

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)



|                                    |                                                                                      |               |                  |      |                |            |
|------------------------------------|--------------------------------------------------------------------------------------|---------------|------------------|------|----------------|------------|
| Property Reference                 | 4907-0015-3817-135                                                                   |               |                  |      | Issued on Date | 09/05/2019 |
| Assessment Reference               | As Built                                                                             | Prop Type Ref | P306i - Det (Op) |      |                |            |
| Property                           | 5, Kiln Row, Botley, SOUTHAMPTON, SO32 2GF                                           |               |                  |      |                |            |
|                                    |                                                                                      |               |                  |      |                |            |
| SAP Rating                         | 87 B                                                                                 | DER           | 14.67            | TER  | 18.83          |            |
| Environmental                      | 88 B                                                                                 | % DER<TER     | 22.08            |      |                |            |
| CO <sub>2</sub> Emissions (t/year) | 1.04                                                                                 | DFEE          | 52.19            | TFEE | 57.93          |            |
| General Requirements Compliance    | Pass                                                                                 | % DFEE<TFEE   | 9.90             |      |                |            |
|                                    |                                                                                      |               |                  |      |                |            |
| Assessor Details                   | Mr. Fraser Browning, Fraser Browning, Tel: 01884 242050, Fraser.browning@aessc.co.uk |               |                  |      | Assessor ID    | T511-0001  |
| Client                             |                                                                                      |               |                  |      |                |            |

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### REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

#### DWELLING AS BUILT

Detached House, total floor area 93 m<sup>2</sup>

This report covers items included within the SAP calculations.  
It is not a complete report of regulations compliance.

#### 1a TER and DER

Fuel for main heating:Mains gas  
Fuel factor:1.00 (mains gas)  
Target Carbon Dioxide Emission Rate (TER) 18.83 kgCO<sub>2</sub>/m<sup>2</sup>  
Dwelling Carbon Dioxide Emission Rate (DER) 14.67 kgCO<sub>2</sub>/m<sup>2</sup>OK

#### 1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)57.9 kWh/m<sup>2</sup>/yr  
Dwelling Fabric Energy Efficiency (DFEE)52.2 kWh/m<sup>2</sup>/yrOK

#### 2 Fabric U-values

| Element       | Average          | Highest          |    |
|---------------|------------------|------------------|----|
| External wall | 0.25 (max. 0.30) | 0.25 (max. 0.70) | OK |
| Floor         | 0.15 (max. 0.25) | 0.15 (max. 0.70) | OK |
| Roof          | 0.13 (max. 0.20) | 0.20 (max. 0.35) | OK |
| Openings      | 1.34 (max. 2.00) | 1.40 (max. 3.30) | OK |

#### 2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

#### 3 Air permeability

Air permeability at 50 pascals: 4.64 (measured in this dwelling)  
Maximum 10.0 OK

#### 4 Heating efficiency

Main heating system: Boiler system with radiators or underfloor - Mains gas  
Data from database  
Potterton Promax Ultra Combi 40 ErP  
Combi boiler  
Efficiency: 89.1% SEDBUK2009  
Minimum: 88.0% OK

Secondary heating system: None

#### 5 Cylinder insulation

Hot water storage No cylinder

#### 6 Controls

Space heating controls: Time and temperature zone control OK

Hot water controls: No cylinder

Boiler interlock Yes OK

#### 7 Low energy lights

Percentage of fixed lights with low-energy fittings:100%  
Minimum 75% OK

#### 8 Mechanical ventilation

Not applicable

#### 9 Summertime temperature

Overheating risk (Southern England): Slight OK  
Based on:  
Overshading: Average  
Windows facing North East: 7.97 m<sup>2</sup>, No overhang  
Windows facing South: 0.68 m<sup>2</sup>, No overhang  
Windows facing South West: 5.76 m<sup>2</sup>, No overhang  
Windows facing West: 0.68 m<sup>2</sup>, No overhang  
Air change rate: 4.00 ach  
Blinds/curtains: None

#### 10 Key features

Door U-value 0.90 W/m<sup>2</sup>K  
Thermal bridging y-value 0.036 W/m<sup>2</sup>K  
Photovoltaic array 0.81 kW

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### CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                                         | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|-------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                      | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                    | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                             |                 |                      |       |                             | 4 * 10 = 40.0000 (7a)      |
| Number of passive vents                                                 |                 |                      |       |                             | 0 * 10 = 0.0000 (7b)       |
| Number of flueless gas fires                                            |                 |                      |       |                             | 0 * 40 = 0.0000 (7c)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) |                 |                      |       |                             | 40.0000 / (5) = 0.1806 (8) |
| Pressure test                                                           |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                    |                 |                      |       |                             | 4.6400                     |
| Infiltration rate                                                       |                 |                      |       |                             | 0.4126 (18)                |
| Number of sides sheltered                                               |                 |                      |       |                             | 0 (19)                     |
| Shelter factor                                                          |                 |                      |       | (20) = 1 - [0.075 x (19)] = | 1.0000 (20)                |
| Infiltration rate adjusted to include shelter factor                    |                 |                      |       | (21) = (18) x (20) =        | 0.4126 (21)                |

  

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)  |
| Wind factor     | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.5260 | 0.5157 | 0.5054 | 0.4538 | 0.4435 | 0.3919 | 0.3919 | 0.3816 | 0.4126 | 0.4435 | 0.4641 | 0.4848 (22b) |
|                 | 0.6384 | 0.6330 | 0.6277 | 0.6030 | 0.5984 | 0.5768 | 0.5768 | 0.5728 | 0.5851 | 0.5984 | 0.6077 | 0.6175 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                        | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K       | A x K<br>kJ/K   |
|----------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------------|-----------------|
| Solid Door                                                     |                         |                            | 1.9600                    | 0.9000                        | 1.7640       |                                      | (26)            |
| Window (Uw = 1.40)                                             |                         |                            | 11.9400                   | 1.3258                        | 15.8295      |                                      | (27)            |
| French (Uw = 1.40)                                             |                         |                            | 3.1500                    | 1.3258                        | 4.1761       |                                      | (27)            |
| Half Glazed Door                                               |                         |                            | 1.8900                    | 1.3000                        | 2.4570       |                                      | (26a)           |
| Heat Loss Floor                                                |                         |                            | 46.7700                   | 0.1500                        | 7.0155       | 75.0000                              | 3507.7500 (28a) |
| 100mm Knauf Supafil                                            | 134.7300                | 18.9400                    | 115.7900                  | 0.2500                        | 28.9475      | 52.8000                              | 6113.7120 (29a) |
| External Plane Roof                                            | 45.7700                 |                            | 45.7700                   | 0.1300                        | 5.9501       | 9.0000                               | 411.9300 (30)   |
| Bay                                                            | 1.0100                  |                            | 1.0100                    | 0.2000                        | 0.2020       | 9.0000                               | 9.0900 (30)     |
| Total net area of external elements Aum(A, m <sup>2</sup> )    |                         |                            | 228.2800                  |                               |              |                                      | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                            |                         |                            |                           | (26)...(30) + (32) =          | 66.3418      |                                      | (33)            |
| GF Masonry                                                     |                         |                            | 41.2600                   |                               |              | 39.0000                              | 1609.1400 (32c) |
| GF Timber                                                      |                         |                            | 34.3700                   |                               |              | 9.0000                               | 309.3300 (32c)  |
| 1F Timber                                                      |                         |                            | 81.4300                   |                               |              | 9.0000                               | 732.8700 (32c)  |
| 1F Metal                                                       |                         |                            | 34.9000                   |                               |              | 20.0000                              | 698.0000 (32c)  |
| Internal Floor                                                 |                         |                            | 45.7600                   |                               |              | 18.0000                              | 823.6800 (32d)  |
| Internal Floor 1                                               |                         |                            | 45.7600                   |                               |              | 18.0000                              | 823.6800 (32e)  |
| Heat capacity Cm = Sum(A x k)                                  |                         |                            |                           |                               |              | (28)...(30) + (32) + (32a)...(32e) = | 15039.1820 (34) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K |                         |                            |                           |                               |              |                                      | 162.5330 (35)   |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)     |                         |                            |                           |                               |              |                                      | 8.1836 (36)     |
| Total fabric heat loss                                         |                         |                            |                           |                               |              | (33) + (36) =                        | 74.5254 (37)    |

  

|                                                                     |          |          |          |          |          |          |          |          |          |          |          |               |
|---------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m                                                               | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
| Heat transfer coeff                                                 | 46.6652  | 46.2725  | 45.8875  | 44.0794  | 43.7411  | 42.1663  | 42.1663  | 41.8746  | 42.7729  | 43.7411  | 44.4254  | 45.1409 (38)  |
| Average = Sum(39)m / 12 =                                           | 121.1905 | 120.7978 | 120.4129 | 118.6047 | 118.2664 | 116.6916 | 116.6916 | 116.4000 | 117.2982 | 118.2664 | 118.9508 | 119.6663 (39) |
|                                                                     |          |          |          |          |          |          |          |          |          |          |          | 118.6031 (39) |

  

|               |        |        |        |        |        |        |        |        |        |        |        |             |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec         |
| HLP (average) | 1.3097 | 1.3055 | 1.3013 | 1.2818 | 1.2781 | 1.2611 | 1.2611 | 1.2580 | 1.2677 | 1.2781 | 1.2855 | 1.2933 (40) |
| Days in month | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31 (41)     |

#### 4. Water heating energy requirements (kWh/year)

|                                          |     |     |     |     |     |     |     |     |     |     |     |              |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------|
| Assumed occupancy                        |     |     |     |     |     |     |     |     |     |     |     | 2.6588 (42)  |
| Average daily hot water use (litres/day) |     |     |     |     |     |     |     |     |     |     |     | 97.3463 (43) |
|                                          | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec          |

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### CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |                |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| Daily hot water use                                             | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055  | 87.6116  | 87.6116  | 91.5055  | 95.3993  | 99.2932  | 103.1870 | 107.0809 (44)  |
| Energy conte                                                    | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903 | 103.4562 | 95.8674  | 110.0092 | 111.3231 | 129.7363 | 141.6173 | 153.7873 (45)  |
| Energy content (annual)                                         |          |          |          |          |          |          |          |          |          |          |          |                |
| Distribution loss (46)m = 0.15 x (45)m                          | 23.8197  | 20.8328  | 21.4976  | 18.7422  | 17.9835  | 15.5184  | 14.3801  | 16.5014  | 16.6985  | 19.4604  | 21.2426  | 23.0681 (46)   |
| Water storage loss:                                             |          |          |          |          |          |          |          |          |          |          |          |                |
| Total storage loss                                              | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (56)    |
| If cylinder contains dedicated solar storage                    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (57)    |
| Combi loss                                                      | 21.0464  | 18.9901  | 20.9755  | 20.2193  | 20.8353  | 20.0965  | 20.7248  | 20.7964  | 20.1634  | 20.9175  | 20.3157  | 21.0249 (61)   |
| Total heat required for water heating calculated for each month | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538 | 161.9330 | 174.8121 (62)  |
| Solar input                                                     | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63)    |
| Solar input (sum of months) = Sum(63)m =                        |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63)    |
| Output from w/h                                                 | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538 | 161.9330 | 174.8121 (64)  |
| Heat gains from water heating, kWh/month                        | 58.0619  | 50.9270  | 52.8970  | 46.5999  | 45.0724  | 39.4233  | 37.0571  | 41.7772  | 42.0558  | 48.3667  | 52.1667  | 56.3905 (65)   |
| Total per year (kWh/year) = Sum(64)m =                          |          |          |          |          |          |          |          |          |          |          |          | 1777.7416 (64) |

#### 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                                                                               | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 22.5781   | 20.0536   | 16.3087   | 12.3467   | 9.2293    | 7.7918    | 8.4193    | 10.9437   | 14.6887   | 18.6506   | 21.7680   | 23.2056 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 243.6560  | 246.1844  | 239.8130  | 226.2489  | 209.1267  | 193.0342  | 182.2835  | 179.7551  | 186.1265  | 199.6906  | 216.8128  | 232.9053 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940 (69)   |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 (71) |
| Water heating gains (Table 5)                                                       | 78.0402   | 75.7842   | 71.0981   | 64.7221   | 60.5811   | 54.7546   | 49.8079   | 56.1521   | 58.4108   | 65.0090   | 72.4537   | 75.7937 (72)   |
| Total internal gains                                                                | 410.1561  | 407.9042  | 393.1016  | 369.1996  | 344.8190  | 321.4625  | 306.3926  | 312.7328  | 325.1079  | 349.2321  | 376.9164  | 397.7864 (73)  |

#### 6. Solar gains

| [Jan]       |          |          |          | Area<br>m <sup>2</sup> | Solar flux<br>Table 6a<br>W/m <sup>2</sup> | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c |          |          | Access<br>factor<br>Table 6d | Gains<br>W   |               |
|-------------|----------|----------|----------|------------------------|--------------------------------------------|-----------------------------------|------------------------------------|----------|----------|------------------------------|--------------|---------------|
| Northeast   |          |          |          | 4.8200                 | 11.2829                                    | 0.6200                            | 0.7000                             |          |          | 0.7700                       | 16.3566 (75) |               |
| South       |          |          |          | 0.6800                 | 46.7521                                    | 0.6200                            | 0.7000                             |          |          | 0.7700                       | 9.5616 (78)  |               |
| Southwest   |          |          |          | 5.7600                 | 36.7938                                    | 0.6200                            | 0.7000                             |          |          | 0.7700                       | 63.7412 (79) |               |
| West        |          |          |          | 0.6800                 | 19.6403                                    | 0.6200                            | 0.7000                             |          |          | 0.7700                       | 4.0168 (80)  |               |
| Northeast   |          |          |          | 3.1500                 | 11.2829                                    | 0.6200                            | 0.7000                             |          |          | 0.7700                       | 10.6895 (75) |               |
| Solar gains | 104.3657 | 187.1451 | 280.6328 | 388.3823               | 471.7586                                   | 484.4059                          | 460.3435                           | 395.7528 | 317.6056 | 213.4916                     | 126.7205     | 88.2017 (83)  |
| Total gains | 514.5219 | 595.0493 | 673.7344 | 757.5819               | 816.5777                                   | 805.8684                          | 766.7361                           | 708.4856 | 642.7135 | 562.7237                     | 503.6369     | 485.9881 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |                           |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |                           |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep                       | Oct     | Nov     | Dec          |
| tau                                                                         | 34.4709 | 34.5830 | 34.6936 | 35.2225 | 35.3232 | 35.7999 | 35.7999 | 35.8896 | 35.6148                   | 35.3232 | 35.1200 | 34.9100      |
| alpha                                                                       | 3.2981  | 3.3055  | 3.3129  | 3.3482  | 3.3549  | 3.3867  | 3.3867  | 3.3926  | 3.3743                    | 3.3549  | 3.3413  | 3.3273       |
| util living area                                                            | 0.9918  | 0.9861  | 0.9734  | 0.9407  | 0.8695  | 0.7418  | 0.6009  | 0.6549  | 0.8511                    | 0.9593  | 0.9868  | 0.9933 (86)  |
| MIT                                                                         | 18.9585 | 19.1663 | 19.5266 | 20.0189 | 20.4701 | 20.7966 | 20.9281 | 20.9024 | 20.6425                   | 20.0619 | 19.4310 | 18.9312 (87) |
| Th 2                                                                        | 19.8332 | 19.8365 | 19.8398 | 19.8551 | 19.8580 | 19.8714 | 19.8714 | 19.8739 | 19.8662                   | 19.8580 | 19.8522 | 19.8461 (88) |
| util rest of house                                                          | 0.9899  | 0.9827  | 0.9666  | 0.9243  | 0.8300  | 0.6590  | 0.4732  | 0.5308  | 0.7907                    | 0.9449  | 0.9831  | 0.9916 (89)  |
| MIT 2                                                                       | 17.1205 | 17.4249 | 17.9492 | 18.6635 | 19.2865 | 19.7034 | 19.8335 | 19.8173 | 19.5305                   | 18.7368 | 17.8218 | 17.0884 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.1962 (91)  |
| MIT                                                                         | 17.4811 | 17.7665 | 18.2586 | 18.9294 | 19.5187 | 19.9179 | 20.0482 | 20.0301 | 19.7487                   | 18.9967 | 18.1374 | 17.4499 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 17.3311 | 17.6165 | 18.1086 | 18.7794 | 19.3687 | 19.7679 | 19.8982 | 19.8801 | 19.5987                   | 18.8467 | 17.9874 | 17.2999 (93) |

#### 8. Space heating requirement

|                   | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec            |
|-------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------|
| Utilisation       | 0.832     | 0.9729    | 0.9518    | 0.9034    | 0.8090   | 0.6503   | 0.4765   | 0.5316   | 0.7728   | 0.9264   | 0.9735    | 0.9859 (94)    |
| Useful gains      | 505.8641  | 578.9178  | 641.2390  | 684.4237  | 660.6292 | 524.0449 | 365.3533 | 376.6084 | 496.6575 | 521.3353 | 490.3029  | 479.1351 (95)  |
| Ext temp.         | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000  | 7.1000    | 4.2000 (96)    |
| Heat loss rate W  | 1579.2408 | 1536.1213 | 1397.8249 | 1171.7380 | 906.9472 | 603.0474 | 384.8750 | 405.0872 | 644.9836 | 975.3107 | 1295.0704 | 1567.6149 (97) |
| Month fracti      | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000    | 1.0000 (97a)   |
| Space heating kWh | 798.5923  | 643.2407  | 562.9000  | 350.8663  | 183.2606 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 337.7577 | 579.4326  | 809.8289 (98)  |
| Space heating     |           |           |           |           |          |          |          |          |          |          |           | 4265.8790 (98) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Space heating per m2 (98) / (4) = 46.1027 (99)

8c. Space cooling requirement

Not applicable

#### 9a. Energy requirements - Individual heating systems, including micro-CHP

|                                                                       |          |          |          |          |          |          |          |          |          |           |          |           |                 |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|----------|-----------|-----------------|
| Fraction of space heat from secondary/supplementary system (Table 11) |          |          |          |          |          |          |          |          |          |           |          |           | 0.0000 (201)    |
| Fraction of space heat from main system(s)                            |          |          |          |          |          |          |          |          |          |           |          |           | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                      |          |          |          |          |          |          |          |          |          |           |          |           | 90.0000 (206)   |
| Efficiency of secondary/supplementary heating system, %               |          |          |          |          |          |          |          |          |          |           |          |           | 0.0000 (208)    |
| Space heating requirement                                             |          |          |          |          |          |          |          |          |          |           |          |           | 4739.8656 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 798.5923 | 643.2407 | 562.9000 | 350.8663 | 183.2606 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 337.7577  | 579.4326 | 809.8289  | (98)            |
| Space heating efficiency (main heating system 1)                      | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 90.0000   | 90.0000  | 90.0000   | (210)           |
| Space heating fuel (main heating system)                              | 887.3247 | 714.7119 | 625.4444 | 389.8514 | 203.6229 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 375.2863  | 643.8140 | 899.8099  | (211)           |
| Water heating requirement                                             | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000   | 0.0000    | (215)           |
| Water heating requirement                                             | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538  | 161.9330 | 174.8121  | (64)            |
| Efficiency of water heater (217)m                                     | 89.3747  | 89.3299  | 89.2327  | 89.0085  | 88.5363  | 86.7000  | 86.7000  | 86.7000  | 86.7000  | 88.9556   | 89.2579  | 86.7000   | (216)           |
| Fuel for water heating, kWh/month                                     | 201.2250 | 176.7333 | 184.1176 | 163.0933 | 158.9469 | 142.5060 | 134.4777 | 150.8716 | 151.6568 | 169.3584  | 181.4214 | 195.5483  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |           |          | 2009.9563 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |           |          | 4739.8656 | (211)           |
| Space heating fuel - secondary                                        |          |          |          |          |          |          |          |          |          |           |          | 0.0000    | (215)           |
| Electricity for pumps and fans:                                       |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| central heating pump                                                  |          |          |          |          |          |          |          |          |          |           |          | 30.0000   | (230c)          |
| main heating flue fan                                                 |          |          |          |          |          |          |          |          |          |           |          | 45.0000   | (230e)          |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |          |          |          |          |           |          | 75.0000   | (231)           |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |          |          |          |          |           |          | 398.7358  | (232)           |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| PV Unit 0 (0.80 * 0.81 * 1029 * 1.00) =                               |          |          |          |          |          |          |          |          |          | -666.9130 |          | -666.9130 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |           |          | 6556.6447 | (238)           |

#### 12a. Carbon dioxide 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               | 4739.8656          | 0.2160                        | 1023.8110 (261)          |
| Space heating - secondary                   | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                  | 2009.9563          | 0.2160                        | 434.1506 (264)           |
| Space and water heating                     |                    |                               | 1457.9615 (265)          |
| Pumps and fans                              | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                         | 398.7358           | 0.5190                        | 206.9439 (268)           |
| Energy saving/generation technologies       |                    |                               |                          |
| PV Unit                                     | -666.9130          | 0.5190                        | -346.1278 (269)          |
| Total CO2, kg/year                          |                    |                               | 1357.7026 (272)          |
| Dwelling Carbon Dioxide Emission Rate (DER) |                    |                               | 14.6700 (273)            |

#### 16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES

|                                                                                 |     |         |     |
|---------------------------------------------------------------------------------|-----|---------|-----|
| DER                                                                             |     | 14.6700 | ZC1 |
| Total Floor Area                                                                |     | 92.5300 |     |
| Assumed number of occupants                                                     | TFA | 2.6588  |     |
| CO2 emission factor in Table 12 for electricity displaced from grid             | N   | 0.5190  |     |
| CO2 emissions from appliances, equation (L14)                                   | EF  | 15.6042 | ZC2 |
| CO2 emissions from cooking, equation (L16)                                      |     | 1.9757  | ZC3 |
| Total CO2 emissions                                                             |     | 32.2499 | ZC4 |
| Residual CO2 emissions offset from biofuel CHP                                  |     | 0.0000  | ZC5 |
| Additional allowable electricity generation, kWh/m²/year                        |     | 0.0000  | ZC6 |
| Resulting CO2 emissions offset from additional allowable electricity generation |     | 0.0000  | ZC7 |
| Net CO2 emissions                                                               |     | 32.2499 | ZC8 |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
CALCULATION OF TARGET EMISSIONS 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total                       | m <sup>3</sup> per hour    |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                               |                 |                      |       |                             | 3 * 10 = 30.0000 (7a)      |
| Number of passive vents                                                   |                 |                      |       |                             | 0 * 10 = 0.0000 (7b)       |
| Number of flueless gas fires                                              |                 |                      |       |                             | 0 * 40 = 0.0000 (7c)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |       |                             | 30.0000 / (5) = 0.1354 (8) |
| Pressure test                                                             |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                      |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                         |                 |                      |       |                             | 0.3854 (18)                |
| Number of sides sheltered                                                 |                 |                      |       |                             | 0 (19)                     |
| Shelter factor                                                            |                 |                      |       | (20) = 1 - [0.075 x (19)] = | 1.0000 (20)                |
| Infiltration rate adjusted to include shelter factor                      |                 |                      |       | (21) = (18) x (20) =        | 0.3854 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)  |
| Wind factor     | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a) |
| Adj infilt rate | 0.4914 | 0.4818 | 0.4721 | 0.4240 | 0.4143 | 0.3662 | 0.3662 | 0.3565 | 0.3854 | 0.4143 | 0.4336 | 0.4529 (22b) |
| Effective ac    | 0.6207 | 0.6161 | 0.6115 | 0.5899 | 0.5858 | 0.5670 | 0.5670 | 0.5636 | 0.5743 | 0.5858 | 0.5940 | 0.6025 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                        | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K |
|----------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|---------------|
| TER Opaque door                                                |                         |                            | 1.9600                    | 1.0000                        | 1.9600       |                                | (26)          |
| TER Semi-glazed door                                           |                         |                            | 1.8900                    | 1.2000                        | 2.2680       |                                | (26a)         |
| TER Opening Type (Uw = 1.40)                                   |                         |                            | 15.0900                   | 1.3258                        | 20.0057      |                                | (27)          |
| Heat Loss Floor                                                |                         |                            | 46.7700                   | 0.1300                        | 6.0801       |                                | (28a)         |
| 100mm Knauf Supafil                                            | 134.7300                | 18.9400                    | 115.7900                  | 0.1800                        | 20.8422      |                                | (29a)         |
| External Plane Roof                                            | 45.7700                 |                            | 45.7700                   | 0.1300                        | 5.9501       |                                | (30)          |
| Bay                                                            | 1.0100                  |                            | 1.0100                    | 0.1300                        | 0.1313       |                                | (30)          |
| Total net area of external elements Aum(A, m <sup>2</sup> )    |                         |                            | 228.2800                  |                               |              |                                | (31)          |
| Fabric heat loss, W/K = Sum (A x U)                            |                         |                            | (26)...(30) + (32) =      |                               | 57.2374      |                                | (33)          |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K |                         |                            |                           |                               |              |                                | 250.0000 (35) |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)     |                         |                            |                           |                               |              |                                | 11.3958 (36)  |
| Total fabric heat loss                                         |                         |                            |                           |                               |              | (33) + (36) =                  | 68.6332 (37)  |

|                                                                     |          |          |          |          |          |          |          |          |          |          |          |               |
|---------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m                                                               | 45.3782  | 45.0355  | 44.6995  | 43.1215  | 42.8262  | 41.4518  | 41.4518  | 41.1973  | 41.9812  | 42.8262  | 43.4235  | 44.0479 (38)  |
| Heat transfer coeff                                                 | 114.0114 | 113.6687 | 113.3327 | 111.7546 | 111.4594 | 110.0850 | 110.0850 | 109.8304 | 110.6144 | 111.4594 | 112.0567 | 112.6811 (39) |
| Average = Sum(39)m / 12 =                                           |          |          |          |          |          |          |          |          |          |          |          | 111.7532 (39) |
| HLP                                                                 | 1.2322   | 1.2285   | 1.2248   | 1.2078   | 1.2046   | 1.1897   | 1.1897   | 1.1870   | 1.1954   | 1.2046   | 1.2110   | 1.2178 (40)   |
| HLP (average)                                                       |          |          |          |          |          |          |          |          |          |          |          | 1.2078 (40)   |
| Days in month                                                       | 31       | 28       | 31       | 30       | 31       | 30       | 31       | 31       | 30       | 31       | 30       | 31 (41)       |

#### 4. Water heating energy requirements (kWh/year)

|                                          |          |          |          |          |          |          |         |          |          |                    |          |                |
|------------------------------------------|----------|----------|----------|----------|----------|----------|---------|----------|----------|--------------------|----------|----------------|
| Assumed occupancy                        |          |          |          |          |          |          |         |          |          |                    |          | 2.6588 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |          |         |          |          |                    |          | 97.3463 (43)   |
| Daily hot water use                      | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055  | 87.6116  | 87.6116 | 91.5055  | 95.3993  | 99.2932            | 103.1870 | 107.0809 (44)  |
| Energy conte                             | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903 | 103.4562 | 95.8674 | 110.0092 | 111.3231 | 129.7363           | 141.6173 | 153.7873 (45)  |
| Energy content (annual)                  |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1531.6359 (45) |
| Distribution loss (46)m = 0.15 x (45)m   | 23.8197  | 20.8328  | 21.4976  | 18.7422  | 17.9835  | 15.5184  | 14.3801 | 16.5014  | 16.6985  | 19.4604            | 21.2426  | 23.0681 (46)   |
| Water storage loss:                      |          |          |          |          |          |          |         |          |          |                    |          |                |
| Total storage loss                       |          |          |          |          |          |          |         |          |          |                    |          |                |

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## Calculation Type: New Build (As Built)

### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| If cylinder contains dedicated solar storage                    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (56)   |
| Combi loss                                                      | 50.9589  | 46.0274  | 50.5987  | 47.0463  | 46.6302  | 43.2057  | 44.6459  | 46.6302  | 47.0463  | 50.5987  | 49.3151  | 50.9589 (61)  |
| Total heat required for water heating calculated for each month | 209.7568 | 184.9130 | 193.9163 | 171.9940 | 166.5205 | 146.6620 | 140.5133 | 156.6394 | 158.3693 | 180.3351 | 190.9324 | 204.7462 (62) |
| Solar input                                                     | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63)   |
| Output from w/h                                                 | 209.7568 | 184.9130 | 193.9163 | 171.9940 | 166.5205 | 146.6620 | 140.5133 | 156.6394 | 158.3693 | 180.3351 | 190.9324 | 204.7462 (64) |
| Heat gains from water heating, kWh/month                        | 65.5400  | 57.6863  | 60.3028  | 53.3067  | 51.5211  | 45.2006  | 43.0374  | 48.2356  | 48.7765  | 55.7870  | 59.4165  | 63.8740 (65)  |

#### 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                                                                               | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 22.5781   | 20.0536   | 16.3087   | 12.3467   | 9.2293    | 7.7918    | 8.4193    | 10.9437   | 14.6887   | 18.6506   | 21.7680   | 23.2056   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 243.6560  | 246.1844  | 239.8130  | 226.2489  | 209.1267  | 193.0342  | 182.2835  | 179.7551  | 186.1265  | 199.6906  | 216.8128  | 232.9053  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | (69) |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | (71) |
| Water heating gains (Table 5)                                                       | 88.0914   | 85.8427   | 81.0521   | 74.0370   | 69.2488   | 62.7786   | 57.8460   | 64.8328   | 67.7451   | 74.9825   | 82.5230   | 85.8521   | (72) |
| Total internal gains                                                                | 420.2074  | 417.9627  | 403.0556  | 378.5145  | 353.4866  | 329.4865  | 314.4306  | 321.4135  | 334.4422  | 359.2056  | 386.9857  | 407.8449  | (73) |

#### 6. Solar gains

| [Jan]       |          |          |          | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g        | Specific data<br>or Table 6b | FF       | Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W   |               |
|-------------|----------|----------|----------|------------|--------------------------------|----------|------------------------------|----------|------------------------------|------------------------------|--------------|---------------|
| Northeast   |          |          |          | 7.9700     | 11.2829                        |          | 0.6300                       |          | 0.7000                       | 0.7700                       | 27.4823 (75) |               |
| South       |          |          |          | 0.6800     | 46.7521                        |          | 0.6300                       |          | 0.7000                       | 0.7700                       | 9.7159 (78)  |               |
| Southwest   |          |          |          | 5.7600     | 36.7938                        |          | 0.6300                       |          | 0.7000                       | 0.7700                       | 64.7693 (79) |               |
| West        |          |          |          | 0.6800     | 19.6403                        |          | 0.6300                       |          | 0.7000                       | 0.7700                       | 4.0816 (80)  |               |
|             |          |          |          |            |                                |          |                              |          |                              |                              |              |               |
| Solar gains | 106.0490 | 190.1636 | 285.1592 | 394.6465   | 479.3677                       | 492.2189 | 467.7684                     | 402.1359 | 322.7283                     | 216.9350                     | 128.7644     | 89.6243 (83)  |
| Total gains | 526.2564 | 608.1262 | 688.2148 | 773.1610   | 832.8543                       | 821.7054 | 782.1990                     | 723.5494 | 657.1705                     | 576.1406                     | 515.7501     | 497.4692 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |         |         |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Thl (C) |         |         |         |         |         |         |         |         |         |         |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec     |              |
| tau                                                                         | 56.3601 | 56.5300 | 56.6976 | 57.4982 | 57.6505 | 58.3703 | 58.3703 | 58.5056 | 58.0910 | 57.6505 | 57.3433 | 57.0255 |              |
| alpha                                                                       | 4.7573  | 4.7687  | 4.7798  | 4.8332  | 4.8434  | 4.8914  | 4.8914  | 4.9004  | 4.8727  | 4.8434  | 4.8229  | 4.8017  |              |
| util living area                                                            | 0.9984  | 0.9965  | 0.9909  | 0.9701  | 0.9056  | 0.7608  | 0.5952  | 0.6571  | 0.8854  | 0.9827  | 0.9968  | 0.9988  | (86)         |
| MIT                                                                         | 19.6214 | 19.7751 | 20.0373 | 20.3952 | 20.7163 | 20.9200 | 20.9810 | 20.9699 | 20.8174 | 20.4040 | 19.9525 | 19.6002 | (87)         |
| Th 2                                                                        | 19.8944 | 19.8973 | 19.9002 | 19.9138 | 19.9163 | 19.9282 | 19.9282 | 19.9304 | 19.9236 | 19.9163 | 19.9112 | 19.9058 | (88)         |
| util rest of house                                                          | 0.9978  | 0.9953  | 0.9874  | 0.9579  | 0.8657  | 0.6683  | 0.4622  | 0.5239  | 0.8213  | 0.9735  | 0.9954  | 0.9984  | (89)         |
| MIT 2                                                                       | 18.0594 | 18.2859 | 18.6695 | 19.1926 | 19.6296 | 19.8730 | 19.9211 | 19.9176 | 19.7697 | 19.2134 | 18.5553 | 18.0363 | (90)         |
| Living area fraction                                                        | 18.3658 | 18.5780 | 18.9378 | 19.4285 | 19.8428 | 20.0784 | 20.1290 | 20.1240 | 19.9752 | 19.4470 | 18.8294 | 18.3431 | (92)         |
| Temperature adjustment                                                      | 18.3658 | 18.5780 | 18.9378 | 19.4285 | 19.8428 | 20.0784 | 20.1290 | 20.1240 | 19.9752 | 19.4470 | 18.8294 | 18.3431 | (93)         |
| adjusted MIT                                                                | 18.3658 | 18.5780 | 18.9378 | 19.4285 | 19.8428 | 20.0784 | 20.1290 | 20.1240 | 19.9752 | 19.4470 | 18.8294 | 18.3431 | (93)         |

#### 8. Space heating requirement

|                      |           |           |           |           |          |          |          |          |          |          |           |           |       |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------|
| Utilisation          | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec       |       |
| Useful gains         | 524.4903  | 603.8956  | 676.5893  | 735.0327  | 718.2738 | 560.9335 | 382.0106 | 397.7604 | 542.2057 | 557.5973 | 512.2945  | 496.1902  | (95)  |
| Ext temp.            | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000  | 7.1000    | 4.2000    | (96)  |
| Heat loss rate W     | 1603.6615 | 1554.7584 | 1409.6140 | 1176.6090 | 907.5874 | 603.0878 | 388.4921 | 409.0123 | 649.8811 | 986.0785 | 1314.3554 | 1593.6587 | (97)  |
| Month fracti         | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000   | 1.0000    | 1.0000    | (97a) |
| Space heating kWh    | 802.9034  | 638.9798  | 545.3704  | 317.9349  | 140.8493 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 318.7900 | 577.4839  | 816.5166  | (98)  |
| Space heating        |           |           |           |           |          |          |          |          |          |          |           | 4158.8283 | (98)  |
| Space heating per m2 |           |           |           |           |          |          |          |          |          |          |           | 44.9457   | (99)  |

#### 8c. Space cooling requirement

Not applicable

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

#### 9a. Energy requirements - Individual heating systems, including micro-CHP

|                                                                       |          |          |          |          |          |          |          |          |          |          |          |           |                 |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------------|
| Fraction of space heat from secondary/supplementary system (Table 11) |          |          |          |          |          |          |          |          |          |          |          |           | 0.0000 (201)    |
| Fraction of space heat from main system(s)                            |          |          |          |          |          |          |          |          |          |          |          |           | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                      |          |          |          |          |          |          |          |          |          |          |          |           | 93.4000 (206)   |
| Efficiency of secondary/supplementary heating system, %               |          |          |          |          |          |          |          |          |          |          |          |           | 0.0000 (208)    |
| Space heating requirement                                             |          |          |          |          |          |          |          |          |          |          |          |           | 4452.7069 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec       |                 |
| Space heating requirement                                             | 802.9034 | 638.9798 | 545.3704 | 317.9349 | 140.8493 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 318.7900 | 577.4839 | 816.5166  | (98)            |
| Space heating efficiency (main heating system 1)                      | 93.4000  | 93.4000  | 93.4000  | 93.4000  | 93.4000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 93.4000  | 93.4000  | 93.4000   | (210)           |
| Space heating fuel (main heating system)                              | 859.6396 | 684.1326 | 583.9083 | 340.4014 | 150.8022 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 341.3169 | 618.2911 | 874.2148  | (211)           |
| Water heating requirement                                             | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (215)           |
| Water heating requirement                                             | 209.7568 | 184.9130 | 193.9163 | 171.9940 | 166.5205 | 146.6620 | 140.5133 | 156.6394 | 158.3693 | 180.3351 | 190.9324 | 204.7462  | (64)            |
| Efficiency of water heater (217)m                                     | 88.1046  | 87.9181  | 87.5128  | 86.5771  | 84.6330  | 80.3000  | 80.3000  | 80.3000  | 80.3000  | 86.4704  | 87.6604  | 88.1765   | (216)           |
| Fuel for water heating, kWh/month                                     | 238.0770 | 210.3242 | 221.5862 | 198.6598 | 196.7561 | 182.6425 | 174.9855 | 195.0678 | 197.2221 | 208.5511 | 217.8093 | 232.2004  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |          |          | 2473.8818 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |          |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |          |          | 4452.7069 | (211)           |
| Space heating fuel - secondary                                        |          |          |          |          |          |          |          |          |          |          |          | 0.0000    | (215)           |
| Electricity for pumps and fans:                                       |          |          |          |          |          |          |          |          |          |          |          |           |                 |
| central heating pump                                                  |          |          |          |          |          |          |          |          |          |          |          | 30.0000   | (230c)          |
| main heating flue fan                                                 |          |          |          |          |          |          |          |          |          |          |          | 45.0000   | (230e)          |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |          |          |          |          |          |          | 75.0000   | (231)           |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |          |          |          |          |          |          | 398.7358  | (232)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |          |          | 7400.3245 | (238)           |

#### 12a. Carbon dioxide 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                                                                     | 4452.7069          | 0.2160                        | 961.7847 (261)           |
| Space heating - secondary                                                                         | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                                                                        | 2473.8818          | 0.2160                        | 534.3585 (264)           |
| Space and water heating                                                                           |                    |                               | 1496.1432 (265)          |
| Pumps and fans                                                                                    | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                                                                               | 398.7358           | 0.5190                        | 206.9439 (268)           |
| Total CO2, kg/m2/year                                                                             |                    |                               | 1742.0120 (272)          |
| Emissions per m2 for space and water heating                                                      |                    |                               | 16.1693 (272a)           |
| Fuel factor (mains gas)                                                                           |                    |                               | 1.0000                   |
| Emissions per m2 for lighting                                                                     |                    |                               | 2.2365 (272b)            |
| Emissions per m2 for pumps and fans                                                               |                    |                               | 0.4207 (272c)            |
| Target Carbon Dioxide Emission Rate (TER) = (16.1693 * 1.00) + 2.2365 + 0.4207, rounded to 2 d.p. |                    |                               | 18.8300 (273)            |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                               |                 |                      |       |                             | 3 * 10 = 30.0000 (7a)      |
| Number of passive vents                                                   |                 |                      |       |                             | 0 * 10 = 0.0000 (7b)       |
| Number of flueless gas fires                                              |                 |                      |       |                             | 0 * 40 = 0.0000 (7c)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |       |                             | 30.0000 / (5) = 0.1354 (8) |
| Pressure test                                                             |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                      |                 |                      |       |                             | 4.6400                     |
| Infiltration rate                                                         |                 |                      |       |                             | 0.3674 (18)                |
| Number of sides sheltered                                                 |                 |                      |       |                             | 0 (19)                     |
| Shelter factor                                                            |                 |                      |       | (20) = 1 - [0.075 x (19)] = | 1.0000 (20)                |
| Infiltration rate adjusted to include shelter factor                      |                 |                      |       | (21) = (18) x (20) =        | 0.3674 (21)                |

  

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)  |
| Wind factor     | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a) |
| Adj infilt rate | 0.4685 | 0.4593 | 0.4501 | 0.4042 | 0.3950 | 0.3491 | 0.3491 | 0.3399 | 0.3674 | 0.3950 | 0.4134 | 0.4317 (22b) |
| Effective ac    | 0.6097 | 0.6055 | 0.6013 | 0.5817 | 0.5780 | 0.5609 | 0.5609 | 0.5578 | 0.5675 | 0.5780 | 0.5854 | 0.5932 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                        | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K       | A x K<br>kJ/K   |
|----------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------------|-----------------|
| Solid Door                                                     |                         |                            | 1.9600                    | 0.9000                        | 1.7640       |                                      | (26)            |
| Window (Uw = 1.40)                                             |                         |                            | 11.9400                   | 1.3258                        | 15.8295      |                                      | (27)            |
| French (Uw = 1.40)                                             |                         |                            | 3.1500                    | 1.3258                        | 4.1761       |                                      | (27)            |
| Half Glazed Door                                               |                         |                            | 1.8900                    | 1.3000                        | 2.4570       |                                      | (26a)           |
| Heat Loss Floor                                                |                         |                            | 46.7700                   | 0.1500                        | 7.0155       | 75.0000                              | 3507.7500 (28a) |
| 100mm Knauf Supafil                                            | 134.7300                | 18.9400                    | 115.7900                  | 0.2500                        | 28.9475      | 52.8000                              | 6113.7120 (29a) |
| External Plane Roof                                            | 45.7700                 |                            | 45.7700                   | 0.1300                        | 5.9501       | 9.0000                               | 411.9300 (30)   |
| Bay                                                            | 1.0100                  |                            | 1.0100                    | 0.2000                        | 0.2020       | 9.0000                               | 9.0900 (30)     |
| Total net area of external elements Aum(A, m <sup>2</sup> )    |                         |                            | 228.2800                  |                               |              |                                      | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                            |                         |                            |                           | (26)...(30) + (32) =          | 66.3418      |                                      | (33)            |
| GF Masonry                                                     |                         |                            | 41.2600                   |                               |              | 39.0000                              | 1609.1400 (32c) |
| GF Timber                                                      |                         |                            | 34.3700                   |                               |              | 9.0000                               | 309.3300 (32c)  |
| 1F Timber                                                      |                         |                            | 81.4300                   |                               |              | 9.0000                               | 732.8700 (32c)  |
| 1F Metal                                                       |                         |                            | 34.9000                   |                               |              | 20.0000                              | 698.0000 (32c)  |
| Internal Floor                                                 |                         |                            | 45.7600                   |                               |              | 18.0000                              | 823.6800 (32d)  |
| Internal Floor 1                                               |                         |                            | 45.7600                   |                               |              | 9.0000                               | 411.8400 (32e)  |
| Heat capacity Cm = Sum(A x k)                                  |                         |                            |                           |                               |              | (28)...(30) + (32) + (32a)...(32e) = | 14627.3420 (34) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K |                         |                            |                           |                               |              |                                      | 158.0822 (35)   |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)     |                         |                            |                           |                               |              |                                      | 8.1836 (36)     |
| Total fabric heat loss                                         |                         |                            |                           |                               |              | (33) + (36) =                        | 74.5254 (37)    |

  

|                                                                     |          |          |          |          |          |          |          |          |          |          |          |               |
|---------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m                                                               | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
| Heat transfer coeff                                                 | 44.5730  | 44.2615  | 43.9562  | 42.5221  | 42.2538  | 41.0048  | 41.0048  | 40.7735  | 41.4859  | 42.2538  | 42.7966  | 43.3641 (38)  |
| Average = Sum(39)m / 12 =                                           | 119.0984 | 118.7869 | 118.4816 | 117.0475 | 116.7792 | 115.5301 | 115.5301 | 115.2988 | 116.0112 | 116.7792 | 117.3220 | 117.8894 (39) |
|                                                                     |          |          |          |          |          |          |          |          |          |          |          | 117.0462 (39) |

  

|               |        |        |        |        |        |        |        |        |        |        |        |             |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec         |
| HLP (average) | 1.2871 | 1.2838 | 1.2805 | 1.2650 | 1.2621 | 1.2486 | 1.2486 | 1.2461 | 1.2538 | 1.2621 | 1.2679 | 1.2741 (40) |
| Days in month | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31 (41)     |

#### 4. Water heating energy requirements (kWh/year)

|                                          |     |     |     |     |     |     |     |     |     |     |     |              |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------|
| Assumed occupancy                        |     |     |     |     |     |     |     |     |     |     |     | 2.6588 (42)  |
| Average daily hot water use (litres/day) |     |     |     |     |     |     |     |     |     |     |     | 97.3463 (43) |
|                                          | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec          |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                              |          |          |          |          |          |          |         |          |          |          |             |                |
|----------------------------------------------|----------|----------|----------|----------|----------|----------|---------|----------|----------|----------|-------------|----------------|
| Daily hot water use                          | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055  | 87.6116  | 87.6116 | 91.5055  | 95.3993  | 99.2932  | 103.1870    | 107.0809 (44)  |
| Energy conte                                 | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903 | 103.4562 | 95.8674 | 110.0092 | 111.3231 | 129.7363 | 141.6173    | 153.7873 (45)  |
| Energy content (annual)                      |          |          |          |          |          |          |         |          |          | Total =  | Sum (45)m = | 1531.6359 (45) |
| Distribution loss (46)m = 0.15 x (45)m       | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000      | 0.0000 (46)    |
| Water storage loss:                          |          |          |          |          |          |          |         |          |          |          |             |                |
| Total storage loss                           | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000      | 0.0000 (56)    |
| If cylinder contains dedicated solar storage | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000      | 0.0000 (57)    |
| Primary loss                                 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000      | 0.0000 (59)    |
| Heat gains from water heating, kWh/month     | 33.7445  | 29.5132  | 30.4550  | 26.5514  | 25.4767  | 21.9844  | 20.3718 | 23.3770  | 23.6562  | 27.5690  | 30.0937     | 32.6798 (65)   |

#### 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                                                                               | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 22.5781   | 20.0536   | 16.3087   | 12.3467   | 9.2293    | 7.7918    | 8.4193    | 10.9437   | 14.6887   | 18.6506   | 21.7680   | 23.2056 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 243.6560  | 246.1844  | 239.8130  | 226.2489  | 209.1267  | 193.0342  | 182.2835  | 179.7551  | 186.1265  | 199.6906  | 216.8128  | 232.9053 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940 (69)   |
| Pumps, fans                                                                         | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 (71) |
| Water heating gains (Table 5)                                                       | 45.3556   | 43.9185   | 40.9341   | 36.8769   | 34.2429   | 30.5340   | 27.3815   | 31.4206   | 32.8558   | 37.0551   | 41.7968   | 43.9245 (72)   |
| Total internal gains                                                                | 374.4715  | 373.0384  | 359.9376  | 338.3544  | 315.4807  | 294.2418  | 280.9661  | 285.0013  | 296.5528  | 318.2782  | 343.2595  | 362.9172 (73)  |

#### 6. Solar gains

| [Jan]       |          |          |          | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c |          | Access<br>factor<br>Table 6d | Gains<br>W   |          |               |
|-------------|----------|----------|----------|------------|--------------------------------|-----------------------------------|------------------------------------|----------|------------------------------|--------------|----------|---------------|
|             |          |          |          |            |                                |                                   |                                    |          |                              |              |          |               |
| Northeast   |          |          |          | 4.8200     | 11.2829                        | 0.6200                            | 0.7000                             |          | 0.7700                       | 16.3566 (75) |          |               |
| South       |          |          |          | 0.6800     | 46.7521                        | 0.6200                            | 0.7000                             |          | 0.7700                       | 9.5616 (78)  |          |               |
| Southwest   |          |          |          | 5.7600     | 36.7938                        | 0.6200                            | 0.7000                             |          | 0.7700                       | 63.7412 (79) |          |               |
| West        |          |          |          | 0.6800     | 19.6403                        | 0.6200                            | 0.7000                             |          | 0.7700                       | 4.0168 (80)  |          |               |
| Northeast   |          |          |          | 3.1500     | 11.2829                        | 0.6200                            | 0.7000                             |          | 0.7700                       | 10.6895 (75) |          |               |
|             |          |          |          |            |                                |                                   |                                    |          |                              |              |          |               |
| Solar gains | 104.3657 | 187.1451 | 280.6328 | 388.3823   | 471.7586                       | 484.4059                          | 460.3435                           | 395.7528 | 317.6056                     | 213.4916     | 126.7205 | 88.2017 (83)  |
| Total gains | 478.8372 | 560.1835 | 640.5705 | 726.7367   | 787.2394                       | 778.6478                          | 741.3096                           | 680.7541 | 614.1585                     | 531.7698     | 469.9800 | 451.1189 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |         |                     |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Thl (C) |         |         |         |         |         |         |         |         |         |                     |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct                 | Nov     | Dec          |
| tau                                                                         | 34.1159 | 34.2054 | 34.2935 | 34.7137 | 34.7935 | 35.1696 | 35.1696 | 35.2402 | 35.0238 | 34.7935             | 34.6325 | 34.4658      |
| alpha                                                                       | 3.2744  | 3.2804  | 3.2862  | 3.3142  | 3.3196  | 3.3446  | 3.3446  | 3.3493  | 3.3349  | 3.3196              | 3.3088  | 3.2977       |
| util living area                                                            | 0.9928  | 0.9873  | 0.9751  | 0.9435  | 0.8741  | 0.7495  | 0.6100  | 0.6665  | 0.8591  | 0.9627              | 0.9883  | 0.9941 (86)  |
| MIT                                                                         | 18.9080 | 19.1195 | 19.4863 | 19.9846 | 20.4465 | 20.7826 | 20.9217 | 20.8929 | 20.6197 | 20.0228             | 19.3803 | 18.8755 (87) |
| Th 2                                                                        | 19.8509 | 19.8536 | 19.8562 | 19.8684 | 19.8707 | 19.8813 | 19.8813 | 19.8833 | 19.8772 | 19.8707             | 19.8660 | 19.8612 (88) |
| util rest of house                                                          | 0.9911  | 0.9843  | 0.9689  | 0.9280  | 0.8362  | 0.6688  | 0.4833  | 0.5440  | 0.8017  | 0.9496              | 0.9851  | 0.9927 (89)  |
| MIT 2                                                                       | 17.9469 | 18.1591 | 18.5245 | 19.0214 | 19.4592 | 19.7566 | 19.8523 | 19.8396 | 19.6294 | 19.0673             | 18.4289 | 17.9220 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA =   | Living area / (4) = |         | 0.1962 (91)  |
| MIT                                                                         | 18.1354 | 18.3475 | 18.7132 | 19.2103 | 19.6529 | 19.9578 | 20.0621 | 20.0463 | 19.8236 | 19.2547             | 18.6155 | 18.1090 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |                     |         | 0.0000       |
| adjusted MIT                                                                | 18.1354 | 18.3475 | 18.7132 | 19.2103 | 19.6529 | 19.9578 | 20.0621 | 20.0463 | 19.8236 | 19.2547             | 18.6155 | 18.1090 (93) |

#### 8. Space heating requirement

|                      |           |           |           |           |          |          |          |          |          |              |           |                |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|--------------|-----------|----------------|
| Utilisation          | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec            |
| Useful gains         | 0.9875    | 0.9789    | 0.9605    | 0.9166    | 0.8275   | 0.6750   | 0.5057   | 0.5640   | 0.7984   | 0.9400       | 0.9800    | 0.9897 (94)    |
| Ext temp.            | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000      | 7.1000    | 4.2000 (96)    |
| Heat loss rate W     | 1647.7796 | 1597.3879 | 1447.0362 | 1206.7966 | 928.7292 | 618.9917 | 399.9750 | 420.4089 | 664.0044 | 1010.6878    | 1351.0251 | 1639.7250 (97) |
| Month fracti         | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000       | 1.0000    | 1.0000 (97a)   |
| Space heating kWh    | 874.1339  | 704.9493  | 618.8305  | 389.2988  | 206.2881 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 380.0357     | 641.1286  | 887.7865 (98)  |
| Space heating        |           |           |           |           |          |          |          |          |          |              |           | 4702.4514 (98) |
| Space heating per m2 |           |           |           |           |          |          |          |          |          | (98) / (4) = |           | 50.8208 (99)   |

#### 8c. Space cooling requirement

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)



### CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

Calculated for June, July and August. See Table 10b

|                                          | Jan    | Feb    | Mar    | Apr    | May     | Jun       | Jul      | Aug      | Sep                      | Oct     | Nov    | Dec      |        |
|------------------------------------------|--------|--------|--------|--------|---------|-----------|----------|----------|--------------------------|---------|--------|----------|--------|
| Ext. temp.                               | 4.3000 | 4.9000 | 6.5000 | 8.9000 | 11.7000 | 14.6000   | 16.6000  | 16.4000  | 14.1000                  | 10.6000 | 7.1000 | 4.2000   |        |
| Heat loss rate W                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1085.9832 | 854.9229 | 876.2710 | 0.0000                   | 0.0000  | 0.0000 | 0.0000   | (100)  |
| Utilisation                              | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 0.7416    | 0.8142   | 0.7788   | 0.0000                   | 0.0000  | 0.0000 | 0.0000   | (101)  |
| Useful loss                              | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 805.3690  | 696.0732 | 682.4025 | 0.0000                   | 0.0000  | 0.0000 | 0.0000   | (102)  |
| Total gains                              | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1011.1003 | 965.3458 | 896.4267 | 0.0000                   | 0.0000  | 0.0000 | 0.0000   | (103)  |
| Month fracti                             | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1.0000    | 1.0000   | 1.0000   | 0.0000                   | 0.0000  | 0.0000 | 0.0000   | (103a) |
| Space cooling kWh                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 148.1265  | 200.3389 | 159.2340 | 0.0000                   | 0.0000  | 0.0000 | 0.0000   | (104)  |
| Space cooling                            |        |        |        |        |         |           |          |          |                          |         |        |          |        |
| Cooled fraction                          |        |        |        |        |         |           |          |          | fC = cooled area / (4) = |         |        | 507.6994 | (104)  |
| Intermittency factor (Table 10b)         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 0.2500    | 0.2500   | 0.2500   | 0.0000                   | 0.0000  | 0.0000 | 0.0000   | (105)  |
| Space cooling kWh                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 37.0316   | 50.0847  | 39.8085  | 0.0000                   | 0.0000  | 0.0000 | 0.0000   | (106)  |
| Space cooling                            |        |        |        |        |         |           |          |          |                          |         |        |          |        |
| Space cooling per m2                     |        |        |        |        |         |           |          |          |                          |         |        | 126.9248 | (107)  |
| Energy for space heating                 |        |        |        |        |         |           |          |          |                          |         |        | 1.3717   | (108)  |
| Energy for space cooling                 |        |        |        |        |         |           |          |          |                          |         |        | 50.8208  | (99)   |
| Total                                    |        |        |        |        |         |           |          |          |                          |         |        | 1.3717   | (108)  |
| Dwelling Fabric Energy Efficiency (DFEE) |        |        |        |        |         |           |          |          |                          |         |        | 52.1925  | (109)  |
|                                          |        |        |        |        |         |           |          |          |                          |         |        | 52.2     | (109)  |

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# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                                         | main<br>heating | secondary<br>heating | other | total                       | m <sup>3</sup> per hour    |
|-------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                      | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                    | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                             |                 |                      |       |                             | 3 * 10 = 30.0000 (7a)      |
| Number of passive vents                                                 |                 |                      |       |                             | 0 * 10 = 0.0000 (7b)       |
| Number of flueless gas fires                                            |                 |                      |       |                             | 0 * 40 = 0.0000 (7c)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) |                 |                      |       |                             | 30.0000 / (5) = 0.1354 (8) |
| Pressure test                                                           |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                    |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                       |                 |                      |       |                             | 0.3854 (18)                |
| Number of sides sheltered                                               |                 |                      |       |                             | 0 (19)                     |
| Shelter factor                                                          |                 |                      |       | (20) = 1 - [0.075 x (19)] = | 1.0000 (20)                |
| Infiltration rate adjusted to include shelter factor                    |                 |                      |       | (21) = (18) x (20) =        | 0.3854 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)  |
| Wind factor     | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a) |
| Adj infilt rate | 0.4914 | 0.4818 | 0.4721 | 0.4240 | 0.4143 | 0.3662 | 0.3662 | 0.3565 | 0.3854 | 0.4143 | 0.4336 | 0.4529 (22b) |
| Effective ac    | 0.6207 | 0.6161 | 0.6115 | 0.5899 | 0.5858 | 0.5670 | 0.5670 | 0.5636 | 0.5743 | 0.5858 | 0.5940 | 0.6025 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                        | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K |
|----------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|---------------|
| TER Opaque door                                                |                         |                            | 1.9600                    | 1.0000                        | 1.9600       |                                | (26)          |
| TER Semi-glazed door                                           |                         |                            | 1.8900                    | 1.2000                        | 2.2680       |                                | (26a)         |
| TER Opening Type (Uw = 1.40)                                   |                         |                            | 15.0900                   | 1.3258                        | 20.0057      |                                | (27)          |
| Heat Loss Floor                                                |                         |                            | 46.7700                   | 0.1300                        | 6.0801       |                                | (28a)         |
| 100mm Knauf Supafil                                            | 134.7300                | 18.9400                    | 115.7900                  | 0.1800                        | 20.8422      |                                | (29a)         |
| External Plane Roof                                            | 45.7700                 |                            | 45.7700                   | 0.1300                        | 5.9501       |                                | (30)          |
| Bay                                                            | 1.0100                  |                            | 1.0100                    | 0.1300                        | 0.1313       |                                | (30)          |
| Total net area of external elements Aum(A, m <sup>2</sup> )    |                         |                            | 228.2800                  |                               |              |                                | (31)          |
| Fabric heat loss, W/K = Sum (A x U)                            |                         |                            |                           | (26)...(30) + (32) =          | 57.2374      |                                | (33)          |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K |                         |                            |                           |                               |              |                                | 250.0000 (35) |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)     |                         |                            |                           |                               |              |                                | 11.3958 (36)  |
| Total fabric heat loss                                         |                         |                            |                           |                               |              | (33) + (36) =                  | 68.6332 (37)  |

|                                                                     |          |          |          |          |          |          |          |          |          |          |          |               |
|---------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m                                                               | 45.3782  | 45.0355  | 44.6995  | 43.1215  | 42.8262  | 41.4518  | 41.4518  | 41.1973  | 41.9812  | 42.8262  | 43.4235  | 44.0479 (38)  |
| Heat transfer coeff                                                 | 114.0114 | 113.6687 | 113.3327 | 111.7546 | 111.4594 | 110.0850 | 110.0850 | 109.8304 | 110.6144 | 111.4594 | 112.0567 | 112.6811 (39) |
| Average = Sum(39)m / 12 =                                           |          |          |          |          |          |          |          |          |          |          |          | 111.7532 (39) |
| HLP                                                                 | 1.2322   | 1.2285   | 1.2248   | 1.2078   | 1.2046   | 1.1897   | 1.1897   | 1.1870   | 1.1954   | 1.2046   | 1.2110   | 1.2178 (40)   |
| HLP (average)                                                       |          |          |          |          |          |          |          |          |          |          |          | 1.2078 (40)   |
| Days in month                                                       | 31       | 28       | 31       | 30       | 31       | 30       | 31       | 31       | 30       | 31       | 30       | 31 (41)       |

#### 4. Water heating energy requirements (kWh/year)

|                                          |          |          |          |          |          |          |         |          |          |                    |          |                |
|------------------------------------------|----------|----------|----------|----------|----------|----------|---------|----------|----------|--------------------|----------|----------------|
| Assumed occupancy                        |          |          |          |          |          |          |         |          |          |                    |          | 2.6588 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |          |         |          |          |                    |          | 97.3463 (43)   |
| Daily hot water use                      | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055  | 87.6116  | 87.6116 | 91.5055  | 95.3993  | 99.2932            | 103.1870 | 107.0809 (44)  |
| Energy conte                             | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903 | 103.4562 | 95.8674 | 110.0092 | 111.3231 | 129.7363           | 141.6173 | 153.7873 (45)  |
| Energy content (annual)                  |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1531.6359 (45) |
| Distribution loss (46)m = 0.15 x (45)m   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000   | 0.0000   | 0.0000             | 0.0000   | 0.0000 (46)    |
| Water storage loss:                      |          |          |          |          |          |          |         |          |          |                    |          |                |
| Total storage loss                       |          |          |          |          |          |          |         |          |          |                    |          |                |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                              |         |         |         |         |         |         |         |         |         |         |         |              |
|----------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| If cylinder contains dedicated solar storage | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000 (56)  |
| Primary loss                                 | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000 (57)  |
| Heat gains from water heating, kWh/month     | 33.7445 | 29.5132 | 30.4550 | 26.5514 | 25.4767 | 21.9844 | 20.3718 | 23.3770 | 23.6562 | 27.5690 | 30.0937 | 32.6798 (65) |

#### 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                                                                                 | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395  | 132.9395 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5       | 22.5781   | 20.0536   | 16.3087   | 12.3467   | 9.2293    | 7.7918    | 8.4193    | 10.9437   | 14.6887   | 18.6506   | 21.7680   | 23.2056 (67)   |
| Appliances gains (calculated in Appendix L13, equation L13 or L13a), also see Table 5 | 243.6560  | 246.1844  | 239.8130  | 226.2489  | 209.1267  | 193.0342  | 182.2835  | 179.7551  | 186.1265  | 199.6906  | 216.8128  | 232.9053 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5      | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940   | 36.2940 (69)   |
| Pumps, fans                                                                           | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                   | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 (71) |
| Water heating gains (Table 5)                                                         | 45.3556   | 43.9185   | 40.9341   | 36.8769   | 34.2429   | 30.5340   | 27.3815   | 31.4206   | 32.8558   | 37.0551   | 41.7968   | 43.9245 (72)   |
| Total internal gains                                                                  | 374.4715  | 373.0384  | 359.9376  | 338.3544  | 315.4807  | 294.2418  | 280.9661  | 285.0013  | 296.5528  | 318.2782  | 343.2595  | 362.9172 (73)  |

#### 6. Solar gains

| [Jan]     | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | Specific data<br>or Table 6b | Specific data<br>or Table 6c | FF     | Access<br>factor<br>Table 6d | Gains<br>W   |
|-----------|------------|--------------------------------|------------------------------|------------------------------|--------|------------------------------|--------------|
| Northeast | 7.9700     | 11.2829                        | 0.6300                       |                              | 0.7000 | 0.7700                       | 27.4823 (75) |
| South     | 0.6800     | 46.7521                        | 0.6300                       |                              | 0.7000 | 0.7700                       | 9.7159 (78)  |
| Southwest | 5.7600     | 36.7938                        | 0.6300                       |                              | 0.7000 | 0.7700                       | 64.7693 (79) |
| West      | 0.6800     | 19.6403                        | 0.6300                       |                              | 0.7000 | 0.7700                       | 4.0816 (80)  |

|             |          |          |          |          |          |          |          |          |          |          |          |               |
|-------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Solar gains | 106.0490 | 190.1636 | 285.1592 | 394.6465 | 479.3677 | 492.2189 | 467.7684 | 402.1359 | 322.7283 | 216.9350 | 128.7644 | 89.6243 (83)  |
| Total gains | 480.5206 | 563.2019 | 645.0968 | 733.0009 | 794.8484 | 786.4607 | 748.7345 | 687.1372 | 619.2811 | 535.2132 | 472.0239 | 452.5415 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |                           |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |                           |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep                       | Oct     | Nov     | Dec          |
| tau                                                                         | 56.3601 | 56.5300 | 56.6976 | 57.4982 | 57.6505 | 58.3703 | 58.3703 | 58.5056 | 58.0910                   | 57.6505 | 57.3433 | 57.0255      |
| alpha                                                                       | 4.7573  | 4.7687  | 4.7798  | 4.8332  | 4.8434  | 4.8914  | 4.8914  | 4.9004  | 4.8727                    | 4.8434  | 4.8229  | 4.8017       |
| util living area                                                            | 0.9989  | 0.9975  | 0.9930  | 0.9756  | 0.9182  | 0.7816  | 0.6175  | 0.6837  | 0.9036                    | 0.9871  | 0.9978  | 0.9992 (86)  |
| MIT                                                                         | 19.5760 | 19.7309 | 19.9959 | 20.3601 | 20.6917 | 20.9095 | 20.9778 | 20.9643 | 20.7950                   | 20.3660 | 19.9092 | 19.5554 (87) |
| Th 2                                                                        | 19.8944 | 19.8973 | 19.9002 | 19.9138 | 19.9163 | 19.9282 | 19.9282 | 19.9304 | 19.9236                   | 19.9163 | 19.9112 | 19.9058 (88) |
| util rest of house                                                          | 0.9986  | 0.9966  | 0.9903  | 0.9653  | 0.8819  | 0.6909  | 0.4817  | 0.5489  | 0.8456                    | 0.9800  | 0.9969  | 0.9989 (89)  |
| MIT 2                                                                       | 18.5962 | 18.7531 | 19.0192 | 19.3882 | 19.7004 | 19.8847 | 19.9224 | 19.9198 | 19.8024                   | 19.3999 | 18.9425 | 18.5847 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.1962 (91)  |
| MIT                                                                         | 18.7884 | 18.9449 | 19.2108 | 19.5788 | 19.8949 | 20.0857 | 20.1294 | 20.1246 | 19.9971                   | 19.5894 | 19.1321 | 18.7751 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | 0.0000       |
| adjusted MIT                                                                | 18.7884 | 18.9449 | 19.2108 | 19.5788 | 19.8949 | 20.0857 | 20.1294 | 20.1246 | 19.9971                   | 19.5894 | 19.1321 | 18.7751 (93) |

#### 8. Space heating requirement

|                      | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec            |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|--------------|-----------|----------------|
| Utilisation          | 0.9980    | 0.9955    | 0.9880    | 0.9612    | 0.8810   | 0.7058   | 0.5086   | 0.5754   | 0.8505   | 0.9771       | 0.9959    | 0.9985 (94)    |
| Useful gains         | 479.5620  | 560.6611  | 637.3663  | 704.5302  | 700.2494 | 555.0878 | 380.8240 | 395.4018 | 526.7157 | 522.9365     | 470.0766  | 451.8687 (95)  |
| Ext temp.            | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000      | 7.1000    | 4.2000 (96)    |
| Heat loss rate W     | 1651.8446 | 1596.4624 | 1440.5475 | 1193.4083 | 913.3955 | 603.8946 | 388.5390 | 409.0796 | 652.3011 | 1001.9539    | 1348.2767 | 1642.3376 (97) |
| Month fracti         | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000       | 1.0000    | 1.0000 (97a)   |
| Space heating kWh    | 872.1783  | 696.0585  | 597.5668  | 351.9923  | 158.5807 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 356.3889     | 632.3041  | 885.7088 (98)  |
| Space heating        |           |           |           |           |          |          |          |          |          |              |           | 4550.7784 (98) |
| Space heating per m2 |           |           |           |           |          |          |          |          |          | (98) / (4) = |           | 49.1817 (99)   |

#### 8c. Space cooling requirement

|                                                     |        |        |        |        |         |           |          |          |         |         |        |               |
|-----------------------------------------------------|--------|--------|--------|--------|---------|-----------|----------|----------|---------|---------|--------|---------------|
| Calculated for June, July and August. See Table 10b | Jan    | Feb    | Mar    | Apr    | May     | Jun       | Jul      | Aug      | Sep     | Oct     | Nov    | Dec           |
| Ext. temp.                                          | 4.3000 | 4.9000 | 6.5000 | 8.9000 | 11.7000 | 14.6000   | 16.6000  | 16.4000  | 14.1000 | 10.6000 | 7.1000 | 4.2000        |
| Heat loss rate W                                    | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1034.7987 | 814.6288 | 834.7114 | 0.0000  | 0.0000  | 0.0000 | 0.0000 (100)  |
| Utilisation                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 0.8243    | 0.8951   | 0.8618   | 0.0000  | 0.0000  | 0.0000 | 0.0000 (101)  |
| Useful loss                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 853.0064  | 729.1933 | 719.3494 | 0.0000  | 0.0000  | 0.0000 | 0.0000 (102)  |
| Total gains                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1020.2324 | 974.0243 | 903.8875 | 0.0000  | 0.0000  | 0.0000 | 0.0000 (103)  |
| Month fracti                                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1.0000    | 1.0000   | 1.0000   | 0.0000  | 0.0000  | 0.0000 | 0.0000 (103a) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)



### CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                        |        |        |        |        |         |          |          |          |                          |        |              |                |
|----------------------------------------|--------|--------|--------|--------|---------|----------|----------|----------|--------------------------|--------|--------------|----------------|
| Space cooling kWh                      | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 120.4027 | 182.1542 | 137.2963 | 0.0000                   | 0.0000 | 0.0000       | 0.0000 (104)   |
| Space cooling                          |        |        |        |        |         |          |          |          |                          |        |              | 439.8533 (104) |
| Cooled fraction                        |        |        |        |        |         |          |          |          | fC = cooled area / (4) = |        |              | 1.0000 (105)   |
| Intermittency factor (Table 10b)       |        |        |        |        |         |          |          |          |                          |        |              |                |
| 0.0000                                 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2500  | 0.2500   | 0.2500   | 0.0000   | 0.0000                   | 0.0000 | 0.0000 (106) |                |
| Space cooling kWh                      |        |        |        |        |         |          |          |          |                          |        |              |                |
| 0.0000                                 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 30.1007 | 45.5386  | 34.3241  | 0.0000   | 0.0000                   | 0.0000 | 0.0000 (107) |                |
| Space cooling                          |        |        |        |        |         |          |          |          |                          |        |              | 109.9633 (107) |
| Space cooling per m2                   |        |        |        |        |         |          |          |          |                          |        |              | 1.1884 (108)   |
| Energy for space heating               |        |        |        |        |         |          |          |          |                          |        |              | 49.1817 (99)   |
| Energy for space cooling               |        |        |        |        |         |          |          |          |                          |        |              | 1.1884 (108)   |
| Total                                  |        |        |        |        |         |          |          |          |                          |        |              | 50.3701 (109)  |
| Target Fabric Energy Efficiency (TFEE) |        |        |        |        |         |          |          |          |                          |        |              | 57.9 (109)     |

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# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF HEAT DEMAND 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
CALCULATION OF HEAT DEMAND 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                      |        |        |        |        |        |        |        |        |        | main heating                 | secondary heating | other  | total | m3 per hour |         |            |              |
|------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------------------------------|-------------------|--------|-------|-------------|---------|------------|--------------|
|                                                      |        |        |        |        |        |        |        |        |        | 0                            | +                 | 0      | +     | 0           | =       | 0 * 40 =   | 0.0000 (6a)  |
| Number of chimneys                                   |        |        |        |        |        |        |        |        |        | 0                            | +                 | 0      | +     | 0           | =       | 0 * 20 =   | 0.0000 (6b)  |
| Number of open flues                                 |        |        |        |        |        |        |        |        |        | 0                            | +                 | 0      | +     | 0           | =       | 4 * 10 =   | 40.0000 (7a) |
| Number of intermittent fans                          |        |        |        |        |        |        |        |        |        |                              |                   |        |       |             |         | 0 * 10 =   | 0.0000 (7b)  |
| Number of passive vents                              |        |        |        |        |        |        |        |        |        |                              |                   |        |       |             |         | 0 * 40 =   | 0.0000 (7c)  |
| Number of flueless gas fires                         |        |        |        |        |        |        |        |        |        |                              |                   |        |       |             |         |            |              |
|                                                      |        |        |        |        |        |        |        |        |        | Air changes per hour         |                   |        |       |             |         |            |              |
| Infiltration due to chimneys, flues and fans         |        |        |        |        |        |        |        |        |        | = (6a)+(6b)+(7a)+(7b)+(7c) = |                   |        |       | 40.0000     | / (5) = | 0.1806 (8) |              |
| Pressure test                                        |        |        |        |        |        |        |        |        |        | Yes                          |                   |        |       |             |         |            |              |
| Measured/design AP50                                 |        |        |        |        |        |        |        |        |        | 4.6400                       |                   |        |       |             |         |            |              |
| Infiltration rate                                    |        |        |        |        |        |        |        |        |        | 0.4126 (18)                  |                   |        |       |             |         |            |              |
| Number of sides sheltered                            |        |        |        |        |        |        |        |        |        | 0 (19)                       |                   |        |       |             |         |            |              |
| Shelter factor                                       |        |        |        |        |        |        |        |        |        | (20) = 1 - [0.075 x (19)] =  |                   |        |       | 1.0000 (20) |         |            |              |
| Infiltration rate adjusted to include shelter factor |        |        |        |        |        |        |        |        |        | (21) = (18) x (20) =         |                   |        |       | 0.4126 (21) |         |            |              |
|                                                      |        |        |        |        |        |        |        |        |        |                              |                   |        |       |             |         |            |              |
| Wind speed                                           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct                          | Nov               | Dec    |       |             |         |            |              |
|                                                      | 4.2000 | 3.9000 | 4.0000 | 3.8000 | 3.8000 | 3.7000 | 3.6000 | 3.5000 | 3.4000 | 3.7000                       | 3.5000            | 3.7000 | (22)  |             |         |            |              |
| Wind factor                                          | 1.0500 | 0.9750 | 1.0000 | 0.9500 | 0.9500 | 0.9250 | 0.9000 | 0.8750 | 0.8500 | 0.9250                       | 0.8750            | 0.9250 | (22a) |             |         |            |              |
| Adj infilt rate                                      | 0.4332 | 0.4023 | 0.4126 | 0.3919 | 0.3919 | 0.3816 | 0.3713 | 0.3610 | 0.3507 | 0.3816                       | 0.3610            | 0.3816 | (22b) |             |         |            |              |
| Effective ac                                         | 0.5938 | 0.5809 | 0.5851 | 0.5768 | 0.5768 | 0.5728 | 0.5689 | 0.5652 | 0.5615 | 0.5728                       | 0.5652            | 0.5728 | (25)  |             |         |            |              |

#### 3. Heat losses and heat loss parameter

| Element                                                             | Gross<br>m2 | Openings<br>m2 | NetArea<br>m2        | U-value<br>W/m2K | A x U<br>W/K | K-value<br>kJ/m2K                    | A x K<br>kJ/K |          |          |          |          |          |      |
|---------------------------------------------------------------------|-------------|----------------|----------------------|------------------|--------------|--------------------------------------|---------------|----------|----------|----------|----------|----------|------|
| Solid Door                                                          |             |                | 1.9600               | 0.9000           | 1.7640       |                                      |               | (26)     |          |          |          |          |      |
| Window (Uw = 1.40)                                                  |             |                | 11.9400              | 1.3258           | 15.8295      |                                      |               | (27)     |          |          |          |          |      |
| French (Uw = 1.40)                                                  |             |                | 3.1500               | 1.3258           | 4.1761       |                                      |               | (27)     |          |          |          |          |      |
| Half Glazed Door                                                    |             |                | 1.8900               | 1.3000           | 2.4570       |                                      |               | (26a)    |          |          |          |          |      |
| Heat Loss Floor                                                     |             |                | 46.7700              | 0.1500           | 7.0155       | 75.0000                              | 3507.7500     | (28a)    |          |          |          |          |      |
| 100mm Knauf Supafil                                                 | 134.7300    | 18.9400        | 115.7900             | 0.2500           | 28.9475      | 52.8000                              | 6113.7120     | (29a)    |          |          |          |          |      |
| External Plane Roof                                                 | 45.7700     |                | 45.7700              | 0.1300           | 5.9501       | 9.0000                               | 411.9300      | (30)     |          |          |          |          |      |
| Bay                                                                 | 1.0100      |                | 1.0100               | 0.2000           | 0.2020       | 9.0000                               | 9.0900        | (30)     |          |          |          |          |      |
| Total net area of external elements Aum(A, m2)                      |             |                | 228.2800             |                  |              |                                      |               | (31)     |          |          |          |          |      |
| Fabric heat loss, W/K = Sum (A x U)                                 |             |                | (26)...(30) + (32) = |                  | 66.3418      |                                      |               | (33)     |          |          |          |          |      |
| GF Masonry                                                          |             |                | 41.2600              |                  |              | 39.0000                              | 1609.1400     | (32c)    |          |          |          |          |      |
| GF Timber                                                           |             |                | 34.3700              |                  |              | 9.0000                               | 309.3300      | (32c)    |          |          |          |          |      |
| 1F Timber                                                           |             |                | 81.4300              |                  |              | 9.0000                               | 732.8700      | (32c)    |          |          |          |          |      |
| 1F Metal                                                            |             |                | 34.9000              |                  |              | 20.0000                              | 698.0000      | (32c)    |          |          |          |          |      |
| Internal Floor                                                      |             |                | 45.7600              |                  |              | 18.0000                              | 823.6800      | (32d)    |          |          |          |          |      |
| Internal Floor 1                                                    |             |                | 45.7600              |                  |              | 18.0000                              | 823.6800      | (32e)    |          |          |          |          |      |
| Heat capacity Cm = Sum(A x k)                                       |             |                |                      |                  |              | (28)...(30) + (32) + (32a)...(32e) = | 15039.1820    | (34)     |          |          |          |          |      |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |             |                |                      |                  |              |                                      | 162.5330      | (35)     |          |          |          |          |      |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |             |                |                      |                  |              |                                      | 8.1836        | (36)     |          |          |          |          |      |
| Total fabric heat loss                                              |             |                |                      |                  |              | (33) + (36) =                        | 74.5254       | (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                                                               | 43.4106     | 42.4657        | 42.7729              | 42.1663          | 42.1663      | 41.8746                              | 41.5908       | 41.3147  | 41.0464  | 41.8746  | 41.3147  | 41.8746  | (38) |
| Heat transfer coeff                                                 | 117.9359    | 116.9910       | 117.2982             | 116.6916         | 116.6916     | 116.4000                             | 116.1161      | 115.8401 | 115.5718 | 116.4000 | 115.8401 | 116.4000 | (39) |
| Average = Sum(39)m / 12 =                                           |             |                |                      |                  |              |                                      |               |          |          |          |          | 116.5147 | (39) |
|                                                                     | Jan         | Feb            | Mar                  | Apr              | May          | Jun                                  | Jul           | Aug      | Sep      | Oct      | Nov      | Dec      |      |
| HLP                                                                 | 1.2746      | 1.2644         | 1.2677               | 1.2611           | 1.2611       | 1.2580                               | 1.2549        | 1.2519   | 1.2490   | 1.2580   | 1.2519   | 1.2580   | (40) |
| HLP (average)                                                       |             |                |                      |                  |              |                                      |               |          |          |          |          | 1.2592   | (40) |
| Days in month                                                       | 31          | 28             | 31                   | 30               | 31           | 30                                   | 31            | 31       | 30       | 31       | 30       | 31       | (41) |

#### 4. Water heating energy requirements (kWh/year)

|                                          |     |     |     |     |     |     |     |     |     |     |     |              |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------|
| Assumed occupancy                        |     |     |     |     |     |     |     |     |     |     |     | 2.6588 (42)  |
| Average daily hot water use (litres/day) |     |     |     |     |     |     |     |     |     |     |     | 97.3463 (43) |
| Jan                                      | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |              |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF HEAT DEMAND 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Daily hot water use                                             | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055  | 87.6116  | 87.6116  | 91.5055  | 95.3993  | 99.2932  | 103.1870 | 107.0809 (44) |
| Energy conte                                                    | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903 | 103.4562 | 95.8674  | 110.0092 | 111.3231 | 129.7363 | 141.6173 | 153.7873 (45) |
| Energy content (annual)                                         |          |          |          |          |          |          |          |          |          |          |          |               |
| Distribution loss (46)m = 0.15 x (45)m                          | 23.8197  | 20.8328  | 21.4976  | 18.7422  | 17.9835  | 15.5184  | 14.3801  | 16.5014  | 16.6985  | 19.4604  | 21.2426  | 23.0681 (46)  |
| Water storage loss:                                             |          |          |          |          |          |          |          |          |          |          |          |               |
| Total storage loss                                              | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (56)   |
| If cylinder contains dedicated solar storage                    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (57)   |
| Combi loss                                                      | 21.0464  | 18.9901  | 20.9755  | 20.2193  | 20.8353  | 20.0965  | 20.7248  | 20.7964  | 20.1634  | 20.9175  | 20.3157  | 21.0249 (61)  |
| Total heat required for water heating calculated for each month |          |          |          |          |          |          |          |          |          |          |          |               |
| Solar input                                                     | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538 | 161.9330 | 174.8121 (62) |
| Solar input (sum of months) = Sum(63)m =                        | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63)   |
| Output from w/h                                                 | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538 | 161.9330 | 174.8121 (64) |
| RHI water heating demand                                        |          |          |          |          |          |          |          |          |          |          |          |               |
| Heat gains from water heating, kWh/month                        | 58.0619  | 50.9270  | 52.8970  | 46.5999  | 45.0724  | 39.4233  | 37.0571  | 41.7772  | 42.0558  | 48.3667  | 52.1667  | 56.3905 (65)  |
|                                                                 |          |          |          |          |          |          |          |          |          |          |          | 1778 (64)     |
|                                                                 |          |          |          |          |          |          |          |          |          |          |          | 1778 (64)     |

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

|                                                                                     |           |           |           |           |           |           |           |           |           |           |           |                |
|-------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| Metabolic gains (Table 5), Watts                                                    |           |           |           |           |           |           |           |           |           |           |           |                |
| (66)m                                                                               | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 56.4452   | 50.1341   | 40.7718   | 30.8669   | 23.0733   | 19.4795   | 21.0483   | 27.3594   | 36.7217   | 46.6266   | 54.4201   | 58.0140 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 363.6657  | 367.4394  | 357.9298  | 337.6849  | 312.1294  | 288.1108  | 272.0649  | 268.2912  | 277.8008  | 298.0457  | 323.6012  | 347.6198 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115 (69)   |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 (71) |
| Water heating gains (Table 5)                                                       | 78.0402   | 75.7842   | 71.0981   | 64.7221   | 60.5811   | 54.7546   | 49.8079   | 56.1521   | 58.4108   | 65.0090   | 72.4537   | 75.7937 (72)   |
| Total internal gains                                                                | 607.9384  | 603.1451  | 579.5870  | 543.0612  | 505.5712  | 472.1322  | 452.7084  | 461.5900  | 482.7206  | 519.4686  | 560.2624  | 591.2148 (73)  |

#### 6. Solar gains

|             |          |            |          |               |          |              |          |          |          |          |          |               |
|-------------|----------|------------|----------|---------------|----------|--------------|----------|----------|----------|----------|----------|---------------|
| [Jan]       |          |            |          |               |          |              |          |          |          |          |          |               |
|             | Area     | Solar flux | g        | FF            | Access   | Gains        |          |          |          |          |          |               |
|             | m2       | Table 6a   | W/m2     | Specific data | factor   | W            |          |          |          |          |          |               |
|             |          |            |          | or Table 6b   | Table 6c |              |          |          |          |          |          |               |
| Northeast   | 4.8200   | 14.6176    | 0.6200   | 0.7000        | 0.7700   | 21.1908 (75) |          |          |          |          |          |               |
| South       | 0.6800   | 56.7559    | 0.6200   | 0.7000        | 0.7700   | 11.6076 (78) |          |          |          |          |          |               |
| Southwest   | 5.7600   | 45.1778    | 0.6200   | 0.7000        | 0.7700   | 78.2656 (79) |          |          |          |          |          |               |
| West        | 0.6800   | 25.1925    | 0.6200   | 0.7000        | 0.7700   | 5.1523 (80)  |          |          |          |          |          |               |
| Northeast   | 3.1500   | 14.6176    | 0.6200   | 0.7000        | 0.7700   | 13.8488 (75) |          |          |          |          |          |               |
| Solar gains | 130.0651 | 199.2367   | 303.0864 | 424.7060      | 491.8483 | 549.0095     | 517.5092 | 454.9706 | 363.2818 | 245.7730 | 157.5652 | 107.9583 (83) |
| Total gains | 738.0035 | 802.3818   | 882.6734 | 967.7672      | 997.4195 | 1021.1417    | 970.2176 | 916.5606 | 846.0024 | 765.2416 | 717.8276 | 699.1731 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |         |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         |              |
| Jan                                                                         | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec     |              |
| tau                                                                         | 35.4222 | 35.7083 | 35.6148 | 35.7999 | 35.7999 | 35.8896 | 35.9773 | 36.0631 | 36.1468 | 35.8896 | 35.8896 |              |
| alpha                                                                       | 3.3615  | 3.3806  | 3.3743  | 3.3867  | 3.3867  | 3.3926  | 3.3985  | 3.4042  | 3.4098  | 3.3926  | 3.3926  |              |
| util living area                                                            | 0.9741  | 0.9648  | 0.9390  | 0.8790  | 0.7699  | 0.5877  | 0.4474  | 0.4694  | 0.7121  | 0.8924  | 0.9572  | 0.9772 (86)  |
| MIT                                                                         | 19.3949 | 19.5508 | 19.8917 | 20.3295 | 20.6943 | 20.9135 | 20.9743 | 20.9705 | 20.8280 | 20.4064 | 19.8641 | 19.3894 (87) |
| Th 2                                                                        | 19.8608 | 19.8689 | 19.8662 | 19.8714 | 19.8714 | 19.8739 | 19.8763 | 19.8787 | 19.8810 | 19.8739 | 19.8787 | 19.8739 (88) |
| util rest of house                                                          | 0.9682  | 0.9570  | 0.9249  | 0.8497  | 0.7119  | 0.4923  | 0.3270  | 0.3447  | 0.6264  | 0.8590  | 0.9458  | 0.9720 (89)  |
| MIT 2                                                                       | 17.7690 | 17.9981 | 18.4835 | 19.0958 | 19.5714 | 19.8146 | 19.8661 | 19.8667 | 19.7430 | 19.2157 | 18.4588 | 17.7698 (90) |
| Living area fraction                                                        | 18.0879 | 18.3027 | 18.7597 | 19.3378 | 19.7916 | 20.0301 | 20.0834 | 20.0832 | 19.9558 | 19.4493 | 18.7345 | 18.0875 (91) |
| MIT                                                                         | 18.0879 | 18.3027 | 18.7597 | 19.3378 | 19.7916 | 20.0301 | 20.0834 | 20.0832 | 19.9558 | 19.4493 | 18.7345 | 18.0875 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |         |         | -0.1500      |
| adjusted MIT                                                                | 17.9379 | 18.1527 | 18.6097 | 19.1878 | 19.6416 | 19.8801 | 19.9334 | 19.9332 | 19.8058 | 19.2993 | 18.5845 | 17.9375 (93) |

#### 8. Space heating requirement

|                   |           |           |           |           |          |          |          |          |          |          |           |                |
|-------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------|
| Utilisation       | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec            |
| Useful gains      | 704.0789  | 754.5547  | 798.0831  | 801.2706  | 696.6102 | 503.3175 | 323.4505 | 321.7427 | 524.4175 | 640.8736 | 665.9213  | 670.4505 (95)  |
| Ext temp.         | 4.9000    | 5.3000    | 7.0000    | 9.5000    | 12.5000  | 15.3000  | 17.1000  | 17.1000  | 14.7000  | 11.4000  | 7.9000    | 5.0000 (96)    |
| Heat loss rate W  | 1537.6395 | 1503.6477 | 1361.7970 | 1130.4863 | 833.3675 | 533.1253 | 329.0089 | 328.1993 | 590.0859 | 919.4740 | 1237.6915 | 1505.9248 (97) |
| Month fracti      | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000    | 1.0000 (97a)   |
| Space heating kWh | 620.1690  | 503.3905  | 419.4032  | 237.0354  | 101.7474 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 207.2787 | 411.6746  | 621.5929 (98)  |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)



### CALCULATION OF HEAT DEMAND 09 Jan 2014

Space heating  
RHI space heating demand

3122.2917 (98)  
3122 (98)

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# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF ENERGY RATINGS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
CALCULATION OF ENERGY RATINGS 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                                         | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|-------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                      | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                    | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                             |                 |                      |       |                             | 4 * 10 = 40.0000 (7a)      |
| Number of passive vents                                                 |                 |                      |       |                             | 0 * 10 = 0.0000 (7b)       |
| Number of flueless gas fires                                            |                 |                      |       |                             | 0 * 40 = 0.0000 (7c)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) |                 |                      |       |                             | 40.0000 / (5) = 0.1806 (8) |
| Pressure test                                                           |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                    |                 |                      |       |                             | 4.6400                     |
| Infiltration rate                                                       |                 |                      |       |                             | 0.4126 (18)                |
| Number of sides sheltered                                               |                 |                      |       |                             | 0 (19)                     |
| Shelter factor                                                          |                 |                      |       | (20) = 1 - [0.075 x (19)] = | 1.0000 (20)                |
| Infiltration rate adjusted to include shelter factor                    |                 |                      |       | (21) = (18) x (20) =        | 0.4126 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)  |
| Wind factor     | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.5260 | 0.5157 | 0.5054 | 0.4538 | 0.4435 | 0.3919 | 0.3919 | 0.3816 | 0.4126 | 0.4435 | 0.4641 | 0.4848 (22b) |
|                 | 0.6384 | 0.6330 | 0.6277 | 0.6030 | 0.5984 | 0.5768 | 0.5768 | 0.5728 | 0.5851 | 0.5984 | 0.6077 | 0.6175 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                     | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K   |
|-------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|-----------------|
| Solid Door                                                  |                         |                            | 1.9600                    | 0.9000                        | 1.7640       |                                | (26)            |
| Window (Uw = 1.40)                                          |                         |                            | 11.9400                   | 1.3258                        | 15.8295      |                                | (27)            |
| French (Uw = 1.40)                                          |                         |                            | 3.1500                    | 1.3258                        | 4.1761       |                                | (27)            |
| Half Glazed Door                                            |                         |                            | 1.8900                    | 1.3000                        | 2.4570       |                                | (26a)           |
| Heat Loss Floor                                             |                         |                            | 46.7700                   | 0.1500                        | 7.0155       | 75.0000                        | 3507.7500 (28a) |
| 100mm Knauf Supafil                                         | 134.7300                | 18.9400                    | 115.7900                  | 0.2500                        | 28.9475      | 52.8000                        | 6113.7120 (29a) |
| External Plane Roof                                         | 45.7700                 |                            | 45.7700                   | 0.1300                        | 5.9501       | 9.0000                         | 411.9300 (30)   |
| Bay                                                         | 1.0100                  |                            | 1.0100                    | 0.2000                        | 0.2020       | 9.0000                         | 9.0900 (30)     |
| Total net area of external elements Aum(A, m <sup>2</sup> ) |                         |                            | 228.2800                  |                               |              |                                | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                         |                         |                            |                           | (26)...(30) + (32) =          | 66.3418      |                                | (33)            |
| GF Masonry                                                  |                         |                            | 41.2600                   |                               |              | 39.0000                        | 1609.1400 (32c) |
| GF Timber                                                   |                         |                            | 34.3700                   |                               |              | 9.0000                         | 309.3300 (32c)  |
| 1F Timber                                                   |                         |                            | 81.4300                   |                               |              | 9.0000                         | 732.8700 (32c)  |
| 1F Metal                                                    |                         |                            | 34.9000                   |                               |              | 20.0000                        | 698.0000 (32c)  |
| Internal Floor                                              |                         |                            | 45.7600                   |                               |              | 18.0000                        | 823.6800 (32d)  |
| Internal Floor 1                                            |                         |                            | 45.7600                   |                               |              | 18.0000                        | 823.6800 (32e)  |

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 15039.1820 (34)  
Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K 162.5330 (35)  
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 8.1836 (36)  
Total fabric heat loss (33) + (36) = 74.5254 (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                     | 46.6652  | 46.2725  | 45.8875  | 44.0794  | 43.7411  | 42.1663  | 42.1663  | 41.8746  | 42.7729  | 43.7411  | 44.4254  | 45.1409 (38)  |
| Heat transfer coeff       | 121.1905 | 120.7978 | 120.4129 | 118.6047 | 118.2664 | 116.6916 | 116.6916 | 116.4000 | 117.2982 | 118.2664 | 118.9508 | 119.6663 (39) |
| Average = Sum(39)m / 12 = |          |          |          |          |          |          |          |          |          |          |          | 118.6031 (39) |
| HLP                       | 1.3097   | 1.3055   | 1.3013   | 1.2818   | 1.2781   | 1.2611   | 1.2611   | 1.2580   | 1.2677   | 1.2781   | 1.2855   | 1.2933 (40)   |
| HLP (average)             |          |          |          |          |          |          |          |          |          |          |          | 1.2818 (40)   |
| Days in month             | 31       | 28       | 31       | 30       | 31       | 30       | 31       | 31       | 30       | 31       | 30       | 31 (41)       |

#### 4. Water heating energy requirements (kWh/year)

|                                          |     |     |     |     |     |     |     |     |     |     |     |              |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------|
| Assumed occupancy                        |     |     |     |     |     |     |     |     |     |     |     | 2.6588 (42)  |
| Average daily hot water use (litres/day) |     |     |     |     |     |     |     |     |     |     |     | 97.3463 (43) |
| Jan                                      | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |              |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF ENERGY RATINGS 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |                     |          |                |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------------|----------|----------------|
| Daily hot water use                                             | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055  | 87.6116  | 87.6116  | 91.5055  | 95.3993  | 99.2932             | 103.1870 | 107.0809 (44)  |
| Energy conte                                                    | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903 | 103.4562 | 95.8674  | 110.0092 | 111.3231 | 129.7363            | 141.6173 | 153.7873 (45)  |
| Energy content (annual)                                         |          |          |          |          |          |          |          |          |          | Total = Sum (45)m = |          | 1531.6359 (45) |
| Distribution loss (46)m = 0.15 x (45)m                          | 23.8197  | 20.8328  | 21.4976  | 18.7422  | 17.9835  | 15.5184  | 14.3801  | 16.5014  | 16.6985  | 19.4604             | 21.2426  | 23.0681 (46)   |
| Water storage loss:                                             |          |          |          |          |          |          |          |          |          |                     |          |                |
| Total storage loss                                              | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000              | 0.0000   | 0.0000 (56)    |
| If cylinder contains dedicated solar storage                    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000              | 0.0000   | 0.0000 (57)    |
| Combi loss                                                      | 21.0464  | 18.9901  | 20.9755  | 20.2193  | 20.8353  | 20.0965  | 20.7248  | 20.7964  | 20.1634  | 20.9175             | 20.3157  | 21.0249 (61)   |
| Total heat required for water heating calculated for each month | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538            | 161.9330 | 174.8121 (62)  |
| Solar input                                                     | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000              | 0.0000   | 0.0000 (63)    |
| Solar input (sum of months) = Sum (63)m =                       |          |          |          |          |          |          |          |          |          |                     |          | 0.0000 (63)    |
| Output from w/h                                                 | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538            | 161.9330 | 174.8121 (64)  |
| Heat gains from water heating, kWh/month                        | 58.0619  | 50.9270  | 52.8970  | 46.5999  | 45.0724  | 39.4233  | 37.0571  | 41.7772  | 42.0558  | 48.3667             | 52.1667  | 56.3905 (65)   |
| Total per year (kWh/year) = Sum (64)m =                         |          |          |          |          |          |          |          |          |          |                     |          | 1777.7416 (64) |

#### 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                                                                               | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 56.4452   | 50.1341   | 40.7718   | 30.8669   | 23.0733   | 19.4795   | 21.0483   | 27.3594   | 36.7217   | 46.6266   | 54.4201   | 58.0140 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 363.6657  | 367.4394  | 357.9298  | 337.6849  | 312.1294  | 288.1108  | 272.0649  | 268.2912  | 277.8008  | 298.0457  | 323.6012  | 347.6198 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115 (69)   |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 (71) |
| Water heating gains (Table 5)                                                       | 78.0402   | 75.7842   | 71.0981   | 64.7221   | 60.5811   | 54.7546   | 49.8079   | 56.1521   | 58.4108   | 65.0090   | 72.4537   | 75.7937 (72)   |
| Total internal gains                                                                | 607.9384  | 603.1451  | 579.5870  | 543.0612  | 505.5712  | 472.1322  | 452.7084  | 461.5900  | 482.7206  | 519.4686  | 560.2624  | 591.2148 (73)  |

#### 6. Solar gains

| [Jan]       |          |          |          |          | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 |          | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d |          | Gains<br>W    |
|-------------|----------|----------|----------|----------|------------|--------------------------------|----------|-----------------------------------|------------------------------------|------------------------------|----------|---------------|
| -----       |          |          |          |          |            |                                |          |                                   |                                    |                              |          |               |
| Northeast   |          |          |          |          | 4.8200     | 11.2829                        |          | 0.6200                            | 0.7000                             | 0.7700                       |          | 16.3566 (75)  |
| South       |          |          |          |          | 0.6800     | 46.7521                        |          | 0.6200                            | 0.7000                             | 0.7700                       |          | 9.5616 (78)   |
| Southwest   |          |          |          |          | 5.7600     | 36.7938                        |          | 0.6200                            | 0.7000                             | 0.7700                       |          | 63.7412 (79)  |
| West        |          |          |          |          | 0.6800     | 19.6403                        |          | 0.6200                            | 0.7000                             | 0.7700                       |          | 4.0168 (80)   |
| Northeast   |          |          |          |          | 3.1500     | 11.2829                        |          | 0.6200                            | 0.7000                             | 0.7700                       |          | 10.6895 (75)  |
| -----       |          |          |          |          |            |                                |          |                                   |                                    |                              |          |               |
| Solar gains | 104.3657 | 187.1451 | 280.6328 | 388.3823 | 471.7586   | 484.4059                       | 460.3435 | 395.7528                          | 317.6056                           | 213.4916                     | 126.7205 | 88.2017 (83)  |
| Total gains | 712.3041 | 790.2902 | 860.2198 | 931.4435 | 977.3298   | 956.5381                       | 913.0520 | 857.3428                          | 800.3262                           | 732.9602                     | 686.9829 | 679.4165 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |                           |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |                           |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep                       | Oct     | Nov     | Dec          |
| tau                                                                         | 34.4709 | 34.5830 | 34.6936 | 35.2225 | 35.3232 | 35.7999 | 35.7999 | 35.8896 | 35.6148                   | 35.3232 | 35.1200 | 34.9100      |
| alpha                                                                       | 3.2981  | 3.3055  | 3.3129  | 3.3482  | 3.3549  | 3.3867  | 3.3867  | 3.3926  | 3.3743                    | 3.3549  | 3.3413  | 3.3273       |
| util living area                                                            | 0.9791  | 0.9691  | 0.9490  | 0.9026  | 0.8136  | 0.6690  | 0.5243  | 0.5702  | 0.7757                    | 0.9205  | 0.9682  | 0.9819 (86)  |
| MIT                                                                         | 19.2108 | 19.4082 | 19.7435 | 20.1928 | 20.5858 | 20.8541 | 20.9525 | 20.9363 | 20.7431                   | 20.2453 | 19.6592 | 19.1810 (87) |
| Th 2                                                                        | 19.8332 | 19.8365 | 19.8398 | 19.8551 | 19.8580 | 19.8714 | 19.8714 | 19.8739 | 19.8662                   | 19.8580 | 19.8522 | 19.8461 (88) |
| util rest of house                                                          | 0.9744  | 0.9622  | 0.9371  | 0.8785  | 0.7654  | 0.5829  | 0.4051  | 0.4514  | 0.7027                    | 0.8959  | 0.9599  | 0.9779 (89)  |
| MIT 2                                                                       | 17.4855 | 17.7723 | 18.2558 | 18.8984 | 19.4264 | 19.7564 | 19.8477 | 19.8392 | 19.6388                   | 18.9855 | 18.1484 | 17.4503 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.1962 (91)  |
| MIT                                                                         | 17.8239 | 18.0931 | 18.5476 | 19.1523 | 19.6539 | 19.9717 | 20.0644 | 20.0544 | 19.8554                   | 19.2326 | 18.4447 | 17.7898 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 17.6739 | 17.9431 | 18.3976 | 19.0023 | 19.5039 | 19.8217 | 19.9144 | 19.9044 | 19.7054                   | 19.0826 | 18.2947 | 17.6398 (93) |

#### 8. Space heating requirement

|                   | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct       | Nov       | Dec            |
|-------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|-----------|-----------|----------------|
| Utilisation       | 0.9616    | 0.9463    | 0.9171    | 0.8560    | 0.7478   | 0.7888   | 0.4100   | 0.4549   | 0.6906   | 0.8739    | 0.9438    | 0.9664 (94)    |
| Useful gains      | 684.9822  | 747.8563  | 788.8847  | 797.3441  | 730.8860 | 553.5985 | 374.3242 | 390.0266 | 552.7053 | 640.5039  | 648.3701  | 656.5549 (95)  |
| Ext temp.         | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000   | 7.1000    | 4.2000 (96)    |
| Heat loss rate W  | 1620.7949 | 1575.5837 | 1432.6241 | 1198.1809 | 922.9343 | 609.3328 | 386.7678 | 407.9171 | 657.5054 | 1003.2074 | 1331.6197 | 1608.2881 (97) |
| Month fracti      | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000    | 1.0000    | 1.0000 (97a)   |
| Space heating kWh | 696.2447  | 556.2328  | 478.9421  | 288.6025  | 142.8839 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 269.8514  | 491.9398  | 708.0895 (98)  |
| Space heating     |           |           |           |           |          |          |          |          |          |           |           | 3632.7867 (98) |

# FULL SAP CALCULATION PRINTOUT

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### CALCULATION OF ENERGY RATINGS 09 Jan 2014

Space heating per m2 (98) / (4) = 39.2606 (99)

8c. Space cooling requirement

Not applicable

#### 9a. Energy requirements - Individual heating systems, including micro-CHP

|                                                                       |          |          |          |          |          |          |          |          |          |           |          |           |                 |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|----------|-----------|-----------------|
| Fraction of space heat from secondary/supplementary system (Table 11) |          |          |          |          |          |          |          |          |          |           |          |           | 0.0000 (201)    |
| Fraction of space heat from main system(s)                            |          |          |          |          |          |          |          |          |          |           |          |           | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                      |          |          |          |          |          |          |          |          |          |           |          |           | 90.0000 (206)   |
| Efficiency of secondary/supplementary heating system, %               |          |          |          |          |          |          |          |          |          |           |          |           | 0.0000 (208)    |
| Space heating requirement                                             |          |          |          |          |          |          |          |          |          |           |          |           | 4036.4296 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 696.2447 | 556.2328 | 478.9421 | 288.6025 | 142.8839 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 269.8514  | 491.9398 | 708.0895  | (98)            |
| Space heating efficiency (main heating system 1)                      | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 90.0000   | 90.0000  | 90.0000   | (210)           |
| Space heating fuel (main heating system)                              | 773.6052 | 618.0364 | 532.1579 | 320.6695 | 158.7599 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 299.8349  | 546.5997 | 786.7661  | (211)           |
| Water heating requirement                                             | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000   | 0.0000    | (215)           |
| Water heating requirement                                             | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538  | 161.9330 | 174.8121  | (64)            |
| Efficiency of water heater (217)m                                     | 89.3022  | 89.2490  | 89.1335  | 88.8680  | 88.3317  | 86.7000  | 86.7000  | 86.7000  | 86.7000  | 88.7892   | 89.1596  | 86.7000   | (216)           |
| Fuel for water heating, kWh/month                                     | 201.3883 | 176.8936 | 184.3225 | 163.3512 | 159.3149 | 142.5060 | 134.4777 | 150.8716 | 151.6568 | 169.6758  | 181.6216 | 195.6995  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |           |          | 2011.7796 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |           |          | 4036.4296 | (211)           |
| Space heating fuel - secondary                                        |          |          |          |          |          |          |          |          |          |           |          | 0.0000    | (215)           |
| Electricity for pumps and fans:                                       |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| central heating pump                                                  |          |          |          |          |          |          |          |          |          |           |          | 30.0000   | (230c)          |
| main heating flue fan                                                 |          |          |          |          |          |          |          |          |          |           |          | 45.0000   | (230e)          |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |          |          |          |          |           |          | 75.0000   | (231)           |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |          |          |          |          |           |          | 398.7358  | (232)           |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| PV Unit 0 (0.80 * 0.81 * 1029 * 1.00) =                               |          |          |          |          |          |          |          |          |          | -666.9130 |          | -666.9130 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |           |          | 5855.0320 | (238)           |

#### 10a. Fuel costs - using Table 12 prices

|                                       | Fuel<br>kWh/year | Fuel price<br>p/kWh | Fuel cost<br>£/year |       |
|---------------------------------------|------------------|---------------------|---------------------|-------|
| Space heating - main system 1         | 4036.4296        | 3.4800              | 140.4678            | (240) |
| Space heating - secondary             | 0.0000           | 0.0000              | 0.0000              | (242) |
| Water heating (other fuel)            | 2011.7796        | 3.4800              | 70.0099             | (247) |
| Pumps and fans for heating            | 75.0000          | 13.1900             | 9.8925              | (249) |
| Energy for lighting                   | 398.7358         | 13.1900             | 52.5933             | (250) |
| Additional standing charges           |                  |                     | 120.0000            | (251) |
| Energy saving/generation technologies |                  |                     |                     |       |
| PV Unit                               | -666.9130        | 13.1900             | -87.9658            | (252) |
| Total energy cost                     |                  |                     | 304.9976            | (255) |

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

|                                  |                                         |         |       |
|----------------------------------|-----------------------------------------|---------|-------|
| Energy cost deflator (Table 12): |                                         | 0.4200  | (256) |
| Energy cost factor (ECF)         | $[(255) \times (256)] / [(4) + 45.0] =$ | 0.9314  | (257) |
| SAP value                        |                                         | 87.0066 |       |
| SAP rating (Section 12)          |                                         | 87      | (258) |
| SAP band                         |                                         | B       |       |

#### 12a. Carbon dioxide 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         | 4036.4296          | 0.2160                        | 871.8688                 | (261) |
| Space heating - secondary             | 0.0000             | 0.0000                        | 0.0000                   | (263) |
| Water heating (other fuel)            | 2011.7796          | 0.2160                        | 434.5444                 | (264) |
| Space and water heating               |                    |                               | 1306.4132                | (265) |
| Pumps and fans                        | 75.0000            | 0.5190                        | 38.9250                  | (267) |
| Energy for lighting                   | 398.7358           | 0.5190                        | 206.9439                 | (268) |
| Energy saving/generation technologies |                    |                               |                          |       |
| PV Unit                               | -666.9130          | 0.5190                        | -346.1278                | (269) |
| Total kg/year                         |                    |                               | 1206.1542                | (272) |
| CO2 emissions per m2                  |                    |                               | 13.0400                  | (273) |
| EI value                              |                    |                               | 88.2480                  |       |
| EI rating                             |                    |                               | 88                       | (274) |
| EI band                               |                    |                               | B                        |       |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)



CALCULATION OF ENERGY RATINGS 09 Jan 2014

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Calculation of stars for heating and DHW  
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|                                    |                                                                     |
|------------------------------------|---------------------------------------------------------------------|
| Main heating energy efficiency     | $3.48 \times (1 + 0.29 \times 0.00) / 0.9000 = 3.867$ , stars = 4   |
| Main heating environmental impact  | $0.216 \times (1 + 0.29 \times 0.00) / 0.9000 = 0.2400$ , stars = 4 |
| Water heating energy efficiency    | $3.48 / 0.8825 = 3.943$ , stars = 4                                 |
| Water heating environmental impact | $0.216 / 0.8825 = 0.2448$ , stars = 4                               |

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# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                      | main<br>heating              | +      | secondary<br>heating | +      | other  | =      | total                       | m3 per hour          |        |        |        |              |
|------------------------------------------------------|------------------------------|--------|----------------------|--------|--------|--------|-----------------------------|----------------------|--------|--------|--------|--------------|
| Number of chimneys                                   | 0                            | +      | 0                    | +      | 0      | =      | 0 * 40 =                    | 0.0000 (6a)          |        |        |        |              |
| Number of open flues                                 | 0                            | +      | 0                    | +      | 0      | =      | 0 * 20 =                    | 0.0000 (6b)          |        |        |        |              |
| Number of intermittent fans                          |                              |        |                      |        |        |        | 4 * 10 =                    | 40.0000 (7a)         |        |        |        |              |
| Number of passive vents                              |                              |        |                      |        |        |        | 0 * 10 =                    | 0.0000 (7b)          |        |        |        |              |
| Number of flueless gas fires                         |                              |        |                      |        |        |        | 0 * 40 =                    | 0.0000 (7c)          |        |        |        |              |
|                                                      |                              |        |                      |        |        |        |                             | Air changes per hour |        |        |        |              |
| Infiltration due to chimneys, flues and fans         | = (6a)+(6b)+(7a)+(7b)+(7c) = |        |                      |        |        |        | 40.0000 / (5) =             | 0.1806 (8)           |        |        |        |              |
| Pressure test                                        |                              |        |                      |        |        |        | Yes                         |                      |        |        |        |              |
| Measured/design AP50                                 |                              |        |                      |        |        |        |                             | 4.6400               |        |        |        |              |
| Infiltration rate                                    |                              |        |                      |        |        |        |                             | 0.4126 (18)          |        |        |        |              |
| Number of sides sheltered                            |                              |        |                      |        |        |        |                             | 0 (19)               |        |        |        |              |
| Shelter factor                                       |                              |        |                      |        |        |        | (20) = 1 - [0.075 x (19)] = | 1.0000 (20)          |        |        |        |              |
| Infiltration rate adjusted to include shelter factor |                              |        |                      |        |        |        | (21) = (18) x (20) =        | 0.4126 (21)          |        |        |        |              |
|                                                      | Jan                          | Feb    | Mar                  | Apr    | May    | Jun    | Jul                         | Aug                  | Sep    | Oct    | Nov    | Dec          |
| Wind speed                                           | 4.2000                       | 3.9000 | 4.0000               | 3.8000 | 3.8000 | 3.7000 | 3.6000                      | 3.5000               | 3.4000 | 3.7000 | 3.5000 | 3.7000 (22)  |
| Wind factor                                          | 1.0500                       | 0.9750 | 1.0000               | 0.9500 | 0.9500 | 0.9250 | 0.9000                      | 0.8750               | 0.8500 | 0.9250 | 0.8750 | 0.9250 (22a) |
| Adj infilt rate                                      | 0.4332                       | 0.4023 | 0.4126               | 0.3919 | 0.3919 | 0.3816 | 0.3713                      | 0.3610               | 0.3507 | 0.3816 | 0.3610 | 0.3816 (22b) |
| Effective ac                                         | 0.5938                       | 0.5809 | 0.5851               | 0.5768 | 0.5768 | 0.5728 | 0.5689                      | 0.5652               | 0.5615 | 0.5728 | 0.5652 | 0.5728 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                             | Gross<br>m2 | Openings<br>m2 | NetArea<br>m2 | U-value<br>W/m2K     | A x U<br>W/K | K-value<br>kJ/m2K                    | A x K<br>kJ/K   |          |          |          |          |               |
|---------------------------------------------------------------------|-------------|----------------|---------------|----------------------|--------------|--------------------------------------|-----------------|----------|----------|----------|----------|---------------|
| Solid Door                                                          |             |                | 1.9600        | 0.9000               | 1.7640       |                                      | (26)            |          |          |          |          |               |
| Window (Uw = 1.40)                                                  |             |                | 11.9400       | 1.3258               | 15.8295      |                                      | (27)            |          |          |          |          |               |
| French (Uw = 1.40)                                                  |             |                | 3.1500        | 1.3258               | 4.1761       |                                      | (27)            |          |          |          |          |               |
| Half Glazed Door                                                    |             |                | 1.8900        | 1.3000               | 2.4570       |                                      | (26a)           |          |          |          |          |               |
| Heat Loss Floor                                                     |             |                | 46.7700       | 0.1500               | 7.0155       | 75.0000                              | 3507.7500 (28a) |          |          |          |          |               |
| 100mm Knauf Supafil                                                 | 134.7300    | 18.9400        | 115.7900      | 0.2500               | 28.9475      | 52.8000                              | 6113.7120 (29a) |          |          |          |          |               |
| External Plane Roof                                                 | 45.7700     |                | 45.7700       | 0.1300               | 5.9501       | 9.0000                               | 411.9300 (30)   |          |          |          |          |               |
| Bay                                                                 | 1.0100      |                | 1.0100        | 0.2000               | 0.2020       | 9.0000                               | 9.0900 (30)     |          |          |          |          |               |
| Total net area of external elements Aum(A, m2)                      |             |                | 228.2800      |                      |              |                                      | (31)            |          |          |          |          |               |
| Fabric heat loss, W/K = Sum (A x U)                                 |             |                |               | (26)...(30) + (32) = | 66.3418      |                                      | (33)            |          |          |          |          |               |
| GF Masonry                                                          |             |                | 41.2600       |                      |              | 39.0000                              | 1609.1400 (32c) |          |          |          |          |               |
| GF Timber                                                           |             |                | 34.3700       |                      |              | 9.0000                               | 309.3300 (32c)  |          |          |          |          |               |
| 1F Timber                                                           |             |                | 81.4300       |                      |              | 9.0000                               | 732.8700 (32c)  |          |          |          |          |               |
| 1F Metal                                                            |             |                | 34.9000       |                      |              | 20.0000                              | 698.0000 (32c)  |          |          |          |          |               |
| Internal Floor                                                      |             |                | 45.7600       |                      |              | 18.0000                              | 823.6800 (32d)  |          |          |          |          |               |
| Internal Floor 1                                                    |             |                | 45.7600       |                      |              | 18.0000                              | 823.6800 (32e)  |          |          |          |          |               |
| Heat capacity Cm = Sum(A x k)                                       |             |                |               |                      |              | (28)...(30) + (32) + (32a)...(32e) = | 15039.1820 (34) |          |          |          |          |               |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |             |                |               |                      |              |                                      | 162.5330 (35)   |          |          |          |          |               |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |             |                |               |                      |              |                                      | 8.1836 (36)     |          |          |          |          |               |
| Total fabric heat loss                                              |             |                |               |                      |              | (33) + (36) =                        | 74.5254 (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                                                               | 43.4106     | 42.4657        | 42.7729       | 42.1663              | 42.1663      | 41.8746                              | 41.5908         | 41.3147  | 41.0464  | 41.8746  | 41.3147  | 41.8746 (38)  |
| Heat transfer coeff                                                 | 117.9359    | 116.9910       | 117.2982      | 116.6916             | 116.6916     | 116.4000                             | 116.1161        | 115.8401 | 115.5718 | 116.4000 | 115.8401 | 116.4000 (39) |
| Average = Sum(39)m / 12 =                                           |             |                |               |                      |              |                                      |                 |          |          |          |          | 116.5147 (39) |
|                                                                     | Jan         | Feb            | Mar           | Apr                  | May          | Jun                                  | Jul             | Aug      | Sep      | Oct      | Nov      | Dec           |
| HLP                                                                 | 1.2746      | 1.2644         | 1.2677        | 1.2611               | 1.2611       | 1.2580                               | 1.2549          | 1.2519   | 1.2490   | 1.2580   | 1.2519   | 1.2580 (40)   |
| HLP (average)                                                       |             |                |               |                      |              |                                      |                 |          |          |          |          | 1.2592 (40)   |
| Days in month                                                       | 31          | 28             | 31            | 30                   | 31           | 30                                   | 31              | 31       | 30       | 31       | 30       | 31 (41)       |

#### 4. Water heating energy requirements (kWh/year)

|                                          |     |     |     |     |     |     |     |     |     |     |     |              |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------|
| Assumed occupancy                        |     |     |     |     |     |     |     |     |     |     |     | 2.6588 (42)  |
| Average daily hot water use (litres/day) |     |     |     |     |     |     |     |     |     |     |     | 97.3463 (43) |
| Jan                                      | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |              |

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## Calculation Type: New Build (As Built)

### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |                |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| Daily hot water use                                             | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055  | 87.6116  | 87.6116  | 91.5055  | 95.3993  | 99.2932  | 103.1870 | 107.0809 (44)  |
| Energy conte                                                    | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903 | 103.4562 | 95.8674  | 110.0092 | 111.3231 | 129.7363 | 141.6173 | 153.7873 (45)  |
| Energy content (annual)                                         |          |          |          |          |          |          |          |          |          |          |          |                |
| Distribution loss (46)m = 0.15 x (45)m                          | 23.8197  | 20.8328  | 21.4976  | 18.7422  | 17.9835  | 15.5184  | 14.3801  | 16.5014  | 16.6985  | 19.4604  | 21.2426  | 23.0681 (46)   |
| Water storage loss:                                             |          |          |          |          |          |          |          |          |          |          |          |                |
| Total storage loss                                              | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (56)    |
| If cylinder contains dedicated solar storage                    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (57)    |
| Combi loss                                                      | 21.0464  | 18.9901  | 20.9755  | 20.2193  | 20.8353  | 20.0965  | 20.7248  | 20.7964  | 20.1634  | 20.9175  | 20.3157  | 21.0249 (61)   |
| Total heat required for water heating calculated for each month |          |          |          |          |          |          |          |          |          |          |          |                |
| Solar input                                                     | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538 | 161.9330 | 174.8121 (62)  |
| Solar input (sum of months) = Sum(63)m =                        | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63)    |
| Output from w/h                                                 | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538 | 161.9330 | 174.8121 (64)  |
| Heat gains from water heating, kWh/month                        | 58.0619  | 50.9270  | 52.8970  | 46.5999  | 45.0724  | 39.4233  | 37.0571  | 41.7772  | 42.0558  | 48.3667  | 52.1667  | 56.3905 (65)   |
| Total per year (kWh/year) = Sum(64)m =                          |          |          |          |          |          |          |          |          |          |          |          | 1777.7416 (64) |

#### 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                                                                               | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 56.4452   | 50.1341   | 40.7718   | 30.8669   | 23.0733   | 19.4795   | 21.0483   | 27.3594   | 36.7217   | 46.6266   | 54.4201   | 58.0140 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 363.6657  | 367.4394  | 357.9298  | 337.6849  | 312.1294  | 288.1108  | 272.0649  | 268.2912  | 277.8008  | 298.0457  | 323.6012  | 347.6198 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115 (69)   |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 (71) |
| Water heating gains (Table 5)                                                       | 78.0402   | 75.7842   | 71.0981   | 64.7221   | 60.5811   | 54.7546   | 49.8079   | 56.1521   | 58.4108   | 65.0090   | 72.4537   | 75.7937 (72)   |
| Total internal gains                                                                | 607.9384  | 603.1451  | 579.5870  | 543.0612  | 505.5712  | 472.1322  | 452.7084  | 461.5900  | 482.7206  | 519.4686  | 560.2624  | 591.2148 (73)  |

#### 6. Solar gains

| [Jan]       |          |          |          | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 |           | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d |          | Gains<br>W   |               |
|-------------|----------|----------|----------|------------|--------------------------------|-----------|-----------------------------------|------------------------------------|------------------------------|----------|--------------|---------------|
| Northeast   |          |          |          | 4.8200     | 14.6176                        |           | 0.6200                            | 0.7000                             | 0.7700                       |          | 21.1908 (75) |               |
| South       |          |          |          | 0.6800     | 56.7559                        |           | 0.6200                            | 0.7000                             | 0.7700                       |          | 11.6076 (78) |               |
| Southwest   |          |          |          | 5.7600     | 45.1778                        |           | 0.6200                            | 0.7000                             | 0.7700                       |          | 78.2656 (79) |               |
| West        |          |          |          | 0.6800     | 25.1925                        |           | 0.6200                            | 0.7000                             | 0.7700                       |          | 5.1523 (80)  |               |
| Northeast   |          |          |          | 3.1500     | 14.6176                        |           | 0.6200                            | 0.7000                             | 0.7700                       |          | 13.8488 (75) |               |
| Solar gains | 130.0651 | 199.2367 | 303.0864 | 424.7060   | 491.8483                       | 549.0095  | 517.5092                          | 454.9706                           | 363.2818                     | 245.7730 | 157.5652     | 107.9583 (83) |
| Total gains | 738.0035 | 802.3818 | 882.6734 | 967.7672   | 997.4195                       | 1021.1417 | 970.2176                          | 916.5606                           | 846.0024                     | 765.2416 | 717.8276     | 699.1731 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |                           |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |                           |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep                       | Oct     | Nov     | Dec          |
| tau                                                                         | 35.4222 | 35.7083 | 35.6148 | 35.7999 | 35.7999 | 35.8896 | 35.9773 | 36.0631 | 36.1468                   | 35.8896 | 36.0631 | 35.8896      |
| alpha                                                                       | 3.3615  | 3.3806  | 3.3743  | 3.3867  | 3.3867  | 3.3926  | 3.3985  | 3.4042  | 3.4098                    | 3.3926  | 3.4042  | 3.3926       |
| util living area                                                            | 0.9741  | 0.9648  | 0.9390  | 0.8790  | 0.7699  | 0.5877  | 0.4474  | 0.4694  | 0.7121                    | 0.8924  | 0.9572  | 0.9772 (86)  |
| MIT                                                                         | 19.3949 | 19.5508 | 19.8917 | 20.3295 | 20.6943 | 20.9135 | 20.9743 | 20.9705 | 20.8280                   | 20.4064 | 19.8641 | 19.3894 (87) |
| Th 2                                                                        | 19.8608 | 19.8689 | 19.8662 | 19.8714 | 19.8714 | 19.8739 | 19.8763 | 19.8787 | 19.8810                   | 19.8739 | 19.8787 | 19.8739 (88) |
| util rest of house                                                          | 0.9682  | 0.9570  | 0.9249  | 0.8497  | 0.7119  | 0.4923  | 0.3270  | 0.3447  | 0.6264                    | 0.8590  | 0.9458  | 0.9720 (89)  |
| MIT 2                                                                       | 17.7690 | 17.9981 | 18.4835 | 19.0958 | 19.5714 | 19.8146 | 19.8661 | 19.8667 | 19.7430                   | 19.2157 | 18.4588 | 17.7698 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.1962 (91)  |
| MIT                                                                         | 18.0879 | 18.3027 | 18.7597 | 19.3378 | 19.7916 | 20.0301 | 20.0834 | 20.0832 | 19.9558                   | 19.4493 | 18.7345 | 18.0875 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 17.9379 | 18.1527 | 18.6097 | 19.1878 | 19.6416 | 19.8801 | 19.9334 | 19.9332 | 19.8058                   | 19.2993 | 18.5845 | 17.9375 (93) |

#### 8. Space heating requirement

|                   |           |           |           |           |          |          |          |          |          |          |           |                |
|-------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------|
| Utilisation       | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec            |
| Useful gains      | 0.9540    | 0.9404    | 0.9042    | 0.8280    | 0.6984   | 0.4929   | 0.3334   | 0.3510   | 0.6199   | 0.8375   | 0.9277    | 0.9589 (94)    |
| Ext temp.         | 704.0789  | 754.5547  | 798.0831  | 801.2706  | 696.6102 | 503.3175 | 323.4505 | 321.7427 | 524.4175 | 640.8736 | 665.9213  | 670.4505 (95)  |
| Heat loss rate W  | 4.9000    | 5.3000    | 7.0000    | 9.5000    | 12.5000  | 15.3000  | 17.1000  | 17.1000  | 14.7000  | 11.4000  | 7.9000    | 5.0000 (96)    |
| Month fracti      | 1537.6395 | 1503.6477 | 1361.7970 | 1130.4863 | 833.3675 | 533.1253 | 329.0089 | 328.1993 | 590.0859 | 919.4740 | 1237.6915 | 1505.9248 (97) |
| Space heating kWh | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000    | 1.0000 (97a)   |
| Space heating     | 620.1690  | 503.3905  | 419.4032  | 237.0354  | 101.7474 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 207.2787 | 411.6746  | 621.5929 (98)  |
|                   |           |           |           |           |          |          |          |          |          |          |           | 3122.2917 (98) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

Space heating per m2 (98) / (4) = 33.7436 (99)

8c. Space cooling requirement

Not applicable

#### 9a. Energy requirements - Individual heating systems, including micro-CHP

|                                                                       |          |          |          |          |          |          |          |          |          |           |          |           |                 |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|----------|-----------|-----------------|
| Fraction of space heat from secondary/supplementary system (Table 11) |          |          |          |          |          |          |          |          |          |           |          |           | 0.0000 (201)    |
| Fraction of space heat from main system(s)                            |          |          |          |          |          |          |          |          |          |           |          |           | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                      |          |          |          |          |          |          |          |          |          |           |          |           | 90.0000 (206)   |
| Efficiency of secondary/supplementary heating system, %               |          |          |          |          |          |          |          |          |          |           |          |           | 0.0000 (208)    |
| Space heating requirement                                             |          |          |          |          |          |          |          |          |          |           |          |           | 3469.2130 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 620.1690 | 503.3905 | 419.4032 | 237.0354 | 101.7474 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 207.2787  | 411.6746 | 621.5929  | (98)            |
| Space heating efficiency (main heating system 1)                      | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 90.0000   | 90.0000  | 90.0000   | (210)           |
| Space heating fuel (main heating system)                              | 689.0767 | 559.3228 | 466.0035 | 263.3726 | 113.0527 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 230.3097  | 457.4162 | 690.6587  | (211)           |
| Water heating requirement                                             | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000   | 0.0000    | (215)           |
| Water heating requirement                                             | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256 | 123.5527 | 116.5921 | 130.8057 | 131.4865 | 150.6538  | 161.9330 | 174.8121  | (64)            |
| Efficiency of water heater (217)m                                     | 89.2365  | 89.1895  | 89.0460  | 88.7174  | 88.0548  | 86.7000  | 86.7000  | 86.7000  | 86.7000  | 88.5809   | 89.0432  | 86.7000   | (216)           |
| Fuel for water heating, kWh/month                                     | 201.5368 | 177.0116 | 184.5035 | 163.6284 | 159.8159 | 142.5060 | 134.4777 | 150.8716 | 151.6568 | 170.0749  | 181.8589 | 195.8585  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |           |          | 2013.8006 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |           |          | 3469.2130 | (211)           |
| Space heating fuel - secondary                                        |          |          |          |          |          |          |          |          |          |           |          | 0.0000    | (215)           |
| Electricity for pumps and fans:                                       |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| central heating pump                                                  |          |          |          |          |          |          |          |          |          |           |          | 30.0000   | (230c)          |
| main heating flue fan                                                 |          |          |          |          |          |          |          |          |          |           |          | 45.0000   | (230e)          |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |          |          |          |          |           |          | 75.0000   | (231)           |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |          |          |          |          |           |          | 398.7358  | (232)           |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| PV Unit 0 (0.80 * 0.81 * 1156 * 1.00) =                               |          |          |          |          |          |          |          |          |          | -749.2375 |          | -749.2375 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |           |          | 5207.5119 | (238)           |

#### 10a. Fuel costs - using BEDF prices (441)

|                                       | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |       |
|---------------------------------------|---------------|------------------|------------------|-------|
| Space heating - main system 1         | 3469.2130     | 3.9200           | 135.9931         | (240) |
| Space heating - secondary             | 0.0000        | 0.0000           | 0.0000           | (242) |
| Water heating (other fuel)            | 2013.8006     | 3.9200           | 78.9410          | (247) |
| Pumps and fans for heating            | 75.0000       | 16.9600          | 12.7200          | (249) |
| Energy for lighting                   | 398.7358      | 16.9600          | 67.6256          | (250) |
| Additional standing charges           |               |                  | 88.0000          | (251) |
| Energy saving/generation technologies |               |                  |                  |       |
| PV Unit                               | -749.2375     | 16.9600          | -127.0707        | (252) |
| Total energy cost                     |               |                  | 256.2090         | (255) |

#### 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|                                       | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |       |
|---------------------------------------|-----------------|----------------------------|-----------------------|-------|
| Space heating - main system 1         | 3469.2130       | 0.2160                     | 749.3500              | (261) |
| Space heating - secondary             | 0.0000          | 0.0000                     | 0.0000                | (263) |
| Water heating (other fuel)            | 2013.8006       | 0.2160                     | 434.9809              | (264) |
| Space and water heating               |                 |                            | 1184.3309             | (265) |
| Pumps and fans                        | 75.0000         | 0.5190                     | 38.9250               | (267) |
| Energy for lighting                   | 398.7358        | 0.5190                     | 206.9439              | (268) |
| Energy saving/generation technologies |                 |                            |                       |       |
| PV Unit                               | -749.2375       | 0.5190                     | -388.8543             | (269) |
| Total kg/year                         |                 |                            | 1041.3456             | (272) |

#### 13a. Primary energy - Individual heating systems including micro-CHP

|                               | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year |       |
|-------------------------------|-----------------|----------------------------------|-------------------------|-------|
| Space heating - main system 1 | 3469.2130       | 1.2200                           | 4232.4399               | (261) |
| Space heating - secondary     | 0.0000          | 0.0000                           | 0.0000                  | (263) |
| Water heating (other fuel)    | 2013.8006       | 1.2200                           | 2456.8367               | (264) |
| Space and water heating       |                 |                                  | 6689.2766               | (265) |
| Pumps and fans                | 75.0000         | 3.0700                           | 230.2500                | (267) |
| Energy for lighting           | 398.7358        | 3.0700                           | 1224.1189               | (268) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

|                                       |           |        |                  |
|---------------------------------------|-----------|--------|------------------|
| Energy saving/generation technologies |           |        |                  |
| PV Unit                               | -749.2375 | 3.0700 | -2300.1591 (269) |
| Primary energy kWh/year               |           |        | 5843.4864 (272)  |
| Primary energy kWh/m2/year            |           |        | 63.1523 (273)    |

#### SAP 2012 EPC IMPROVEMENTS

|                                      |      |
|--------------------------------------|------|
| Current energy efficiency rating:    | B 87 |
| Current environmental impact rating: | B 88 |

(For testing purposes):

|                             |                   |
|-----------------------------|-------------------|
| A                           | Not considered    |
| B                           | Not considered    |
| C                           | Not considered    |
| D                           | Not considered    |
| E Low energy lighting       | Already installed |
| F                           | Not considered    |
| G                           | Not considered    |
| H                           | Not considered    |
| I                           | Not considered    |
| J                           | Not considered    |
| K                           | Not considered    |
| M                           | Not considered    |
| N Solar water heating       | Recommended       |
| O                           | Not considered    |
| P                           | Not considered    |
| R                           | Not considered    |
| S                           | Not considered    |
| T                           | Not considered    |
| U Solar photovoltaic panels | Already installed |
| A2                          | Not considered    |
| A3                          | Not considered    |
| T2                          | Not considered    |
| W                           | Not considered    |
| X                           | Not considered    |
| Y                           | Not considered    |
| J2                          | Not considered    |
| Q2                          | Not considered    |
| Z1                          | Not considered    |
| Z2                          | Not considered    |
| Z3                          | Not considered    |
| Z4                          | Not considered    |
| Z5                          | Not considered    |
| V2 Wind turbine             | Not applicable    |
| L2                          | Not considered    |
| Q3                          | Not considered    |
| O3                          | Not considered    |

|                       |            |             |                 |
|-----------------------|------------|-------------|-----------------|
| Recommended measures: | SAP change | Cost change | CO2 change      |
| N Solar water heating | + 1.2      | -£ 32       | -195 kg (18.7%) |

| Recommended measures | Typical annual savings | Energy efficiency | Environmental impact |
|----------------------|------------------------|-------------------|----------------------|
| Solar water heating  | £32 2.11 kg/m²         | B 88              | B 90                 |
| Total Savings        | £32 2.11 kg/m²         |                   |                      |

|                                        |      |
|----------------------------------------|------|
| Potential energy efficiency rating:    | B 88 |
| Potential environmental impact rating: | B 90 |

Fuel prices for cost data on this page from database revision number 441 TEST (27 Mar 2019)  
Recommendation texts revision number 4.9c (22 Feb 2014)

Typical heating and lighting costs of this home (per year, Southern England):

|                          | Current    | Potential  | Saving     |
|--------------------------|------------|------------|------------|
| Electricity              | £80        | £89        | -£8        |
| Mains gas                | £303       | £263       | £40        |
| Space heating            | £237       | £237       | £0         |
| Water heating            | £79        | £47        | £32        |
| Lighting                 | £68        | £68        | £0         |
| Generated (PV)           | -£127      | -£127      | £0         |
| Total cost of fuels      | £256       | £225       | £32        |
| Total cost of uses       | £257       | £225       | £32        |
| Delivered energy         | 56 kWh/m²  | 46 kWh/m²  | 11 kWh/m²  |
| Carbon dioxide emissions | 1.0 tonnes | 0.8 tonnes | 0.2 tonnes |
| CO2 emissions per m²     | 11 kg/m²   | 9 kg/m²    | 2 kg/m²    |
| Primary energy           | 63 kWh/m²  | 51 kWh/m²  | 12 kWh/m²  |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                      |        |        |        |        |        |        |        |        |        | main<br>heating              | secondary<br>heating | other  | total | m3 per hour |         |          |              |
|------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------------------------------|----------------------|--------|-------|-------------|---------|----------|--------------|
| Number of chimneys                                   |        |        |        |        |        |        |        |        |        | 0                            | +                    | 0      | +     | 0           | =       | 0 * 40 = | 0.0000 (6a)  |
| Number of open flues                                 |        |        |        |        |        |        |        |        |        | 0                            | +                    | 0      | +     | 0           | =       | 0 * 20 = | 0.0000 (6b)  |
| Number of intermittent fans                          |        |        |        |        |        |        |        |        |        |                              |                      |        |       |             |         | 4 * 10 = | 40.0000 (7a) |
| Number of passive vents                              |        |        |        |        |        |        |        |        |        |                              |                      |        |       |             |         | 0 * 10 = | 0.0000 (7b)  |
| Number of flueless gas fires                         |        |        |        |        |        |        |        |        |        |                              |                      |        |       |             |         | 0 * 40 = | 0.0000 (7c)  |
|                                                      |        |        |        |        |        |        |        |        |        | Air changes per hour         |                      |        |       |             |         |          |              |
| Infiltration due to chimneys, flues and fans         |        |        |        |        |        |        |        |        |        | = (6a)+(6b)+(7a)+(7b)+(7c) = |                      |        |       |             | 40.0000 | / (5) =  | 0.1806 (8)   |
| Pressure test                                        |        |        |        |        |        |        |        |        |        | Yes                          |                      |        |       |             |         |          |              |
| Measured/design AP50                                 |        |        |        |        |        |        |        |        |        | 4.6400                       |                      |        |       |             |         |          |              |
| Infiltration rate                                    |        |        |        |        |        |        |        |        |        | 0.4126 (18)                  |                      |        |       |             |         |          |              |
| Number of sides sheltered                            |        |        |        |        |        |        |        |        |        | 0 (19)                       |                      |        |       |             |         |          |              |
| Shelter factor                                       |        |        |        |        |        |        |        |        |        | (20) = 1 - [0.075 x (19)] =  |                      |        |       |             | 1.0000  | (20)     |              |
| Infiltration rate adjusted to include shelter factor |        |        |        |        |        |        |        |        |        | (21) = (18) x (20) =         |                      |        |       |             | 0.4126  | (21)     |              |
|                                                      |        |        |        |        |        |        |        |        |        |                              |                      |        |       |             |         |          |              |
| Wind speed                                           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct                          | Nov                  | Dec    |       |             |         |          |              |
| Wind factor                                          | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000                       | 4.5000               | 4.7000 | (22)  |             |         |          |              |
| Adj infilt rate                                      | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750                       | 1.1250               | 1.1750 | (22a) |             |         |          |              |
|                                                      | 0.5260 | 0.5157 | 0.5054 | 0.4538 | 0.4435 | 0.3919 | 0.3919 | 0.3816 | 0.4126 | 0.4435                       | 0.4641               | 0.4848 | (22b) |             |         |          |              |
| Effective ac                                         | 0.6384 | 0.6330 | 0.6277 | 0.6030 | 0.5984 | 0.5768 | 0.5768 | 0.5728 | 0.5851 | 0.5984                       | 0.6077               | 0.6175 | (25)  |             |         |          |              |

#### 3. Heat losses and heat loss parameter

| Element                                                             | Gross<br>m2 | Openings<br>m2 | NetArea<br>m2 | U-value<br>W/m2K     | A x U<br>W/K | K-value<br>kJ/m2K                    | A x K<br>kJ/K   |          |          |          |          |               |
|---------------------------------------------------------------------|-------------|----------------|---------------|----------------------|--------------|--------------------------------------|-----------------|----------|----------|----------|----------|---------------|
| Solid Door                                                          |             |                | 1.9600        | 0.9000               | 1.7640       |                                      | (26)            |          |          |          |          |               |
| Window (Uw = 1.40)                                                  |             |                | 11.9400       | 1.3258               | 15.8295      |                                      | (27)            |          |          |          |          |               |
| French (Uw = 1.40)                                                  |             |                | 3.1500        | 1.3258               | 4.1761       |                                      | (27)            |          |          |          |          |               |
| Half Glazed Door                                                    |             |                | 1.8900        | 1.3000               | 2.4570       |                                      | (26a)           |          |          |          |          |               |
| Heat Loss Floor                                                     |             |                | 46.7700       | 0.1500               | 7.0155       | 75.0000                              | 3507.7500 (28a) |          |          |          |          |               |
| 100mm Knauf Supafil                                                 | 134.7300    | 18.9400        | 115.7900      | 0.2500               | 28.9475      | 52.8000                              | 6113.7120 (29a) |          |          |          |          |               |
| External Plane Roof                                                 | 45.7700     |                | 45.7700       | 0.1300               | 5.9501       | 9.0000                               | 411.9300 (30)   |          |          |          |          |               |
| Bay                                                                 | 1.0100      |                | 1.0100        | 0.2000               | 0.2020       | 9.0000                               | 9.0900 (30)     |          |          |          |          |               |
| Total net area of external elements Aum(A, m2)                      |             |                | 228.2800      |                      |              |                                      | (31)            |          |          |          |          |               |
| Fabric heat loss, W/K = Sum (A x U)                                 |             |                |               | (26)...(30) + (32) = | 66.3418      |                                      | (33)            |          |          |          |          |               |
| GF Masonry                                                          |             |                | 41.2600       |                      |              | 39.0000                              | 1609.1400 (32c) |          |          |          |          |               |
| GF Timber                                                           |             |                | 34.3700       |                      |              | 9.0000                               | 309.3300 (32c)  |          |          |          |          |               |
| 1F Timber                                                           |             |                | 81.4300       |                      |              | 9.0000                               | 732.8700 (32c)  |          |          |          |          |               |
| 1F Metal                                                            |             |                | 34.9000       |                      |              | 20.0000                              | 698.0000 (32c)  |          |          |          |          |               |
| Internal Floor                                                      |             |                | 45.7600       |                      |              | 18.0000                              | 823.6800 (32d)  |          |          |          |          |               |
| Internal Floor 1                                                    |             |                | 45.7600       |                      |              | 18.0000                              | 823.6800 (32e)  |          |          |          |          |               |
| Heat capacity Cm = Sum(A x k)                                       |             |                |               |                      |              | (28)...(30) + (32) + (32a)...(32e) = | 15039.1820 (34) |          |          |          |          |               |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |             |                |               |                      |              |                                      | 162.5330 (35)   |          |          |          |          |               |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |             |                |               |                      |              |                                      | 8.1836 (36)     |          |          |          |          |               |
| Total fabric heat loss                                              |             |                |               |                      |              | (33) + (36) =                        | 74.5254 (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                                                               | 46.6652     | 46.2725        | 45.8875       | 44.0794              | 43.7411      | 42.1663                              | 42.1663         | 41.8746  | 42.7729  | 43.7411  | 44.4254  | 45.1409 (38)  |
| Heat transfer coeff                                                 | 121.1905    | 120.7978       | 120.4129      | 118.6047             | 118.2664     | 116.6916                             | 116.6916        | 116.4000 | 117.2982 | 118.2664 | 118.9508 | 119.6663 (39) |
| Average = Sum(39)m / 12 =                                           |             |                |               |                      |              |                                      |                 |          |          |          |          | 118.6031 (39) |
|                                                                     | Jan         | Feb            | Mar           | Apr                  | May          | Jun                                  | Jul             | Aug      | Sep      | Oct      | Nov      | Dec           |
| HLP                                                                 | 1.3097      | 1.3055         | 1.3013        | 1.2818               | 1.2781       | 1.2611                               | 1.2611          | 1.2580   | 1.2677   | 1.2781   | 1.2855   | 1.2933 (40)   |
| HLP (average)                                                       |             |                |               |                      |              |                                      |                 |          |          |          |          | 1.2818 (40)   |
| Days in month                                                       | 31          | 28             | 31            | 30                   | 31           | 30                                   | 31              | 31       | 30       | 31       | 30       | 31 (41)       |

#### 4. Water heating energy requirements (kWh/year)

|                                          |     |     |     |     |     |     |     |     |     |     |     |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                                          |     |     |     |     |     |     |     |     |     |     |     |
| Assumed occupancy                        |     |     |     |     |     |     |     |     |     |     |     |
| 2.6588 (42)                              |     |     |     |     |     |     |     |     |     |     |     |
| Average daily hot water use (litres/day) |     |     |     |     |     |     |     |     |     |     |     |
| 97.3463 (43)                             |     |     |     |     |     |     |     |     |     |     |     |
| Jan                                      | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

|                                                                 |          |          |          |          |           |           |           |          |          |          |          |                 |
|-----------------------------------------------------------------|----------|----------|----------|----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------------|
| Daily hot water use                                             | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055   | 87.6116   | 87.6116   | 91.5055  | 95.3993  | 99.2932  | 103.1870 | 107.0809 (44)   |
| Energy conte                                                    | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903  | 103.4562  | 95.8674   | 110.0092 | 111.3231 | 129.7363 | 141.6173 | 153.7873 (45)   |
| Energy content (annual)                                         |          |          |          |          |           |           |           |          |          |          |          |                 |
| Distribution loss (46)m = 0.15 x (45)m                          |          |          |          |          |           |           |           |          |          |          |          |                 |
|                                                                 | 23.8197  | 20.8328  | 21.4976  | 18.7422  | 17.9835   | 15.5184   | 14.3801   | 16.5014  | 16.6985  | 19.4604  | 21.2426  | 23.0681 (46)    |
| Water storage loss:                                             |          |          |          |          |           |           |           |          |          |          |          |                 |
| Total storage loss                                              |          |          |          |          |           |           |           |          |          |          |          |                 |
|                                                                 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (56)     |
| If cylinder contains dedicated solar storage                    |          |          |          |          |           |           |           |          |          |          |          |                 |
|                                                                 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (57)     |
| Combi loss                                                      | 21.0464  | 18.9901  | 20.9755  | 20.2193  | 20.8353   | 20.0965   | 20.7248   | 20.7964  | 20.1634  | 20.9175  | 20.3157  | 21.0249 (61)    |
| Total heat required for water heating calculated for each month |          |          |          |          |           |           |           |          |          |          |          |                 |
|                                                                 | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256  | 123.5527  | 116.5921  | 130.8057 | 131.4865 | 150.6538 | 161.9330 | 174.8121 (62)   |
| Aperture area of solar collector                                |          |          |          |          |           |           |           |          |          |          |          |                 |
| Zero-loss collector efficiency                                  |          |          |          |          |           |           |           |          |          |          |          | 3.0000 (H1)     |
| Collector heat loss coefficient                                 |          |          |          |          |           |           |           |          |          |          |          | 0.7000 (H2)     |
| Collector 2nd order heat loss coefficient                       |          |          |          |          |           |           |           |          |          |          |          | 1.8000 (H3)     |
| Collector effective heat loss coefficient                       |          |          |          |          |           |           |           |          |          |          |          | 0.0050 (H3a)    |
| Collector performance ratio                                     |          |          |          |          |           |           |           |          |          |          |          | 1.8063 (H3b)    |
| Annual solar radiation per m2                                   |          |          |          |          |           |           |           |          |          |          |          | 2.5804 (H4)     |
| Overshading factor                                              |          |          |          |          |           |           |           |          |          |          |          | 1079.5246 (H5)  |
| Solar energy available                                          |          |          |          |          |           |           |           |          |          |          |          | 0.8000 (H6)     |
| Adjustment factor for showers                                   |          |          |          |          |           |           |           |          |          |          |          | 1813.6014 (H7)  |
| Solar-to-load ratio                                             |          |          |          |          |           |           |           |          |          |          |          | 1.0000 (H7a)    |
| Utilisation factor                                              |          |          |          |          |           |           |           |          |          |          |          | 1.1841 (H8)     |
| Collector performance factor                                    |          |          |          |          |           |           |           |          |          |          |          | 0.5702 (H9)     |
| Dedicated solar storage volume                                  |          |          |          |          |           |           |           |          |          |          |          | 0.8793 (H10)    |
| Effective solar volume                                          |          |          |          |          |           |           |           |          |          |          |          | 75.0000 (H11)   |
| Daily hot water demand                                          |          |          |          |          |           |           |           |          |          |          |          | 75.0000 (H13)   |
| Volume ratio Veff/V                                             |          |          |          |          |           |           |           |          |          |          |          | 97.3463 (H14)   |
| Solar storage volume factor                                     |          |          |          |          |           |           |           |          |          |          |          | 0.7704 (H15)    |
| Solar input                                                     |          |          |          |          |           |           |           |          |          |          |          | 0.9478 (H16)    |
| Solar input                                                     | -24.9941 | -41.7080 | -71.0334 | -95.1988 | -117.6101 | -115.6295 | -114.1014 | -99.6909 | -78.0780 | -53.3181 | -29.6466 | -861.9246 (H17) |
| Solar input (sum of months) = Sum (63)m =                       |          |          |          |          |           |           |           |          |          |          |          | -20.9158 (63)   |
|                                                                 |          |          |          |          |           |           |           |          |          |          |          | -861.9246 (63)  |
| Output from w/h                                                 |          |          |          |          |           |           |           |          |          |          |          |                 |
|                                                                 | 154.8502 | 116.1678 | 93.2596  | 49.9682  | 23.1155   | 7.9232    | 2.4908    | 31.1147  | 53.4085  | 97.3358  | 132.2864 | 153.8964 (64)   |
| Total per year (kWh/year) = Sum (64)m =                         |          |          |          |          |           |           |           |          |          |          |          | 915.8170 (64)   |
| Heat gains from water heating, kWh/month                        |          |          |          |          |           |           |           |          |          |          |          |                 |
|                                                                 | 58.0619  | 50.9270  | 52.8970  | 46.5999  | 45.0724   | 39.4233   | 37.0571   | 41.7772  | 42.0558  | 48.3667  | 52.1667  | 56.3905 (65)    |

#### 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                                                                               | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 56.4452   | 50.1341   | 40.7718   | 30.8669   | 23.0733   | 19.4795   | 21.0483   | 27.3594   | 36.7217   | 46.6266   | 54.4201   | 58.0140 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 363.6657  | 367.4394  | 357.9298  | 337.6849  | 312.1294  | 288.1108  | 272.0649  | 268.2912  | 277.8008  | 298.0457  | 323.6012  | 347.6198 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115 (69)   |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 (71) |
| Water heating gains (Table 5)                                                       |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 78.0402   | 75.7842   | 71.0981   | 64.7221   | 60.5811   | 54.7546   | 49.8079   | 56.1521   | 58.4108   | 65.0090   | 72.4537   | 75.7937 (72)   |
| Total internal gains                                                                |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 607.9384  | 603.1451  | 579.5870  | 543.0612  | 505.5712  | 472.1322  | 452.7084  | 461.5900  | 482.7206  | 519.4686  | 560.2624  | 591.2148 (73)  |

#### 6. Solar gains

|             |          |            |          |               |             |              |          |          |          |          |          |               |
|-------------|----------|------------|----------|---------------|-------------|--------------|----------|----------|----------|----------|----------|---------------|
| [Jan]       |          |            |          |               |             |              |          |          |          |          |          |               |
|             | Area     | Solar flux | g        | FF            | Access      | Gains        |          |          |          |          |          |               |
|             | m2       | Table 6a   | W/m2     | Specific data | factor      | W            |          |          |          |          |          |               |
|             |          |            |          | or Table 6b   | or Table 6c |              |          |          |          |          |          |               |
| Northeast   | 4.8200   | 11.2829    | 0.6200   | 0.7000        | 0.7700      | 16.3566 (75) |          |          |          |          |          |               |
| South       | 0.6800   | 46.7521    | 0.6200   | 0.7000        | 0.7700      | 9.5616 (78)  |          |          |          |          |          |               |
| Southwest   | 5.7600   | 36.7938    | 0.6200   | 0.7000        | 0.7700      | 63.7412 (79) |          |          |          |          |          |               |
| West        | 0.6800   | 19.6403    | 0.6200   | 0.7000        | 0.7700      | 4.0168 (80)  |          |          |          |          |          |               |
| Northeast   | 3.1500   | 11.2829    | 0.6200   | 0.7000        | 0.7700      | 10.6895 (75) |          |          |          |          |          |               |
| Solar gains | 104.3657 | 187.1451   | 280.6328 | 388.3823      | 471.7586    | 484.4059     | 460.3435 | 395.7528 | 317.6056 | 213.4916 | 126.7205 | 88.2017 (83)  |
| Total gains | 712.3041 | 790.2902   | 860.2198 | 931.4435      | 977.3298    | 956.5381     | 913.0520 | 857.3428 | 800.3262 | 732.9602 | 686.9829 | 679.4165 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |         |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         |              |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
| tau                                                                         | 34.4709 | 34.5830 | 34.6936 | 35.2225 | 35.3232 | 35.7999 | 35.7999 | 35.8896 | 35.6148 | 35.3232 | 35.1200 | 34.9100      |
| alpha                                                                       | 3.2981  | 3.3055  | 3.3129  | 3.3482  | 3.3549  | 3.3867  | 3.3867  | 3.3926  | 3.3743  | 3.3549  | 3.3413  | 3.3273       |
| util living area                                                            |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.9791  | 0.9691  | 0.9490  | 0.9026  | 0.8136  | 0.6690  | 0.5243  | 0.5702  | 0.7757  | 0.9205  | 0.9682  | 0.9819 (86)  |
| MIT                                                                         | 19.2108 | 19.4082 | 19.7435 | 20.1928 | 20.5858 | 20.8541 | 20.9525 | 20.9363 | 20.7431 | 20.2453 | 19.6592 | 19.1810 (87) |
| Th 2                                                                        | 19.8332 | 19.8365 | 19.8398 | 19.8551 | 19.8580 | 19.8714 | 19.8714 | 19.8739 | 19.8662 | 19.8580 | 19.8522 | 19.8461 (88) |
| util rest of house                                                          |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.9744  | 0.9622  | 0.9371  | 0.8785  | 0.7654  | 0.5829  | 0.4051  | 0.4514  | 0.7027  | 0.8959  | 0.9599  | 0.9779 (89)  |
| MIT 2                                                                       | 17.4855 | 17.7723 | 18.2558 | 18.8984 | 19.4264 | 19.7564 | 19.8477 | 19.8392 | 19.6388 | 18.9855 | 18.1484 | 17.4503 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         |         |         |         |              |
| MIT                                                                         | 17.8239 | 18.0931 | 18.5476 | 19.1523 | 19.6539 | 19.9717 | 20.0644 | 20.0544 | 19.8554 | 19.2326 | 18.4447 | 17.7898 (92) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

|                        |         |         |         |         |         |         |         |         |         |         |         |  |              |
|------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--|--------------|
| Temperature adjustment |         |         |         |         |         |         |         |         |         |         |         |  | -0.1500      |
| adjusted MIT           | 17.6739 | 17.9431 | 18.3976 | 19.0023 | 19.5039 | 19.8217 | 19.9144 | 19.9044 | 19.7054 | 19.0826 | 18.2947 |  | 17.6398 (93) |

#### 8. Space heating requirement

|                      | Jan       | Feb       | Mar       | Apr      | May      | Jun      | Jul      | Aug      | Sep       | Oct       | Nov          | Dec       |       |
|----------------------|-----------|-----------|-----------|----------|----------|----------|----------|----------|-----------|-----------|--------------|-----------|-------|
| Utilisation          | 0.9616    | 0.9463    | 0.9171    | 0.8560   | 0.7478   | 0.5788   | 0.4100   | 0.4549   | 0.6906    | 0.8739    | 0.9438       | 0.9664    | (94)  |
| Useful gains         | 684.9822  | 747.8563  | 788.8847  | 797.3441 | 730.8860 | 553.5985 | 374.3242 | 390.0266 | 552.7053  | 640.5039  | 648.3701     | 656.5549  | (95)  |
| Ext temp.            | 4.3000    | 4.9000    | 6.5000    | 8.9000   | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000   | 10.6000   | 7.1000       | 4.2000    | (96)  |
| Heat loss rate W     |           |           |           |          |          |          |          |          |           |           |              |           |       |
| 1620.7949            | 1575.5837 | 1432.6241 | 1198.1809 | 922.9343 | 609.3328 | 386.7678 | 407.9171 | 657.5054 | 1003.2074 | 1331.6197 | 1608.2881    | 1608.2881 | (97)  |
| Month fracti         | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 1.0000    | 1.0000       | 1.0000    | (97a) |
| Space heating kWh    | 696.2447  | 556.2328  | 478.9421  | 288.6025 | 142.8839 | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 269.8514  | 491.9398     | 708.0895  | (98)  |
| Space heating        |           |           |           |          |          |          |          |          |           |           |              | 3632.7867 | (98)  |
| Space heating per m2 |           |           |           |          |          |          |          |          |           |           | (98) / (4) = | 39.2606   | (99)  |

#### 8c. Space cooling requirement

Not applicable

#### 9a. Energy requirements - Individual heating systems, including micro-CHP

| Fraction of space heat from secondary/supplementary system (Table 11) |          |          |          |          |          |         |         |         |         |           |          |           | 0.0000 (201)    |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|---------|---------|---------|---------|-----------|----------|-----------|-----------------|
| Fraction of space heat from main system(s)                            |          |          |          |          |          |         |         |         |         |           |          |           | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                      |          |          |          |          |          |         |         |         |         |           |          |           | 90.0000 (206)   |
| Efficiency of secondary/supplementary heating system, %               |          |          |          |          |          |         |         |         |         |           |          |           | 0.0000 (208)    |
| Space heating requirement                                             |          |          |          |          |          |         |         |         |         |           |          |           | 4036.4296 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun     | Jul     | Aug     | Sep     | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 696.2447 | 556.2328 | 478.9421 | 288.6025 | 142.8839 | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 269.8514  | 491.9398 | 708.0895  | (98)            |
| Space heating efficiency (main heating system 1)                      | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 90.0000   | 90.0000  | 90.0000   | (210)           |
| Space heating fuel (main heating system)                              | 773.6052 | 618.0364 | 532.1579 | 320.6695 | 158.7599 | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 299.8349  | 546.5997 | 786.7661  | (211)           |
| Water heating requirement                                             | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000    | 0.0000   | 0.0000    | (215)           |
| Water heating                                                         |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| Water heating requirement                                             | 154.8502 | 116.1678 | 93.2596  | 49.9682  | 23.1155  | 7.9232  | 2.4908  | 31.1147 | 53.4085 | 97.3358   | 132.2864 | 153.8964  | (64)            |
| Efficiency of water heater (217)m                                     | 89.3810  | 89.4120  | 89.4451  | 89.4973  | 89.5255  | 86.7000 | 86.7000 | 86.7000 | 86.7000 | 89.1010   | 89.2799  | 86.7000   | (216)           |
| Fuel for water heating, kWh/month                                     | 173.2473 | 129.9241 | 104.2646 | 55.8321  | 25.8201  | 9.1386  | 2.8729  | 35.8878 | 61.6014 | 109.2421  | 148.1705 | 172.1580  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |         |         |         |         |           |          | 1028.1594 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |         |         |         |         |           |          | 4036.4296 | (211)           |
| Space heating fuel - secondary                                        |          |          |          |          |          |         |         |         |         |           |          | 0.0000    | (215)           |
| Electricity for pumps and fans:                                       |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| central heating pump                                                  |          |          |          |          |          |         |         |         |         |           |          | 30.0000   | (230c)          |
| main heating flue fan                                                 |          |          |          |          |          |         |         |         |         |           |          | 45.0000   | (230e)          |
| pump for solar water heating                                          |          |          |          |          |          |         |         |         |         |           |          | 50.0000   | (230g)          |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |         |         |         |         |           |          | 125.0000  | (231)           |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |         |         |         |         |           |          | 398.7358  | (232)           |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| PV Unit 0 (0.80 * 0.81 * 1029 * 1.00) =                               |          |          |          |          |          |         |         |         |         | -666.9130 |          | -666.9130 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |         |         |         |         |           |          | 4921.4118 | (238)           |

#### 10a. Fuel costs - using Table 12 prices

|                                       | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |       |
|---------------------------------------|---------------|------------------|------------------|-------|
| Space heating - main system 1         | 4036.4296     | 3.4800           | 140.4678         | (240) |
| Space heating - secondary             | 0.0000        | 0.0000           | 0.0000           | (242) |
| Water heating (other fuel)            | 1028.1594     | 3.4800           | 35.7799          | (247) |
| Pumps and fans for heating            | 75.0000       | 13.1900          | 9.8925           | (249) |
| Pump for solar water heating          | 50.0000       | 13.1900          | 6.5950           | (249) |
| Energy for lighting                   | 398.7358      | 13.1900          | 52.5933          | (250) |
| Additional standing charges           |               |                  | 120.0000         | (251) |
| Energy saving/generation technologies |               |                  |                  |       |
| PV Unit                               | -666.9130     | 13.1900          | -87.9658         | (252) |
| Total energy cost                     |               |                  | 277.3626         | (255) |

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

|                                  |  |                                  |              |
|----------------------------------|--|----------------------------------|--------------|
| Energy cost deflator (Table 12): |  |                                  | 0.4200 (256) |
| Energy cost factor (ECF)         |  | [(255) x (256)] / [(4) + 45.0] = | 0.8470 (257) |
| SAP value                        |  |                                  | 88.1839      |
| SAP rating (Section 12)          |  |                                  | 88 (258)     |
| SAP band                         |  |                                  | B            |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)



CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

12a. Carbon dioxide 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         | 4036.4296          | 0.2160                        | 871.8688                 | (261) |
| Space heating - secondary             | 0.0000             | 0.0000                        | 0.0000                   | (263) |
| Water heating (other fuel)            | 1028.1594          | 0.2160                        | 222.0824                 | (264) |
| Space and water heating               |                    |                               | 1093.9512                | (265) |
| Pumps and fans                        | 125.0000           | 0.5190                        | 64.8750                  | (267) |
| Energy for lighting                   | 398.7358           | 0.5190                        | 206.9439                 | (268) |
| Energy saving/generation technologies |                    |                               |                          |       |
| PV Unit                               | -666.9130          | 0.5190                        | -346.1278                | (269) |
| Total kg/year                         |                    |                               | 1019.6423                | (272) |
| CO2 emissions per m2                  |                    |                               | 11.0200                  | (273) |
| EI value                              |                    |                               | 90.0653                  |       |
| EI rating                             |                    |                               | 90                       | (274) |
| EI band                               |                    |                               | B                        |       |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Built) (Version 9.92, January 2014)  
 CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 46.7700 (1b)              | x 2.3100 (2b)                   | = 108.0387 (1b) - (3b)      |
| First floor                                            | 45.7600 (1c)              | x 2.4800 (2c)                   | = 113.4848 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.5300                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 221.5235 (5)              |

#### 2. Ventilation rate

|                                                      |  |  |  |  |  |  |  |  |  | main heating                 | secondary heating | other  | total  | m3 per hour |         |            |              |        |        |        |              |
|------------------------------------------------------|--|--|--|--|--|--|--|--|--|------------------------------|-------------------|--------|--------|-------------|---------|------------|--------------|--------|--------|--------|--------------|
|                                                      |  |  |  |  |  |  |  |  |  | 0                            | +                 | 0      | +      | 0           | =       | 0 * 40 =   | 0.0000 (6a)  |        |        |        |              |
| Number of chimneys                                   |  |  |  |  |  |  |  |  |  | 0                            | +                 | 0      | +      | 0           | =       | 0 * 20 =   | 0.0000 (6b)  |        |        |        |              |
| Number of open flues                                 |  |  |  |  |  |  |  |  |  | 0                            | +                 | 0      | +      | 0           | =       | 4 * 10 =   | 40.0000 (7a) |        |        |        |              |
| Number of intermittent fans                          |  |  |  |  |  |  |  |  |  |                              |                   |        |        |             |         | 0 * 10 =   | 0.0000 (7b)  |        |        |        |              |
| Number of passive vents                              |  |  |  |  |  |  |  |  |  |                              |                   |        |        |             |         | 0 * 40 =   | 0.0000 (7c)  |        |        |        |              |
| Number of flueless gas fires                         |  |  |  |  |  |  |  |  |  |                              |                   |        |        |             |         |            |              |        |        |        |              |
|                                                      |  |  |  |  |  |  |  |  |  | Air changes per hour         |                   |        |        |             |         |            |              |        |        |        |              |
| Infiltration due to chimneys, flues and fans         |  |  |  |  |  |  |  |  |  | = (6a)+(6b)+(7a)+(7b)+(7c) = |                   |        |        | 40.0000     | / (5) = | 0.1806 (8) |              |        |        |        |              |
| Pressure test                                        |  |  |  |  |  |  |  |  |  | Yes                          |                   |        |        |             |         |            |              |        |        |        |              |
| Measured/design AP50                                 |  |  |  |  |  |  |  |  |  | 4.6400                       |                   |        |        |             |         |            |              |        |        |        |              |
| Infiltration rate                                    |  |  |  |  |  |  |  |  |  | 0.4126 (18)                  |                   |        |        |             |         |            |              |        |        |        |              |
| Number of sides sheltered                            |  |  |  |  |  |  |  |  |  | 0 (19)                       |                   |        |        |             |         |            |              |        |        |        |              |
| Shelter factor                                       |  |  |  |  |  |  |  |  |  | (20) = 1 - [0.075 x (19)] =  |                   |        |        | 1.0000 (20) |         |            |              |        |        |        |              |
| Infiltration rate adjusted to include shelter factor |  |  |  |  |  |  |  |  |  | (21) = (18) x (20) =         |                   |        |        | 0.4126 (21) |         |            |              |        |        |        |              |
|                                                      |  |  |  |  |  |  |  |  |  |                              |                   |        |        |             |         |            |              |        |        |        |              |
| Wind speed                                           |  |  |  |  |  |  |  |  |  | Jan                          | Feb               | Mar    | Apr    | May         | Jun     | Jul        | Aug          | Sep    | Oct    | Nov    | Dec          |
| Wind factor                                          |  |  |  |  |  |  |  |  |  | 4.2000                       | 3.9000            | 4.0000 | 3.8000 | 3.8000      | 3.7000  | 3.6000     | 3.5000       | 3.4000 | 3.7000 | 3.5000 | 3.7000 (22)  |
| Adj infilt rate                                      |  |  |  |  |  |  |  |  |  | 1.0500                       | 0.9750            | 1.0000 | 0.9500 | 0.9500      | 0.9250  | 0.9000     | 0.8750       | 0.8500 | 0.9250 | 0.8750 | 0.9250 (22a) |
|                                                      |  |  |  |  |  |  |  |  |  | 0.4332                       | 0.4023            | 0.4126 | 0.3919 | 0.3919      | 0.3816  | 0.3713     | 0.3610       | 0.3507 | 0.3816 | 0.3610 | 0.3816 (22b) |
| Effective ac                                         |  |  |  |  |  |  |  |  |  | 0.5938                       | 0.5809            | 0.5851 | 0.5768 | 0.5768      | 0.5728  | 0.5689     | 0.5652       | 0.5615 | 0.5728 | 0.5652 | 0.5728 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                             | Gross<br>m2 | Openings<br>m2 | NetArea<br>m2        | U-value<br>W/m2K | A x U<br>W/K | K-value<br>kJ/m2K                    | A x K<br>kJ/K |          |          |          |          |          |      |
|---------------------------------------------------------------------|-------------|----------------|----------------------|------------------|--------------|--------------------------------------|---------------|----------|----------|----------|----------|----------|------|
| Solid Door                                                          |             |                | 1.9600               | 0.9000           | 1.7640       |                                      |               | (26)     |          |          |          |          |      |
| Window (Uw = 1.40)                                                  |             |                | 11.9400              | 1.3258           | 15.8295      |                                      |               | (27)     |          |          |          |          |      |
| French (Uw = 1.40)                                                  |             |                | 3.1500               | 1.3258           | 4.1761       |                                      |               | (27)     |          |          |          |          |      |
| Half Glazed Door                                                    |             |                | 1.8900               | 1.3000           | 2.4570       |                                      |               | (26a)    |          |          |          |          |      |
| Heat Loss Floor                                                     |             |                | 46.7700              | 0.1500           | 7.0155       | 75.0000                              | 3507.7500     | (28a)    |          |          |          |          |      |
| 100mm Knauf Supafil                                                 | 134.7300    | 18.9400        | 115.7900             | 0.2500           | 28.9475      | 52.8000                              | 6113.7120     | (29a)    |          |          |          |          |      |
| External Plane Roof                                                 | 45.7700     |                | 45.7700              | 0.1300           | 5.9501       | 9.0000                               | 411.9300      | (30)     |          |          |          |          |      |
| Bay                                                                 | 1.0100      |                | 1.0100               | 0.2000           | 0.2020       | 9.0000                               | 9.0900        | (30)     |          |          |          |          |      |
| Total net area of external elements Aum(A, m2)                      |             |                | 228.2800             |                  |              |                                      |               | (31)     |          |          |          |          |      |
| Fabric heat loss, W/K = Sum (A x U)                                 |             |                | (26)...(30) + (32) = |                  | 66.3418      |                                      |               | (33)     |          |          |          |          |      |
| GF Masonry                                                          |             |                | 41.2600              |                  |              | 39.0000                              | 1609.1400     | (32c)    |          |          |          |          |      |
| GF Timber                                                           |             |                | 34.3700              |                  |              | 9.0000                               | 309.3300      | (32c)    |          |          |          |          |      |
| 1F Timber                                                           |             |                | 81.4300              |                  |              | 9.0000                               | 732.8700      | (32c)    |          |          |          |          |      |
| 1F Metal                                                            |             |                | 34.9000              |                  |              | 20.0000                              | 698.0000      | (32c)    |          |          |          |          |      |
| Internal Floor                                                      |             |                | 45.7600              |                  |              | 18.0000                              | 823.6800      | (32d)    |          |          |          |          |      |
| Internal Floor 1                                                    |             |                | 45.7600              |                  |              | 18.0000                              | 823.6800      | (32e)    |          |          |          |          |      |
| Heat capacity Cm = Sum(A x k)                                       |             |                |                      |                  |              | (28)...(30) + (32) + (32a)...(32e) = | 15039.1820    | (34)     |          |          |          |          |      |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |             |                |                      |                  |              |                                      | 162.5330      | (35)     |          |          |          |          |      |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |             |                |                      |                  |              |                                      | 8.1836        | (36)     |          |          |          |          |      |
| Total fabric heat loss                                              |             |                |                      |                  |              | (33) + (36) =                        | 74.5254       | (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                                                               | 43.4106     | 42.4657        | 42.7729              | 42.1663          | 42.1663      | 41.8746                              | 41.5908       | 41.3147  | 41.0464  | 41.8746  | 41.3147  | 41.8746  | (38) |
| Heat transfer coeff                                                 | 117.9359    | 116.9910       | 117.2982             | 116.6916         | 116.6916     | 116.4000                             | 116.1161      | 115.8401 | 115.5718 | 116.4000 | 115.8401 | 116.4000 | (39) |
| Average = Sum(39)m / 12 =                                           |             |                |                      |                  |              |                                      |               |          |          |          |          | 116.5147 | (39) |
|                                                                     | Jan         | Feb            | Mar                  | Apr              | May          | Jun                                  | Jul           | Aug      | Sep      | Oct      | Nov      | Dec      |      |
| HLP                                                                 | 1.2746      | 1.2644         | 1.2677               | 1.2611           | 1.2611       | 1.2580                               | 1.2549        | 1.2519   | 1.2490   | 1.2580   | 1.2519   | 1.2580   | (40) |
| HLP (average)                                                       |             |                |                      |                  |              |                                      |               |          |          |          |          | 1.2592   | (40) |
| Days in month                                                       | 31          | 28             | 31                   | 30               | 31           | 30                                   | 31            | 31       | 30       | 31       | 30       | 31       | (41) |

#### 4. Water heating energy requirements (kWh/year)

|                                          |     |     |     |     |     |     |     |     |     |     |     |              |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------|
| Assumed occupancy                        |     |     |     |     |     |     |     |     |     |     |     | 2.6588 (42)  |
| Average daily hot water use (litres/day) |     |     |     |     |     |     |     |     |     |     |     | 97.3463 (43) |
| Jan                                      | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |              |

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### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

|                                                                 |          |          |          |          |           |           |           |           |          |          |          |                 |
|-----------------------------------------------------------------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|----------|----------|----------|-----------------|
| Daily hot water use                                             | 107.0809 | 103.1870 | 99.2932  | 95.3993  | 91.5055   | 87.6116   | 87.6116   | 91.5055   | 95.3993  | 99.2932  | 103.1870 | 107.0809 (44)   |
| Energy conte                                                    | 158.7979 | 138.8856 | 143.3175 | 124.9477 | 119.8903  | 103.4562  | 95.8674   | 110.0092  | 111.3231 | 129.7363 | 141.6173 | 153.7873 (45)   |
| Energy content (annual)                                         |          |          |          |          |           |           |           |           |          |          |          |                 |
| Distribution loss (46)m = 0.15 x (45)m                          |          |          |          |          |           |           |           |           |          |          |          |                 |
|                                                                 | 23.8197  | 20.8328  | 21.4976  | 18.7422  | 17.9835   | 15.5184   | 14.3801   | 16.5014   | 16.6985  | 19.4604  | 21.2426  | 23.0681 (46)    |
| Water storage loss:                                             |          |          |          |          |           |           |           |           |          |          |          |                 |
| Total storage loss                                              |          |          |          |          |           |           |           |           |          |          |          |                 |
|                                                                 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (56)     |
| If cylinder contains dedicated solar storage                    |          |          |          |          |           |           |           |           |          |          |          |                 |
|                                                                 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (57)     |
| Combi loss                                                      | 21.0464  | 18.9901  | 20.9755  | 20.2193  | 20.8353   | 20.0965   | 20.7248   | 20.7964   | 20.1634  | 20.9175  | 20.3157  | 21.0249 (61)    |
| Total heat required for water heating calculated for each month |          |          |          |          |           |           |           |           |          |          |          |                 |
|                                                                 | 179.8443 | 157.8758 | 164.2930 | 145.1670 | 140.7256  | 123.5527  | 116.5921  | 130.8057  | 131.4865 | 150.6538 | 161.9330 | 174.8121 (62)   |
| Aperture area of solar collector                                |          |          |          |          |           |           |           |           |          |          |          |                 |
| Zero-loss collector efficiency                                  |          |          |          |          |           |           |           |           |          |          |          | 3.0000 (H1)     |
| Collector heat loss coefficient                                 |          |          |          |          |           |           |           |           |          |          |          | 0.7000 (H2)     |
| Collector 2nd order heat loss coefficient                       |          |          |          |          |           |           |           |           |          |          |          | 1.8000 (H3)     |
| Collector effective heat loss coefficient                       |          |          |          |          |           |           |           |           |          |          |          | 0.0050 (H3a)    |
| Collector performance ratio                                     |          |          |          |          |           |           |           |           |          |          |          | 1.8063 (H3b)    |
| Annual solar radiation per m2                                   |          |          |          |          |           |           |           |           |          |          |          | 2.5804 (H4)     |
| Overshading factor                                              |          |          |          |          |           |           |           |           |          |          |          | 1208.1510 (H5)  |
| Solar energy available                                          |          |          |          |          |           |           |           |           |          |          |          | 0.8000 (H6)     |
| Adjustment factor for showers                                   |          |          |          |          |           |           |           |           |          |          |          | 2029.6937 (H7)  |
| Solar-to-load ratio                                             |          |          |          |          |           |           |           |           |          |          |          | 1.0000 (H7a)    |
| Utilisation factor                                              |          |          |          |          |           |           |           |           |          |          |          | 1.3252 (H8)     |
| Collector performance factor                                    |          |          |          |          |           |           |           |           |          |          |          | 0.5298 (H9)     |
| Dedicated solar storage volume                                  |          |          |          |          |           |           |           |           |          |          |          | 0.8793 (H10)    |
| Effective solar volume                                          |          |          |          |          |           |           |           |           |          |          |          | 75.0000 (H11)   |
| Daily hot water demand                                          |          |          |          |          |           |           |           |           |          |          |          | 75.0000 (H13)   |
| Volume ratio Veff/V                                             |          |          |          |          |           |           |           |           |          |          |          | 97.3463 (H14)   |
| Solar storage volume factor                                     |          |          |          |          |           |           |           |           |          |          |          | 0.7704 (H15)    |
| Solar input                                                     |          |          |          |          |           |           |           |           |          |          |          | 0.9478 (H16)    |
| Solar input                                                     | -29.2372 | -41.5734 | -71.4547 | -96.4089 | -113.2381 | -120.9561 | -118.4124 | -105.9827 | -82.9771 | -57.3675 | -34.5799 | -896.2294 (H17) |
| Solar input (sum of months) = Sum (63)m =                       |          |          |          |          |           |           |           |           |          |          |          | -896.2294 (63)  |
| Output from w/h                                                 |          |          |          |          |           |           |           |           |          |          |          |                 |
|                                                                 | 150.6071 | 116.3024 | 92.8384  | 48.7581  | 27.4876   | 2.5965    | 0.0000    | 24.8230   | 48.5093  | 93.2863  | 127.3531 | 150.7707 (64)   |
| Total per year (kWh/year) = Sum (64)m =                         |          |          |          |          |           |           |           |           |          |          |          | 883.3325 (64)   |
| Heat gains from water heating, kWh/month                        |          |          |          |          |           |           |           |           |          |          |          |                 |
|                                                                 | 58.0619  | 50.9270  | 52.8970  | 46.5999  | 45.0724   | 39.4233   | 37.0571   | 41.7772   | 42.0558  | 48.3667  | 52.1667  | 56.3905 (65)    |

#### 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                                                                               | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274  | 159.5274 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 56.4452   | 50.1341   | 40.7718   | 30.8669   | 23.0733   | 19.4795   | 21.0483   | 27.3594   | 36.7217   | 46.6266   | 54.4201   | 58.0140 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 363.6657  | 367.4394  | 357.9298  | 337.6849  | 312.1294  | 288.1108  | 272.0649  | 268.2912  | 277.8008  | 298.0457  | 323.6012  | 347.6198 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115   | 53.6115 (69)   |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 | -106.3516 (71) |
| Water heating gains (Table 5)                                                       |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 78.0402   | 75.7842   | 71.0981   | 64.7221   | 60.5811   | 54.7546   | 49.8079   | 56.1521   | 58.4108   | 65.0090   | 72.4537   | 75.7937 (72)   |
| Total internal gains                                                                |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 607.9384  | 603.1451  | 579.5870  | 543.0612  | 505.5712  | 472.1322  | 452.7084  | 461.5900  | 482.7206  | 519.4686  | 560.2624  | 591.2148 (73)  |

#### 6. Solar gains

|             |          |            |             |               |          |              |          |          |          |          |          |               |
|-------------|----------|------------|-------------|---------------|----------|--------------|----------|----------|----------|----------|----------|---------------|
| [Jan]       |          |            |             |               |          |              |          |          |          |          |          |               |
|             | Area     | Solar flux | g           | FF            | Access   | Gains        |          |          |          |          |          |               |
|             | m2       | Table 6a   | or Table 6b | Specific data | factor   | W            |          |          |          |          |          |               |
|             |          | W/m2       |             | or Table 6c   | Table 6d |              |          |          |          |          |          |               |
| Northeast   | 4.8200   | 14.6176    | 0.6200      | 0.7000        | 0.7700   | 21.1908 (75) |          |          |          |          |          |               |
| South       | 0.6800   | 56.7559    | 0.6200      | 0.7000        | 0.7700   | 11.6076 (78) |          |          |          |          |          |               |
| Southwest   | 5.7600   | 45.1778    | 0.6200      | 0.7000        | 0.7700   | 78.2656 (79) |          |          |          |          |          |               |
| West        | 0.6800   | 25.1925    | 0.6200      | 0.7000        | 0.7700   | 5.1523 (80)  |          |          |          |          |          |               |
| Northeast   | 3.1500   | 14.6176    | 0.6200      | 0.7000        | 0.7700   | 13.8488 (75) |          |          |          |          |          |               |
| Solar gains | 130.0651 | 199.2367   | 303.0864    | 424.7060      | 491.8483 | 549.0095     | 517.5092 | 454.9706 | 363.2818 | 245.7730 | 157.5652 | 107.9583 (83) |
| Total gains | 738.0035 | 802.3818   | 882.6734    | 967.7672      | 997.4195 | 1021.1417    | 970.2176 | 916.5606 | 846.0024 | 765.2416 | 717.8276 | 699.1731 (84) |

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

|                                                                             |         |         |         |         |         |         |         |         |         |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         |              |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
| tau                                                                         | 35.4222 | 35.7083 | 35.6148 | 35.7999 | 35.7999 | 35.8896 | 35.9773 | 36.0631 | 36.1468 | 35.8896 | 36.0631 | 35.8896      |
| alpha                                                                       | 3.3615  | 3.3806  | 3.3743  | 3.3867  | 3.3867  | 3.3926  | 3.3985  | 3.4042  | 3.4098  | 3.3926  | 3.4042  | 3.3926       |
| util living area                                                            |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.9741  | 0.9648  | 0.9390  | 0.8790  | 0.7699  | 0.5877  | 0.4474  | 0.4694  | 0.7121  | 0.8924  | 0.9572  | 0.9772 (86)  |
| MIT                                                                         | 19.3949 | 19.5508 | 19.8917 | 20.3295 | 20.6943 | 20.9135 | 20.9743 | 20.9705 | 20.8280 | 20.4064 | 19.8641 | 19.3894 (87) |
| Th 2                                                                        | 19.8608 | 19.8689 | 19.8662 | 19.8714 | 19.8714 | 19.8739 | 19.8763 | 19.8787 | 19.8810 | 19.8739 | 19.8787 | 19.8739 (88) |
| util rest of house                                                          |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.9682  | 0.9570  | 0.9249  | 0.8497  | 0.7119  | 0.4923  | 0.3270  | 0.3447  | 0.6264  | 0.8590  | 0.9458  | 0.9720 (89)  |
| MIT 2                                                                       | 17.7690 | 17.9981 | 18.4835 | 19.0958 | 19.5714 | 19.8146 | 19.8661 | 19.8667 | 19.7430 | 19.2157 | 18.4588 | 17.7698 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         |         |         |         |              |
| MIT                                                                         | 18.0879 | 18.3027 | 18.7597 | 19.3378 | 19.7916 | 20.0301 | 20.0834 | 20.0832 | 19.9558 | 19.4493 | 18.7345 | 18.0875 (92) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

|                        |         |         |         |         |         |         |         |         |         |         |         |  |              |
|------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--|--------------|
| Temperature adjustment |         |         |         |         |         |         |         |         |         |         |         |  | -0.1500      |
| adjusted MIT           | 17.9379 | 18.1527 | 18.6097 | 19.1878 | 19.6416 | 19.8801 | 19.9334 | 19.9332 | 19.8058 | 19.2993 | 18.5845 |  | 17.9375 (93) |

#### 8. Space heating requirement

|                      | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov          | Dec       |       |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|--------------|-----------|-------|
| Utilisation          | 0.9540    | 0.9404    | 0.9042    | 0.8280    | 0.6984   | 0.4929   | 0.3334   | 0.3510   | 0.6199   | 0.8375   | 0.9277       | 0.9589    | (94)  |
| Useful gains         | 704.0789  | 754.5547  | 798.0831  | 801.2706  | 696.6102 | 503.3175 | 323.4505 | 321.7427 | 524.4175 | 640.8736 | 665.9213     | 670.4505  | (95)  |
| Ext temp.            | 4.9000    | 5.3000    | 7.0000    | 9.5000    | 12.5000  | 15.3000  | 17.1000  | 17.1000  | 14.7000  | 11.4000  | 7.9000       | 5.0000    | (96)  |
| Heat loss rate W     | 1537.6395 | 1503.6477 | 1361.7970 | 1130.4863 | 833.3675 | 533.1253 | 329.0089 | 328.1993 | 590.0859 | 919.4740 | 1237.6915    | 1505.9248 | (97)  |
| Month fracti         | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000       | 1.0000    | (97a) |
| Space heating kWh    | 620.1690  | 503.3905  | 419.4032  | 237.0354  | 101.7474 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 207.2787 | 411.6746     | 621.5929  | (98)  |
| Space heating        |           |           |           |           |          |          |          |          |          |          |              | 3122.2917 | (98)  |
| Space heating per m2 |           |           |           |           |          |          |          |          |          |          | (98) / (4) = | 33.7436   | (99)  |

#### 8c. Space cooling requirement

Not applicable

#### 9a. Energy requirements - Individual heating systems, including micro-CHP

| Fraction of space heat from secondary/supplementary system (Table 11) |          |          |          |          |          |         |         |         |         |           |          |           | 0.0000 (201)    |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|---------|---------|---------|---------|-----------|----------|-----------|-----------------|
| Fraction of space heat from main system(s)                            |          |          |          |          |          |         |         |         |         |           |          |           | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                      |          |          |          |          |          |         |         |         |         |           |          |           | 90.0000 (206)   |
| Efficiency of secondary/supplementary heating system, %               |          |          |          |          |          |         |         |         |         |           |          |           | 0.0000 (208)    |
| Space heating requirement                                             |          |          |          |          |          |         |         |         |         |           |          |           | 3469.2130 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun     | Jul     | Aug     | Sep     | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 620.1690 | 503.3905 | 419.4032 | 237.0354 | 101.7474 | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 207.2787  | 411.6746 | 621.5929  | (98)            |
| Space heating efficiency (main heating system 1)                      | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 90.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 90.0000   | 90.0000  | 90.0000   | (210)           |
| Space heating fuel (main heating system)                              | 689.0767 | 559.3228 | 466.0035 | 263.3726 | 113.0527 | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 230.3097  | 457.4162 | 690.6587  | (211)           |
| Water heating requirement                                             | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000    | 0.0000   | 0.0000    | (215)           |
| Water heating                                                         |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| Water heating requirement                                             | 150.6071 | 116.3024 | 92.8384  | 48.7581  | 27.4876  | 2.5965  | 0.0000  | 24.8230 | 48.5093 | 93.2863   | 127.3531 | 150.7707  | (64)            |
| Efficiency of water heater (217)m                                     | 89.3356  | 89.3617  | 89.3834  | 89.4193  | 89.2772  | 86.7000 | 86.7000 | 86.7000 | 86.7000 | 88.9492   | 89.1979  | 86.7000   | (216)           |
| Fuel for water heating, kWh/month                                     | 168.5858 | 130.1480 | 103.8653 | 54.5274  | 30.7890  | 2.9949  | 0.0000  | 28.6309 | 55.9508 | 104.8759  | 142.7760 | 168.7677  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |         |         |         |         |           |          | 991.9116  | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |         |         |         |         |           |          | 3469.2130 | (211)           |
| Space heating fuel - secondary                                        |          |          |          |          |          |         |         |         |         |           |          | 0.0000    | (215)           |
| Electricity for pumps and fans:                                       |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| central heating pump                                                  |          |          |          |          |          |         |         |         |         |           |          | 30.0000   | (230c)          |
| main heating flue fan                                                 |          |          |          |          |          |         |         |         |         |           |          | 45.0000   | (230e)          |
| pump for solar water heating                                          |          |          |          |          |          |         |         |         |         |           |          | 50.0000   | (230g)          |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |         |         |         |         |           |          | 125.0000  | (231)           |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |         |         |         |         |           |          | 398.7358  | (232)           |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| PV Unit 0 (0.80 * 0.81 * 1156 * 1.00) =                               |          |          |          |          |          |         |         |         |         | -749.2375 |          | -749.2375 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |         |         |         |         |           |          | 4235.6230 | (238)           |

#### 10a. Fuel costs - using BEDF prices (441)

|                                       | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |       |
|---------------------------------------|---------------|------------------|------------------|-------|
| Space heating - main system 1         | 3469.2130     | 3.9200           | 135.9931         | (240) |
| Space heating - secondary             | 0.0000        | 0.0000           | 0.0000           | (242) |
| Water heating (other fuel)            | 991.9116      | 3.9200           | 38.8829          | (247) |
| Pumps and fans for heating            | 75.0000       | 16.9600          | 12.7200          | (249) |
| Pump for solar water heating          | 50.0000       | 16.9600          | 8.4800           | (249) |
| Energy for lighting                   | 398.7358      | 16.9600          | 67.6256          | (250) |
| Additional standing charges           |               |                  | 88.0000          | (251) |
| Energy saving/generation technologies |               |                  |                  |       |
| PV Unit                               | -749.2375     | 16.9600          | -127.0707        | (252) |
| Total energy cost                     |               |                  | 224.6310         | (255) |

#### 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|                               | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |       |
|-------------------------------|-----------------|----------------------------|-----------------------|-------|
| Space heating - main system 1 | 3469.2130       | 0.2160                     | 749.3500              | (261) |
| Space heating - secondary     | 0.0000          | 0.0000                     | 0.0000                | (263) |
| Water heating (other fuel)    | 991.9116        | 0.2160                     | 214.2529              | (264) |
| Space and water heating       |                 |                            | 963.6029              | (265) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Built)

### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

|                                       |           |        |                 |
|---------------------------------------|-----------|--------|-----------------|
| Pumps and fans                        | 125.0000  | 0.5190 | 64.8750 (267)   |
| Energy for lighting                   | 398.7358  | 0.5190 | 206.9439 (268)  |
| Energy saving/generation technologies |           |        |                 |
| PV Unit                               | -749.2375 | 0.5190 | -388.8543 (269) |
| Total kg/year                         |           |        | 846.5675 (272)  |

#### 13a. Primary energy - Individual heating systems including micro-CHP

|                                       | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year |
|---------------------------------------|-----------------|----------------------------------|-------------------------|
| Space heating - main system 1         | 3469.2130       | 1.2200                           | 4232.4399 (261)         |
| Space heating - secondary             | 0.0000          | 0.0000                           | 0.0000 (263)            |
| Water heating (other fuel)            | 991.9116        | 1.2200                           | 1210.1322 (264)         |
| Space and water heating               |                 |                                  | 5442.5721 (265)         |
| Pumps and fans                        | 125.0000        | 3.0700                           | 383.7500 (267)          |
| Energy for lighting                   | 398.7358        | 3.0700                           | 1224.1189 (268)         |
| Energy saving/generation technologies |                 |                                  |                         |
| PV Unit                               | -749.2375       | 3.0700                           | -2300.1591 (269)        |
| Primary energy kWh/year               |                 |                                  | 4750.2819 (272)         |
| Primary energy kWh/m2/year            |                 |                                  | 51.3377 (273)           |

#### SAP 2012 OVERHEATING ASSESSMENT FOR New Build (As Built) 9.92

##### Overheating Calculation Input Data

|                                           |                                               |
|-------------------------------------------|-----------------------------------------------|
| Dwelling type                             | Detached House                                |
| Number of storeys                         | 2                                             |
| Cross ventilation possible                | Yes                                           |
| SAP Region                                | Southern England                              |
| Front of dwelling faces                   | South West                                    |
| Overshading                               | Average or unknown                            |
| Thermal mass parameter                    | 162.5 (calculated from construction elements) |
| Night ventilation                         | No                                            |
| Ventilation rate during hot weather (ach) | 4.00 (Windows half open)                      |

##### Overheating Calculation

|                                          |             |
|------------------------------------------|-------------|
| Summer ventilation heat loss coefficient | 292.41 (P1) |
| Transmission heat loss coefficient       | 74.53 (37)  |
| Summer heat loss coefficient             | 366.94 (P2) |

| Overhangs   | Ratio | Z_overhangs | Overhang type |
|-------------|-------|-------------|---------------|
| Orientation |       |             |               |
| North East  | 0.000 | 1.000       | None          |
| South       | 0.000 | 1.000       | None          |
| South West  | 0.000 | 1.000       | None          |
| West        | 0.000 | 1.000       | None          |

| Solar shading | Z blinds | Solar access | Z overhangs | Z summer   |
|---------------|----------|--------------|-------------|------------|
| Orientation   |          |              |             |            |
| North East    | 1.000    | 0.90         | 1.000       | 0.900 (P8) |
| South         | 1.000    | 0.90         | 1.000       | 0.900 (P8) |
| South West    | 1.000    | 0.90         | 1.000       | 0.900 (P8) |
| West          | 1.000    | 0.90         | 1.000       | 0.900 (P8) |

| [Jul]      | Area m2 | Solar flux Table 6a W/m2 | Specific data g or Table 6b | FF Specific data or Table 6c | Shading | Gains W  |
|------------|---------|--------------------------|-----------------------------|------------------------------|---------|----------|
| North East | 4.8200  | 106.0502                 | 0.6200                      | 0.7000                       | 0.9000  | 179.6939 |
| South      | 0.6800  | 118.5567                 | 0.6200                      | 0.7000                       | 0.9000  | 28.3406  |
| South West | 5.7600  | 127.3119                 | 0.6200                      | 0.7000                       | 0.9000  | 257.7900 |
| West       | 0.6800  | 125.2818                 | 0.6200                      | 0.7000                       | 0.9000  | 29.9483  |
| North East | 3.1500  | 106.0502                 | 0.6200                      | 0.7000                       | 0.9000  | 117.4348 |

total: 613.2076

|                    | Jun  | Jul  | Aug |      |
|--------------------|------|------|-----|------|
| Solar gains        | 661  | 613  | 537 | (P3) |
| Internal gains     | 469  | 450  | 459 |      |
| Total summer gains | 1130 | 1063 | 996 | (P5) |

|                                                  |                 |        |        |      |
|--------------------------------------------------|-----------------|--------|--------|------|
| Summer gain/loss ratio                           | 3.08            | 2.90   | 2.71   | (P6) |
| Summer external temperature                      | 15.40           | 17.30  | 17.30  |      |
| Thermal mass temperature increment (TMP = 162.5) | 0.86            | 0.86   | 0.86   |      |
| Threshold temperature                            | 19.34           | 21.06  | 20.88  | (P7) |
| Likelihood of high internal temperature          | Not significant | Slight | Slight |      |

Assessment of likelihood of high internal temperature: Slight