# 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 12

**Address :** FLAT 12, 43 London Street, Reading, RG1 4PS

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 56 | (1a) x | 2.3 | (2a) = | 128.8 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 56 | (4) | | | | |
| Dwelling volume | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | | 128.8 | (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) = 72.25 (23c)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0.36 | 0.36 | 0.35 | 0.33 | 0.33 | 0.3 | 0.3 | 0.3 | 0.31 | 0.33 | 0.34 | 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 | 0.36 | 0.35 | 0.33 | 0.33 | 0.3 | 0.3 | 0.3 | 0.31 | 0.33 | 0.34 | 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 | 0.33 | = | 0.693 | | | (26) |
| Windows Type 1 | | | 3.72 | x1/[1/( 0.92 )+ 0.04] | | = | 3.3 | | | (27) |
| Windows Type 2 | | | 1.16 | x1/[1/( 0.92 )+ 0.04] | | = | 1.03 | | | (27) |
| Windows Type 3 | | | 1.75 | x1/[1/( 1.1 )+ 0.04] | | = | 1.84 | | | (27) |
| Windows Type 4 | | | 2.12 | x1/[1/( 1.1 )+ 0.04] | | = | 2.23 | | | (27) |
| Windows Type 5 | | | 2.12 | x1/[1/( 1.1 )+ 0.04] | | = | 2.23 | | | (27) |
| Windows Type 6 | | | 1.14 | x1/[1/( 1.1 )+ 0.04] | | = | 1.2 | | | (27) |
| Windows Type 7 | | | 2.81 | x1/[1/( 1.1 )+ 0.04] | | = | 2.96 | | | (27) |
| Floor | | | 37.5 | x | 0.16 | = | 6 | 20 | 750 | (28) |
| Walls Type1 | 49.32 | 14.82 | 34.5 | x | 0.16 | = | 5.52 | 14 | 483 | (29) |
| Walls Type2 | 9.43 | 2.1 | 7.33 | x | 0.14 | = | 1.03 | 14 | 102.62 | (29) |
| Walls Type3 | 11.4 | 0 | 11.4 | x | 0.14 | = | 1.6 | 9 | 102.6 | (29) |
| Total area of elements, m² | | | 107.65 | | | | | | | (31) |
| Party wall | | | 11.73 | x | 0 | = | 0 | 20 | 234.6 | (32) |
| Party floor | | | 18.5 | | | | | 30 | 555 | (32a) |
| Party ceiling | | | 56 | | | | | 20 | 1120 | (32b) |
| Internal wall ** | | | 98.9 | | | | | 9 | 890.1 | (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) = 29.64 (33)

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| | | | |
|---|---|---|---|
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 4237.92 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | = (34) ÷ (4) = | 75.68 | (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 | 16.15 | (36) |

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

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 45.79 | (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= | 15.38 | 15.2 | 15.01 | 14.08 | 13.89 | 12.96 | 12.96 | 12.78 | 13.34 | 13.89 | 14.27 | 14.64 | (38) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 61.17 | 60.98 | 60.8 | 59.87 | 59.68 | 58.75 | 58.75 | 58.56 | 59.12 | 59.68 | 60.05 | 60.42 | |

Average = Sum(39)$_{1…12}$ /12= 59.82 (39)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.09 | 1.09 | 1.09 | 1.07 | 1.07 | 1.05 | 1.05 | 1.05 | 1.06 | 1.07 | 1.07 | 1.08 | |

Average = Sum(40)$_{1…12}$ /12= 1.07 (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 1.87 (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 78.53 (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= | 86.38 | 83.24 | 80.1 | 76.96 | 73.82 | 70.68 | 70.68 | 73.82 | 76.96 | 80.1 | 83.24 | 86.38 |

Total = Sum(44)$_{1…12}$ = 942.38 (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= | 128.11 | 112.04 | 115.62 | 100.8 | 96.72 | 83.46 | 77.34 | 88.75 | 89.81 | 104.66 | 114.25 | 124.06 |

Total = Sum(45)$_{1…12}$ = 1235.61 (45)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 19.22 | 16.81 | 17.34 | 15.12 | 14.51 | 12.52 | 11.6 | 13.31 | 13.47 | 15.7 | 17.14 | 18.61 | (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= | 142.17 | 124.74 | 129.68 | 114.41 | 110.78 | 97.07 | 91.4 | 102.81 | 103.42 | 118.72 | 127.85 | 138.13 | (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= | 142.17 | 124.74 | 129.68 | 114.41 | 110.78 | 97.07 | 91.4 | 102.81 | 103.42 | 118.72 | 127.85 | 138.13 |

Output from water heater (annual)$_{1...12}$ | 1401.17 | (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= | 42.6 | 37.25 | 38.44 | 33.52 | 32.16 | 27.75 | 25.72 | 29.51 | 29.86 | 34.8 | 37.99 | 41.25 | (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= | 93.33 | 93.33 | 93.33 | 93.33 | 93.33 | 93.33 | 93.33 | 93.33 | 93.33 | 93.33 | 93.33 | 93.33 | (66) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 14.51 | 12.89 | 10.48 | 7.93 | 5.93 | 5.01 | 5.41 | 7.03 | 9.44 | 11.99 | 13.99 | 14.91 | (67) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 162.76 | 164.45 | 160.19 | 151.13 | 139.69 | 128.94 | 121.76 | 120.07 | 124.33 | 133.39 | 144.83 | 155.58 | (68) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 32.33 | 32.33 | 32.33 | 32.33 | 32.33 | 32.33 | 32.33 | 32.33 | 32.33 | 32.33 | 32.33 | 32.33 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | (70) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -74.66 | -74.66 | -74.66 | -74.66 | -74.66 | -74.66 | -74.66 | -74.66 | -74.66 | -74.66 | -74.66 | -74.66 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 57.25 | 55.44 | 51.67 | 46.55 | 43.22 | 38.54 | 34.56 | 39.66 | 41.47 | 46.77 | 52.76 | 55.45 | (72) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 293.25 | 291.5 | 281.07 | 264.34 | 247.58 | 231.22 | 220.46 | 225.5 | 233.97 | 250.88 | 270.3 | 284.66 | (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 | 1.14 | x | 10.63 | x | 0.63 | x | 0.7 | = | 3.7 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 20.32 | x | 0.63 | x | 0.7 | = | 7.08 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 34.53 | x | 0.63 | x | 0.7 | = | 12.03 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 55.46 | x | 0.63 | x | 0.7 | = | 19.32 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 74.72 | x | 0.63 | x | 0.7 | = | 26.03 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 79.99 | x | 0.63 | x | 0.7 | = | 27.87 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 74.68 | x | 0.63 | x | 0.7 | = | 26.02 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 59.25 | x | 0.63 | x | 0.7 | = | 20.64 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 41.52 | x | 0.63 | x | 0.7 | = | 14.46 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 24.19 | x | 0.63 | x | 0.7 | = | 8.43 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 13.12 | x | 0.63 | x | 0.7 | = | 4.57 | (74) |
| North | 0.9x | 0.77 | x | 1.14 | x | 8.86 | x | 0.63 | x | 0.7 | = | 3.09 | (74) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 11.28 | x | 0.63 | x | 0.7 | = | 7.31 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 22.97 | x | 0.63 | x | 0.7 | = | 14.88 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 41.38 | x | 0.63 | x | 0.7 | = | 26.81 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 67.96 | x | 0.63 | x | 0.7 | = | 44.03 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 91.35 | x | 0.63 | x | 0.7 | = | 59.18 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 97.38 | x | 0.63 | x | 0.7 | = | 63.1 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 91.1 | x | 0.63 | x | 0.7 | = | 59.02 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 72.63 | x | 0.63 | x | 0.7 | = | 47.05 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 50.42 | x | 0.63 | x | 0.7 | = | 32.67 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 28.07 | x | 0.63 | x | 0.7 | = | 18.18 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 14.2 | x | 0.63 | x | 0.7 | = | 9.2 | (75) |
| Northeast | 0.9x | 0.77 | x | 2.12 | x | 9.21 | x | 0.63 | x | 0.7 | = | 5.97 | (75) |
| East | 0.9x | 0.77 | x | 2.81 | x | 19.64 | x | 0.63 | x | 0.7 | = | 16.87 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 38.42 | x | 0.63 | x | 0.7 | = | 32.99 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 63.27 | x | 0.63 | x | 0.7 | = | 54.34 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 92.28 | x | 0.63 | x | 0.7 | = | 79.25 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 113.09 | x | 0.63 | x | 0.7 | = | 97.12 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 115.77 | x | 0.63 | x | 0.7 | = | 99.42 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 110.22 | x | 0.63 | x | 0.7 | = | 94.65 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 94.68 | x | 0.63 | x | 0.7 | = | 81.31 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 73.59 | x | 0.63 | x | 0.7 | = | 63.2 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 45.59 | x | 0.63 | x | 0.7 | = | 39.15 | (76) |

# DER WorkSheet: New dwelling design stage

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 0.77 | x | 2.81 | x | 24.49 | x | 0.63 | x | 0.7 | = | 21.03 | (76) |
| East | 0.9x | 0.77 | x | 2.81 | x | 16.15 | x | 0.63 | x | 0.7 | = | 13.87 | (76) |
| South | 0.9x | 0.77 | x | 1.16 | x | 46.75 | x | 0.51 | x | 0.8 | = | 15.33 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 76.57 | x | 0.51 | x | 0.8 | = | 25.11 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 97.53 | x | 0.51 | x | 0.8 | = | 31.99 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 110.23 | x | 0.51 | x | 0.8 | = | 36.16 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 114.87 | x | 0.51 | x | 0.8 | = | 37.68 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 110.55 | x | 0.51 | x | 0.8 | = | 36.26 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 108.01 | x | 0.51 | x | 0.8 | = | 35.43 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 104.89 | x | 0.51 | x | 0.8 | = | 34.4 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 101.89 | x | 0.51 | x | 0.8 | = | 33.42 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 82.59 | x | 0.51 | x | 0.8 | = | 27.09 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 55.42 | x | 0.51 | x | 0.8 | = | 18.18 | (78) |
| South | 0.9x | 0.77 | x | 1.16 | x | 40.4 | x | 0.51 | x | 0.8 | = | 13.25 | (78) |
| West | 0.9x | 0.77 | x | 3.72 | x | 19.64 | x | 0.51 | x | 0.8 | = | 20.66 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 19.64 | x | 0.63 | x | 0.7 | = | 10.5 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 38.42 | x | 0.51 | x | 0.8 | = | 40.41 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 38.42 | x | 0.63 | x | 0.7 | = | 20.55 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 63.27 | x | 0.51 | x | 0.8 | = | 66.55 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 63.27 | x | 0.63 | x | 0.7 | = | 33.84 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 92.28 | x | 0.51 | x | 0.8 | = | 97.06 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 92.28 | x | 0.63 | x | 0.7 | = | 49.35 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 113.09 | x | 0.51 | x | 0.8 | = | 118.95 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 113.09 | x | 0.63 | x | 0.7 | = | 60.48 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 115.77 | x | 0.51 | x | 0.8 | = | 121.77 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 115.77 | x | 0.63 | x | 0.7 | = | 61.92 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 110.22 | x | 0.51 | x | 0.8 | = | 115.93 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 110.22 | x | 0.63 | x | 0.7 | = | 58.95 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 94.68 | x | 0.51 | x | 0.8 | = | 99.58 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 94.68 | x | 0.63 | x | 0.7 | = | 50.63 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 73.59 | x | 0.51 | x | 0.8 | = | 77.4 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 73.59 | x | 0.63 | x | 0.7 | = | 39.36 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 45.59 | x | 0.51 | x | 0.8 | = | 47.95 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 45.59 | x | 0.63 | x | 0.7 | = | 24.38 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 24.49 | x | 0.51 | x | 0.8 | = | 25.76 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 24.49 | x | 0.63 | x | 0.7 | = | 13.1 | (80) |
| West | 0.9x | 0.77 | x | 3.72 | x | 16.15 | x | 0.51 | x | 0.8 | = | 16.99 | (80) |
| West | 0.9x | 0.77 | x | 1.75 | x | 16.15 | x | 0.63 | x | 0.7 | = | 8.64 | (80) |
| Northwest | 0.9x | 0.77 | x | 2.12 | x | 11.28 | x | 0.63 | x | 0.7 | = | 7.31 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.12 | x | 22.97 | x | 0.63 | x | 0.7 | = | 14.88 | (81) |
| Northwest | 0.9x | 0.77 | x | 2.12 | x | 41.38 | x | 0.63 | x | 0.7 | = | 26.81 | (81) |

# DER WorkSheet: New dwelling design stage

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Northwest 0.9x | 0.77 | x | 2.12 | x | 67.96 | x | 0.63 | x | 0.7 | = | 44.03 | (81) |
| Northwest 0.9x | 0.77 | x | 2.12 | x | 91.35 | x | 0.63 | x | 0.7 | = | 59.18 | (81) |
| Northwest 0.9x | 0.77 | x | 2.12 | x | 97.38 | x | 0.63 | x | 0.7 | = | 63.1 | (81) |
| Northwest 0.9x | 0.77 | x | 2.12 | x | 91.1 | x | 0.63 | x | 0.7 | = | 59.02 | (81) |
| Northwest 0.9x | 0.77 | x | 2.12 | x | 72.63 | x | 0.63 | x | 0.7 | = | 47.05 | (81) |
| Northwest 0.9x | 0.77 | x | 2.12 | x | 50.42 | x | 0.63 | x | 0.7 | = | 32.67 | (81) |
| Northwest 0.9x | 0.77 | x | 2.12 | x | 28.07 | x | 0.63 | x | 0.7 | = | 18.18 | (81) |
| Northwest 0.9x | 0.77 | x | 2.12 | x | 14.2 | x | 0.63 | x | 0.7 | = | 9.2 | (81) |
| Northwest 0.9x | 0.77 | x | 2.12 | x | 9.21 | x | 0.63 | x | 0.7 | = | 5.97 | (81) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 81.69 | 155.91 | 252.37 | 369.2 | 458.63 | 473.42 | 449.02 | 380.68 | 293.17 | 183.37 | 101.03 | 67.77 | (83) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 374.93 | 447.41 | 533.44 | 633.54 | 706.21 | 704.64 | 669.48 | 606.17 | 527.14 | 434.25 | 371.33 | 352.44 | (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 | 0.9 | 0.85 | 0.74 | 0.61 | 0.47 | 0.36 | 0.4 | 0.61 | 0.81 | 0.91 | 0.94 | (86) |

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

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

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 20.45 | 20.46 | 20.46 | 20.47 | 20.47 | 20.48 | 20.48 | 20.48 | 20.47 | 20.47 | 20.46 | 20.46 | (88) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.93 | 0.9 | 0.84 | 0.73 | 0.59 | 0.44 | 0.32 | 0.37 | 0.58 | 0.8 | 0.9 | 0.94 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 20.45 | 20.46 | 20.46 | 20.47 | 20.47 | 20.48 | 20.48 | 20.48 | 20.47 | 20.47 | 20.46 | 20.46 | (90) |

fLA = Living area ÷ (4) = 0.44 (91)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 20.69 | 20.69 | 20.69 | 20.7 | 20.7 | 20.7 | 20.7 | 20.71 | 20.7 | 20.7 | 20.7 | 20.7 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 20.69 | 20.69 | 20.69 | 20.7 | 20.7 | 20.7 | 20.7 | 20.71 | 20.7 | 20.7 | 20.7 | 20.7 | (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 | 0.9 | 0.84 | 0.73 | 0.6 | 0.45 | 0.34 | 0.38 | 0.59 | 0.8 | 0.9 | 0.94 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 349.07 | 402.29 | 448.28 | 465.63 | 422.69 | 318.02 | 226.47 | 232.19 | 310.71 | 348.51 | 335.84 | 330.86 | (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= | 1002.7 | 963.12 | 862.97 | 706.37 | 537.13 | 358.66 | 241.16 | 252.17 | 390.39 | 602.78 | 816.6 | 996.78 | (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= | 486.31 | 376.88 | 308.53 | 173.34 | 85.15 | 0 | 0 | 0 | 0 | 189.18 | 346.15 | 495.44 |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2460.97 (98)

Space heating requirement in kWh/m²/year 43.95 (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 | 509.18 | (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) | 486.31 | 376.88 | 308.53 | 173.34 | 85.15 | 0 | 0 | 0 | 0 | 189.18 | 346.15 | 495.44 | |
| (211)m = {[(98)m x (204)] } x 100 ÷ (206) | 95.51 | 74.02 | 60.59 | 34.04 | 16.72 | 0 | 0 | 0 | 0 | 37.15 | 67.98 | 97.3 | |

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 483.32 (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)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 142.17 | 124.74 | 129.68 | 114.41 | 110.78 | 97.07 | 91.4 | 102.81 | 103.42 | 118.72 | 127.85 | 138.13 |

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= | 73.21 | 64.24 | 66.78 | 58.92 | 57.05 | 49.99 | 47.07 | 52.95 | 53.26 | 61.14 | 65.84 | 71.13 |

Total = Sum(219a)$_{1...12}$ = 721.58 (219)

| **Annual totals** | **kWh/year** | **kWh/year** | |
|---|---|---|---|
| Space heating fuel used, main system 1 | | 483.32 | |
| Water heating fuel used | | 721.58 | |
| Electricity for pumps, fans and electric keep-hot | | | |
| mechanical ventilation - balanced, extract or positive input from outside | 143.39 | | (230a) |
| warm air heating system fans | 77.28 | | (230b) |
| Total electricity for the above, kWh/year sum of (230a)…(230g) = | | 220.67 | (231) |
| Electricity for lighting | | 256.25 | (232) |
| Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) = | | 1681.82 | (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 | = | 250.84 | (261) |
| Space heating (secondary) | (215) x | 0.519 | = | 0 | (263) |
| Water heating | (219) x | 0.519 | = | 374.5 | (264) |
| Space and water heating | (261) + (262) + (263) + (264) = | | | 625.34 | (265) |
| Electricity for pumps, fans and electric keep-hot | (231) x | 0.519 | = | 114.53 | (267) |
| Electricity for lighting | (232) x | 0.519 | = | 132.99 | (268) |
| Total CO2, kg/year | | sum of (265)…(271) = | | 872.87 | (272) |
| **Dwelling CO2 Emission Rate** | | (272) ÷ (4) = | | 15.59 | (273) |
| EI rating (section 14) | | | | 88 | (274) |