Mainer Associates
James McGlashan
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# SAP WorkSheet: New dwelling as built

MAINER ASSOCIATES

## User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | James Mcglashan | **Stroma Number:** | STRO000976 |
| **Software Name:** | Stroma FSAP 2009 | **Software Version:** | Version: 1.5.0.95 |

## Property Address: 21 ASHP

**Address :** Flat 21, Anello Building, 116 Bayham Street, LONDON, NW1 0BA

## 1. Overall dwelling dimensions:

| | Area(m²) | | Ave Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 161.88 | (1a) x | 2.476 | (2a) = | 400.81 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 161.88 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 400.81 | (5) |

## 2. Ventilation rate:

| | main heating | | Secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

**Air changes per hour**

| | | | | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 0 | ÷ (5) = | 0 | (8) |

*If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)*

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |

*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*

| | | | |
|---|---|---|---|
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 9.89 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.49 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides on which sheltered | | 2 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.42 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.4 | 5.1 | 5.1 | 4.5 | 4.1 | 3.9 | 3.7 | 3.7 | 4.2 | 4.5 | 4.8 | 5.1 |
| Wind Factor (22a)m = (22)m ÷ 4 | | | | | | | | | | | | |
| (22a)m= | 1.35 | 1.27 | 1.27 | 1.12 | 1.02 | 0.98 | 0.92 | 0.92 | 1.05 | 1.12 | 1.2 | 1.27 |

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.57 | 0.54 | 0.54 | 0.47 | 0.43 | 0.41 | 0.39 | 0.39 | 0.44 | 0.47 | 0.5 | 0.54 |

*Calculate effective air change rate for the applicable case*

| | | |
|---|---|---|
| If mechanical ventilation: | 0.5 | (23a) |
| If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) | 0.5 | (23b) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = | 73.1 | (23c) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0.7 | 0.67 | 0.67 | 0.61 | 0.57 | 0.54 | 0.52 | 0.52 | 0.58 | 0.61 | 0.64 | 0.67 | (24a) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.7 | 0.67 | 0.67 | 0.61 | 0.57 | 0.54 | 0.52 | 0.52 | 0.58 | 0.61 | 0.64 | 0.67 | (25) |

## 3. Heat losses and heat loss parameter:

| **ELEMENT** | Gross area (m²) | Openings m² | Net Area A ,m² | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|
| Windows Type 1 | | | 20.99 | x1/[1/( 1.6 )+ 0.04] | = | 31.56 | | | (27) |
| Windows Type 2 | | | 16.23 | x1/[1/( 1.6 )+ 0.04] | = | 24.41 | | | (27) |
| Windows Type 3 | | | 2.23 | x1/[1/( 1.6 )+ 0.04] | = | 3.35 | | | (27) |
| Windows Type 4 | | | 53.37 | x1/[1/( 1.6 )+ 0.04] | = | 80.26 | | | (27) |
| Windows Type 5 | | | 2.23 | x1/[1/( 1.6 )+ 0.04] | = | 3.35 | | | (27) |
| Rooflights | | | 1.44 | x1/[1/(1.6) + 0.04] | = | 2.304 | | | (27b) |
| Walls | 132.86 | 95.05 | 37.81 | x 0.29 | = | 10.96 | | | (29) |
| Roof | 161.88 | 4.32 | 157.56 | x 0.14 | = | 22.06 | | | (30) |
| Total area of elements, m² | | | 294.74 | | | | | | (31) |
| Party wall | | | 27.51 | x 0.2 | = | 5.5 | | | (32) |

* *for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
** *include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 187.95 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 2497.5801 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Low | 100 | (35) |

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

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 44.21 | (36) |

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

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 232.16 | (37) |

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

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 92.84 | 88.68 | 88.68 | 80.34 | 74.78 | 72 | 69.22 | 69.22 | 76.17 | 80.34 | 84.51 | 88.68 | (38) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 325.01 | 320.84 | 320.84 | 312.5 | 306.94 | 304.16 | 301.38 | 301.38 | 308.33 | 312.5 | 316.67 | 320.84 | |

Average = Sum(39)$_{1...12}$ /12= 312.62 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 2.01 | 1.98 | 1.98 | 1.93 | 1.9 | 1.88 | 1.86 | 1.86 | 1.9 | 1.93 | 1.96 | 1.98 | |

Average = Sum(40)$_{1...12}$ /12= 1.93 (40)

Number of days in month (Table 1a)

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

## 4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.95 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 104.3 (43)

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

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

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 114.73 | 110.56 | 106.38 | 102.21 | 98.04 | 93.87 | 93.87 | 98.04 | 102.21 | 106.38 | 110.56 | 114.73 | |

Total = Sum(44)$_{1...12}$ = 1251.59 (44)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 170.55 | 149.16 | 153.92 | 134.19 | 128.76 | 111.11 | 102.96 | 118.15 | 119.56 | 139.33 | 152.09 | 165.17 | |

Total = Sum(45)$_{1...12}$ = 1644.95 (45)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.58 | 22.37 | 23.09 | 20.13 | 19.31 | 16.67 | 15.44 | 17.72 | 17.93 | 20.9 | 22.81 | 24.77 | (46) |

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.67 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.9018 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

*If community heating and no tank in dwelling, enter 110 litres in box (50)*

*Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)*

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.9 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 27.96 | 25.25 | 27.96 | 27.05 | 27.96 | 27.05 | 27.96 | 27.96 | 27.05 | 27.96 | 27.05 | 27.96 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 27.96 | 25.25 | 27.96 | 27.05 | 27.96 | 27.05 | 27.96 | 27.96 | 27.05 | 27.96 | 27.05 | 27.96 | (57) |

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Primary circuit loss (annual) from Table 3 | 360 | (58)

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

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 30.58 | 27.62 | 30.58 | 29.59 | 30.58 | 29.59 | 30.58 | 30.58 | 29.59 | 30.58 | 29.59 | 30.58 | (59) |

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

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

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 229.08 | 202.03 | 212.45 | 190.83 | 187.29 | 167.75 | 161.49 | 176.68 | 176.2 | 197.87 | 208.74 | 223.7 | (62) |

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

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

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

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 229.08 | 202.03 | 212.45 | 190.83 | 187.29 | 167.75 | 161.49 | 176.68 | 176.2 | 197.87 | 208.74 | 223.7 |

Output from water heater (annual)$_{1...12}$ | 2334.11 | (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 103.53 | 91.89 | 98 | 89.93 | 89.64 | 82.26 | 81.06 | 86.11 | 85.07 | 93.15 | 95.89 | 101.74 | (65) |

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

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 177.09 | 177.09 | 177.09 | 177.09 | 177.09 | 177.09 | 177.09 | 177.09 | 177.09 | 177.09 | 177.09 | 177.09 | (66) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 74.26 | 65.95 | 53.64 | 40.61 | 30.35 | 25.63 | 27.69 | 35.99 | 48.31 | 61.34 | 71.59 | 76.32 | (67) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 497.27 | 502.43 | 489.43 | 461.75 | 426.8 | 393.96 | 372.02 | 366.86 | 379.86 | 407.54 | 442.49 | 475.33 | (68) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.66 | 55.66 | 55.66 | 55.66 | 55.66 | 55.66 | 55.66 | 55.66 | 55.66 | 55.66 | 55.66 | 55.66 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | (70) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -118.06 | -118.06 | -118.06 | -118.06 | -118.06 | -118.06 | -118.06 | -118.06 | -118.06 | -118.06 | -118.06 | -118.06 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 139.16 | 136.74 | 131.73 | 124.91 | 120.48 | 114.25 | 108.95 | 115.74 | 118.15 | 125.21 | 133.17 | 136.75 | (72) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 835.38 | 829.82 | 799.48 | 751.95 | 702.33 | 658.53 | 633.35 | 643.28 | 671.01 | 718.78 | 771.95 | 813.09 | (73) |

## 6. Solar gains:

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

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 11.51 | x | 0.63 | x | 0.8 | = | 84.38 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 11.51 | x | 0.63 | x | 0.8 | = | 65.25 | (75) |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 23.55 | x | 0.63 | x | 0.8 | = | 172.68 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 23.55 | x | 0.63 | x | 0.8 | = | 133.52 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 41.13 | x | 0.63 | x | 0.8 | = | 301.51 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 41.13 | x | 0.63 | x | 0.8 | = | 233.13 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 67.8 | x | 0.63 | x | 0.8 | = | 497.04 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 67.8 | x | 0.63 | x | 0.8 | = | 384.32 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 89.77 | x | 0.63 | x | 0.8 | = | 658.09 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 89.77 | x | 0.63 | x | 0.8 | = | 508.86 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 97.5 | x | 0.63 | x | 0.8 | = | 714.81 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 97.5 | x | 0.63 | x | 0.8 | = | 552.71 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 92.98 | x | 0.63 | x | 0.8 | = | 681.65 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 92.98 | x | 0.63 | x | 0.8 | = | 527.07 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 75.42 | x | 0.63 | x | 0.8 | = | 552.9 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 75.42 | x | 0.63 | x | 0.8 | = | 427.52 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 51.24 | x | 0.63 | x | 0.8 | = | 375.69 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 51.24 | x | 0.63 | x | 0.8 | = | 290.49 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 29.6 | x | 0.63 | x | 0.8 | = | 217 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 29.6 | x | 0.63 | x | 0.8 | = | 167.79 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 14.52 | x | 0.63 | x | 0.8 | = | 106.49 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 14.52 | x | 0.63 | x | 0.8 | = | 82.34 | (75) |
| Northeast | 0.9x | 0.77 | x | 20.99 | x | 9.36 | x | 0.63 | x | 0.8 | = | 68.62 | (75) |
| Northeast | 0.9x | 0.77 | x | 16.23 | x | 9.36 | x | 0.63 | x | 0.8 | = | 53.06 | (75) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 37.39 | x | 0.63 | x | 0.8 | = | 29.12 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 63.74 | x | 0.63 | x | 0.8 | = | 49.64 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 84.22 | x | 0.63 | x | 0.8 | = | 65.59 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 103.49 | x | 0.63 | x | 0.8 | = | 80.61 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 113.34 | x | 0.63 | x | 0.8 | = | 88.28 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 115.04 | x | 0.63 | x | 0.8 | = | 89.61 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 112.79 | x | 0.63 | x | 0.8 | = | 87.85 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 105.34 | x | 0.63 | x | 0.8 | = | 82.05 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 92.9 | x | 0.63 | x | 0.8 | = | 72.36 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 72.36 | x | 0.63 | x | 0.8 | = | 56.36 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 44.83 | x | 0.63 | x | 0.8 | = | 34.91 | (77) |
| Southeast | 0.9x | 0.77 | x | 2.23 | x | 31.95 | x | 0.63 | x | 0.8 | = | 24.88 | (77) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 37.39 | | 0.63 | x | 0.8 | = | 696.93 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 63.74 | | 0.63 | x | 0.8 | = | 1188.07 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 84.22 | | 0.63 | x | 0.8 | = | 1569.84 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 103.49 | | 0.63 | x | 0.8 | = | 1929.1 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 113.34 | | 0.63 | x | 0.8 | = | 2112.67 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 115.04 | | 0.63 | x | 0.8 | = | 2144.5 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 112.79 | | 0.63 | x | 0.8 | = | 2102.5 | (79) |

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| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 105.34 | | 0.63 | x | 0.8 | = | 1963.62 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 92.9 | | 0.63 | x | 0.8 | = | 1731.67 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 72.36 | | 0.63 | x | 0.8 | = | 1348.89 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 44.83 | | 0.63 | x | 0.8 | = | 835.58 | (79) |
| Southwest | 0.9x | 0.77 | x | 53.37 | x | 31.95 | | 0.63 | x | 0.8 | = | 595.56 | (79) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 11.51 | x | 0.63 | x | 0.8 | = | 8.96 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 23.55 | x | 0.63 | x | 0.8 | = | 18.35 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 41.13 | x | 0.63 | x | 0.8 | = | 32.03 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 67.8 | x | 0.63 | x | 0.8 | = | 52.81 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 89.77 | x | 0.63 | x | 0.8 | = | 69.92 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 97.5 | x | 0.63 | x | 0.8 | = | 75.94 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 92.98 | x | 0.63 | x | 0.8 | = | 72.42 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 75.42 | x | 0.63 | x | 0.8 | = | 58.74 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 51.24 | x | 0.63 | x | 0.8 | = | 39.91 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 29.6 | x | 0.63 | x | 0.8 | = | 23.05 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 14.52 | x | 0.63 | x | 0.8 | = | 11.31 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.23 | x | 9.36 | x | 0.63 | x | 0.8 | = | 7.29 | (81) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 26 | x | 0.63 | x | 0.8 | = | 50.95 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 54 | x | 0.63 | x | 0.8 | = | 105.82 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 94 | x | 0.63 | x | 0.8 | = | 184.2 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 150 | x | 0.63 | x | 0.8 | = | 293.93 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 190 | x | 0.63 | x | 0.8 | = | 372.31 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 201 | x | 0.63 | x | 0.8 | = | 393.87 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 194 | x | 0.63 | x | 0.8 | = | 380.15 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 164 | x | 0.63 | x | 0.8 | = | 321.37 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 116 | x | 0.63 | x | 0.8 | = | 227.31 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 68 | x | 0.63 | x | 0.8 | = | 133.25 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 33 | x | 0.63 | x | 0.8 | = | 64.67 | (82) |
| Rooflights | 0.9x | 1 | x | 1.44 | x | 21 | x | 0.63 | x | 0.8 | = | 41.15 | (82) |

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 935.59 | 1668.08 | 2386.31 | 3237.81 | 3810.12 | 3971.42 | 3851.64 | 3406.2 | 2737.42 | 1946.34 | 1135.29 | 790.58 | (83) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1770.97 | 2497.89 | 3185.79 | 3989.76 | 4512.45 | 4629.95 | 4484.99 | 4049.48 | 3408.43 | 2665.12 | 1907.24 | 1603.67 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 0.92 | 0.86 | 0.77 | 0.65 | 0.51 | 0.37 | 0.26 | 0.28 | 0.49 | 0.72 | 0.88 | 0.93 | (86) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 18.48 | 18.94 | 19.51 | 20.05 | 20.49 | 20.72 | 20.82 | 20.81 | 20.61 | 20.04 | 19.08 | 18.5 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 19.33 | 19.35 | 19.35 | 19.39 | 19.41 | 19.42 | 19.43 | 19.43 | 19.4 | 19.39 | 19.37 | 19.35 | (88) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.9 | 0.83 | 0.73 | 0.6 | 0.44 | 0.29 | 0.17 | 0.18 | 0.4 | 0.66 | 0.86 | 0.91 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 16.18 | 16.82 | 17.59 | 18.31 | 18.86 | 19.13 | 19.22 | 19.22 | 19.01 | 18.33 | 17.04 | 16.22 | (90) |

fLA = Living area ÷ (4) = 0.56 (91)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 17.46 | 18 | 18.66 | 19.28 | 19.77 | 20.01 | 20.11 | 20.1 | 19.9 | 19.28 | 18.18 | 17.49 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 17.46 | 18 | 18.66 | 19.28 | 19.77 | 20.01 | 20.11 | 20.1 | 19.9 | 19.28 | 18.18 | 17.49 | (93) |

## 8. Space heating requirement

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.88 | 0.81 | 0.72 | 0.6 | 0.46 | 0.32 | 0.21 | 0.23 | 0.43 | 0.66 | 0.83 | 0.89 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1560.16 | 2020.01 | 2280.43 | 2386.95 | 2066.61 | 1503.85 | 931.62 | 922.95 | 1469.99 | 1759.57 | 1592.41 | 1430.17 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.5 | 5 | 6.8 | 8.7 | 11.7 | 14.6 | 16.9 | 16.9 | 14.3 | 10.8 | 7 | 4.9 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 4212.27 | 4170.37 | 3804.55 | 3305.22 | 2476.72 | 1646.57 | 967.6 | 965.68 | 1726.89 | 2650.21 | 3539.67 | 4039.07 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1973.18 | 1445.04 | 1133.94 | 661.16 | 305.12 | 0 | 0 | 0 | 0 | 662.63 | 1402.03 | 1941.02 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 9524.13 (98)

Space heating requirement in kWh/m²/year 58.83 (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 2615.79 | 1868.56 | 1868.56 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.87 | 0.91 | 0.9 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 2264.81 | 1708.81 | 1684.21 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 5509.79 | 5267.07 | 4806.77 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 2336.39 | 2647.34 | 2323.18 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 7306.91 (104)

Cooled fraction f C = cooled area ÷ (4) = 0.83 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

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Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 487.07 | 551.9 | 484.32 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 1523.29 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 9.41 (108)

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

**Space heating:**

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system | | 0 | (201) |
| Fraction of space heat from main system(s) | (202) = 1 – (201) = | 1 | (202) |
| Fraction of total heating from main system 1 | (204) = (202) × [1 – (203)] = | 1 | (204) |
| Efficiency of main space heating system 1 | | 250 | (206) |
| Efficiency of secondary/supplementary heating system, % | | 0 | (208) |
| Cooling System Energy Efficiency Ratio | | 4.63 | (209) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | kWh/year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating requirement (calculated above) | 1973.18 | 1445.04 | 1133.94 | 661.16 | 305.12 | 0 | 0 | 0 | 0 | 662.63 | 1402.03 | 1941.02 | |
| (211)m = {[(98)m x (204)]} x 100 ÷ (206) | 789.27 | 578.02 | 453.58 | 264.46 | 122.05 | 0 | 0 | 0 | 0 | 265.05 | 560.81 | 776.41 | (211) |

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 3809.65 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

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

Total (kWh/year) =Sum(215)$_{1...5,10....12}$= 0 (215)

**Water heating**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Output from water heater (calculated above) | 229.08 | 202.03 | 212.45 | 190.83 | 187.29 | 167.75 | 161.49 | 176.68 | 176.2 | 197.87 | 208.74 | 223.7 | |
| Efficiency of water heater | | | | | | | | | | | | | 175 (216) |
| (217)m= | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | (217) |

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (219)m= | 130.9 | 115.44 | 121.4 | 109.05 | 107.02 | 95.86 | 92.28 | 100.96 | 100.69 | 113.07 | 119.28 | 127.83 |

Total = Sum(219a)$_{1...12}$ = 1333.78 (219)

**Space cooling fuel, kWh/month.**
(221)m = (107)m÷ (209)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (221)m= | 0 | 0 | 0 | 0 | 0 | 105.19 | 119.19 | 104.59 | 0 | 0 | 0 | 0 |

Total = Sum(221)$_{6...8}$ = 328.97 (221)

| **Annual totals** | **kWh/year** | **kWh/year** | |
|---|---|---|---|
| Space heating fuel used, main system 1 | | 3809.65 | |
| Water heating fuel used | | 1333.78 | |
| Space cooling fuel used | | 328.97 | |
| Electricity for pumps, fans and electric keep-hot | | | |
| mechanical ventilation - balanced, extract or positive input from outside | 623.47 | | (230a) |
| central heating pump: | 130 | | (230c) |

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| | | | |
|---|---|---|---|
| Total electricity for the above, kWh/year | sum of (230a)…(230g) = | 753.47 | (231) |
| Electricity for lighting | | 524.56 | (232) |
| Electricity generated by PVs | | -686.72 | (233) |

## 10a. Fuel costs - individual heating systems:

| | Fuel kWh/year | Fuel Price (Table 12) | | Fuel Cost £/year | |
|---|---|---|---|---|---|
| Space heating - main system 1 | (211) x | 11.46 | x 0.01 = | 436.586 | (240) |
| Space heating - main system 2 | (213) x | 0 | x 0.01 = | 0 | (241) |
| Space heating - secondary | (215) x | 0 | x 0.01 = | 0 | (242) |
| Water heating cost (other fuel) | (219) | 11.46 | x 0.01 = | 152.85 | (247) |
| Space cooling | (221) | 11.46 | x 0.01 = | 37.7 | (248) |
| Pumps, fans and electric keep-hot | (231) | 11.46 | x 0.01 = | 86.35 | (249) |

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

| | | | | | |
|---|---|---|---|---|---|
| Energy for lighting | (232) | 11.46 | x 0.01 = | 60.11 | (250) |
| Additional standing charges (Table 12) | | | | 0 | (251) |
| | one of (233) to (235) x) | 11.46 | x 0.01 = | -78.7 | (252) |

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

| | | | |
|---|---|---|---|
| **Total energy cost** | (245)...(247) + (250)…(254) = | 694.9002 | (255) |

## 11a. SAP rating - individual heating systems

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.47 | (256) |
| Energy cost factor (ECF) | [(255) x (256)] ÷ [(4) + 45.0] = | 1.5787 | (257) |
| **SAP rating (Section 12)** | | 77.977 | (258) |

## 12a. $CO_2$ emissions – Individual heating systems including micro-CHP

| | Energy kWh/year | Emission factor kg $CO_2$/kWh | | Emissions kg $CO_2$/year | |
|---|---|---|---|---|---|
| Space heating (main system 1) | (211) x | 0.517 | = | 1969.59 | (261) |
| Space heating (secondary) | (215) x | 0 | = | 0 | (263) |
| Water heating | (219) x | 0.517 | = | 689.56 | (264) |
| Space and water heating | (261) + (262) + (263) + (264) = | | | 2659.15 | (265) |
| Space cooling | (221) x | 0.517 | = | 170.08 | (266) |
| Electricity for pumps, fans and electric keep-hot | (231) x | 0.517 | = | 389.54 | (267) |
| Electricity for lighting | (232) x | 0.517 | = | 271.2 | (268) |
| Energy saving/generation technologies Item 1 | | 0.529 | = | -363.27 | (269) |
| Total $CO_2$, kg/year | | sum of (265)…(271) = | | 3126.69 | (272) |
| **$CO_2$ emissions per m²** | | (272) ÷ (4) = | | 19.31 | (273) |

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MAINER ASSOCIATES

| | | | | |
|---|---|---|---|---|
| EI rating (section 14) | | | 80 | (274) |

## 13a. Primary Energy

| | Energy kWh/year | Primary factor | | P. Energy kWh/year | |
|---|---|---|---|---|---|
| Space heating (main system 1) | (211) x | 2.92 | = | 11124.18 | (261) |
| Space heating (secondary) | (215) x | 0 | = | 0 | (263) |
| Energy for water heating | (219) x | 2.92 | = | 3894.63 | (264) |
| Space and water heating | (261) + (262) + (263) + (264) = | | | 15018.81 | (265) |
| Space cooling | (221) x | 2.92 | = | 960.59 | (266) |
| Electricity for pumps, fans and electric keep-hot | (231) x | 2.92 | = | 2200.13 | (267) |
| Electricity for lighting | (232) x | 0 | = | 1531.71 | (268) |
| Energy saving/generation technologies | | | | | |
| Item 1 | | 2.92 | = | -2005.22 | (269) |
| ‘Total Primary Energy | | sum of (265)…(271) = | | 17706.01 | (272) |
| **Primary energy kWh/m²/year** | | (272) ÷ (4) = | | 109.38 | (273) |