11 | = | 210.97 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 97.53  | x | 0.63 | x | 1.11 | = | 268.74 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 110.23 | x | 0.63 | x | 1.11 | = | 303.74 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 114.87 | x | 0.63 | x | 1.11 | = | 316.51 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 110.55 | x | 0.63 | x | 1.11 | = | 304.6  | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 108.01 | x | 0.63 | x | 1.11 | = | 297.61 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 104.89 | x | 0.63 | x | 1.11 | = | 289.02 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 101.89 | x | 0.63 | x | 1.11 | = | 280.73 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 82.59  | x | 0.63 | x | 1.11 | = | 227.55 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 55.42  | x | 0.63 | x | 1.11 | = | 152.69 | (78) |
| South | 0.9x | 0.77 | x | 5.68 | x | 40.4   | x | 0.63 | x | 1.11 | = | 111.31 | (78) |

Solar gains in watts, calculated for each month

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

|        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| (83)m= | 172.41 | 294.27 | 410.28 | 531.09 | 622.78 | 632.47 | 603.72 | 531.88 | 450.91 | 326.71 | 206.47 | 147.65 | (83) |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|

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

|        |        |        |         |         |         |         |         |         |       |        |        |        |      |
|--------|--------|--------|---------|---------|---------|---------|---------|---------|-------|--------|--------|--------|------|
| (84)m= | 843.63 | 960.53 | 1051.96 | 1134.62 | 1187.08 | 1161.86 | 1112.88 | 1050.15 | 991.3 | 905.46 | 827.81 | 801.38 | (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= | 0.94 | 0.91 | 0.88 | 0.82 | 0.72 | 0.59 | 0.46 | 0.5 | 0.68 | 0.84 | 0.91 | 0.94 | (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= | 19.79 | 19.79 | 19.8 | 19.81 | 19.81 | 19.82 | 19.82 | 19.82 | 19.82 | 19.81 | 19.81 | 19.8 | (88) |
|--------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|

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

|        |      |     |      |      |      |      |      |     |      |     |     |      |      |
|--------|------|-----|------|------|------|------|------|-----|------|-----|-----|------|------|
| (89)m= | 0.93 | 0.9 | 0.86 | 0.79 | 0.67 | 0.51 | 0.36 | 0.4 | 0.61 | 0.8 | 0.9 | 0.93 | (89) |
|--------|------|-----|------|------|------|------|------|-----|------|-----|-----|------|------|

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

|        |       |       |      |       |       |       |       |       |       |       |       |      |      |
|--------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|
| (90)m= | 19.79 | 19.79 | 19.8 | 19.81 | 19.81 | 19.82 | 19.82 | 19.82 | 19.82 | 19.81 | 19.81 | 19.8 | (90) |
|--------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|

fLA = Living area ÷ (4) =

0.18 (91)

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

|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (92)m= | 20.01 | 20.01 | 20.01 | 20.02 | 20.02 | 20.03 | 20.03 | 20.03 | 20.03 | 20.02 | 20.02 | 20.01 | (92) |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|

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

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|        |       |       |       |       |       |       |       |       |       |       |       |       |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| (93)m= | 20.01 | 20.01 | 20.01 | 20.02 | 20.02 | 20.03 | 20.03 | 20.03 | 20.03 | 20.02 | 20.02 | 20.01 | (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= | 0.93 | 0.9 | 0.86 | 0.79 | 0.68 | 0.53 | 0.38 | 0.42 | 0.62 | 0.81 | 0.9 | 0.94 | (94) |
|--------|------|-----|------|------|------|------|------|------|------|------|-----|------|------|

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

|        |        |        |       |        |       |        |        |        |        |        |        |        |      |
|--------|--------|--------|-------|--------|-------|--------|--------|--------|--------|--------|--------|--------|------|
| (95)m= | 783.88 | 868.05 | 908.8 | 899.17 | 808.3 | 610.67 | 420.89 | 436.83 | 614.91 | 732.88 | 746.39 | 750.27 | (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= | 2135.96 | 2049.76 | 1828.69 | 1488.61 | 1111.7 | 718.38 | 453.78 | 479.57 | 787.05 | 1258.65 | 1733 | 2130.84 | (97) |
|--------|---------|---------|---------|---------|--------|--------|--------|--------|--------|---------|------|---------|------|

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

|                                                     |         |        |       |       |        |   |   |   |   |        |        |         |      |
|-----------------------------------------------------|---------|--------|-------|-------|--------|---|---|---|---|--------|--------|---------|------|
| (98)m=                                              | 1005.94 | 794.11 | 684.4 | 424.4 | 225.73 | 0 | 0 | 0 | 0 | 391.18 | 710.36 | 1027.14 |      |
| Total per year ( $kWh/year$ ) = $Sum(98)_{1..12} =$ |         |        |       |       |        |   |   |   |   |        |        | 5263.27 | (98) |

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

|       |      |
|-------|------|
| 52.78 | (99) |
|-------|------|

### 9. Space heating requirements - 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

|        |       |
|--------|-------|
| 351.98 | (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)

|         |        |       |       |        |   |   |   |   |        |        |         |
|---------|--------|-------|-------|--------|---|---|---|---|--------|--------|---------|
| 1005.94 | 794.11 | 684.4 | 424.4 | 225.73 | 0 | 0 | 0 | 0 | 391.18 | 710.36 | 1027.14 |
|---------|--------|-------|-------|--------|---|---|---|---|--------|--------|---------|

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

|        |        |        |        |       |   |   |   |   |        |        |        |
|--------|--------|--------|--------|-------|---|---|---|---|--------|--------|--------|
| 285.79 | 225.61 | 194.44 | 120.57 | 64.13 | 0 | 0 | 0 | 0 | 111.14 | 201.82 | 291.82 |
|--------|--------|--------|--------|-------|---|---|---|---|--------|--------|--------|

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

|         |       |
|---------|-------|
| 1495.33 | (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 |   |       |
| Total (kWh/year) =Sum(215) <sub>1...5,10...12</sub> |   |   |   |   |   |   |   |   |   |   |   | 0 | (215) |

#### Water heating

Output from water heater (calculated above)

|        |       |        |        |        |        |        |        |        |        |        |        |
|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 207.18 | 182.5 | 191.41 | 171.23 | 167.53 | 149.32 | 143.05 | 157.47 | 157.34 | 177.57 | 188.21 | 202.08 |
|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|

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 | (217) |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|

Fuel for water heating,  $kWh/month$

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

|                               |        |        |        |       |       |       |       |       |      |        |        |         |       |
|-------------------------------|--------|--------|--------|-------|-------|-------|-------|-------|------|--------|--------|---------|-------|
| (219)m=                       | 117.06 | 103.12 | 108.15 | 96.75 | 94.66 | 84.37 | 80.83 | 88.97 | 88.9 | 100.33 | 106.34 | 114.18  |       |
| Total = $Sum(219a)_{1..12} =$ |        |        |        |       |       |       |       |       |      |        |        | 1183.66 | (219) |

#### Annual totals

**kWh/year**

**kWh/year**

Space heating fuel used, main system 1

|         |
|---------|
| 1495.33 |
|---------|

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|                                                   |                          |         |       |
|---------------------------------------------------|--------------------------|---------|-------|
| Water heating fuel used                           |                          | 1183.66 |       |
| Electricity for pumps, fans and electric keep-hot |                          |         |       |
| Total electricity for the above, kWh/year         | sum of (230a)...(230g) = | 0       | (231) |
| Electricity for lighting                          |                          | 419.09  | (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 = 197.23 (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 = 156.12 (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 = 55.28 (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) = | 528.64 | (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] = | 1.53 | (257) |
| <b>SAP rating (Section 12)</b>  |                                  | 78.6 | (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                         | = 776.08 (261)           |
| Space heating (secondary)                         | (215) x                         | 0.519                         | = 0 (263)                |
| Water heating                                     | (219) x                         | 0.216                         | = 255.67 (264)           |
| Space and water heating                           | (261) + (262) + (263) + (264) = |                               | 1031.75 (265)            |
| Electricity for pumps, fans and electric keep-hot | (231) x                         | 0.519                         | = 0 (267)                |
| Electricity for lighting                          | (232) x                         | 0.519                         | = 217.51 (268)           |
| Total CO2, kg/year                                |                                 | sum of (265)...(271) =        | 1249.26 (272)            |
| <b>CO2 emissions per m²</b>                       |                                 | (272) ÷ (4) =                 | 12.53 (273)              |
| EI rating (section 14)                            |                                 |                               | 88 (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              | = 4590.67 (261)       |

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|                                                   |                                 |                        |   |         |       |
|---------------------------------------------------|---------------------------------|------------------------|---|---------|-------|
| Space heating (secondary)                         | {215} x                         | 3.07                   | = | 0       | {263} |
| Energy for water heating                          | {219} x                         | 1.22                   | = | 1444.06 | {264} |
| Space and water heating                           | {261} + {262} + {263} + {264} = |                        |   | 6034.73 | {265} |
| Electricity for pumps, fans and electric keep-hot | {231} x                         | 3.07                   | = | 0       | {267} |
| Electricity for lighting                          | {232} x                         | 0                      | = | 1286.61 | {268} |
| 'Total Primary Energy                             |                                 | sum of {265}...{271} = |   | 7321.35 | {272} |
| <b>Primary energy kWh/m<sup>2</sup>/year</b>      |                                 | {272} ÷ {4} =          |   | 73.42   | {273} |