# DER WorkSheet: New dwelling design stage

## User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | Ondrej Gajdos | **Stroma Number:** | STRO006629 |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.5.60 |

## Property Address: FLAT 10

**Address :** FLAT 10, 43 London Street, Reading, RG1 4PS

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 68.2 | (1a) x | 2.25 | (2a) = | 153.45 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 68.2 | (4) | | | | |
| Dwelling volume | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | | 153.45 | (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 | | 5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.25 | (18) |

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

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 4 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.7 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.18 | (21) |

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.22 | 0.22 | 0.21 | 0.19 | 0.19 | 0.17 | 0.17 | 0.16 | 0.18 | 0.19 | 0.2 | 0.21 |

*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= | 0.36 | 0.35 | 0.35 | 0.33 | 0.32 | 0.3 | 0.3 | 0.3 | 0.31 | 0.32 | 0.33 | 0.34 | (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= | 0.36 | 0.35 | 0.35 | 0.33 | 0.32 | 0.3 | 0.3 | 0.3 | 0.31 | 0.32 | 0.33 | 0.34 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.85 | = | 1.785 | | | (26) |
| Windows Type 1 | | | 2.87 | x1/[1/( 1.1 )+ 0.04] | | = | 3.02 | | | (27) |
| Windows Type 2 | | | 1.75 | x1/[1/( 1.1 )+ 0.04] | | = | 1.84 | | | (27) |
| Windows Type 3 | | | 4.29 | x1/[1/( 1.1 )+ 0.04] | | = | 4.52 | | | (27) |
| Windows Type 4 | | | 1.71 | x1/[1/( 1.1 )+ 0.04] | | = | 1.8 | | | (27) |
| Windows Type 5 | | | 1.73 | x1/[1/( 0.92 )+ 0.04] | | = | 1.54 | | | (27) |
| Windows Type 6 | | | 5.54 | x1/[1/( 0.92 )+ 0.04] | | = | 4.92 | | | (27) |
| Rooflights | | | 1.632 | x1/[1/(1.3) + 0.04] | | = | 2.1216 | | | (27b) |
| Walls Type1 | 17.98 | 2.1 | 15.88 | x | 0.19 | = | 3.02 | 14 | 222.32 | (29) |
| Walls Type2 | 24.32 | 0 | 24.32 | x | 0.16 | = | 3.89 | 14 | 340.48 | (29) |
| Walls Type3 | 45.38 | 19.64 | 25.74 | x | 0.12 | = | 3.09 | 14 | 360.29 | (29) |
| Roof Type1 | 38.8 | 0 | 38.8 | x | 0.11 | = | 4.27 | 9 | 349.2 | (30) |
| Roof Type2 | 30.3 | 1.63 | 28.67 | x | 0.11 | = | 3.15 | 9 | 258.01 | (30) |
| Total area of elements, m² | | | 156.77 | | | | | | | (31) |
| Party wall | | | 3.15 | x | 0 | = | 0 | 20 | 63 | (32) |
| Party floor | | | 68.2 | | | | | 30 | 2046 | (32a) |
| Internal wall ** | | | 132.21 | | | | | 9 | 1189.89 | (32c) |

** 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) = 40.7 (33)

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| | | | |
|---|---|---|---|
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 4829.19 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | = (34) ÷ (4) = | 70.81 | (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 | 23.52 | (36) |

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

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 64.22 | (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= | 18.11 | 17.89 | 17.67 | 16.56 | 16.34 | 15.23 | 15.23 | 15.01 | 15.67 | 16.34 | 16.78 | 17.22 | (38) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 82.33 | 82.11 | 81.89 | 80.78 | 80.56 | 79.45 | 79.45 | 79.23 | 79.89 | 80.56 | 81 | 81.44 | |

Average = Sum(39)$_{1…12}$ /12= 80.72 (39)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.21 | 1.2 | 1.2 | 1.18 | 1.18 | 1.16 | 1.16 | 1.16 | 1.17 | 1.18 | 1.19 | 1.19 | |

Average = Sum(40)$_{1…12}$ /12= 1.18 (40)

Number of days in month (Table 1a)

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

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

Assumed occupancy, N 2.2 (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 86.49 (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= | 95.14 | 91.68 | 88.22 | 84.76 | 81.3 | 77.84 | 77.84 | 81.3 | 84.76 | 88.22 | 91.68 | 95.14 |

Total = Sum(44)$_{1…12}$ = 1037.87 (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= | 141.09 | 123.4 | 127.33 | 111.01 | 106.52 | 91.92 | 85.18 | 97.74 | 98.91 | 115.27 | 125.82 | 136.64 |

Total = Sum(45)$_{1…12}$ = 1360.81 (45)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 21.16 | 18.51 | 19.1 | 16.65 | 15.98 | 13.79 | 12.78 | 14.66 | 14.84 | 17.29 | 18.87 | 20.5 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

| | | | |
|---|---|---|---|
| a) If manufacturer's declared loss factor is known (kWh/day): | | 0.54 | (48) |
| Temperature factor from Table 2b | | 0.4536 | (49) |
| Energy lost from water storage, kWh/year | (48) x (49) = | 0 | (50) |

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

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| | | | |
|---|---|---|---|
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | 0 | (51) |
| If community heating see section 4.3 | | | |
| Volume factor from Table 2a | | 0 | (52) |
| Temperature factor from Table 2b | | 0 | (53) |
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0 | (54) |
| Enter (50) or (54) in (55) | | 0.45 | (55) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 14.06 | 12.7 | 14.06 | 13.61 | 14.06 | 13.61 | 14.06 | 14.06 | 13.61 | 14.06 | 13.61 | 14.06 | (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= | 14.06 | 12.7 | 14.06 | 13.61 | 14.06 | 13.61 | 14.06 | 14.06 | 13.61 | 14.06 | 13.61 | 14.06 | (57) |

Primary circuit loss (annual) from Table 3 | 0 | (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= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (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= | 155.15 | 136.1 | 141.39 | 124.62 | 120.58 | 105.53 | 99.24 | 111.8 | 112.51 | 129.33 | 139.43 | 150.7 | (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= | 155.15 | 136.1 | 141.39 | 124.62 | 120.58 | 105.53 | 99.24 | 111.8 | 112.51 | 129.33 | 139.43 | 150.7 | |

Output from water heater (annual)$_{1...12}$ | 1526.37 | (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 46.91 | 41.03 | 42.34 | 36.91 | 35.42 | 30.56 | 28.32 | 32.5 | 32.89 | 38.33 | 41.84 | 45.43 | (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= | 110.08 | 110.08 | 110.08 | 110.08 | 110.08 | 110.08 | 110.08 | 110.08 | 110.08 | 110.08 | 110.08 | 110.08 | (66) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 17.21 | 15.29 | 12.43 | 9.41 | 7.04 | 5.94 | 6.42 | 8.34 | 11.2 | 14.22 | 16.59 | 17.69 | (67) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 193.06 | 195.06 | 190.01 | 179.27 | 165.7 | 152.95 | 144.43 | 142.43 | 147.48 | 158.22 | 171.79 | 184.54 | (68) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 34.01 | 34.01 | 34.01 | 34.01 | 34.01 | 34.01 | 34.01 | 34.01 | 34.01 | 34.01 | 34.01 | 34.01 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 9.21 | 9.21 | 9.21 | 9.21 | 9.21 | 9.21 | 9.21 | 9.21 | 9.21 | 9.21 | 9.21 | 9.21 | (70) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -88.07 | -88.07 | -88.07 | -88.07 | -88.07 | -88.07 | -88.07 | -88.07 | -88.07 | -88.07 | -88.07 | -88.07 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 63.05 | 61.06 | 56.91 | 51.27 | 47.6 | 42.45 | 38.07 | 43.68 | 45.68 | 51.51 | 58.11 | 61.06 | (72) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 338.56 | 336.64 | 324.59 | 305.18 | 285.57 | 266.57 | 254.15 | 259.68 | 269.58 | 289.19 | 311.72 | 328.53 | (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) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 0.77 | x 1.75 | x | 10.63 | x | 0.63 | x | 0.7 | = | 11.37 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 10.63 | x | 0.63 | x | 0.7 | = | 13.94 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 10.63 | x | 0.63 | x | 0.7 | = | 5.56 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 20.32 | x | 0.63 | x | 0.7 | = | 21.74 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 20.32 | x | 0.63 | x | 0.7 | = | 26.64 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 20.32 | x | 0.63 | x | 0.7 | = | 10.62 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 34.53 | x | 0.63 | x | 0.7 | = | 36.94 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 34.53 | x | 0.63 | x | 0.7 | = | 45.27 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 34.53 | x | 0.63 | x | 0.7 | = | 18.05 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 55.46 | x | 0.63 | x | 0.7 | = | 59.33 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 55.46 | x | 0.63 | x | 0.7 | = | 72.72 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 55.46 | x | 0.63 | x | 0.7 | = | 28.99 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 74.72 | x | 0.63 | x | 0.7 | = | 79.92 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 74.72 | x | 0.63 | x | 0.7 | = | 97.96 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 74.72 | x | 0.63 | x | 0.7 | = | 39.05 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 79.99 | x | 0.63 | x | 0.7 | = | 85.56 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 79.99 | x | 0.63 | x | 0.7 | = | 104.87 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 79.99 | x | 0.63 | x | 0.7 | = | 41.8 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 74.68 | x | 0.63 | x | 0.7 | = | 79.88 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 74.68 | x | 0.63 | x | 0.7 | = | 97.91 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 74.68 | x | 0.63 | x | 0.7 | = | 39.03 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 59.25 | x | 0.63 | x | 0.7 | = | 63.37 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 59.25 | x | 0.63 | x | 0.7 | = | 77.68 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 59.25 | x | 0.63 | x | 0.7 | = | 30.96 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 41.52 | x | 0.63 | x | 0.7 | = | 44.41 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 41.52 | x | 0.63 | x | 0.7 | = | 54.43 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 41.52 | x | 0.63 | x | 0.7 | = | 21.7 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 24.19 | x | 0.63 | x | 0.7 | = | 25.87 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 24.19 | x | 0.63 | x | 0.7 | = | 31.71 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 24.19 | x | 0.63 | x | 0.7 | = | 12.64 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 13.12 | x | 0.63 | x | 0.7 | = | 14.03 | (74) |
| North | 0.9x | 0.77 | x 4.29 | x | 13.12 | x | 0.63 | x | 0.7 | = | 17.2 | (74) |
| North | 0.9x | 0.77 | x 1.71 | x | 13.12 | x | 0.63 | x | 0.7 | = | 6.86 | (74) |
| North | 0.9x | 0.77 | x 1.75 | x | 8.86 | x | 0.63 | x | 0.7 | = | 9.48 | (74) |

# DER WorkSheet: New dwelling design stage

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 0.77 | x | 4.29 | x | 8.86 | x | 0.63 | x | 0.7 | = | 11.62 | (74) |
| North | 0.9x | 0.77 | x | 1.71 | x | 8.86 | x | 0.63 | x | 0.7 | = | 4.63 | (74) |
| East | 0.9x | 0.77 | x | 2.87 | x | 19.64 | x | 0.63 | x | 0.7 | = | 17.23 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 19.64 | x | 0.51 | x | 0.8 | = | 30.76 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 38.42 | x | 0.63 | x | 0.7 | = | 33.7 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 38.42 | x | 0.51 | x | 0.8 | = | 60.18 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 63.27 | x | 0.63 | x | 0.7 | = | 55.5 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 63.27 | x | 0.51 | x | 0.8 | = | 99.11 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 92.28 | x | 0.63 | x | 0.7 | = | 80.94 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 92.28 | x | 0.51 | x | 0.8 | = | 144.55 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 113.09 | x | 0.63 | x | 0.7 | = | 99.19 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 113.09 | x | 0.51 | x | 0.8 | = | 177.15 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 115.77 | x | 0.63 | x | 0.7 | = | 101.54 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 115.77 | x | 0.51 | x | 0.8 | = | 181.34 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 110.22 | x | 0.63 | x | 0.7 | = | 96.67 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 110.22 | x | 0.51 | x | 0.8 | = | 172.65 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 94.68 | x | 0.63 | x | 0.7 | = | 83.04 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 94.68 | x | 0.51 | x | 0.8 | = | 148.3 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 73.59 | x | 0.63 | x | 0.7 | = | 64.55 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 73.59 | x | 0.51 | x | 0.8 | = | 115.27 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 45.59 | x | 0.63 | x | 0.7 | = | 39.99 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 45.59 | x | 0.51 | x | 0.8 | = | 71.41 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 24.49 | x | 0.63 | x | 0.7 | = | 21.48 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 24.49 | x | 0.51 | x | 0.8 | = | 38.36 | (76) |
| East | 0.9x | 0.77 | x | 2.87 | x | 16.15 | x | 0.63 | x | 0.7 | = | 14.17 | (76) |
| East | 0.9x | 0.77 | x | 5.54 | x | 16.15 | x | 0.51 | x | 0.8 | = | 25.3 | (76) |
| South | 0.9x | 0.77 | x | 1.73 | x | 46.75 | x | 0.51 | x | 0.8 | = | 22.87 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 76.57 | x | 0.51 | x | 0.8 | = | 37.45 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 97.53 | x | 0.51 | x | 0.8 | = | 47.71 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 110.23 | x | 0.51 | x | 0.8 | = | 53.92 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 114.87 | x | 0.51 | x | 0.8 | = | 56.19 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 110.55 | x | 0.51 | x | 0.8 | = | 54.07 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 108.01 | x | 0.51 | x | 0.8 | = | 52.83 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 104.89 | x | 0.51 | x | 0.8 | = | 51.31 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 101.89 | x | 0.51 | x | 0.8 | = | 49.84 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 82.59 | x | 0.51 | x | 0.8 | = | 40.4 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 55.42 | x | 0.51 | x | 0.8 | = | 27.11 | (78) |
| South | 0.9x | 0.77 | x | 1.73 | x | 40.4 | x | 0.51 | x | 0.8 | = | 19.76 | (78) |
| Rooflights | 0.9x | 1 | x | 1.63 | x | 34.34 | x | 0.63 | x | 0.7 | = | 22.24 | (82) |
| Rooflights | 0.9x | 1 | x | 1.63 | x | 66.69 | x | 0.63 | x | 0.7 | = | 43.19 | (82) |
| Rooflights | 0.9x | 1 | x | 1.63 | x | 109.61 | x | 0.63 | x | 0.7 | = | 71 | (82) |

# DER WorkSheet: New dwelling design stage

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rooflights 0.9x | 1 | x | 1.63 | x | 161.05 | x | 0.63 | x | 0.7 | = | 104.32 | (82) |
| Rooflights 0.9x | 1 | x | 1.63 | x | 199.42 | x | 0.63 | x | 0.7 | = | 129.17 | (82) |
| Rooflights 0.9x | 1 | x | 1.63 | x | 205.27 | x | 0.63 | x | 0.7 | = | 132.96 | (82) |
| Rooflights 0.9x | 1 | x | 1.63 | x | 194.95 | x | 0.63 | x | 0.7 | = | 126.28 | (82) |
| Rooflights 0.9x | 1 | x | 1.63 | x | 165.92 | x | 0.63 | x | 0.7 | = | 107.47 | (82) |
| Rooflights 0.9x | 1 | x | 1.63 | x | 127.73 | x | 0.63 | x | 0.7 | = | 82.74 | (82) |
| Rooflights 0.9x | 1 | x | 1.63 | x | 78.98 | x | 0.63 | x | 0.7 | = | 51.16 | (82) |
| Rooflights 0.9x | 1 | x | 1.63 | x | 42.71 | x | 0.63 | x | 0.7 | = | 27.66 | (82) |
| Rooflights 0.9x | 1 | x | 1.63 | x | 28.32 | x | 0.63 | x | 0.7 | = | 18.35 | (82) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 123.98 | 233.53 | 373.57 | 544.76 | 678.63 | 702.15 | 665.24 | 562.13 | 432.93 | 273.18 | 152.69 | 103.31 | (83) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 462.53 | 570.16 | 698.15 | 849.94 | 964.2 | 968.72 | 919.39 | 821.82 | 702.51 | 562.37 | 464.42 | 431.84 | (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= | 0.93 | 0.89 | 0.83 | 0.72 | 0.59 | 0.45 | 0.35 | 0.4 | 0.59 | 0.8 | 0.9 | 0.94 | (86) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 20.4 | 20.4 | 20.4 | 20.41 | 20.41 | 20.42 | 20.42 | 20.42 | 20.41 | 20.41 | 20.41 | 20.4 | (88) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.92 | 0.89 | 0.82 | 0.71 | 0.57 | 0.42 | 0.31 | 0.35 | 0.56 | 0.78 | 0.9 | 0.93 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 20.4 | 20.4 | 20.4 | 20.41 | 20.41 | 20.42 | 20.42 | 20.42 | 20.41 | 20.41 | 20.41 | 20.4 | (90) |

fLA = Living area ÷ (4) = | 0.42 | (91)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 20.65 | 20.65 | 20.65 | 20.66 | 20.66 | 20.66 | 20.66 | 20.66 | 20.66 | 20.66 | 20.65 | 20.65 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 20.65 | 20.65 | 20.65 | 20.66 | 20.66 | 20.66 | 20.66 | 20.66 | 20.66 | 20.66 | 20.65 | 20.65 | (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= | 0.93 | 0.89 | 0.83 | 0.71 | 0.58 | 0.43 | 0.33 | 0.37 | 0.58 | 0.79 | 0.9 | 0.94 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 428.58 | 507.57 | 576.64 | 607.62 | 555.73 | 419.78 | 299.14 | 305.74 | 404.65 | 445.06 | 417.31 | 403.79 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 1345.99 | 1293.18 | 1158.75 | 949.58 | 721.49 | 481.54 | 322.64 | 337.66 | 524.02 | 810.11 | 1097.91 | 1339.95 | (97) |

# DER WorkSheet: New dwelling design stage

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (98)m= | 682.55 | 527.93 | 433.09 | 246.21 | 123.33 | 0 | 0 | 0 | 0 | 271.59 | 490.03 | 696.5 |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3471.23 (98)

Space heating requirement in kWh/m²/year 50.9 (99)

## 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 | | 512.02 | (206) |
| Efficiency of secondary/supplementary heating system, % | | 100 | (208) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | kWh/year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating requirement (calculated above) | 682.55 | 527.93 | 433.09 | 246.21 | 123.33 | 0 | 0 | 0 | 0 | 271.59 | 490.03 | 696.5 | |
| (211)m = {[(98)m x (204)] } x 100 ÷ (206) | 133.3 | 103.11 | 84.58 | 48.09 | 24.09 | 0 | 0 | 0 | 0 | 53.04 | 95.7 | 136.03 | |

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 677.94 (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)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 155.15 | 136.1 | 141.39 | 124.62 | 120.58 | 105.53 | 99.24 | 111.8 | 112.51 | 129.33 | 139.43 | 150.7 |

Efficiency of water heater 194.18 (216)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (217)m= | 194.18 | 194.18 | 194.18 | 194.18 | 194.18 | 194.18 | 194.18 | 194.18 | 194.18 | 194.18 | 194.18 | 194.18 | (217) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (219)m= | 79.9 | 70.09 | 72.82 | 64.18 | 62.1 | 54.34 | 51.11 | 57.58 | 57.94 | 66.6 | 71.8 | 77.61 |

Total = Sum(219a)$_{1...12}$ = 786.06 (219)

| **Annual totals** | **kWh/year** | **kWh/year** | |
|---|---|---|---|
| Space heating fuel used, main system 1 | | 677.94 | |
| Water heating fuel used | | 786.06 | |
| Electricity for pumps, fans and electric keep-hot | | | |
| mechanical ventilation - balanced, extract or positive input from outside | 177.85 | | (230a) |
| warm air heating system fans | 92.07 | | (230b) |
| Total electricity for the above, kWh/year | sum of (230a)…(230g) = | 269.92 | (231) |
| Electricity for lighting | | 303.96 | (232) |
| Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) = | | 2037.88 | (338) |

## 12a. CO2 emissions – Individual heating systems including micro-CHP

# DER WorkSheet: New dwelling design stage

| | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|
| Space heating (main system 1) | (211) x | 0.519 | = | 351.85 | (261) |
| Space heating (secondary) | (215) x | 0.519 | = | 0 | (263) |
| Water heating | (219) x | 0.519 | = | 407.97 | (264) |
| Space and water heating | (261) + (262) + (263) + (264) = | | | 759.82 | (265) |
| Electricity for pumps, fans and electric keep-hot | (231) x | 0.519 | = | 140.09 | (267) |
| Electricity for lighting | (232) x | 0.519 | = | 157.75 | (268) |
| Total CO2, kg/year | | sum of (265)…(271) = | | 1057.66 | (272) |
| **Dwelling CO2 Emission Rate** | | (272) ÷ (4) = | | 15.51 | (273) |
| EI rating (section 14) | | | | 87 | (274) |