

APPENDIX VI – TER SAP WORKSHEETS

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 1B2P-TF-N (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	51.67 (1a)	2.53 (2a)	130.47 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	51.67 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	130.47 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.15 (8)
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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)

Additional infiltration

[(9)-1]x0.1 =

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

0.25 - [0.2 x (14) ÷ 100] =

Infiltration rate

(8) + (10) + (11) + (12) + (13) + (15) =

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

(20) = 1 - [0.075 x (19)] =

Infiltration rate incorporating shelter factor

(21) = (18) x (20) =

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.34	0.37	0.39	0.4
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

(25)m= 0.6 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (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	2		
Windows Type 1			8.79	$\times 1/[1/(1.4) + 0.04]$	11.65		
Windows Type 2			2.13	$\times 1/[1/(1.4) + 0.04]$	2.82		
Walls Type1	15.15	10.92	4.23	0.18	0.76		
Walls Type2	29	2	27	0.18	4.86		
Roof	51.67	0	51.67	0.13	6.72		
Total area of elements, m²			95.82				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 28.82 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 1247.13 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 4.79 (36)

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

Total fabric heat loss (33) + (36) = 33.61 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	25.64	25.48	25.32	24.59	24.45	23.81	23.81	23.69	24.06	24.45	24.73	25.02

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

(39)m=	59.25	59.09	58.93	58.19	58.06	57.42	57.42	57.3	57.66	58.06	58.34	58.63
Average = Sum(39) _{1...12} /12=												58.19

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	1.15	1.14	1.14	1.13	1.12	1.11	1.11	1.11	1.12	1.12	1.13	1.13		
Average = Sum(40) _{1...12} /12=													1.13	(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

1.74

(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

75.51

(43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	83.06	80.04	77.02	74	70.98	67.96	67.96	70.98	74	77.02	80.04	83.06		
Total = Sum(44) _{1...12} =													906.11	(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=	123.18	107.73	111.17	96.92	93	80.25	74.36	85.33	86.35	100.63	109.85	119.29																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	</
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If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	18.48	16.16	16.68	14.54	13.95	12.04	11.15	12.8	12.95	15.1	16.48	17.89		(46)
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Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.39

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

(48) x (49) =

0.75

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

(47) x (51) x (52) x (53) =

0

(54)

Enter (50) or (54) in (55)

0.75

(55)

Water storage loss calculated for each month

((56)m = (55) x (41)m

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(56)
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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=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(57)
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Primary circuit loss (annual) from Table 3

0

(58)

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	0	0	0	0	0	0	0	0	0	0	0	(61)
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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=	169.77	149.82	157.76	142.01	139.59	125.34	120.96	131.93	131.44	147.23	154.94	165.88	(62)
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Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

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

(63)m=	0	0	0	0	0	0	0	0	0	0	0	(63)
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Output from water heater

(64)m=	169.77	149.82	157.76	142.01	139.59	125.34	120.96	131.93	131.44	147.23	154.94	165.88	
Output from water heater (annual) _{1...12}												1736.67	(64)

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

(65)m=	78.23	69.49	74.24	68.3	68.2	62.76	62	65.65	64.79	70.74	72.6	76.94	(65)
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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=	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	(66)

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

(67)m=	13.93	12.37	10.06	7.62	5.69	4.81	5.19	6.75	9.06	11.5	13.43	14.31	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	151.57	153.14	149.18	140.74	130.09	120.08	113.39	111.82	115.78	124.22	134.87	144.88	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	(69)
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Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
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Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	(71)
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Water heating gains (Table 5)

(72)m=	105.15	103.41	99.78	94.86	91.66	87.16	83.34	88.24	89.98	95.08	100.83	103.41	(72)
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Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	322.74	321.01	311.11	295.31	279.54	264.14	254.01	258.9	266.91	282.89	301.22	314.7	(73)
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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 m ²	Flux Table 6a			g_ Table 6b	FF Table 6c			Gains (W)	
North	0.9x	0.54	x	8.79	x	10.63	x	0.63	x	0.7	=	20.03	(74)
North	0.9x	0.54	x	8.79	x	20.32	x	0.63	x	0.7	=	38.28	(74)
North	0.9x	0.54	x	8.79	x	34.53	x	0.63	x	0.7	=	65.05	(74)
North	0.9x	0.54	x	8.79	x	55.46	x	0.63	x	0.7	=	104.49	(74)
North	0.9x	0.54	x	8.79	x	74.72	x	0.63	x	0.7	=	140.76	(74)

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North	0.9x	0.54	x	8.79	x	79.99	x	0.63	x	0.7	=	150.69	(74)
North	0.9x	0.54	x	8.79	x	74.68	x	0.63	x	0.7	=	140.69	(74)
North	0.9x	0.54	x	8.79	x	59.25	x	0.63	x	0.7	=	111.62	(74)
North	0.9x	0.54	x	8.79	x	41.52	x	0.63	x	0.7	=	78.21	(74)
North	0.9x	0.54	x	8.79	x	24.19	x	0.63	x	0.7	=	45.57	(74)
North	0.9x	0.54	x	8.79	x	13.12	x	0.63	x	0.7	=	24.71	(74)
North	0.9x	0.54	x	8.79	x	8.86	x	0.63	x	0.7	=	16.7	(74)
West	0.9x	0.54	x	2.13	x	19.64	x	0.63	x	0.7	=	8.97	(80)
West	0.9x	0.54	x	2.13	x	38.42	x	0.63	x	0.7	=	17.54	(80)
West	0.9x	0.54	x	2.13	x	63.27	x	0.63	x	0.7	=	28.89	(80)
West	0.9x	0.54	x	2.13	x	92.28	x	0.63	x	0.7	=	42.13	(80)
West	0.9x	0.54	x	2.13	x	113.09	x	0.63	x	0.7	=	51.63	(80)
West	0.9x	0.54	x	2.13	x	115.77	x	0.63	x	0.7	=	52.85	(80)
West	0.9x	0.54	x	2.13	x	110.22	x	0.63	x	0.7	=	50.32	(80)
West	0.9x	0.54	x	2.13	x	94.68	x	0.63	x	0.7	=	43.22	(80)
West	0.9x	0.54	x	2.13	x	73.59	x	0.63	x	0.7	=	33.59	(80)
West	0.9x	0.54	x	2.13	x	45.59	x	0.63	x	0.7	=	20.81	(80)
West	0.9x	0.54	x	2.13	x	24.49	x	0.63	x	0.7	=	11.18	(80)
West	0.9x	0.54	x	2.13	x	16.15	x	0.63	x	0.7	=	7.37	(80)

Solar gains in watts, calculated for each month

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

(83)m=	29	55.82	93.94	146.62	192.39	203.54	191	154.84	111.81	66.38	35.89	24.07	(83)
--------	----	-------	-------	--------	--------	--------	-----	--------	--------	-------	-------	-------	------

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

(84)m=	351.74	376.83	405.05	441.93	471.92	467.67	445.01	413.73	378.72	349.27	337.11	338.77	(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=	1	0.99	0.99	0.96	0.89	0.72	0.55	0.61	0.86	0.97	0.99	1	(86)

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

(87)m=	19.84	19.95	20.17	20.49	20.78	20.95	20.99	20.98	20.87	20.52	20.13	19.82	(87)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(88)m=	19.96	19.97	19.97	19.98	19.98	19.99	19.99	19.99	19.99	19.98	19.98	19.97	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	1	0.99	0.98	0.95	0.84	0.63	0.43	0.49	0.79	0.96	0.99	1	(89)
--------	---	------	------	------	------	------	------	------	------	------	------	---	------

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

(90)m=	18.42	18.59	18.91	19.38	19.76	19.96	19.99	19.99	19.88	19.42	18.86	18.4	(90)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	------

fLA = Living area ÷ (4) =

0.51 (91)

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

(92)m=	19.14	19.28	19.55	19.94	20.28	20.46	20.5	20.49	20.38	19.98	19.51	19.13	(92)
--------	-------	-------	-------	-------	-------	-------	------	-------	-------	-------	-------	-------	------

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

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(93)m=	19.14	19.28	19.55	19.94	20.28	20.46	20.5	20.49	20.38	19.98	19.51	19.13	(93)
--------	-------	-------	-------	-------	-------	-------	------	-------	-------	-------	-------	-------	------

8. Space heating requirement

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

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

Utilisation factor for gains, h_m :

(94)m=	0.99	0.99	0.98	0.95	0.86	0.68	0.5	0.55	0.82	0.96	0.99	1	(94)
--------	------	------	------	------	------	------	-----	------	------	------	------	---	------

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

(95)m=	349.64	373.35	397.42	419.27	405.06	316.63	220.53	228.97	309.83	335.48	333.42	337.09	(95)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
--------	-----	-----	-----	-----	------	------	------	------	------	------	-----	-----	------

Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	879.42	849.81	769.3	642.73	498.08	336.46	223.77	234.52	362.19	544.58	723.84	875.02	(97)
--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(98)m=	394.16	320.18	276.68	160.89	69.21	0	0	0	0	155.57	281.1	400.22	
--------	--------	--------	--------	--------	-------	---	---	---	---	--------	-------	--------	--

Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 2058.01 (98)

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

39.83 (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) = $(202) \times [1 - (203)] =$

1 (204)

Efficiency of main space heating system 1

93.5 (206)

Efficiency of secondary/supplementary heating system, %

0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----------

Space heating requirement (calculated above)

394.16	320.18	276.68	160.89	69.21	0	0	0	0	155.57	281.1	400.22
--------	--------	--------	--------	-------	---	---	---	---	--------	-------	--------

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

421.56	342.44	295.91	172.08	74.02	0	0	0	0	166.38	300.64	428.04
--------	--------	--------	--------	-------	---	---	---	---	--------	--------	--------

Total ($kWh/year$) = $Sum(211)_{1..5,10..12} =$ 2201.08 (211)

Space heating fuel (secondary), $kWh/month$

= $\{[(98)m \times (201)]\} \times 100 \div (208)$

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

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

Water heating

Output from water heater (calculated above)

169.77	149.82	157.76	142.01	139.59	125.34	120.96	131.93	131.44	147.23	154.94	165.88
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Efficiency of water heater

79.8 (216)

(217)m=	86.99	86.79	86.3	85.15	83.05	79.8	79.8	79.8	79.8	84.96	86.38	87.08	(217)
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Fuel for water heating, $kWh/month$

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

(219)m=	195.16	172.62	182.81	166.78	168.07	157.07	151.58	165.32	164.71	173.29	179.36	190.5	
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Total = $Sum(219a)_{1..12} =$ 2067.28 (219)

Annual totals

$kWh/year$

$kWh/year$

Space heating fuel used, main system 1

2201.08

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Water heating fuel used			2067.28	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		75	(231)
Electricity for lighting			245.96	(232)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x		0.216	=	475.43	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	446.53	(264)
Space and water heating	(261) + (262) + (263) + (264) =				921.96	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93	(267)
Electricity for lighting	(232) x		0.519	=	127.66	(268)
Total CO2, kg/year		sum of (265)...(271) =			1088.55	(272)

TER = 21.07 (273)

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User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 1B2P-TF-S (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	51.9 (1a)	2.53 (2a)	131.05 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	51.9 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	131.05 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.15 (8)
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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)

Additional infiltration

[(9)-1]x0.1 =

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

0.25 - [0.2 x (14) ÷ 100] =

Infiltration rate

(8) + (10) + (11) + (12) + (13) + (15) =

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

(20) = 1 - [0.075 x (19)] =

Infiltration rate incorporating shelter factor

(21) = (18) x (20) =

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.34	0.37	0.39	0.4
------	------	------	------	------	------	------	------	------	------	------	-----

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

(25)m= 0.6 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (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	2		
Windows Type 1			8.58	$\times 1/[1/(1.4) + 0.04]$	11.37		
Windows Type 2			2.39	$\times 1/[1/(1.4) + 0.04]$	3.17		
Walls Type1	37.37	10.97	26.4	0.18	4.75		
Walls Type2	3.54	2	1.54	0.18	0.28		
Roof	51.9	0	51.9	0.13	6.75		
Total area of elements, m²			92.81				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 28.32 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 2342.73 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 4.64 (36)

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

Total fabric heat loss (33) + (36) = 32.96 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	25.74	25.58	25.42	24.69	24.55	23.91	23.91	23.79	24.16	24.55	24.83	25.12

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

(39)m=	58.7	58.54	58.38	57.65	57.51	56.87	56.87	56.75	57.11	57.51	57.79	58.08
Average = Sum(39) _{1...12} /12=												57.65 (39)

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	1.13	1.13	1.12	1.11	1.11	1.1	1.1	1.09	1.1	1.11	1.11	1.12		
Average = Sum(40) _{1...12} /12=													1.11	(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

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

if TFA ≤ 13.9, N = 1

1.75

(42)

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

75.67

(43)

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

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

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

(44)m=	83.24	80.21	77.18	74.16	71.13	68.1	68.1	71.13	74.16	77.18	80.21	83.24		
Total = Sum(44) _{1...12} =													908.04	(44)

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

(45)m=	123.44	107.96	111.41	97.13	93.19	80.42	74.52	85.51	86.53	100.85	110.08	119.54		
Total = Sum(45) _{1...12} =													1190.59	(45)

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

(46)m=	18.52	16.19	16.71	14.57	13.98	12.06	11.18	12.83	12.98	15.13	16.51	17.93		(46)
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Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.39

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

(48) × (49) =

0.75

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

(47) × (51) × (52) × (53) =

0

(54)

Enter (50) or (54) in (55)

0.75

(55)

Water storage loss calculated for each month

((56)m = (55) × (41)m

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(56)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--	------

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

(57)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	0	0	0	0	0	0	0	0	0	0	0	(61)
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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=	170.03	150.05	158	142.22	139.79	125.51	121.12	132.11	131.63	147.44	155.18	166.14	(62)
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Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)

(63)m=	0	0	0	0	0	0	0	0	0	0	0	(63)
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Output from water heater

(64)m=	170.03	150.05	158	142.22	139.79	125.51	121.12	132.11	131.63	147.44	155.18	166.14	
Output from water heater (annual) _{1...12}												1739.21	(64)

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

(65)m=	78.32	69.57	74.32	68.37	68.26	62.81	62.05	65.71	64.85	70.81	72.68	77.02	(65)
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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=	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	(66)

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

(67)m=	13.98	12.42	10.1	7.65	5.72	4.83	5.21	6.78	9.1	11.55	13.48	14.37	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	152.17	153.75	149.77	141.3	130.6	120.55	113.84	112.26	116.24	124.71	135.4	145.45	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	(69)
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Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
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Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	105.27	103.52	99.89	94.96	91.75	87.24	83.41	88.32	90.06	95.17	100.94	103.53	(72)
--------	--------	--------	-------	-------	-------	-------	-------	-------	-------	-------	--------	--------	------

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

(73)m=	323.61	321.88	311.95	296.09	280.26	264.81	254.65	259.55	267.59	283.62	302.01	315.54	(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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast 0.9x	0.54	x	8.58	x	36.79	x	0.63	x	0.7	=	67.66	(77)
Southeast 0.9x	0.54	x	8.58	x	62.67	x	0.63	x	0.7	=	115.25	(77)
Southeast 0.9x	0.54	x	8.58	x	85.75	x	0.63	x	0.7	=	157.69	(77)
Southeast 0.9x	0.54	x	8.58	x	106.25	x	0.63	x	0.7	=	195.39	(77)
Southeast 0.9x	0.54	x	8.58	x	119.01	x	0.63	x	0.7	=	218.85	(77)

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Southeast 0.9x	0.54	x	8.58	x	118.15	x	0.63	x	0.7	=	217.27	(77)
Southeast 0.9x	0.54	x	8.58	x	113.91	x	0.63	x	0.7	=	209.47	(77)
Southeast 0.9x	0.54	x	8.58	x	104.39	x	0.63	x	0.7	=	191.97	(77)
Southeast 0.9x	0.54	x	8.58	x	92.85	x	0.63	x	0.7	=	170.75	(77)
Southeast 0.9x	0.54	x	8.58	x	69.27	x	0.63	x	0.7	=	127.38	(77)
Southeast 0.9x	0.54	x	8.58	x	44.07	x	0.63	x	0.7	=	81.04	(77)
Southeast 0.9x	0.54	x	8.58	x	31.49	x	0.63	x	0.7	=	57.9	(77)
Northwest 0.9x	0.54	x	2.39	x	11.28	x	0.63	x	0.7	=	5.78	(81)
Northwest 0.9x	0.54	x	2.39	x	22.97	x	0.63	x	0.7	=	11.76	(81)
Northwest 0.9x	0.54	x	2.39	x	41.38	x	0.63	x	0.7	=	21.2	(81)
Northwest 0.9x	0.54	x	2.39	x	67.96	x	0.63	x	0.7	=	34.81	(81)
Northwest 0.9x	0.54	x	2.39	x	91.35	x	0.63	x	0.7	=	46.79	(81)
Northwest 0.9x	0.54	x	2.39	x	97.38	x	0.63	x	0.7	=	49.88	(81)
Northwest 0.9x	0.54	x	2.39	x	91.1	x	0.63	x	0.7	=	46.67	(81)
Northwest 0.9x	0.54	x	2.39	x	72.63	x	0.63	x	0.7	=	37.2	(81)
Northwest 0.9x	0.54	x	2.39	x	50.42	x	0.63	x	0.7	=	25.83	(81)
Northwest 0.9x	0.54	x	2.39	x	28.07	x	0.63	x	0.7	=	14.38	(81)
Northwest 0.9x	0.54	x	2.39	x	14.2	x	0.63	x	0.7	=	7.27	(81)
Northwest 0.9x	0.54	x	2.39	x	9.21	x	0.63	x	0.7	=	4.72	(81)

Solar gains in watts, calculated for each month

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

(83)m=	73.44	127.02	178.89	230.2	265.64	267.15	256.14	229.17	196.57	141.75	88.31	62.62	(83)
--------	-------	--------	--------	-------	--------	--------	--------	--------	--------	--------	-------	-------	------

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

(84)m=	397.05	448.89	490.84	526.29	545.9	531.96	510.79	488.72	464.17	425.38	390.33	378.17	(84)
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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=	0.99	0.99	0.97	0.93	0.83	0.65	0.48	0.52	0.76	0.94	0.99	1	(86)

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

(87)m=	19.94	20.09	20.33	20.62	20.85	20.97	20.99	20.99	20.93	20.64	20.24	19.91	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.98	19.98	19.98	19.99	19.99	20	20	20.01	20	19.99	19.99	19.99	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.98	0.96	0.91	0.78	0.56	0.38	0.42	0.68	0.92	0.98	0.99	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.58	18.8	19.15	19.56	19.85	19.98	20	20	19.95	19.6	19.03	18.54	(90)
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fLA = Living area ÷ (4) =

0.48 (91)

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

(92)m=	19.23	19.43	19.72	20.07	20.33	20.46	20.48	20.48	20.42	20.1	19.61	19.2	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

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(93)m=	19.23	19.43	19.72	20.07	20.33	20.46	20.48	20.48	20.42	20.1	19.61	19.2	(93)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	-------	------	------

8. Space heating requirement

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

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

Utilisation factor for gains, h_m :

(94)m=	0.99	0.98	0.96	0.91	0.8	0.6	0.43	0.47	0.72	0.92	0.98	0.99	(94)
--------	------	------	------	------	-----	-----	------	------	------	------	------	------	------

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

(95)m=	393.17	440.6	471.99	478.69	434.5	321.72	219.09	229.02	333.5	392.62	382.68	375.21	(95)
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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)
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Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]$

(97)m=	876.46	850.31	771.56	643.98	496.49	333.13	220.65	231.48	360.9	546.32	722.93	871.25	(97)
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Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	359.57	275.33	222.88	119.01	46.12	0	0	0	0	114.35	244.98	369.06	
--------	--------	--------	--------	--------	-------	---	---	---	---	--------	--------	--------	--

Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 1751.3 (98)

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

33.74 (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) = $(202) \times [1 - (203)] =$ 1 (204)

Efficiency of main space heating system 1

93.5 (206)

Efficiency of secondary/supplementary heating system, %

0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
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Space heating requirement (calculated above)

359.57	275.33	222.88	119.01	46.12	0	0	0	0	114.35	244.98	369.06
--------	--------	--------	--------	-------	---	---	---	---	--------	--------	--------

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

384.56	294.47	238.38	127.29	49.33	0	0	0	0	122.3	262.01	394.71
--------	--------	--------	--------	-------	---	---	---	---	-------	--------	--------

Total ($kWh/year$) = $Sum(211)_{1..5,10..12} =$ 1873.05 (211)

Space heating fuel (secondary), $kWh/month$

= $\{[(98)m \times (201)]\} \times 100 \div (208)$

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

Water heating

Output from water heater (calculated above)

170.03	150.05	158	142.22	139.79	125.51	121.12	132.11	131.63	147.44	155.18	166.14
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Efficiency of water heater

79.8 (216)

(217)m=	86.76	86.41	85.73	84.34	82.21	79.8	79.8	79.8	79.8	84.15	86.03	86.88	(217)
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Fuel for water heating, $kWh/month$

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

(219)m=	195.97	173.64	184.3	168.62	170.04	157.28	151.77	165.55	164.95	175.22	180.38	191.22	
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Total = $Sum(219a)_{1..12} =$ 2078.94 (219)

Annual totals

$kWh/year$

$kWh/year$

Space heating fuel used, main system 1

1873.05

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Water heating fuel used			2078.94	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		75	(231)
Electricity for lighting			246.93	(232)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x		0.216	=	404.58	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	449.05	(264)
Space and water heating	(261) + (262) + (263) + (264) =				853.63	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93	(267)
Electricity for lighting	(232) x		0.519	=	128.16	(268)
Total CO2, kg/year		sum of (265)...(271) =			1020.71	(272)
TER =					19.67	(273)

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User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 1B-DUPLEX (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)		Av. Height(m)		Volume(m ³)
Ground floor	24 (1a)	x	3.27 (2a)	=	78.41 (3a)
First floor	45.71 (1b)	x	2.47 (2b)	=	113.13 (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	69.71 (4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	191.54 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total		m ³ per hour
Number of chimneys	0	+	0	=	0 x 40 =	0 (6a)
Number of open flues	0	+	0	=	0 x 20 =	0 (6b)
Number of intermittent fans				2	x 10 =	20 (7a)
Number of passive vents				0	x 10 =	0 (7b)
Number of flueless gas fires				0	x 40 =	0 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =						20 ÷ (5) = 0.1 (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)						0.35 (18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used						
Number of sides sheltered						1 (19)
Shelter factor				(20) = 1 - [0.075 x (19)] =		0.92 (20)
Infiltration rate incorporating shelter factor				(21) = (18) x (20) =		0.33 (21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

	0.42	0.41	0.4	0.36	0.35	0.31	0.31	0.3	0.33	0.35	0.37	0.39
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0
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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
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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
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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 × 0.5]

(24d)m=	0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57
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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	2		
Windows Type 1			9.26	$\times 1/[1/(1.4) + 0.04]$	12.28		
Windows Type 2			1.44	$\times 1/[1/(1.4) + 0.04]$	1.91		
Windows Type 3			4.73	$\times 1/[1/(1.4) + 0.04]$	6.27		
Walls Type1	126	15.43	110.57	0.18	19.9		
Walls Type2	25.2	2	23.2	0.18	4.18		
Roof	45.71	0	45.71	0.13	5.94		
Total area of elements, m²			196.91				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value}) + 0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 52.48 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 8568.89 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 9.85 (36)

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

Total fabric heat loss (33) + (36) = 62.32 (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
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(38)m=

37.13	36.91	36.7	35.71	35.53	34.67	34.67	34.51	35	35.53	35.9	36.29
-------	-------	------	-------	-------	-------	-------	-------	----	-------	------	-------

 (38)

Heat transfer coefficient, W/K

(39)m = (37) + (38)m

(39)m=

99.45	99.23	99.02	98.04	97.85	96.99	96.99	96.83	97.32	97.85	98.23	98.62
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

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

98.04

 (39)

Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=

1.43	1.42	1.42	1.41	1.4	1.39	1.39	1.39	1.4	1.4	1.41	1.41
------	------	------	------	-----	------	------	------	-----	-----	------	------

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

1.41

 (40)

Number of days in month (Table 1a)

(41)m=

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28	31	30	31	30	31	31	30	31	30	31

 (41)

4. Water heating energy requirement:

kWh/year:

Assumed occupancy, N

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

if TFA ≤ 13.9, N = 1

2.24

(42)

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

87.38

(43)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
96.12	92.62	89.13	85.63	82.14	78.64	78.64	82.14	85.63	89.13	92.62	96.12

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

96.12	92.62	89.13	85.63	82.14	78.64	78.64	82.14	85.63	89.13	92.62	96.12
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

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

1048.53

 (44)
Energy content of hot water used - calculated monthly = 4.190 × Vd,m × nm × DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)
(45)m=

142.54	124.66	128.64	112.15	107.61	92.86	86.05	98.74	99.92	116.45	127.12	138.04
--------	--------	--------	--------	--------	-------	-------	-------	-------	--------	--------	--------

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

1374.79

 (45)

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

(46)m=

21.38	18.7	19.3	16.82	16.14	13.93	12.91	14.81	14.99	17.47	19.07	20.71
-------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (46)

Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.39

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

(48) × (49) =

0.75

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

(47) × (51) × (52) × (53) =

0

(54)

Enter (50) or (54) in (55)

0.75

(55)

Water storage loss calculated for each month

((56)m = (55) × (41)m

(56)m=

23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (56)

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

(57)m=

23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (57)

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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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(59)

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=	189.13	166.75	175.24	157.24	154.21	137.95	132.65	145.34	145.02	163.05	172.21	184.63
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(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=	189.13	166.75	175.24	157.24	154.21	137.95	132.65	145.34	145.02	163.05	172.21	184.63
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Output from water heater (annual)_{1...12}

1923.41

(64)

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

(65)m=	84.67	75.12	80.05	73.36	73.06	66.95	65.89	70.11	69.3	76	78.34	83.17
--------	-------	-------	-------	-------	-------	-------	-------	-------	------	----	-------	-------

(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=	111.95	111.95	111.95	111.95	111.95	111.95	111.95	111.95	111.95	111.95	111.95	111.95

(66)

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

(67)m=	17.53	15.57	12.66	9.59	7.17	6.05	6.54	8.5	11.41	14.48	16.9	18.02
--------	-------	-------	-------	------	------	------	------	-----	-------	-------	------	-------

(67)

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

(68)m=	196.62	198.66	193.52	182.57	168.76	155.77	147.09	145.05	150.2	161.14	174.96	187.94
--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	--------	--------

(68)

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

(69)m=	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2
--------	------	------	------	------	------	------	------	------	------	------	------	------

(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3
--------	---	---	---	---	---	---	---	---	---	---	---	---

(70)

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

(71)m=	-89.56	-89.56	-89.56	-89.56	-89.56	-89.56	-89.56	-89.56	-89.56	-89.56	-89.56	-89.56
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(71)

Water heating gains (Table 5)

(72)m=	113.8	111.78	107.59	101.89	98.2	92.99	88.56	94.23	96.25	102.14	108.8	111.79
--------	-------	--------	--------	--------	------	-------	-------	-------	-------	--------	-------	--------

(72)

Total internal gains =

(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	387.54	385.6	373.36	353.64	333.7	314.39	301.78	307.37	317.43	337.35	360.25	377.34
--------	--------	-------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------

(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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)
North	0.9x	0.77	x	1.44	x	10.63	x	0.63	x	0.7	= 4.68 (74)
North	0.9x	0.77	x	1.44	x	20.32	x	0.63	x	0.7	= 8.94 (74)

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North	0.9x	0.77	x	1.44	x	34.53	x	0.63	x	0.7	=	15.2	(74)
North	0.9x	0.77	x	1.44	x	55.46	x	0.63	x	0.7	=	24.41	(74)
North	0.9x	0.77	x	1.44	x	74.72	x	0.63	x	0.7	=	32.88	(74)
North	0.9x	0.77	x	1.44	x	79.99	x	0.63	x	0.7	=	35.2	(74)
North	0.9x	0.77	x	1.44	x	74.68	x	0.63	x	0.7	=	32.86	(74)
North	0.9x	0.77	x	1.44	x	59.25	x	0.63	x	0.7	=	26.07	(74)
North	0.9x	0.77	x	1.44	x	41.52	x	0.63	x	0.7	=	18.27	(74)
North	0.9x	0.77	x	1.44	x	24.19	x	0.63	x	0.7	=	10.65	(74)
North	0.9x	0.77	x	1.44	x	13.12	x	0.63	x	0.7	=	5.77	(74)
North	0.9x	0.77	x	1.44	x	8.86	x	0.63	x	0.7	=	3.9	(74)
East	0.9x	0.77	x	4.73	x	19.64	x	0.63	x	0.7	=	28.39	(76)
East	0.9x	0.77	x	4.73	x	38.42	x	0.63	x	0.7	=	55.54	(76)
East	0.9x	0.77	x	4.73	x	63.27	x	0.63	x	0.7	=	91.46	(76)
East	0.9x	0.77	x	4.73	x	92.28	x	0.63	x	0.7	=	133.4	(76)
East	0.9x	0.77	x	4.73	x	113.09	x	0.63	x	0.7	=	163.48	(76)
East	0.9x	0.77	x	4.73	x	115.77	x	0.63	x	0.7	=	167.35	(76)
East	0.9x	0.77	x	4.73	x	110.22	x	0.63	x	0.7	=	159.33	(76)
East	0.9x	0.77	x	4.73	x	94.68	x	0.63	x	0.7	=	136.86	(76)
East	0.9x	0.77	x	4.73	x	73.59	x	0.63	x	0.7	=	106.38	(76)
East	0.9x	0.77	x	4.73	x	45.59	x	0.63	x	0.7	=	65.9	(76)
East	0.9x	0.77	x	4.73	x	24.49	x	0.63	x	0.7	=	35.4	(76)
East	0.9x	0.77	x	4.73	x	16.15	x	0.63	x	0.7	=	23.35	(76)
South	0.9x	0.77	x	9.26	x	46.75	x	0.63	x	0.7	=	132.31	(78)
South	0.9x	0.77	x	9.26	x	76.57	x	0.63	x	0.7	=	216.69	(78)
South	0.9x	0.77	x	9.26	x	97.53	x	0.63	x	0.7	=	276.02	(78)
South	0.9x	0.77	x	9.26	x	110.23	x	0.63	x	0.7	=	311.96	(78)
South	0.9x	0.77	x	9.26	x	114.87	x	0.63	x	0.7	=	325.08	(78)
South	0.9x	0.77	x	9.26	x	110.55	x	0.63	x	0.7	=	312.85	(78)
South	0.9x	0.77	x	9.26	x	108.01	x	0.63	x	0.7	=	305.67	(78)
South	0.9x	0.77	x	9.26	x	104.89	x	0.63	x	0.7	=	296.85	(78)
South	0.9x	0.77	x	9.26	x	101.89	x	0.63	x	0.7	=	288.33	(78)
South	0.9x	0.77	x	9.26	x	82.59	x	0.63	x	0.7	=	233.72	(78)
South	0.9x	0.77	x	9.26	x	55.42	x	0.63	x	0.7	=	156.83	(78)
South	0.9x	0.77	x	9.26	x	40.4	x	0.63	x	0.7	=	114.33	(78)

Solar gains in watts, calculated for each month

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

(83)m= 165.38 281.17 382.68 469.77 521.44 515.4 497.86 459.78 412.98 310.26 198 141.57 (83)

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

(84)m= 552.92 666.77 756.04 823.41 855.15 829.79 799.64 767.15 730.42 647.62 558.25 518.92 (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
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

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(86)m=	0.99	0.99	0.97	0.93	0.84	0.68	0.52	0.56	0.78	0.94	0.99	1	(86)
--------	------	------	------	------	------	------	------	------	------	------	------	---	------

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

(87)m=	19.57	19.79	20.1	20.45	20.75	20.93	20.98	20.98	20.87	20.48	19.95	19.53	(87)
--------	-------	-------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(88)m=	19.74	19.75	19.75	19.76	19.76	19.77	19.77	19.77	19.76	19.76	19.75	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	0.99	0.98	0.96	0.9	0.78	0.58	0.38	0.42	0.68	0.92	0.98	0.99	(89)
--------	------	------	------	-----	------	------	------	------	------	------	------	------	------

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

(90)m=	17.89	18.21	18.64	19.15	19.53	19.72	19.76	19.76	19.67	19.19	18.45	17.84	(90)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

$$fLA = \text{Living area} \div (4) = \boxed{0.36} \quad (91)$$

Mean internal temperature (for the whole dwelling) = $fLA \times T1 + (1 - fLA) \times T2$

(92)m=	18.49	18.77	19.16	19.62	19.96	20.16	20.2	20.2	20.1	19.65	18.99	18.44	(92)
--------	-------	-------	-------	-------	-------	-------	------	------	------	-------	-------	-------	------

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

(93)m=	18.49	18.77	19.16	19.62	19.96	20.16	20.2	20.2	20.1	19.65	18.99	18.44	(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=	0.99	0.98	0.95	0.9	0.79	0.61	0.43	0.47	0.71	0.91	0.98	0.99	(94)

Useful gains, hmGm, W = (94)m x (84)m

(95)m=	546.58	650.66	718.63	737.03	673.8	506.44	343.75	359.68	519.74	591.62	545.67	514.25	(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=	1411.45	1376.88	1253.96	1050.52	808.7	538.86	349.28	367.76	583.72	885.62	1167.58	1404.77	(97)
--------	---------	---------	---------	---------	-------	--------	--------	--------	--------	--------	---------	---------	------

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

(98)m=	643.47	488.02	398.28	225.71	100.37	0	0	0	0	218.74	447.78	662.55	(98)
--------	--------	--------	--------	--------	--------	---	---	---	---	--------	--------	--------	------

$$\text{Total per year (kWh/year)} = \text{Sum}(98)_{1..5,9..12} = \boxed{3184.91} \quad (98)$$

Space heating requirement in kWh/m²/year

$$\boxed{45.69} \quad (99)$$

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

Space heating:

Fraction of space heat from secondary/supplementary system (201)

Fraction of space heat from main system(s) (202) = 1 - (201) = (202)

Fraction of total heating from main system 1 (204) = (202) x [1 - (203)] = (204)

Efficiency of main space heating system 1 (206)

Efficiency of secondary/supplementary heating system, % (208)

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

 kWh/year

Space heating requirement (calculated above)

(211)m = {[(98)m x (204)]} x 100 ÷ (206)	643.47	488.02	398.28	225.71	100.37	0	0	0	0	218.74	447.78	662.55	(211)
--	--------	--------	--------	--------	--------	---	---	---	---	--------	--------	--------	-------

$$\text{Total (kWh/year)} = \text{Sum}(211)_{1..5,10..12} = \boxed{3406.32} \quad (211)$$

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Space heating fuel (secondary), kWh/month

$$= \{[(98)m \times (201)]\} \times 100 \div (208)$$

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

Water heating

Output from water heater (calculated above)

	189.13	166.75	175.24	157.24	154.21	137.95	132.65	145.34	145.02	163.05	172.21	184.63	
Efficiency of water heater													79.8 (216)
(217)m=	87.82	87.51	86.94	85.78	83.7	79.8	79.8	79.8	79.8	85.6	87.25	87.93	(217)

Fuel for water heating, kWh/month

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

(219)m=	215.35	190.54	201.56	183.32	184.24	172.87	166.22	182.13	181.72	190.48	197.37	209.98	
Total = Sum(219a) _{1...12} =													2275.79 (219)

Annual totals

	kWh/year												kWh/year
Space heating fuel used, main system 1													3406.32
Water heating fuel used													2275.79

Electricity for pumps, fans and electric keep-hot

central heating pump:		30	(230c)
boiler with a fan-assisted flue		45	(230e)

Total electricity for the above, kWh/year sum of (230a)...(230g) =

Electricity for lighting 309.61 (232)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year
Space heating (main system 1)	(211) x		0.216	=	735.76 (261)
Space heating (secondary)	(215) x		0.519	=	0 (263)
Water heating	(219) x		0.216	=	491.57 (264)
Space and water heating	(261) + (262) + (263) + (264) =				1227.33 (265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93 (267)
Electricity for lighting	(232) x		0.519	=	160.69 (268)
Total CO2, kg/year	sum of (265)...(271) =				1426.95 (272)

TER = 20.47 (273)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 1B-MF (E-W) (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	47.7 (1a)	2.36 (2a)	112.76 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	47.7 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	112.76 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20 ÷ (5) = 0.18 (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)

Additional infiltration

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

Infiltration rate

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

Infiltration rate incorporating shelter factor

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.42	0.41	0.41	0.36	0.36	0.31	0.31	0.31	0.33	0.36	0.37	0.39
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 0.59 0.59 0.58 0.57 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.58 (24d)

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

(25)m= 0.59 0.59 0.58 0.57 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.58 (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	2		
Windows			5.79	$1/[1/(1.4)+0.04]$	7.68		
Walls Type1	13.71	5.79	7.92	0.18	1.43		
Walls Type2	17.14	2	15.14	0.18	2.73		
Total area of elements, m²			30.85				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 13.83 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 826.92 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 1.54 (36)

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

Total fabric heat loss (33) + (36) = 15.37 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	21.92	21.79	21.67	21.08	20.96	20.45	20.45	20.35	20.65	20.96	21.19	21.42

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

(39)m= 37.29 37.16 37.04 36.44 36.33 35.82 35.82 35.72 36.02 36.33 36.56 36.79
Average = Sum(39)_{1...12} /12= 36.44 (39)

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

(40)m= 0.78 0.78 0.78 0.76 0.76 0.75 0.75 0.75 0.76 0.76 0.77 0.77
Average = Sum(40)_{1...12} /12= 0.76 (40)

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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 1.62 (42)

if TFA > 13.9, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

if TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$ 72.74 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
(44)m=	80.01	77.1	74.19	71.28	68.37	65.46	65.46	68.37	71.28	74.19	77.1	80.01	
Total = Sum(44) _{1...12} =												872.86	(44)

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$ kWh/month (see Tables 1b, 1c, 1d)

(45)m=	118.66	103.78	107.09	93.36	89.58	77.3	71.63	82.2	83.18	96.94	105.82	114.91	
Total = Sum(45) _{1...12} =												1144.45	(45)

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

(46)m=	17.8	15.57	16.06	14	13.44	11.6	10.74	12.33	12.48	14.54	15.87	17.24	(46)
--------	------	-------	-------	----	-------	------	-------	-------	-------	-------	-------	-------	------

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.39 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) × (49) = 0.75 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) × (51) × (52) × (53) = 0 (54)

Enter (50) or (54) in (55) 0.75 (55)

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

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

If cylinder contains dedicated solar storage, $(57)m = (56)m \times [(50) - (H11)] \div (50)$, else $(57)m = (56)m$ where (H11) is from Appendix H

(57)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(57)
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Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month $(59)m = (58) \div 365 \times (41)m$

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Combi loss calculated for each month $(61)m = (60) \div 365 \times (41)m$

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)
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Total heat required for water heating calculated for each month (62)m = $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

(62)m=	165.25	145.86	153.68	138.45	136.18	122.4	118.23	128.79	128.27	143.54	150.91	161.51	(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=	165.25	145.86	153.68	138.45	136.18	122.4	118.23	128.79	128.27	143.54	150.91	161.51	
Output from water heater (annual) _{1...12}												1693.07	(64)

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

(65)m=	76.73	68.17	72.88	67.12	67.06	61.78	61.09	64.61	63.73	69.51	71.26	75.48	(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=	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	(66)

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

(67)m=	13.94	12.38	10.07	7.62	5.7	4.81	5.2	6.76	9.07	11.52	13.44	14.33	(67)
--------	-------	-------	-------	------	-----	------	-----	------	------	-------	-------	-------	------

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

(68)m=	141.26	142.73	139.04	131.17	121.24	111.91	105.68	104.22	107.91	115.77	125.7	135.03	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	(69)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
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Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	103.13	101.45	97.96	93.22	90.14	85.8	82.12	86.84	88.52	93.43	98.97	101.46	(72)
--------	--------	--------	-------	-------	-------	------	-------	-------	-------	-------	-------	--------	------

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

(73)m=	308.68	306.9	297.41	282.35	267.42	252.87	243.34	248.15	255.84	271.06	288.45	301.16	(73)
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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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
West	0.9x	0.77	x	5.79	x	19.64	x	0.63	x	0.7	=	34.75 (80)
West	0.9x	0.77	x	5.79	x	38.42	x	0.63	x	0.7	=	67.99 (80)
West	0.9x	0.77	x	5.79	x	63.27	x	0.63	x	0.7	=	111.96 (80)
West	0.9x	0.77	x	5.79	x	92.28	x	0.63	x	0.7	=	163.29 (80)
West	0.9x	0.77	x	5.79	x	113.09	x	0.63	x	0.7	=	200.12 (80)
West	0.9x	0.77	x	5.79	x	115.77	x	0.63	x	0.7	=	204.86 (80)
West	0.9x	0.77	x	5.79	x	110.22	x	0.63	x	0.7	=	195.03 (80)
West	0.9x	0.77	x	5.79	x	94.68	x	0.63	x	0.7	=	167.53 (80)

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West	0.9x	0.77	x	5.79	x	73.59	x	0.63	x	0.7	=	130.22	(80)
West	0.9x	0.77	x	5.79	x	45.59	x	0.63	x	0.7	=	80.67	(80)
West	0.9x	0.77	x	5.79	x	24.49	x	0.63	x	0.7	=	43.33	(80)
West	0.9x	0.77	x	5.79	x	16.15	x	0.63	x	0.7	=	28.58	(80)

Solar gains in watts, calculated for each month

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

(83)m=	34.75	67.99	111.96	163.29	200.12	204.86	195.03	167.53	130.22	80.67	43.33	28.58	(83)
--------	-------	-------	--------	--------	--------	--------	--------	--------	--------	-------	-------	-------	------

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

(84)m=	343.43	374.89	409.37	445.64	467.54	457.72	438.37	415.68	386.05	351.73	331.79	329.74	(84)
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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=	0.99	0.99	0.96	0.87	0.7	0.5	0.36	0.39	0.63	0.91	0.98	0.99	(86)

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

(87)m=	20.41	20.52	20.7	20.89	20.98	21	21	21	20.99	20.87	20.61	20.39	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.27	20.27	20.27	20.28	20.29	20.3	20.3	20.3	20.29	20.29	20.28	20.28	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.98	0.95	0.84	0.65	0.44	0.3	0.33	0.57	0.88	0.98	0.99	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	19.48	19.64	19.9	20.16	20.27	20.3	20.3	20.3	20.29	20.15	19.79	19.46	(90)
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fLA = Living area ÷ (4) =

0.52

(91)

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

(92)m=	19.96	20.1	20.32	20.54	20.64	20.66	20.66	20.67	20.66	20.53	20.22	19.95	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.96	20.1	20.32	20.54	20.64	20.66	20.66	20.67	20.66	20.53	20.22	19.95	(93)
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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
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Utilisation factor for gains, hm:

(94)m=	0.99	0.98	0.95	0.85	0.68	0.47	0.33	0.37	0.6	0.89	0.98	0.99	(94)
--------	------	------	------	------	------	------	------	------	-----	------	------	------	------

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	339.8	367.28	388.52	380.32	316.88	216.63	145.56	152.3	233.32	312.01	323.74	326.96	(95)
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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)
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Heat loss rate for mean internal temperature, Lm , W = [(39)m x [(93)m – (96)m]

(97)m=	584.19	564.91	511.68	424.32	324.83	217.18	145.59	152.38	236.13	360.8	479.76	579.32	(97)
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Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	181.83	132.81	91.63	31.68	5.92	0	0	0	0	36.3	112.33	187.75	(98)
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Total per year (kWh/year) = Sum(98)_{1...5,9...12} =

780.25

(98)

Space heating requirement in kWh/m²/year

16.36

(99)

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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	$(204) = (202) \times [1 - (203)] =$	1	(204)
Efficiency of main space heating system 1		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
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Space heating requirement (calculated above)

181.83	132.81	91.63	31.68	5.92	0	0	0	0	36.3	112.33	187.75	
$(211)m = \{[(98)m \times (204)]\} \times 100 \div (206)$												(211)
194.47	142.04	98	33.88	6.33	0	0	0	0	38.82	120.14	200.81	
Total (kWh/year) = Sum(211) _{1...5,10...12} =												834.49
												(211)

Space heating fuel (secondary), kWh/month

$= \{[(98)m \times (201)]\} \times 100 \div (208)$

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

Water heating

Output from water heater (calculated above)

165.25	145.86	153.68	138.45	136.18	122.4	118.23	128.79	128.27	143.54	150.91	161.51	
Efficiency of water heater												79.8
(217)m=	85.07	84.56	83.49	81.6	80.19	79.8	79.8	79.8	79.8	81.75	84.04	85.22
Fuel for water heating, kWh/month												
(219)m = (64)m x 100 ÷ (217)m												
(219)m=	194.25	172.49	184.08	169.68	169.81	153.38	148.16	161.4	160.74	175.58	179.57	189.53
Total = Sum(219a) _{1...12} =												2058.65
												(219)

Annual totals

Space heating fuel used, main system 1		834.49		kWh/year	kWh/year
Water heating fuel used		2058.65			
Electricity for pumps, fans and electric keep-hot					
central heating pump:		30			(230c)
boiler with a fan-assisted flue		45			(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =	75			(231)
Electricity for lighting		246.24			(232)

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

	Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year
Space heating (main system 1)	(211) x	0.216	=	180.25
Space heating (secondary)	(215) x	0.519	=	0
Water heating	(219) x	0.216	=	444.67
Space and water heating	(261) + (262) + (263) + (264) =			624.92

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Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	127.8	(268)
Total CO2, kg/year		sum of (265)...(271) =		791.64	(272)
TER	=			16.6	(273)

DRAFT

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 1B-MF-N (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	51.67 (1a)	2.53 (2a)	130.47 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	51.67 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	130.47 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.15 (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)

Additional infiltration

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

Infiltration rate

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

Infiltration rate incorporating shelter factor

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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TER WorkSheet: New dwelling design stage

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

0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.34	0.37	0.39	0.4
------	------	------	------	------	------	------	------	------	------	------	-----

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

(25)m= 0.6 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (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	2		
Windows Type 1			8.79	$\times 1/[1/(1.4) + 0.04]$	11.65		
Windows Type 2			2.13	$\times 1/[1/(1.4) + 0.04]$	2.82		
Walls Type1	15.15	10.92	4.23	0.18	0.76		
Walls Type2	29	2	27	0.18	4.86		
Total area of elements, m²			44.15				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 22.1 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 782.1 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 2.21 (36)

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

Total fabric heat loss (33) + (36) = 24.31 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	25.64	25.48	25.32	24.59	24.45	23.81	23.81	23.69	24.06	24.45	24.73	25.02

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

(39)m=	49.95	49.79	49.63	48.89	48.76	48.12	48.12	48	48.36	48.76	49.03	49.33
Average = Sum(39) _{1...12} /12=												48.89

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	0.97	0.96	0.96	0.95	0.94	0.93	0.93	0.93	0.94	0.94	0.95	0.95		
Average = Sum(40) _{1...12} /12=													0.95	(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

1.74

(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

75.51

(43)

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

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

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

(44)m=	83.06	80.04	77.02	74	70.98	67.96	67.96	70.98	74	77.02	80.04	83.06		
Total = Sum(44) _{1...12} =													906.11	(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=	123.18	107.73	111.17	96.92	93	80.25	74.36	85.33	86.35	100.63	109.85	119.29		
Total = Sum(45) _{1...12} =													1188.05	(45)

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

(46)m=	18.48	16.16	16.68	14.54	13.95	12.04	11.15	12.8	12.95	15.1	16.48	17.89		(46)
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Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.39

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

(48) x (49) =

0.75

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

(47) x (51) x (52) x (53) =

0

(54)

Enter (50) or (54) in (55)

0.75

(55)

Water storage loss calculated for each month

((56)m = (55) x (41)m

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(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=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(57)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--	------

Primary circuit loss (annual) from Table 3

0

(58)

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

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

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

(62)m=	169.77	149.82	157.76	142.01	139.59	125.34	120.96	131.93	131.44	147.23	154.94	165.88	(62)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

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

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

Output from water heater

(64)m=	169.77	149.82	157.76	142.01	139.59	125.34	120.96	131.93	131.44	147.23	154.94	165.88	
Output from water heater (annual) _{1...12}												1736.67	(64)

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

(65)m=	78.23	69.49	74.24	68.3	68.2	62.76	62	65.65	64.79	70.74	72.6	76.94	(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=	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	86.97	(66)

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

(67)m=	13.54	12.03	9.78	7.41	5.54	4.67	5.05	6.56	8.81	11.19	13.06	13.92	(67)
--------	-------	-------	------	------	------	------	------	------	------	-------	-------	-------	------

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

(68)m=	151.57	153.14	149.18	140.74	130.09	120.08	113.39	111.82	115.78	124.22	134.87	144.88	(68)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(69)m=	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	(69)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

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

(71)m=	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	-69.57	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	105.15	103.41	99.78	94.86	91.66	87.16	83.34	88.24	89.98	95.08	100.83	103.41	(72)
--------	--------	--------	-------	-------	-------	-------	-------	-------	-------	-------	--------	--------	------

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

(73)m=	322.35	320.67	310.84	295.1	279.38	264.01	253.87	258.71	266.66	282.57	300.85	314.31	(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	8.79	x	10.63	x	0.63	x	0.7	=	28.56	(74)
North	0.9x	0.77	x	8.79	x	20.32	x	0.63	x	0.7	=	54.59	(74)
North	0.9x	0.77	x	8.79	x	34.53	x	0.63	x	0.7	=	92.76	(74)
North	0.9x	0.77	x	8.79	x	55.46	x	0.63	x	0.7	=	149	(74)
North	0.9x	0.77	x	8.79	x	74.72	x	0.63	x	0.7	=	200.71	(74)

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North	0.9x	0.77	x	8.79	x	79.99	x	0.63	x	0.7	=	214.87	(74)
North	0.9x	0.77	x	8.79	x	74.68	x	0.63	x	0.7	=	200.61	(74)
North	0.9x	0.77	x	8.79	x	59.25	x	0.63	x	0.7	=	159.16	(74)
North	0.9x	0.77	x	8.79	x	41.52	x	0.63	x	0.7	=	111.53	(74)
North	0.9x	0.77	x	8.79	x	24.19	x	0.63	x	0.7	=	64.98	(74)
North	0.9x	0.77	x	8.79	x	13.12	x	0.63	x	0.7	=	35.24	(74)
North	0.9x	0.77	x	8.79	x	8.86	x	0.63	x	0.7	=	23.81	(74)
West	0.9x	0.77	x	2.13	x	19.64	x	0.63	x	0.7	=	12.78	(80)
West	0.9x	0.77	x	2.13	x	38.42	x	0.63	x	0.7	=	25.01	(80)
West	0.9x	0.77	x	2.13	x	63.27	x	0.63	x	0.7	=	41.19	(80)
West	0.9x	0.77	x	2.13	x	92.28	x	0.63	x	0.7	=	60.07	(80)
West	0.9x	0.77	x	2.13	x	113.09	x	0.63	x	0.7	=	73.62	(80)
West	0.9x	0.77	x	2.13	x	115.77	x	0.63	x	0.7	=	75.36	(80)
West	0.9x	0.77	x	2.13	x	110.22	x	0.63	x	0.7	=	71.75	(80)
West	0.9x	0.77	x	2.13	x	94.68	x	0.63	x	0.7	=	61.63	(80)
West	0.9x	0.77	x	2.13	x	73.59	x	0.63	x	0.7	=	47.9	(80)
West	0.9x	0.77	x	2.13	x	45.59	x	0.63	x	0.7	=	29.68	(80)
West	0.9x	0.77	x	2.13	x	24.49	x	0.63	x	0.7	=	15.94	(80)
West	0.9x	0.77	x	2.13	x	16.15	x	0.63	x	0.7	=	10.51	(80)

Solar gains in watts, calculated for each month

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

(83)m=	41.35	79.6	133.95	209.07	274.33	290.23	272.35	220.79	159.43	94.66	51.18	34.33	(83)
--------	-------	------	--------	--------	--------	--------	--------	--------	--------	-------	-------	-------	------

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

(84)m=	363.7	400.27	444.78	504.16	553.71	554.23	526.22	479.5	426.09	377.23	352.03	348.63	(84)
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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=	1	0.99	0.98	0.91	0.76	0.55	0.4	0.46	0.73	0.95	0.99	1	(86)

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

(87)m=	20.11	20.24	20.46	20.75	20.94	20.99	21	21	20.96	20.72	20.37	20.09	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.11	20.11	20.12	20.13	20.13	20.14	20.14	20.14	20.14	20.13	20.13	20.12	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	0.99	0.99	0.97	0.89	0.7	0.48	0.32	0.37	0.66	0.93	0.99	1	(89)
--------	------	------	------	------	-----	------	------	------	------	------	------	---	------

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

(90)m=	18.93	19.12	19.44	19.85	20.07	20.14	20.14	20.14	20.11	19.81	19.32	18.91	(90)
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fLA = Living area ÷ (4) =

0.51 (91)

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

(92)m=	19.53	19.69	19.96	20.31	20.51	20.57	20.58	20.58	20.54	20.27	19.86	19.51	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

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(93)m=	19.53	19.69	19.96	20.31	20.51	20.57	20.58	20.58	20.54	20.27	19.86	19.51	(93)
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8. Space heating requirement

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

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

Utilisation factor for gains, h_m :

(94)m=	0.99	0.99	0.97	0.89	0.73	0.51	0.36	0.42	0.7	0.93	0.98	0.99	(94)
--------	------	------	------	------	------	------	------	------	-----	------	------	------	------

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

(95)m=	361.04	394.87	429.92	450.93	403.62	284.58	191.09	199.88	296.87	351.56	346.68	346.58	(95)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
--------	-----	-----	-----	-----	------	------	------	------	------	------	-----	-----	------

Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]$

(97)m=	760.81	736.21	668.04	557.84	429.66	287.34	191.38	200.52	311.56	471.67	625.46	755.31	(97)
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Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	297.43	229.38	177.16	76.97	19.37	0	0	0	0	89.36	200.72	304.09	
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Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 1394.49 (98)

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

26.99 (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) = $(202) \times [1 - (203)] =$

1 (204)

Efficiency of main space heating system 1

93.5 (206)

Efficiency of secondary/supplementary heating system, %

0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
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Space heating requirement (calculated above)

297.43	229.38	177.16	76.97	19.37	0	0	0	0	89.36	200.72	304.09
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(211)m = $\{[(98)m \times (204)]\} \times 100 \div (206)$ (211)

318.1	245.33	189.48	82.33	20.72	0	0	0	0	95.58	214.68	325.23
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Total ($kWh/year$) = $Sum(211)_{1..5,10..12} =$ 1491.43 (211)

Space heating fuel (secondary), $kWh/month$

= $\{[(98)m \times (201)]\} \times 100 \div (208)$

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

Water heating

Output from water heater (calculated above)

169.77	149.82	157.76	142.01	139.59	125.34	120.96	131.93	131.44	147.23	154.94	165.88
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Efficiency of water heater

79.8 (216)

(217)m=	86.3	85.95	85.12	83.26	80.97	79.8	79.8	79.8	79.8	83.53	85.51	86.41	(217)
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Fuel for water heating, $kWh/month$

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

(219)m=	196.73	174.31	185.33	170.56	172.41	157.07	151.58	165.32	164.71	176.26	181.21	191.97	
---------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--

Total = $Sum(219a)_{1..12} =$ 2087.46 (219)

Annual totals

$kWh/year$

$kWh/year$

Space heating fuel used, main system 1

1491.43

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Water heating fuel used		2087.46	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		75 (231)
Electricity for lighting		239.19	(232)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x		0.216	=	322.15	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	450.89	(264)
Space and water heating	(261) + (262) + (263) + (264) =				773.04	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93	(267)
Electricity for lighting	(232) x		0.519	=	124.14	(268)
Total CO2, kg/year	sum of (265)...(271) =				936.1	(272)

TER = 18.12 (273)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 1B-MF-S (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	51.9 (1a)	2.53 (2a)	131.05 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	51.9 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	131.05 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20 ÷ (5) = 0.15 (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)

Additional infiltration

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

Infiltration rate

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

Infiltration rate incorporating shelter factor

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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TER WorkSheet: New dwelling design stage

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

0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.34	0.37	0.39	0.4
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

(25)m= 0.6 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (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	2		
Windows Type 1			8.58	$\times 1/[1/(1.4) + 0.04]$	11.37		
Windows Type 2			2.39	$\times 1/[1/(1.4) + 0.04]$	3.17		
Walls Type1	37.37	10.97	26.4	0.18	4.75		
Walls Type2	3.54	2	1.54	0.18	0.28		
Total area of elements, m²			40.9				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 21.57 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 1875.63 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 2.05 (36)

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

Total fabric heat loss (33) + (36) = 23.62 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	25.74	25.58	25.42	24.69	24.55	23.91	23.91	23.79	24.16	24.55	24.83	25.12

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

(39)m=	49.36	49.2	49.04	48.3	48.17	47.53	47.53	47.41	47.77	48.17	48.45	48.74
Average = Sum(39) _{1...12} /12=												48.3

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	0.95	0.95	0.94	0.93	0.93	0.92	0.92	0.91	0.92	0.93	0.93	0.94		
Average = Sum(40) _{1...12} /12=													0.93	(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

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

if TFA ≤ 13.9, N = 1

1.75

(42)

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

75.67

(43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
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Hot water usage in litres per day for each month Vd,m = factor from Table 1c × (43)

(44)m=	83.24	80.21	77.18	74.16	71.13	68.1	68.1	71.13	74.16	77.18	80.21	83.24		
Total = Sum(44) _{1...12} =													908.04	(44)

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

(45)m=	123.44	107.96	111.41	97.13	93.19	80.42	74.52	85.51	86.53	100.85	110.08	119.54		
Total = Sum(45) _{1...12} =													1190.59	(45)

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

(46)m=	18.52	16.19	16.71	14.57	13.98	12.06	11.18	12.83	12.98	15.13	16.51	17.93		(46)
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Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.39

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

(48) × (49) =

0.75

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

(47) × (51) × (52) × (53) =

0

(54)

Enter (50) or (54) in (55)

0.75

(55)

Water storage loss calculated for each month

((56)m = (55) × (41)m

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(56)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--	------

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

(57)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

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

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

(62)m=	170.03	150.05	158	142.22	139.79	125.51	121.12	132.11	131.63	147.44	155.18	166.14	(62)
--------	--------	--------	-----	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)

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

Output from water heater

(64)m=	170.03	150.05	158	142.22	139.79	125.51	121.12	132.11	131.63	147.44	155.18	166.14	
Output from water heater (annual) _{1...12}												1739.21	(64)

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

(65)m=	78.32	69.57	74.32	68.37	68.26	62.81	62.05	65.71	64.85	70.81	72.68	77.02	(65)
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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=	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	87.31	(66)

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

(67)m=	13.6	12.08	9.82	7.44	5.56	4.69	5.07	6.59	8.85	11.23	13.11	13.97	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	152.17	153.75	149.77	141.3	130.6	120.55	113.84	112.26	116.24	124.71	135.4	145.45	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	(69)
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Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

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

(71)m=	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	-69.84	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	105.27	103.52	99.89	94.96	91.75	87.24	83.41	88.32	90.06	95.17	100.94	103.53	(72)
--------	--------	--------	-------	-------	-------	-------	-------	-------	-------	-------	--------	--------	------

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

(73)m=	323.22	321.53	311.67	295.88	280.1	264.68	254.51	259.36	267.34	283.31	301.64	315.15	(73)
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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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast 0.9x	0.77	x	8.58	x	36.79	x	0.63	x	0.7	=	96.48	(77)
Southeast 0.9x	0.77	x	8.58	x	62.67	x	0.63	x	0.7	=	164.34	(77)
Southeast 0.9x	0.77	x	8.58	x	85.75	x	0.63	x	0.7	=	224.86	(77)
Southeast 0.9x	0.77	x	8.58	x	106.25	x	0.63	x	0.7	=	278.61	(77)
Southeast 0.9x	0.77	x	8.58	x	119.01	x	0.63	x	0.7	=	312.06	(77)

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Southeast 0.9x	0.77	x	8.58	x	118.15	x	0.63	x	0.7	=	309.81	(77)
Southeast 0.9x	0.77	x	8.58	x	113.91	x	0.63	x	0.7	=	298.69	(77)
Southeast 0.9x	0.77	x	8.58	x	104.39	x	0.63	x	0.7	=	273.73	(77)
Southeast 0.9x	0.77	x	8.58	x	92.85	x	0.63	x	0.7	=	243.47	(77)
Southeast 0.9x	0.77	x	8.58	x	69.27	x	0.63	x	0.7	=	181.63	(77)
Southeast 0.9x	0.77	x	8.58	x	44.07	x	0.63	x	0.7	=	115.56	(77)
Southeast 0.9x	0.77	x	8.58	x	31.49	x	0.63	x	0.7	=	82.57	(77)
Northwest 0.9x	0.77	x	2.39	x	11.28	x	0.63	x	0.7	=	8.24	(81)
Northwest 0.9x	0.77	x	2.39	x	22.97	x	0.63	x	0.7	=	16.78	(81)
Northwest 0.9x	0.77	x	2.39	x	41.38	x	0.63	x	0.7	=	30.22	(81)
Northwest 0.9x	0.77	x	2.39	x	67.96	x	0.63	x	0.7	=	49.64	(81)
Northwest 0.9x	0.77	x	2.39	x	91.35	x	0.63	x	0.7	=	66.72	(81)
Northwest 0.9x	0.77	x	2.39	x	97.38	x	0.63	x	0.7	=	71.13	(81)
Northwest 0.9x	0.77	x	2.39	x	91.1	x	0.63	x	0.7	=	66.54	(81)
Northwest 0.9x	0.77	x	2.39	x	72.63	x	0.63	x	0.7	=	53.05	(81)
Northwest 0.9x	0.77	x	2.39	x	50.42	x	0.63	x	0.7	=	36.83	(81)
Northwest 0.9x	0.77	x	2.39	x	28.07	x	0.63	x	0.7	=	20.5	(81)
Northwest 0.9x	0.77	x	2.39	x	14.2	x	0.63	x	0.7	=	10.37	(81)
Northwest 0.9x	0.77	x	2.39	x	9.21	x	0.63	x	0.7	=	6.73	(81)

Solar gains in watts, calculated for each month

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

(83)m=	104.72	181.12	255.08	328.24	378.79	380.94	365.23	326.78	280.3	202.13	125.93	89.3	(83)
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Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	427.94	502.65	566.75	624.12	658.89	645.62	619.74	586.14	547.64	485.44	427.57	404.44	(84)
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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=	0.99	0.97	0.93	0.83	0.66	0.47	0.34	0.37	0.59	0.87	0.97	0.99	(86)

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

(87)m=	20.25	20.43	20.66	20.87	20.97	21	21	21	20.99	20.85	20.52	20.21	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.12	20.13	20.13	20.14	20.14	20.15	20.15	20.16	20.15	20.14	20.14	20.13	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	0.99	0.97	0.92	0.79	0.6	0.41	0.27	0.3	0.52	0.83	0.97	0.99	(89)
--------	------	------	------	------	-----	------	------	-----	------	------	------	------	------

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

(90)m=	19.14	19.4	19.72	20	20.12	20.15	20.15	20.16	20.14	19.99	19.54	19.1	(90)
--------	-------	------	-------	----	-------	-------	-------	-------	-------	-------	-------	------	------

fLA = Living area ÷ (4) =

0.48 (91)

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

(92)m=	19.67	19.9	20.17	20.42	20.53	20.56	20.56	20.56	20.55	20.41	20.01	19.64	(92)
--------	-------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

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(93)m=	19.67	19.9	20.17	20.42	20.53	20.56	20.56	20.56	20.55	20.41	20.01	19.64	(93)
--------	-------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

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

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

Utilisation factor for gains, h_m :

(94)m=	0.98	0.96	0.92	0.8	0.63	0.44	0.3	0.34	0.55	0.84	0.96	0.99	(94)
--------	------	------	------	-----	------	------	-----	------	------	------	------	------	------

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

(95)m=	421.34	484.62	519.34	501.34	413.79	282.12	188.17	197.14	303.83	410.13	412.47	399.66	(95)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
--------	-----	-----	-----	-----	------	------	------	------	------	------	-----	-----	------

Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	758.72	737.86	670.39	556.57	425.29	283.21	188.27	197.31	308.11	472.29	625.34	752.27	(97)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(98)m=	251.01	170.17	112.38	39.77	8.55	0	0	0	0	46.24	153.27	262.34	
Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$												1043.73	(98)

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

20.11	(99)
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9a. Energy requirements – Individual heating systems including micro-CHP

Space heating:

Fraction of space heat from secondary/supplementary system (201) = 0

Fraction of space heat from main system(s) (202) = $1 - (201) =$

Fraction of total heating from main system 1 (204) = $(202) \times [1 - (203)] =$

Efficiency of main space heating system 1 (206) = 93.5

Efficiency of secondary/supplementary heating system, % (208) = 0

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$kWh/year$
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------------

Space heating requirement (calculated above)

251.01	170.17	112.38	39.77	8.55	0	0	0	0	46.24	153.27	262.34
--------	--------	--------	-------	------	---	---	---	---	-------	--------	--------

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

268.46	182	120.19	42.53	9.15	0	0	0	0	49.46	163.92	280.58
--------	-----	--------	-------	------	---	---	---	---	-------	--------	--------

Total ($kWh/year$) = $Sum(211)_{1..5,10..12} =$ 1116.29 (211)

Space heating fuel (secondary), $kWh/month$

= $\{[(98)m \times (201)]\} \times 100 \div (208)$

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

Water heating

Output from water heater (calculated above)

170.03	150.05	158	142.22	139.79	125.51	121.12	132.11	131.63	147.44	155.18	166.14
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Efficiency of water heater 79.8 (216)

(217)m= (217)

85.85	85.15	83.92	81.92	80.35	79.8	79.8	79.8	79.8	82.12	84.78	86.03
-------	-------	-------	-------	-------	------	------	------	------	-------	-------	-------

Fuel for water heating, $kWh/month$

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

(219)m=	198.06	176.21	188.27	173.61	173.98	157.28	151.77	165.55	164.95	179.55	183.03	193.12	
Total = $Sum(219a)_{1..12} =$												2105.39	(219)

Annual totals

Space heating fuel used, main system 1

$kWh/year$

$kWh/year$

1116.29

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Water heating fuel used		2105.39	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		75 (231)
Electricity for lighting		240.13	(232)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x		0.216	=	241.12	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	454.76	(264)
Space and water heating	(261) + (262) + (263) + (264) =				695.88	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93	(267)
Electricity for lighting	(232) x		0.519	=	124.63	(268)
Total CO2, kg/year			sum of (265)...(271) =		859.43	(272)

TER = 16.56 (273)

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User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 1B-TF (E-W) (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	47.7 (1a)	2.36 (2a)	112.76 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	47.7 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	112.76 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20 ÷ (5) = 0.18 (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)

Additional infiltration

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

Infiltration rate

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

Infiltration rate incorporating shelter factor

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

0.42	0.41	0.41	0.36	0.36	0.31	0.31	0.31	0.33	0.36	0.37	0.39
------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (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= 0.59 0.59 0.58 0.57 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.58 (24d)

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

(25)m= 0.59 0.59 0.58 0.57 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.58 (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	2		
Windows			5.79	$1/[1/(1.4)+0.04]$	7.68		
Walls Type1	13.71	5.79	7.92	0.18	1.43		
Walls Type2	17.14	2	15.14	0.18	2.73		
Roof	47.7	0	47.7	0.13	6.2		
Total area of elements, m²			78.55				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 20.03 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 1256.22 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 3.93 (36)

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

Total fabric heat loss (33) + (36) = 23.96 (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=	21.92	21.79	21.67	21.08	20.96	20.45	20.45	20.35	20.65	20.96	21.19	21.42

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

(39)m= 45.88 45.75 45.62 45.03 44.92 44.4 44.4 44.31 44.6 44.92 45.14 45.38
Average = Sum(39)_{1...12} /12= 45.03 (39)

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Heat loss parameter (HLP), W/m²K

$$(40)m = (39)m \div (4)$$

(40)m=	0.96	0.96	0.96	0.94	0.94	0.93	0.93	0.93	0.94	0.94	0.95	0.95		
Average = Sum(40) _{1...12} / 12 =													0.94	(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

$$\text{if TFA} > 13.9, N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$$

$$\text{if TFA} \leq 13.9, N = 1$$

1.62

(42)

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$

72.74

(43)

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

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

Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)

(44)m=	80.01	77.1	74.19	71.28	68.37	65.46	65.46	68.37	71.28	74.19	77.1	80.01		
Total = Sum(44) _{1...12} =													872.86	(44)

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$ kWh/month (see Tables 1b, 1c, 1d)

(45)m=	118.66	103.78	107.09	93.36	89.58	77.3	71.63	82.2	83.18	96.94	105.82	114.91		
Total = Sum(45) _{1...12} =													1144.45	(45)

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

(46)m=	17.8	15.57	16.06	14	13.44	11.6	10.74	12.33	12.48	14.54	15.87	17.24		(46)
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Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.39

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

$$(48) \times (49) =$$

0.75

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

$$(47) \times (51) \times (52) \times (53) =$$

0

(54)

Enter (50) or (54) in (55)

0.75

(55)

Water storage loss calculated for each month

$$((56)m = (55) \times (41)m$$

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(56)
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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=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

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

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

(62)m=	165.25	145.86	153.68	138.45	136.18	122.4	118.23	128.79	128.27	143.54	150.91	161.51	(62)
--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	------

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

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

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

Output from water heater

(64)m=	165.25	145.86	153.68	138.45	136.18	122.4	118.23	128.79	128.27	143.54	150.91	161.51	
Output from water heater (annual) _{1...12}												1693.07	(64)

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

(65)m=	76.73	68.17	72.88	67.12	67.06	61.78	61.09	64.61	63.73	69.51	71.26	75.48	(65)
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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=	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	81.13	(66)

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

(67)m=	13.94	12.38	10.07	7.62	5.7	4.81	5.2	6.76	9.07	11.52	13.44	14.33	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	141.26	142.73	139.04	131.17	121.24	111.91	105.68	104.22	107.91	115.77	125.7	135.03	(68)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	------

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

(69)m=	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	(69)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

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

(71)m=	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	103.13	101.45	97.96	93.22	90.14	85.8	82.12	86.84	88.52	93.43	98.97	101.46	(72)
--------	--------	--------	-------	-------	-------	------	-------	-------	-------	-------	-------	--------	------

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

(73)m=	308.68	306.9	297.41	282.35	267.42	252.87	243.34	248.15	255.84	271.06	288.45	301.16	(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 m ²	Flux Table 6a			g_ Table 6b	FF Table 6c			Gains (W)	
West	0.9x	0.77	x	5.79	x	19.64	x	0.63	x	0.7	=	34.75	(80)
West	0.9x	0.77	x	5.79	x	38.42	x	0.63	x	0.7	=	67.99	(80)
West	0.9x	0.77	x	5.79	x	63.27	x	0.63	x	0.7	=	111.96	(80)
West	0.9x	0.77	x	5.79	x	92.28	x	0.63	x	0.7	=	163.29	(80)
West	0.9x	0.77	x	5.79	x	113.09	x	0.63	x	0.7	=	200.12	(80)

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West	0.9x	0.77	x	5.79	x	115.77	x	0.63	x	0.7	=	204.86	(80)
West	0.9x	0.77	x	5.79	x	110.22	x	0.63	x	0.7	=	195.03	(80)
West	0.9x	0.77	x	5.79	x	94.68	x	0.63	x	0.7	=	167.53	(80)
West	0.9x	0.77	x	5.79	x	73.59	x	0.63	x	0.7	=	130.22	(80)
West	0.9x	0.77	x	5.79	x	45.59	x	0.63	x	0.7	=	80.67	(80)
West	0.9x	0.77	x	5.79	x	24.49	x	0.63	x	0.7	=	43.33	(80)
West	0.9x	0.77	x	5.79	x	16.15	x	0.63	x	0.7	=	28.58	(80)

Solar gains in watts, calculated for each month

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

(83)m=	34.75	67.99	111.96	163.29	200.12	204.86	195.03	167.53	130.22	80.67	43.33	28.58	(80)
--------	-------	-------	--------	--------	--------	--------	--------	--------	--------	-------	-------	-------	------

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

(84)m=	343.43	374.89	409.37	445.64	467.54	457.72	438.37	415.68	386.05	351.73	331.79	329.74	(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=	0.99	0.99	0.98	0.93	0.8	0.61	0.44	0.49	0.74	0.95	0.99	1	(86)

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

(87)m=	20.13	20.25	20.47	20.73	20.91	20.99	21	21	20.96	20.73	20.39	20.11	(87)
--------	-------	-------	-------	-------	-------	-------	----	----	-------	-------	-------	-------	------

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

(88)m=	20.12	20.12	20.12	20.13	20.13	20.14	20.14	20.14	20.14	20.13	20.13	20.12	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	0.99	0.99	0.97	0.9	0.75	0.53	0.36	0.4	0.67	0.92	0.98	0.99	(89)
--------	------	------	------	-----	------	------	------	-----	------	------	------	------	------

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

(90)m=	18.97	19.14	19.45	19.82	20.05	20.13	20.14	20.14	20.11	19.82	19.35	18.94	(90)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

fLA = Living area ÷ (4) =

0.52 (91)

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

(92)m=	19.58	19.73	19.98	20.3	20.5	20.58	20.59	20.59	20.55	20.3	19.89	19.56	(92)
--------	-------	-------	-------	------	------	-------	-------	-------	-------	------	-------	-------	------

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

(93)m=	19.58	19.73	19.98	20.3	20.5	20.58	20.59	20.59	20.55	20.3	19.89	19.56	(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=	0.99	0.99	0.97	0.91	0.78	0.57	0.4	0.44	0.71	0.93	0.98	0.99	(94)
--------	------	------	------	------	------	------	-----	------	------	------	------	------	------

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	340.64	369.5	395.83	404.7	362.44	261.14	176.7	184.82	273.15	326.97	326.27	327.57	(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=	700.98	678.29	615.05	513.23	395.44	265.55	177.17	185.65	287.81	435.56	577.47	696.87	(97)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(98)m=	268.1	207.51	163.1	78.14	24.55	0	0	0	0	80.79	180.86	274.76	
--------	-------	--------	-------	-------	-------	---	---	---	---	-------	--------	--------	--

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$$\text{Total per year (kWh/year)} = \text{Sum}(98)_{1...5,9...12} = \boxed{1277.8} \quad (98)$$

$$\text{Space heating requirement in kWh/m}^2\text{/year} = \boxed{26.79} \quad (99)$$

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

Space heating:

$$\text{Fraction of space heat from secondary/supplementary system} = \boxed{0} \quad (201)$$

$$\text{Fraction of space heat from main system(s)} \quad (202) = 1 - (201) = \boxed{1} \quad (202)$$

$$\text{Fraction of total heating from main system 1} \quad (204) = (202) \times [1 - (203)] = \boxed{1} \quad (204)$$

$$\text{Efficiency of main space heating system 1} = \boxed{93.5} \quad (206)$$

$$\text{Efficiency of secondary/supplementary heating system, \%} = \boxed{0} \quad (208)$$

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----------

Space heating requirement (calculated above)

268.1	207.51	163.1	78.14	24.55	0	0	0	0	80.79	180.86	274.76	
-------	--------	-------	-------	-------	---	---	---	---	-------	--------	--------	--

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

286.73	221.93	174.44	83.57	26.26	0	0	0	0	86.4	193.44	293.86	
--------	--------	--------	-------	-------	---	---	---	---	------	--------	--------	--

$$\text{Total (kWh/year)} = \text{Sum}(211)_{1...5,10...12} = \boxed{1366.63} \quad (211)$$

Space heating fuel (secondary), kWh/month

$$= \{[(98)_m \times (201)]\} \times 100 \div (208)$$

$$(215)_m = \boxed{0} \quad (215)$$

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

Water heating

Output from water heater (calculated above)

165.25	145.86	153.68	138.45	136.18	122.4	118.23	128.79	128.27	143.54	150.91	161.51	
--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--

$$\text{Efficiency of water heater} = \boxed{79.8} \quad (216)$$

$$(217)_m = \boxed{86.1} \quad (217)$$

86.1	85.75	84.97	83.36	81.27	79.8	79.8	79.8	79.8	83.35	85.3	86.22	
------	-------	-------	-------	-------	------	------	------	------	-------	------	-------	--

Fuel for water heating, kWh/month

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

$$(219)_m = \boxed{191.93} \quad (219)$$

191.93	170.09	180.86	166.1	167.57	153.38	148.16	161.4	160.74	172.21	176.92	187.32	
--------	--------	--------	-------	--------	--------	--------	-------	--------	--------	--------	--------	--

$$\text{Total} = \text{Sum}(219a)_{1...12} = \boxed{2036.68} \quad (219)$$

Annual totals

$$\text{Space heating fuel used, main system 1} \quad \text{kWh/year} = \boxed{1366.63} \quad (219)$$

$$\text{Water heating fuel used} \quad \text{kWh/year} = \boxed{2036.68} \quad (219)$$

Electricity for pumps, fans and electric keep-hot

$$\text{central heating pump:} \quad \boxed{30} \quad (230c)$$

$$\text{boiler with a fan-assisted flue} \quad \boxed{45} \quad (230e)$$

$$\text{Total electricity for the above, kWh/year} \quad \text{sum of (230a)...(230g)} = \boxed{75} \quad (231)$$

$$\text{Electricity for lighting} = \boxed{246.24} \quad (232)$$

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating (main system 1)	(211) x	0.216	= 295.19 (261)

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Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	439.92	(264)
Space and water heating	(261) + (262) + (263) + (264) =			735.12	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	127.8	(268)
Total CO2, kg/year	sum of (265)...(271) =			901.84	(272)
TER =				18.91	(273)

DRAFT

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User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 2B3P-TF-S (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	64.22 (1a)	2.53 (2a)	162.16 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	64.22 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	162.16 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.12 (8)
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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)

Additional infiltration

[(9)-1]x0.1 =

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

0.25 - [0.2 x (14) ÷ 100] =

Infiltration rate

(8) + (10) + (11) + (12) + (13) + (15) =

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

(20) = 1 - [0.075 x (19)] =

Infiltration rate incorporating shelter factor

(21) = (18) x (20) =

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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TER WorkSheet: New dwelling design stage

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

0.37	0.36	0.35	0.32	0.31	0.27	0.27	0.27	0.29	0.31	0.33	0.34
------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 0.57 0.57 0.56 0.55 0.55 0.54 0.54 0.54 0.54 0.55 0.55 0.56 (24d)

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

(25)m= 0.57 0.57 0.56 0.55 0.55 0.54 0.54 0.54 0.54 0.55 0.55 0.56 (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	2		
Windows			14.06	$1/[1/(1.4)+0.04]$	18.64		
Walls Type1	25.25	14.06	11.19	0.18	2.01		
Walls Type2	18.26	2	16.26	0.18	2.93		
Roof	64.22	0	64.22	0.13	8.35		
Total area of elements, m²			107.74				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U)

(26)...(30) + (32) = 33.93 (33)

Heat capacity Cm = S(A x k)

((28)...(30) + (32) + (32a)...(32e) = 1654.05 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K

Indicative Value: Medium 250 (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

5.39 (36)

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

Total fabric heat loss

(33) + (36) = 39.32 (37)

Ventilation heat loss calculated monthly

(38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	30.4	30.26	30.12	29.47	29.34	28.78	28.78	28.67	29	29.34	29.59	29.85

Heat transfer coefficient, W/K

(39)m = (37) + (38)m

(39)m=	69.71	69.57	69.43	68.78	68.66	68.09	68.09	67.99	68.31	68.66	68.91	69.17
Average = Sum(39) _{1...12} /12=												68.78 (39)

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	1.09	1.08	1.08	1.07	1.07	1.06	1.06	1.06	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

2.1

(42)

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

if TFA ≤ 13.9, N = 1

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

84.03

(43)

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

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

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

(44)m=	92.43	89.07	85.71	82.35	78.99	75.63	75.63	78.99	82.35	85.71	89.07	92.43		
	Total = Sum(44) _{1...12} =												1008.36	(44)

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

(45)m=	137.08	119.89	123.71	107.86	103.49	89.3	82.75	94.96	96.09	111.99	122.24	132.75		
	Total = Sum(45) _{1...12} =												1322.12	(45)

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

(46)m=	20.56	17.98	18.56	16.18	15.52	13.4	12.41	14.24	14.41	16.8	18.34	19.91		(46)
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Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.89

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

(48) × (49) =

1.02

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

(47) × (51) × (52) × (53) =

0

(54)

Enter (50) or (54) in (55)

1.02

(55)

Water storage loss calculated for each month

((56)m = (55) × (41)m

(56)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64		(56)
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If cylinder contains dedicated solar storage, (57)m = (56)m × [(50) - (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64		(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

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

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

(62)m=	191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66	(62)
--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	-------	--------	--------	------

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

(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)

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

Output from water heater

(64)m=	191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66	
Output from water heater (annual) _{1...12}												1968.6	(64)

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

(65)m=	89.5	79.54	85.06	78.37	78.34	72.2	71.44	75.5	74.46	81.16	83.15	88.06	(65)
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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=	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	(66)

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

(67)m=	16.75	14.88	12.1	9.16	6.85	5.78	6.25	8.12	10.9	13.84	16.15	17.22	(67)
--------	-------	-------	------	------	------	------	------	------	------	-------	-------	-------	------

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

(68)m=	183.45	185.35	180.56	170.34	157.45	145.34	137.24	135.34	140.14	150.35	163.24	175.36	(68)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(69)m=	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	(69)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

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

(71)m=	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	120.3	118.36	114.33	108.85	105.29	100.28	96.02	101.48	103.42	109.09	115.49	118.37	(72)
--------	-------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	------

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

(73)m=	377.98	376.07	364.46	345.83	327.06	308.87	296.98	302.41	311.92	330.75	352.36	368.41	(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 m ²	Flux Table 6a			g_ Table 6b	FF Table 6c			Gains (W)	
South	0.9x	0.54	x	14.06	x	46.75	x	0.63	x	0.7	=	140.88	(78)
South	0.9x	0.54	x	14.06	x	76.57	x	0.63	x	0.7	=	230.73	(78)
South	0.9x	0.54	x	14.06	x	97.53	x	0.63	x	0.7	=	293.91	(78)
South	0.9x	0.54	x	14.06	x	110.23	x	0.63	x	0.7	=	332.18	(78)
South	0.9x	0.54	x	14.06	x	114.87	x	0.63	x	0.7	=	346.16	(78)

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South	0.9x	0.54	x	14.06	x	110.55	x	0.63	x	0.7	=	333.13	(78)
South	0.9x	0.54	x	14.06	x	108.01	x	0.63	x	0.7	=	325.49	(78)
South	0.9x	0.54	x	14.06	x	104.89	x	0.63	x	0.7	=	316.09	(78)
South	0.9x	0.54	x	14.06	x	101.89	x	0.63	x	0.7	=	307.02	(78)
South	0.9x	0.54	x	14.06	x	82.59	x	0.63	x	0.7	=	248.87	(78)
South	0.9x	0.54	x	14.06	x	55.42	x	0.63	x	0.7	=	167	(78)
South	0.9x	0.54	x	14.06	x	40.4	x	0.63	x	0.7	=	121.74	(78)

Solar gains in watts, calculated for each month

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

(83)m=	140.88	230.73	293.91	332.18	346.16	333.13	325.49	316.09	307.02	248.87	167	121.74	(83)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-----	--------	------

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

(84)m=	518.86	606.8	658.37	678.01	673.22	642	622.47	618.5	618.95	579.61	519.35	490.15	(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=	0.99	0.98	0.96	0.91	0.82	0.65	0.48	0.5	0.71	0.92	0.98	0.99	(86)

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

(87)m=	20.04	20.22	20.45	20.68	20.87	20.97	21	20.99	20.95	20.73	20.34	20	(87)
--------	-------	-------	-------	-------	-------	-------	----	-------	-------	-------	-------	----	------

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

(88)m=	20.01	20.01	20.02	20.02	20.03	20.03	20.03	20.03	20.03	20.03	20.02	20.02	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	0.99	0.98	0.95	0.89	0.77	0.56	0.37	0.4	0.63	0.88	0.98	0.99	(89)
--------	------	------	------	------	------	------	------	-----	------	------	------	------	------

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

(90)m=	18.75	19.02	19.34	19.67	19.9	20.02	20.03	20.03	20	19.73	19.19	18.7	(90)
--------	-------	-------	-------	-------	------	-------	-------	-------	----	-------	-------	------	------

fLA = Living area ÷ (4) =

0.4 (91)

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

(92)m=	19.27	19.51	19.78	20.08	20.3	20.4	20.42	20.42	20.38	20.14	19.65	19.23	(92)
--------	-------	-------	-------	-------	------	------	-------	-------	-------	-------	-------	-------	------

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

(93)m=	19.27	19.51	19.78	20.08	20.3	20.4	20.42	20.42	20.38	20.14	19.65	19.23	(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=	0.99	0.97	0.95	0.89	0.78	0.6	0.42	0.44	0.66	0.89	0.97	0.99	(94)
--------	------	------	------	------	------	-----	------	------	------	------	------	------	------

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	512.19	590.02	622.29	603.27	526.35	383.34	258.84	271.52	408.7	515.02	504.99	485.28	(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=	1043.81	1016.2	922.41	769.06	590.19	395.11	260.25	273.43	429.27	654.77	865.02	1039.3	(97)
--------	---------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(98)m=	395.52	286.4	223.29	119.37	47.49	0	0	0	0	103.97	259.22	412.19	
--------	--------	-------	--------	--------	-------	---	---	---	---	--------	--------	--------	--

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$$\text{Total per year (kWh/year)} = \text{Sum}(98)_{1...5,9...12} = 1847.46 \quad (98)$$

$$\text{Space heating requirement in kWh/m}^2/\text{year} = 28.77 \quad (99)$$

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

Space heating:

$$\text{Fraction of space heat from secondary/supplementary system} = 0 \quad (201)$$

$$\text{Fraction of space heat from main system(s)} \quad (202) = 1 - (201) = 1 \quad (202)$$

$$\text{Fraction of total heating from main system 1} \quad (204) = (202) \times [1 - (203)] = 1 \quad (204)$$

$$\text{Efficiency of main space heating system 1} = 93.5 \quad (206)$$

$$\text{Efficiency of secondary/supplementary heating system, \%} = 0 \quad (208)$$

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
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Space heating requirement (calculated above)

395.52	286.4	223.29	119.37	47.49	0	0	0	0	103.97	259.22	412.19	
--------	-------	--------	--------	-------	---	---	---	---	--------	--------	--------	--

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

423.02	306.31	238.82	127.67	50.79	0	0	0	0	111.2	277.24	440.85	
--------	--------	--------	--------	-------	---	---	---	---	-------	--------	--------	--

$$\text{Total (kWh/year)} = \text{Sum}(211)_{1...5,10...12} = 1975.89 \quad (211)$$

Space heating fuel (secondary), kWh/month

$$= \{[(98)_m \times (201)]\} \times 100 \div (208)$$

$$(215)_m = 0 \quad (215)$$

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

Water heating

Output from water heater (calculated above)

191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66	
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$$\text{Efficiency of water heater} = 79.8 \quad (216)$$

$$(217)_m = 86.7 \quad (217)$$

86.7	86.2	85.41	84.03	82.04	79.8	79.8	79.8	79.8	83.59	85.85	86.86	
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Fuel for water heating, kWh/month

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

$$(219)_m = 221.43 \quad (219)$$

$$\text{Total} = \text{Sum}(219a)_{1...12} = 2357.62 \quad (219)$$

Annual totals

$$\text{Space heating fuel used, main system 1} \quad \text{kWh/year} = 1975.89 \quad \text{kWh/year}$$

$$\text{Water heating fuel used} \quad \text{kWh/year} = 2357.62 \quad \text{kWh/year}$$

Electricity for pumps, fans and electric keep-hot

$$\text{central heating pump:} \quad 30 \quad (230c)$$

$$\text{boiler with a fan-assisted flue} \quad 45 \quad (230e)$$

$$\text{Total electricity for the above, kWh/year} \quad \text{sum of (230a)...(230g)} = 75 \quad (231)$$

$$\text{Electricity for lighting} = 295.88 \quad (232)$$

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating (main system 1)	(211) ×	0.216	= 426.79 (261)

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Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	509.25	(264)
Space and water heating	(261) + (262) + (263) + (264) =			936.04	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	153.56	(268)
Total CO2, kg/year	sum of (265)...(271) =			1128.53	(272)
TER =				17.57	(273)

DRAFT

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 2B-MF (E-W) (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	62.1 (1a) ×	2.4 (2a) =	149.04 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62.1 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	149.04 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0 × 40 =	0 (6a)
Number of open flues	0	0	0	0 × 20 =	0 (6b)
Number of intermittent fans				2 × 10 =	20 (7a)
Number of passive vents				0 × 10 =	0 (7b)
Number of flueless gas fires				0 × 40 =	0 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20 ÷ (5) =	0.13 (8)
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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)

Additional infiltration

[(9)-1]×0.1 =

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

0.25 - [0.2 × (14) ÷ 100] =

Infiltration rate

(8) + (10) + (11) + (12) + (13) + (15) =

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

(20) = 1 - [0.075 × (19)] =

Infiltration rate incorporating shelter factor

(21) = (18) × (20) =

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.42	0.41	0.4	0.36	0.35	0.31	0.31	0.3	0.33	0.35	0.37	0.38
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 0.59 0.58 0.58 0.56 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.57 (24d)

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

(25)m= 0.59 0.58 0.58 0.56 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.57 (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	2		
Windows Type 1			7.72	$\times 1/[1/(1.4) + 0.04]$	10.23		
Windows Type 2			3.86	$\times 1/[1/(1.4) + 0.04]$	5.12		
Walls Type1	33.8	11.58	22.22	0.18	4		
Walls Type2	8.74	2	6.74	0.18	1.21		
Roof	20	0	20	0.13	2.6		
Total area of elements, m²			62.54				
Party wall			46	0	0		

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 25.17 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 2776.72 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 3.13 (36)

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

Total fabric heat loss (33) + (36) = 28.29 (37)

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

(38)m= 28.85 28.69 28.53 27.76 27.62 26.96 26.96 26.84 27.21 27.62 27.91 28.21 (38)

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

(39)m= 57.15 56.98 56.82 56.06 55.91 55.25 55.25 55.13 55.51 55.91 56.2 56.5

Average = Sum(39)_{1...12} /12= 56.06 (39)

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	0.92	0.92	0.91	0.9	0.9	0.89	0.89	0.89	0.89	0.9	0.91	0.91		
Average = Sum(40) _{1...12} /12=													0.9	(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

2.04

(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

82.66

(43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
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Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	90.92	87.62	84.31	81.01	77.7	74.39	74.39	77.7	81.01	84.31	87.62	90.92		
Total = Sum(44) _{1...12} =													991.9	(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=	134.84	117.93	121.69	106.09	101.8	87.85	81.4	93.41	94.53	110.16	120.25	130.58		
Total = Sum(45) _{1...12} =													1300.53	(45)

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

(46)m=	20.23	17.69	18.25	15.91	15.27	13.18	12.21	14.01	14.18	16.52	18.04	19.59		(46)
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Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.89

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

(48) x (49) =

1.02

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

(47) x (51) x (52) x (53) =

0

(54)

Enter (50) or (54) in (55)

1.02

(55)

Water storage loss calculated for each month

((56)m = (55) x (41)m

(56)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64		(56)
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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=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64		(57)
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Primary circuit loss (annual) from Table 3

0

(58)

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	0	0	0	0	0	0	0	0	0	0	0	(61)
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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=	189.74	167.52	176.6	159.23	156.71	140.98	136.31	148.32	147.66	165.07	173.39	185.49	(62)
--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)

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

Output from water heater

(64)m=	189.74	167.52	176.6	159.23	156.71	140.98	136.31	148.32	147.66	165.07	173.39	185.49	
Output from water heater (annual) _{1...12}												1947.02	(64)

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

(65)m=	88.76	78.89	84.39	77.79	77.77	71.72	70.99	74.98	73.94	80.55	82.49	87.34	(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=	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	(66)

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

(67)m=	16.14	14.34	11.66	8.83	6.6	5.57	6.02	7.82	10.5	13.33	15.56	16.59	(67)
--------	-------	-------	-------	------	-----	------	------	------	------	-------	-------	-------	------

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

(68)m=	178.21	180.06	175.4	165.48	152.96	141.19	133.32	131.47	136.13	146.05	158.58	170.35	(68)
--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(69)m=	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	(69)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

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

(71)m=	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	119.3	117.39	113.43	108.03	104.54	99.61	95.42	100.79	102.69	108.27	114.57	117.4	(72)
--------	-------	--------	--------	--------	--------	-------	-------	--------	--------	--------	--------	-------	------

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

(73)m=	370.26	368.39	357.09	338.94	320.69	302.97	291.37	296.69	305.93	324.26	345.31	360.94	(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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southwest _{0.9x}	0.77	x	3.86	x	36.79		0.63	x	0.7	=	43.4	(79)
Southwest _{0.9x}	0.77	x	3.86	x	62.67		0.63	x	0.7	=	73.93	(79)
Southwest _{0.9x}	0.77	x	3.86	x	85.75		0.63	x	0.7	=	101.16	(79)
Southwest _{0.9x}	0.77	x	3.86	x	106.25		0.63	x	0.7	=	125.34	(79)
Southwest _{0.9x}	0.77	x	3.86	x	119.01		0.63	x	0.7	=	140.39	(79)

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Southwest	0.9x	0.77	x	3.86	x	118.15	0.63	x	0.7	=	139.38	(79)
Southwest	0.9x	0.77	x	3.86	x	113.91	0.63	x	0.7	=	134.37	(79)
Southwest	0.9x	0.77	x	3.86	x	104.39	0.63	x	0.7	=	123.15	(79)
Southwest	0.9x	0.77	x	3.86	x	92.85	0.63	x	0.7	=	109.53	(79)
Southwest	0.9x	0.77	x	3.86	x	69.27	0.63	x	0.7	=	81.71	(79)
Southwest	0.9x	0.77	x	3.86	x	44.07	0.63	x	0.7	=	51.99	(79)
Southwest	0.9x	0.77	x	3.86	x	31.49	0.63	x	0.7	=	37.15	(79)
West	0.9x	0.77	x	7.72	x	19.64	0.63	x	0.7	=	46.34	(80)
West	0.9x	0.77	x	7.72	x	38.42	0.63	x	0.7	=	90.65	(80)
West	0.9x	0.77	x	7.72	x	63.27	0.63	x	0.7	=	149.28	(80)
West	0.9x	0.77	x	7.72	x	92.28	0.63	x	0.7	=	217.72	(80)
West	0.9x	0.77	x	7.72	x	113.09	0.63	x	0.7	=	266.82	(80)
West	0.9x	0.77	x	7.72	x	115.77	0.63	x	0.7	=	273.14	(80)
West	0.9x	0.77	x	7.72	x	110.22	0.63	x	0.7	=	260.04	(80)
West	0.9x	0.77	x	7.72	x	94.68	0.63	x	0.7	=	223.37	(80)
West	0.9x	0.77	x	7.72	x	73.59	0.63	x	0.7	=	173.62	(80)
West	0.9x	0.77	x	7.72	x	45.59	0.63	x	0.7	=	107.56	(80)
West	0.9x	0.77	x	7.72	x	24.49	0.63	x	0.7	=	57.78	(80)
West	0.9x	0.77	x	7.72	x	16.15	0.63	x	0.7	=	38.11	(80)

Solar gains in watts, calculated for each month

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

(83)m=	89.74	164.58	250.44	343.06	407.22	412.52	394.42	346.52	283.16	189.27	109.77	75.25	(83)
--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	------

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

(84)m=	460	532.97	607.53	682.01	727.91	715.49	685.78	643.2	589.09	513.54	455.08	436.19	(84)
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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=	0.99	0.98	0.95	0.86	0.69	0.49	0.35	0.39	0.63	0.91	0.98	1	(86)

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

(87)m=	20.22	20.38	20.61	20.85	20.97	21	21	21	20.98	20.82	20.47	20.19	(87)
--------	-------	-------	-------	-------	-------	----	----	----	-------	-------	-------	-------	------

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

(88)m=	20.15	20.15	20.15	20.17	20.17	20.18	20.18	20.18	20.17	20.17	20.16	20.16	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	0.99	0.98	0.94	0.82	0.63	0.43	0.29	0.32	0.56	0.88	0.98	0.99	(89)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(90)m=	19.11	19.35	19.68	20	20.14	20.17	20.18	20.18	20.16	19.97	19.49	19.07	(90)
--------	-------	-------	-------	----	-------	-------	-------	-------	-------	-------	-------	-------	------

fLA = Living area ÷ (4) =

0.42 (91)

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

(92)m=	19.57	19.78	20.07	20.36	20.49	20.52	20.52	20.52	20.51	20.33	19.9	19.54	(92)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	-------	------

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

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(93)m=	19.57	19.78	20.07	20.36	20.49	20.52	20.52	20.52	20.51	20.33	19.9	19.54	(93)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	-------	------

8. Space heating requirement

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

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

Utilisation factor for gains, h_m :

(94)m=	0.99	0.98	0.94	0.83	0.65	0.46	0.32	0.35	0.59	0.88	0.98	0.99	(94)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(95)m=	455.38	520.55	570.21	567.93	476.05	325.61	216.51	226.99	349.19	453.62	444.53	432.85	(95)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
--------	-----	-----	-----	-----	------	------	------	------	------	------	-----	-----	------

Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	872.82	847.92	771.11	642.38	491.23	326.99	216.63	227.22	355.59	543.77	719.6	866.75	(97)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	------

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

(98)m=	310.58	220	149.47	53.61	11.3	0	0	0	0	67.07	198.05	322.82	
--------	--------	-----	--------	-------	------	---	---	---	---	-------	--------	--------	--

Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 1332.89 (98)

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

21.46 (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) = $(202) \times [1 - (203)] =$ 1 (204)

Efficiency of main space heating system 1

93.5 (206)

Efficiency of secondary/supplementary heating system, %

0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----------

Space heating requirement (calculated above)

310.58	220	149.47	53.61	11.3	0	0	0	0	67.07	198.05	322.82
--------	-----	--------	-------	------	---	---	---	---	-------	--------	--------

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

332.17	235.29	159.86	57.34	12.08	0	0	0	0	71.73	211.82	345.26
--------	--------	--------	-------	-------	---	---	---	---	-------	--------	--------

Total ($kWh/year$) = $Sum(211)_{1..5,10..12} =$ 1425.55 (211)

Space heating fuel (secondary), $kWh/month$

= $\{[(98)m \times (201)]\} \times 100 \div (208)$

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

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

Water heating

Output from water heater (calculated above)

189.74	167.52	176.6	159.23	156.71	140.98	136.31	148.32	147.66	165.07	173.39	185.49
--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Efficiency of water heater

79.8 (216)

(217)m = 86.12 85.54 84.37 82.25 80.44 79.8 79.8 79.8 79.8 82.62 85.17 86.28 (217)

Fuel for water heating, $kWh/month$

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

(219)m=	220.32	195.84	209.31	193.59	194.81	176.67	170.81	185.86	185.04	199.79	203.58	214.99	
---------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--

Total = $Sum(219a)_{1..12} =$ 2350.62 (219)

Annual totals

$kWh/year$

$kWh/year$

Space heating fuel used, main system 1

1425.55

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Water heating fuel used		2350.62	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		75 (231)
Electricity for lighting		285.04	(232)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year
Space heating (main system 1)	(211) x		0.216	=	307.92 (261)
Space heating (secondary)	(215) x		0.519	=	0 (263)
Water heating	(219) x		0.216	=	507.73 (264)
Space and water heating	(261) + (262) + (263) + (264) =				815.65 (265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93 (267)
Electricity for lighting	(232) x		0.519	=	147.93 (268)
Total CO2, kg/year	sum of (265)...(271) =				1002.51 (272)

TER = 16.14 (273)

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User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 2B-MF-N (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	64.22 (1a)	2.53 (2a)	162.16 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	64.22 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	162.16 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.12 (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)

Additional infiltration

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

Infiltration rate

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

Infiltration rate incorporating shelter factor

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

0.37	0.36	0.35	0.32	0.31	0.27	0.27	0.27	0.29	0.31	0.33	0.34
------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 0.57 0.57 0.56 0.55 0.55 0.54 0.54 0.54 0.54 0.55 0.55 0.56 (24d)

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

(25)m= 0.57 0.57 0.56 0.55 0.55 0.54 0.54 0.54 0.54 0.55 0.55 0.56 (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	2		
Windows			14.06	$1/[1/(1.4)+0.04]$	18.64		
Walls Type1	25.25	14.06	11.19	0.18	2.01		
Walls Type2	18.26	2	16.26	0.18	2.93		
Total area of elements, m²			43.51				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 25.58 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 1076.07 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 2.18 (36)

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

Total fabric heat loss (33) + (36) = 27.76 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	30.4	30.26	30.12	29.47	29.34	28.78	28.78	28.67	29	29.34	29.59	29.85

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

(39)m=	58.15	58.01	57.87	57.22	57.1	56.53	56.53	56.43	56.75	57.1	57.35	57.61
	Average = Sum(39) _{1...12} /12= 57.22											(39)

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

(40)m=	0.91	0.9	0.9	0.89	0.89	0.88	0.88	0.88	0.88	0.89	0.89	0.9
	Average = Sum(40) _{1...12} /12= 0.89											(40)

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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 2.1 (42)

if TFA > 13.9, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

if TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$ 84.03 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
(44)m=	92.43	89.07	85.71	82.35	78.99	75.63	75.63	78.99	82.35	85.71	89.07	92.43	
Total = Sum(44) _{1...12} =												1008.36	(44)

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$ kWh/month (see Tables 1b, 1c, 1d)

(45)m=	137.08	119.89	123.71	107.86	103.49	89.3	82.75	94.96	96.09	111.99	122.24	132.75	
Total = Sum(45) _{1...12} =												1322.12	(45)

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

(46)m=	20.56	17.98	18.56	16.18	15.52	13.4	12.41	14.24	14.41	16.8	18.34	19.91	(46)
--------	-------	-------	-------	-------	-------	------	-------	-------	-------	------	-------	-------	------

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.89 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) × (49) = 1.02 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) × (51) × (52) × (53) = 0 (54)

Enter (50) or (54) in (55) 1.02 (55)

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

(56)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64	(56)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

If cylinder contains dedicated solar storage, $(57)m = (56)m \times [(50) - (H11)] \div (50)$, else $(57)m = (56)m$ where (H11) is from Appendix H

(57)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64	(57)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month $(59)m = (58) \div 365 \times (41)m$

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Combi loss calculated for each month $(61)m = (60) \div 365 \times (41)m$

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

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

(62)m=

191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66
--------	--------	--------	--------	-------	--------	--------	--------	--------	-------	--------	--------

 (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=

191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66
--------	--------	--------	--------	-------	--------	--------	--------	--------	-------	--------	--------

Output from water heater (annual)_{1...12}

1968.6

 (64)

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

(65)m=

89.5	79.54	85.06	78.37	78.34	72.2	71.44	75.5	74.46	81.16	83.15	88.06
------	-------	-------	-------	-------	------	-------	------	-------	-------	-------	-------

 (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

(66)m=

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9

 (66)

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

(67)m=

16.75	14.88	12.1	9.16	6.85	5.78	6.25	8.12	10.9	13.84	16.15	17.22
-------	-------	------	------	------	------	------	------	------	-------	-------	-------

 (67)

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

(68)m=

183.45	185.35	180.56	170.34	157.45	145.34	137.24	135.34	140.14	150.35	163.24	175.36
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (68)

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

(69)m=

33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (69)

Pumps and fans gains (Table 5a)

(70)m=

3	3	3	3	3	3	3	3	3	3	3	3
---	---	---	---	---	---	---	---	---	---	---	---

 (70)

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

(71)m=

-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (71)

Water heating gains (Table 5)

(72)m=

120.3	118.36	114.33	108.85	105.29	100.28	96.02	101.48	103.42	109.09	115.49	118.37
-------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------

 (72)

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

(73)m=

377.98	376.07	364.46	345.83	327.06	308.87	296.98	302.41	311.92	330.75	352.36	368.41
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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	Area			Flux			g_		FF		Gains	
	Table 6d		m²		Table 6a			Table 6b		Table 6c		(W)	
North	0.9x	0.54	x	14.06	x	10.63	x	0.63	x	0.7	=	32.04	(74)
North	0.9x	0.54	x	14.06	x	20.32	x	0.63	x	0.7	=	61.24	(74)
North	0.9x	0.54	x	14.06	x	34.53	x	0.63	x	0.7	=	104.05	(74)
North	0.9x	0.54	x	14.06	x	55.46	x	0.63	x	0.7	=	167.14	(74)
North	0.9x	0.54	x	14.06	x	74.72	x	0.63	x	0.7	=	225.15	(74)
North	0.9x	0.54	x	14.06	x	79.99	x	0.63	x	0.7	=	241.03	(74)
North	0.9x	0.54	x	14.06	x	74.68	x	0.63	x	0.7	=	225.03	(74)
North	0.9x	0.54	x	14.06	x	59.25	x	0.63	x	0.7	=	178.53	(74)

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North	0.9x	0.54	x	14.06	x	41.52	x	0.63	x	0.7	=	125.11	(74)
North	0.9x	0.54	x	14.06	x	24.19	x	0.63	x	0.7	=	72.89	(74)
North	0.9x	0.54	x	14.06	x	13.12	x	0.63	x	0.7	=	39.53	(74)
North	0.9x	0.54	x	14.06	x	8.86	x	0.63	x	0.7	=	26.71	(74)

Solar gains in watts, calculated for each month

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

(83)m=	32.04	61.24	104.05	167.14	225.15	241.03	225.03	178.53	125.11	72.89	39.53	26.71	(83)
--------	-------	-------	--------	--------	--------	--------	--------	--------	--------	-------	-------	-------	------

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

(84)m=	410.02	437.3	468.51	512.96	552.21	549.9	522.02	480.94	437.03	403.64	391.89	395.13	(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=	1	0.99	0.99	0.95	0.84	0.64	0.47	0.53	0.81	0.97	0.99	1	(86)

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

(87)m=	20.14	20.24	20.42	20.69	20.9	20.99	21	21	20.94	20.69	20.37	20.12	(87)
--------	-------	-------	-------	-------	------	-------	----	----	-------	-------	-------	-------	------

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

(88)m=	20.16	20.16	20.17	20.18	20.18	20.18	20.18	20.19	20.18	20.18	20.17	20.17	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	1	0.99	0.98	0.94	0.8	0.57	0.39	0.44	0.74	0.96	0.99	1	(89)
--------	---	------	------	------	-----	------	------	------	------	------	------	---	------

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

(90)m=	19.01	19.15	19.43	19.81	20.08	20.17	20.18	20.18	20.14	19.81	19.36	18.99	(90)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

fLA = Living area ÷ (4) = 0.4 (91)

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

(92)m=	19.47	19.59	19.83	20.16	20.41	20.5	20.51	20.51	20.46	20.17	19.77	19.45	(92)
--------	-------	-------	-------	-------	-------	------	-------	-------	-------	-------	-------	-------	------

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

(93)m=	19.47	19.59	19.83	20.16	20.41	20.5	20.51	20.51	20.46	20.17	19.77	19.45	(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	
(94)m=	1	0.99	0.98	0.94	0.81	0.6	0.42	0.48	0.77	0.96	0.99	1	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	407.98	433.7	459.64	481.42	448.68	327.81	220.64	230.83	335.61	385.49	387.88	393.54	(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=	882.05	852.29	771.43	644.57	497.47	333.72	221.24	232.08	361.08	546.36	726.7	878.32	(97)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	------

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

(98)m=	352.71	281.3	231.98	117.47	36.3	0	0	0	0	119.69	243.95	360.68	(98)
--------	--------	-------	--------	--------	------	---	---	---	---	--------	--------	--------	------

Total per year (kWh/year) = Sum(98)_{1...5,9...12} = 1744.07 (98)

Space heating requirement in kWh/m²/year

27.16 (99)

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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		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----------

Space heating requirement (calculated above)

352.71	281.3	231.98	117.47	36.3	0	0	0	0	119.69	243.95	360.68	
(211)m = {[[(98)m x (204)] } x 100 ÷ (206)												(211)
377.23	300.85	248.1	125.63	38.82	0	0	0	0	128.01	260.91	385.75	
Total (kWh/year) = Sum(211) _{1...5,10...12} =												1865.31 (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	
Total (kWh/year) = Sum(215) _{1...5,10...12} =												0 (215)

Water heating

Output from water heater (calculated above)

191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66	
Efficiency of water heater												79.8 (216)
(217)m =	86.42	86.16	85.51	83.99	81.6	79.8	79.8	79.8	79.8	83.95	85.69	86.53 (217)
Fuel for water heating, kWh/month												
(219)m = (64)m x 100 ÷ (217)m												
(219)m =	222.16	196.71	208.88	191.68	194.12	178.5	172.51	187.8	187.01	198.82	204.66	216.87
Total = Sum(219a) _{1...12} =												2359.71 (219)

Annual totals

Space heating fuel used, main system 1		1865.31	kWh/year		kWh/year
Water heating fuel used		2359.71			
Electricity for pumps, fans and electric keep-hot					
central heating pump:		30			(230c)
boiler with a fan-assisted flue		45			(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =	75			(231)
Electricity for lighting		295.88			(232)

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

	Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year
Space heating (main system 1)	(211) x	0.216	=	402.91 (261)
Space heating (secondary)	(215) x	0.519	=	0 (263)
Water heating	(219) x	0.216	=	509.7 (264)
Space and water heating	(261) + (262) + (263) + (264) =			912.6 (265)

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Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	153.56	(268)
Total CO2, kg/year		sum of (265)...(271) =		1105.09	(272)
TER	=			17.21	(273)

DRAFT

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 2B-MF-S (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	64.22 (1a)	2.53 (2a)	162.16 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	64.22 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	162.16 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.12 (8)
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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)

Additional infiltration

[(9)-1]x0.1 =

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

0.25 - [0.2 x (14) ÷ 100] =

Infiltration rate

(8) + (10) + (11) + (12) + (13) + (15) =

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

(20) = 1 - [0.075 x (19)] =

Infiltration rate incorporating shelter factor

(21) = (18) x (20) =

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

0.37	0.36	0.35	0.32	0.31	0.27	0.27	0.27	0.29	0.31	0.33	0.34
------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 0.57 0.57 0.56 0.55 0.55 0.54 0.54 0.54 0.54 0.55 0.55 0.56 (24d)

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

(25)m= 0.57 0.57 0.56 0.55 0.55 0.54 0.54 0.54 0.54 0.55 0.55 0.56 (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	2		
Windows			14.06	$1/[1/(1.4)+0.04]$	18.64		
Walls Type1	25.25	14.06	11.19	0.18	2.01		
Walls Type2	18.26	2	16.26	0.18	2.93		
Total area of elements, m²			43.51				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 25.58 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 1076.07 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 2.18 (36)

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

Total fabric heat loss (33) + (36) = 27.76 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	30.4	30.26	30.12	29.47	29.34	28.78	28.78	28.67	29	29.34	29.59	29.85

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

(39)m=	58.15	58.01	57.87	57.22	57.1	56.53	56.53	56.43	56.75	57.1	57.35	57.61
	Average = Sum(39) _{1...12} /12= 57.22											(39)

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

(40)m=	0.91	0.9	0.9	0.89	0.89	0.88	0.88	0.88	0.88	0.89	0.89	0.9
	Average = Sum(40) _{1...12} /12= 0.89											(40)

TER WorkSheet: New dwelling design stage

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 2.1 (42)

if TFA > 13.9, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

if TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$ 84.03 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
(44)m=	92.43	89.07	85.71	82.35	78.99	75.63	75.63	78.99	82.35	85.71	89.07	92.43	
Total = Sum(44) _{1...12} =												1008.36	(44)

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$ kWh/month (see Tables 1b, 1c, 1d)

(45)m=	137.08	119.89	123.71	107.86	103.49	89.3	82.75	94.96	96.09	111.99	122.24	132.75	
Total = Sum(45) _{1...12} =												1322.12	(45)

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

(46)m=	20.56	17.98	18.56	16.18	15.52	13.4	12.41	14.24	14.41	16.8	18.34	19.91	(46)
--------	-------	-------	-------	-------	-------	------	-------	-------	-------	------	-------	-------	------

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.89 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) \times (49) = 1.02 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) \times (51) \times (52) \times (53) = 0 (54)

Enter (50) or (54) in (55) 1.02 (55)

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

(56)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64	(56)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

If cylinder contains dedicated solar storage, $(57)m = (56)m \times [(50) - (H11)] \div (50)$, else $(57)m = (56)m$ where (H11) is from Appendix H

(57)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64	(57)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month $(59)m = (58) \div 365 \times (41)m$

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Combi loss calculated for each month $(61)m = (60) \div 365 \times (41)m$

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)
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TER WorkSheet: New dwelling design stage

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

(62)m=	191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66	(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=	191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66	
Output from water heater (annual) _{1...12}												1968.6	(64)

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

(65)m=	89.5	79.54	85.06	78.37	78.34	72.2	71.44	75.5	74.46	81.16	83.15	88.06	(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=	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	(66)

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

(67)m=	16.75	14.88	12.1	9.16	6.85	5.78	6.25	8.12	10.9	13.84	16.15	17.22	(67)
--------	-------	-------	------	------	------	------	------	------	------	-------	-------	-------	------

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

(68)m=	183.45	185.35	180.56	170.34	157.45	145.34	137.24	135.34	140.14	150.35	163.24	175.36	(68)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(69)m=	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	33.49	(69)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

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

(71)m=	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	-83.92	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	120.3	118.36	114.33	108.85	105.29	100.28	96.02	101.48	103.42	109.09	115.49	118.37	(72)
--------	-------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	------

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

(73)m=	377.98	376.07	364.46	345.83	327.06	308.87	296.98	302.41	311.92	330.75	352.36	368.41	(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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
South	0.9x	0.54	x	14.06	x	46.75	x	0.63	x	0.7	=	140.88 (78)
South	0.9x	0.54	x	14.06	x	76.57	x	0.63	x	0.7	=	230.73 (78)
South	0.9x	0.54	x	14.06	x	97.53	x	0.63	x	0.7	=	293.91 (78)
South	0.9x	0.54	x	14.06	x	110.23	x	0.63	x	0.7	=	332.18 (78)
South	0.9x	0.54	x	14.06	x	114.87	x	0.63	x	0.7	=	346.16 (78)
South	0.9x	0.54	x	14.06	x	110.55	x	0.63	x	0.7	=	333.13 (78)
South	0.9x	0.54	x	14.06	x	108.01	x	0.63	x	0.7	=	325.49 (78)
South	0.9x	0.54	x	14.06	x	104.89	x	0.63	x	0.7	=	316.09 (78)

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South	0.9x	0.54	x	14.06	x	101.89	x	0.63	x	0.7	=	307.02	(78)
South	0.9x	0.54	x	14.06	x	82.59	x	0.63	x	0.7	=	248.87	(78)
South	0.9x	0.54	x	14.06	x	55.42	x	0.63	x	0.7	=	167	(78)
South	0.9x	0.54	x	14.06	x	40.4	x	0.63	x	0.7	=	121.74	(78)

Solar gains in watts, calculated for each month

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

(83)m=	140.88	230.73	293.91	332.18	346.16	333.13	325.49	316.09	307.02	248.87	167	121.74	(83)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-----	--------	------

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

(84)m=	518.86	606.8	658.37	678.01	673.22	642	622.47	618.5	618.95	579.61	519.35	490.15	(84)
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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=	0.99	0.97	0.94	0.87	0.74	0.56	0.4	0.42	0.62	0.87	0.97	0.99	(86)

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

(87)m=	20.3	20.47	20.66	20.84	20.95	20.99	21	21	20.99	20.86	20.55	20.26	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.16	20.16	20.17	20.18	20.18	20.18	20.18	20.19	20.18	20.18	20.17	20.17	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.97	0.93	0.84	0.69	0.49	0.33	0.35	0.55	0.83	0.97	0.99	(89)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(90)m=	19.24	19.49	19.76	20	20.13	20.18	20.18	20.19	20.17	20.04	19.62	19.19	(90)
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fLA = Living area ÷ (4) = 0.4 (91)

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

(92)m=	19.67	19.89	20.13	20.34	20.46	20.51	20.51	20.51	20.5	20.37	20	19.63	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.67	19.89	20.13	20.34	20.46	20.51	20.51	20.51	20.5	20.37	20	19.63	(93)
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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
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Utilisation factor for gains, hm:

(94)m=	0.98	0.96	0.92	0.85	0.71	0.52	0.36	0.37	0.58	0.84	0.96	0.99	(94)
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Useful gains, hmGm , W = (94)m x (84)m

(95)m=	510.86	584.88	608.77	573.32	477.36	331.37	221.06	231.88	357.81	489.36	500.48	484.45	(95)
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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)
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Heat loss rate for mean internal temperature, Lm , W = [(39)m x [(93)m – (96)m]

(97)m=	893.87	869.68	788.55	654.81	500.48	334.08	221.28	232.19	363.34	557.93	739.53	888.66	(97)
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Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	284.96	191.39	133.76	58.67	17.2	0	0	0	0	51.01	172.11	300.73	(98)
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Total per year (kWh/year) = Sum(98)_{1...5,9...12} = 1209.83 (98)

Space heating requirement in kWh/m²/year

18.84 (99)

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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		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
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Space heating requirement (calculated above)

284.96	191.39	133.76	58.67	17.2	0	0	0	0	51.01	172.11	300.73
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(211)m = {[[(98)m × (204)] } × 100 ÷ (206) (211)

304.77	204.69	143.06	62.75	18.39	0	0	0	0	54.56	184.08	321.64
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Total (kWh/year) = Sum(211)_{1...5,10...12} = 1293.94 (211)

Space heating fuel (secondary), kWh/month

= {[[(98)m × (201)] } × 100 ÷ (208)

(215)m=	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)

191.98	169.48	178.62	160.99	158.4	142.44	137.66	149.87	149.23	166.9	175.38	187.66
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Efficiency of water heater 79.8 (216)

(217)m= 85.87 85.14 84.06 82.4 80.73 79.8 79.8 79.8 79.8 82.07 84.76 86.07 (217)

Fuel for water heating, kWh/month

(219)m = (64)m × 100 ÷ (217)m

(219)m=	223.58	199.06	212.5	195.37	196.19	178.5	172.51	187.8	187.01	203.35	206.9	218.04
Total = Sum(219a) _{1...12} =												2380.82 (219)

Annual totals

Space heating fuel used, main system 1	1293.94
Water heating fuel used	2380.82

Electricity for pumps, fans and electric keep-hot

central heating pump: 30 (230c)

boiler with a fan-assisted flue 45 (230e)

Total electricity for the above, kWh/year sum of (230a)...(230g) = 75 (231)

Electricity for lighting 295.88 (232)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating (main system 1)	(211) ×	0.216 =	279.49 (261)
Space heating (secondary)	(215) ×	0.519 =	0 (263)
Water heating	(219) ×	0.216 =	514.26 (264)
Space and water heating	(261) + (262) + (263) + (264) =		793.75 (265)

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Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	153.56	(268)
Total CO2, kg/year		sum of (265)...(271) =		986.24	(272)
TER	=			15.36	(273)

DRAFT

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 2B-TF (E-W) (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	62.1 (1a)	2.4 (2a)	149.04 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62.1 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	149.04 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.13 (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)

Additional infiltration

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

Infiltration rate

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

Infiltration rate incorporating shelter factor

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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TER WorkSheet: New dwelling design stage

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

0.42	0.41	0.4	0.36	0.35	0.31	0.31	0.3	0.33	0.35	0.37	0.38
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 0.59 0.58 0.58 0.56 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.57 (24d)

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

(25)m= 0.59 0.58 0.58 0.56 0.56 0.55 0.55 0.55 0.55 0.56 0.57 0.57 (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	2		
Windows Type 1			7.72	$\times 1/[1/(1.4) + 0.04]$	10.23		
Windows Type 2			3.86	$\times 1/[1/(1.4) + 0.04]$	5.12		
Walls Type1	33.8	11.58	22.22	0.18	4		
Walls Type2	8.74	2	6.74	0.18	1.21		
Roof	62.1	0	62.1	0.13	8.07		
Total area of elements, m²			104.64				
Party wall			46	0	0		

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 30.64 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 3155.62 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 5.23 (36)

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

Total fabric heat loss (33) + (36) = 35.87 (37)

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

(38)m= 28.85 28.69 28.53 27.76 27.62 26.96 26.96 26.84 27.21 27.62 27.91 28.21 (38)

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

(39)m= 64.72 64.56 64.4 63.63 63.49 62.83 62.83 62.71 63.08 63.49 63.78 64.08

Average = Sum(39)_{1...12} /12= 63.63 (39)

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	1.04	1.04	1.04	1.02	1.02	1.01	1.01	1.01	1.02	1.02	1.03	1.03	
Average = Sum(40) _{1...12} /12=													1.02 (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

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

if TFA ≤ 13.9, N = 1

2.04 (42)

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

82.66 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c × (43)													
(44)m=	90.92	87.62	84.31	81.01	77.7	74.39	74.39	77.7	81.01	84.31	87.62	90.92	
Total = Sum(44) _{1...12} =													991.9 (44)

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

(45)m=	134.84	117.93	121.69	106.09	101.8	87.85	81.4	93.41	94.53	110.16	120.25	130.58	
Total = Sum(45) _{1...12} =													1300.53 (45)

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

(46)m=	20.23	17.69	18.25	15.91	15.27	13.18	12.21	14.01	14.18	16.52	18.04	19.59	(46)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

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

1.89 (48)

Temperature factor from Table 2b

0.54 (49)

Energy lost from water storage, kWh/year

(48) × (49) =

1.02 (50)

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

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

0 (51)

If community heating see section 4.3

Volume factor from Table 2a

0 (52)

Temperature factor from Table 2b

0 (53)

Energy lost from water storage, kWh/year

(47) × (51) × (52) × (53) =

0 (54)

Enter (50) or (54) in (55)

1.02 (55)

Water storage loss calculated for each month

((56)m = (55) × (41)m

(56)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64	(56)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(57)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

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

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

(62)m=	189.74	167.52	176.6	159.23	156.71	140.98	136.31	148.32	147.66	165.07	173.39	185.49	(62)
--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)

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

Output from water heater

(64)m=	189.74	167.52	176.6	159.23	156.71	140.98	136.31	148.32	147.66	165.07	173.39	185.49	
Output from water heater (annual) _{1...12}												1947.02	(64)

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

(65)m=	88.76	78.89	84.39	77.79	77.77	71.72	70.99	74.98	73.94	80.55	82.49	87.34	(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=	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	102.02	(66)

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

(67)m=	16.14	14.34	11.66	8.83	6.6	5.57	6.02	7.82	10.5	13.33	15.56	16.59	(67)
--------	-------	-------	-------	------	-----	------	------	------	------	-------	-------	-------	------

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

(68)m=	178.21	180.06	175.4	165.48	152.96	141.19	133.32	131.47	136.13	146.05	158.58	170.35	(68)
--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(69)m=	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	(69)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

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

(71)m=	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	-81.61	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	119.3	117.39	113.43	108.03	104.54	99.61	95.42	100.79	102.69	108.27	114.57	117.4	(72)
--------	-------	--------	--------	--------	--------	-------	-------	--------	--------	--------	--------	-------	------

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

(73)m=	370.26	368.39	357.09	338.94	320.69	302.97	291.37	296.69	305.93	324.26	345.31	360.94	(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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southwest _{0.9x}	0.77	x	3.86	x	36.79		0.63	x	0.7	=	43.4	(79)
Southwest _{0.9x}	0.77	x	3.86	x	62.67		0.63	x	0.7	=	73.93	(79)
Southwest _{0.9x}	0.77	x	3.86	x	85.75		0.63	x	0.7	=	101.16	(79)
Southwest _{0.9x}	0.77	x	3.86	x	106.25		0.63	x	0.7	=	125.34	(79)
Southwest _{0.9x}	0.77	x	3.86	x	119.01		0.63	x	0.7	=	140.39	(79)

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Southwest	0.9x	0.77	x	3.86	x	118.15		0.63	x	0.7	=	139.38	(79)
Southwest	0.9x	0.77	x	3.86	x	113.91		0.63	x	0.7	=	134.37	(79)
Southwest	0.9x	0.77	x	3.86	x	104.39		0.63	x	0.7	=	123.15	(79)
Southwest	0.9x	0.77	x	3.86	x	92.85		0.63	x	0.7	=	109.53	(79)
Southwest	0.9x	0.77	x	3.86	x	69.27		0.63	x	0.7	=	81.71	(79)
Southwest	0.9x	0.77	x	3.86	x	44.07		0.63	x	0.7	=	51.99	(79)
Southwest	0.9x	0.77	x	3.86	x	31.49		0.63	x	0.7	=	37.15	(79)
West	0.9x	0.77	x	7.72	x	19.64	x	0.63	x	0.7	=	46.34	(80)
West	0.9x	0.77	x	7.72	x	38.42	x	0.63	x	0.7	=	90.65	(80)
West	0.9x	0.77	x	7.72	x	63.27	x	0.63	x	0.7	=	149.28	(80)
West	0.9x	0.77	x	7.72	x	92.28	x	0.63	x	0.7	=	217.72	(80)
West	0.9x	0.77	x	7.72	x	113.09	x	0.63	x	0.7	=	266.82	(80)
West	0.9x	0.77	x	7.72	x	115.77	x	0.63	x	0.7	=	273.14	(80)
West	0.9x	0.77	x	7.72	x	110.22	x	0.63	x	0.7	=	260.04	(80)
West	0.9x	0.77	x	7.72	x	94.68	x	0.63	x	0.7	=	223.37	(80)
West	0.9x	0.77	x	7.72	x	73.59	x	0.63	x	0.7	=	173.62	(80)
West	0.9x	0.77	x	7.72	x	45.59	x	0.63	x	0.7	=	107.56	(80)
West	0.9x	0.77	x	7.72	x	24.49	x	0.63	x	0.7	=	57.78	(80)
West	0.9x	0.77	x	7.72	x	16.15	x	0.63	x	0.7	=	38.11	(80)

Solar gains in watts, calculated for each month

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

(83)m=	89.74	164.58	250.44	343.06	407.22	412.52	394.42	346.52	283.16	189.27	109.77	75.25	(83)
--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	------

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

(84)m=	460	532.97	607.53	682.01	727.91	715.49	685.78	643.2	589.09	513.54	455.08	436.19	(84)
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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=	0.99	0.99	0.96	0.89	0.75	0.55	0.4	0.45	0.7	0.93	0.99	1	(86)

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

(87)m=	20.04	20.21	20.46	20.75	20.93	20.99	21	21	20.96	20.72	20.32	20.01	(87)
--------	-------	-------	-------	-------	-------	-------	----	----	-------	-------	-------	-------	------

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

(88)m=	20.05	20.05	20.05	20.06	20.06	20.07	20.07	20.08	20.07	20.06	20.06	20.06	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	0.99	0.98	0.95	0.86	0.69	0.48	0.32	0.36	0.62	0.9	0.98	0.99	(89)
--------	------	------	------	------	------	------	------	------	------	-----	------	------	------

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

(90)m=	18.78	19.02	19.39	19.79	20	20.07	20.07	20.07	20.04	19.76	19.2	18.74	(90)
--------	-------	-------	-------	-------	----	-------	-------	-------	-------	-------	------	-------	------

fLA = Living area ÷ (4) =

0.42 (91)

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

(92)m=	19.31	19.52	19.84	20.19	20.39	20.45	20.46	20.46	20.43	20.16	19.67	19.27	(92)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

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(93)m=	19.31	19.52	19.84	20.19	20.39	20.45	20.46	20.46	20.43	20.16	19.67	19.27	(93)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

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

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

Utilisation factor for gains, h_m :

(94)m=	0.99	0.98	0.95	0.87	0.71	0.51	0.35	0.39	0.65	0.91	0.98	0.99	(94)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(95)m=	455.82	522.43	577.53	591.8	517.13	363.3	242.07	253.75	383.13	466.28	446.16	433.12	(95)
--------	--------	--------	--------	-------	--------	-------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
--------	-----	-----	-----	-----	------	------	------	------	------	------	-----	-----	------

Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	971.2	943.83	858.97	718.48	551.61	367.72	242.55	254.62	399.18	606.9	801.8	965.71	(97)
--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	-------	-------	--------	------

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

(98)m=	383.45	283.18	209.39	91.21	25.65	0	0	0	0	104.62	256.06	396.25	
--------	--------	--------	--------	-------	-------	---	---	---	---	--------	--------	--------	--

Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 1749.8 (98)

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

28.18 (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) = $(202) \times [1 - (203)] =$ 1 (204)

Efficiency of main space heating system 1

93.5 (206)

Efficiency of secondary/supplementary heating system, %

0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----------

Space heating requirement (calculated above)

383.45	283.18	209.39	91.21	25.65	0	0	0	0	104.62	256.06	396.25
--------	--------	--------	-------	-------	---	---	---	---	--------	--------	--------

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

410.1	302.87	223.94	97.55	27.43	0	0	0	0	111.9	273.86	423.79
-------	--------	--------	-------	-------	---	---	---	---	-------	--------	--------

Total ($kWh/year$) = $Sum(211)_{1..5,10..12} =$ 1871.45 (211)

Space heating fuel (secondary), $kWh/month$

= $\{[(98)m \times (201)]\} \times 100 \div (208)$

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

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

Water heating

Output from water heater (calculated above)

189.74	167.52	176.6	159.23	156.71	140.98	136.31	148.32	147.66	165.07	173.39	185.49
--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Efficiency of water heater

79.8 (216)

(217)m=	86.65	86.2	85.27	83.39	81.15	79.8	79.8	79.8	79.8	83.64	85.85	86.79	(217)
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Fuel for water heating, $kWh/month$

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

(219)m=	218.97	194.33	207.11	190.95	193.11	176.67	170.81	185.86	185.04	197.36	201.96	213.72	
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Total = $Sum(219a)_{1..12} =$ 2335.9 (219)

Annual totals

$kWh/year$

$kWh/year$

Space heating fuel used, main system 1

1871.45

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Water heating fuel used		2335.9	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		75 (231)
Electricity for lighting		285.04	(232)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x		0.216	=	404.23	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	504.55	(264)
Space and water heating	(261) + (262) + (263) + (264) =				908.79	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93	(267)
Electricity for lighting	(232) x		0.519	=	147.93	(268)
Total CO2, kg/year			sum of (265)...(271) =		1095.65	(272)
TER =					17.64	(273)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 3B-DUPLEX (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)		Av. Height(m)		Volume(m ³)
Ground floor	38 (1a)	x	5.32 (2a)	=	202.35 (3a)
First floor	50 (1b)	x	2.42 (2b)	=	121.25 (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	88 (4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	323.6 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				3	30 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = 30 ÷ (5) = 0.09 (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)

Additional infiltration

[(9)-1]x0.1 =

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

0.25 - [0.2 x (14) ÷ 100] =

Infiltration rate

(8) + (10) + (11) + (12) + (13) + (15) =

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

(20) = 1 - [0.075 x (19)] =

Infiltration rate incorporating shelter factor

(21) = (18) x (20) =

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
--------	-----	---	-----	-----	-----	-----	-----	-----	---	-----	-----	-----

TER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

	0.37	0.36	0.36	0.32	0.31	0.28	0.28	0.27	0.29	0.31	0.33	0.34
--	------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0
---------	---	---	---	---	---	---	---	---	---	---	---	---

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
---------	---	---	---	---	---	---	---	---	---	---	---	---

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
---------	---	---	---	---	---	---	---	---	---	---	---	---

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 × 0.5]

(24d)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56
---------	------	------	------	------	------	------	------	------	------	------	------	------

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

(25)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56
--------	------	------	------	------	------	------	------	------	------	------	------	------

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	2		(26)
Windows Type 1			11.05	$\times 1/[1/(1.4) + 0.04]$	14.65		(27)
Windows Type 2			2.13	$\times 1/[1/(1.4) + 0.04]$	2.82		(27)
Windows Type 3			6.82	$\times 1/[1/(1.4) + 0.04]$	9.04		(27)
Walls Type1	92.31	20	72.31	0.18	13.02		(29)
Walls Type2	14	2	12	0.18	2.16		(29)
Roof	88	0	88	0.13	11.44		(30)
Total area of elements, m²			194.31				(31)
Party wall			34.39	0	0		(32)

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A × U) (26)...(30) + (32) = 55.13 (33)

Heat capacity Cm = S(A × k) ((28)...(30) + (32) + (32a)...(32e) = 6757.5 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 × Y) calculated using Appendix K 9.72 (36)

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

Total fabric heat loss (33) + (36) = 64.85 (37)

TER WorkSheet: New dwelling design stage

Ventilation heat loss calculated monthly

$$(38)m = 0.33 \times (25)m \times (5)$$

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	60.76	60.47	60.19	58.88	58.63	57.48	57.48	57.27	57.92	58.63	59.13	59.65	(38)

Heat transfer coefficient, W/K

$$(39)m = (37) + (38)m$$

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(39)m=	125.61	125.32	125.04	123.72	123.48	122.33	122.33	122.12	122.77	123.48	123.97	124.5	
Average = Sum(39) _{1...12} /12=												123.72	(39)

Heat loss parameter (HLP), W/m²K

$$(40)m = (39)m \div (4)$$

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(40)m=	1.43	1.42	1.42	1.41	1.4	1.39	1.39	1.39	1.4	1.4	1.41	1.41	
Average = Sum(40) _{1...12} /12=												1.41	(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

$$\text{if TFA} > 13.9, N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$$

$$\text{if TFA} \leq 13.9, N = 1$$

2.6

(42)

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$

95.89

(43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
(44)m=	105.48	101.64	97.8	93.97	90.13	86.3	86.3	90.13	93.97	97.8	101.64	105.48	
Total = Sum(44) _{1...12} =												1150.64	(44)

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$ kWh/month (see Tables 1b, 1c, 1d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(45)m=	156.42	136.8	141.17	123.07	118.09	101.91	94.43	108.36	109.65	127.79	139.49	151.48	
Total = Sum(45) _{1...12} =												1508.67	(45)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(46)m=	23.46	20.52	21.18	18.46	17.71	15.29	14.16	16.25	16.45	19.17	20.92	22.72	(46)

Water storage loss:

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

150

(47)

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

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

Water storage loss:

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

1.89

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

$$(48) \times (49) =$$

1.02

(50)

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

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

0

(51)

If community heating see section 4.3

Volume factor from Table 2a

0

(52)

Temperature factor from Table 2b

0

(53)

Energy lost from water storage, kWh/year

$$(47) \times (51) \times (52) \times (53) =$$

0

(54)

Enter (50) or (54) in (55)

1.02

(55)

Water storage loss calculated for each month

$$((56)m = (55) \times (41)m$$

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64	(56)

TER WorkSheet: New dwelling design stage

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

(57)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64	(57)
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Primary circuit loss (annual) from Table 3	0	(58)
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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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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=	211.32	186.4	196.08	176.21	173	155.04	149.34	163.27	162.79	182.7	192.63	206.39	(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=	211.32	186.4	196.08	176.21	173	155.04	149.34	163.27	162.79	182.7	192.63	206.39	
Output from water heater (annual) ^{1...12}												2155.16	(64)

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

(65)m=	95.93	85.16	90.86	83.43	83.19	76.39	75.32	79.96	78.97	86.42	88.89	94.29	(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=	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	(66)

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

(67)m=	20.98	18.64	15.16	11.47	8.58	7.24	7.82	10.17	13.65	17.33	20.23	21.56	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	235.35	237.79	231.64	218.54	202	186.45	176.07	173.63	179.78	192.88	209.42	224.97	(68)
--------	--------	--------	--------	--------	-----	--------	--------	--------	--------	--------	--------	--------	------

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

(69)m=	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	(69)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

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

(71)m=	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	(71)
--------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	------

Water heating gains (Table 5)

(72)m=	128.94	126.73	122.13	115.88	111.82	106.1	101.24	107.47	109.68	116.15	123.46	126.74	(72)
--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	------

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

(73)m=	450.24	448.12	433.88	410.85	387.35	364.75	350.09	356.22	368.07	391.33	418.07	438.23	(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 m ²	Flux Table 6a	g_ Table 6b	FF Table 6c	Gains (W)
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TER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	2.13	x	36.79	0.63	x	0.7	=	23.95	(79)	
Southwest	0.9x	0.77	x	2.13	x	62.67	0.63	x	0.7	=	40.8	(79)	
Southwest	0.9x	0.77	x	2.13	x	85.75	0.63	x	0.7	=	55.82	(79)	
Southwest	0.9x	0.77	x	2.13	x	106.25	0.63	x	0.7	=	69.17	(79)	
Southwest	0.9x	0.77	x	2.13	x	119.01	0.63	x	0.7	=	77.47	(79)	
Southwest	0.9x	0.77	x	2.13	x	118.15	0.63	x	0.7	=	76.91	(79)	
Southwest	0.9x	0.77	x	2.13	x	113.91	0.63	x	0.7	=	74.15	(79)	
Southwest	0.9x	0.77	x	2.13	x	104.39	0.63	x	0.7	=	67.95	(79)	
Southwest	0.9x	0.77	x	2.13	x	92.85	0.63	x	0.7	=	60.44	(79)	
Southwest	0.9x	0.77	x	2.13	x	69.27	0.63	x	0.7	=	45.09	(79)	
Southwest	0.9x	0.77	x	2.13	x	44.07	0.63	x	0.7	=	28.69	(79)	
Southwest	0.9x	0.77	x	2.13	x	31.49	0.63	x	0.7	=	20.5	(79)	
West	0.9x	0.77	x	11.05	x	19.64	x	0.63	x	0.7	=	66.33	(80)
West	0.9x	0.77	x	6.82	x	19.64	x	0.63	x	0.7	=	40.94	(80)
West	0.9x	0.77	x	11.05	x	38.42	x	0.63	x	0.7	=	129.75	(80)
West	0.9x	0.77	x	6.82	x	38.42	x	0.63	x	0.7	=	80.08	(80)
West	0.9x	0.77	x	11.05	x	63.27	x	0.63	x	0.7	=	213.67	(80)
West	0.9x	0.77	x	6.82	x	63.27	x	0.63	x	0.7	=	131.88	(80)
West	0.9x	0.77	x	11.05	x	92.28	x	0.63	x	0.7	=	311.63	(80)
West	0.9x	0.77	x	6.82	x	92.28	x	0.63	x	0.7	=	192.34	(80)
West	0.9x	0.77	x	11.05	x	113.09	x	0.63	x	0.7	=	381.92	(80)
West	0.9x	0.77	x	6.82	x	113.09	x	0.63	x	0.7	=	235.72	(80)
West	0.9x	0.77	x	11.05	x	115.77	x	0.63	x	0.7	=	390.96	(80)
West	0.9x	0.77	x	6.82	x	115.77	x	0.63	x	0.7	=	241.3	(80)
West	0.9x	0.77	x	11.05	x	110.22	x	0.63	x	0.7	=	372.21	(80)
West	0.9x	0.77	x	6.82	x	110.22	x	0.63	x	0.7	=	229.73	(80)
West	0.9x	0.77	x	11.05	x	94.68	x	0.63	x	0.7	=	319.72	(80)
West	0.9x	0.77	x	6.82	x	94.68	x	0.63	x	0.7	=	197.33	(80)
West	0.9x	0.77	x	11.05	x	73.59	x	0.63	x	0.7	=	248.51	(80)
West	0.9x	0.77	x	6.82	x	73.59	x	0.63	x	0.7	=	153.38	(80)
West	0.9x	0.77	x	11.05	x	45.59	x	0.63	x	0.7	=	153.96	(80)
West	0.9x	0.77	x	6.82	x	45.59	x	0.63	x	0.7	=	95.02	(80)
West	0.9x	0.77	x	11.05	x	24.49	x	0.63	x	0.7	=	82.7	(80)
West	0.9x	0.77	x	6.82	x	24.49	x	0.63	x	0.7	=	51.04	(80)
West	0.9x	0.77	x	11.05	x	16.15	x	0.63	x	0.7	=	54.54	(80)
West	0.9x	0.77	x	6.82	x	16.15	x	0.63	x	0.7	=	33.66	(80)

Solar gains in watts, calculated for each month

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

(83)m= 131.21 250.62 401.37 573.13 695.1 709.17 676.09 585.01 462.34 294.07 162.43 108.7 (83)

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

(84)m= 581.45 698.74 835.26 983.98 1082.46 1073.92 1026.18 941.23 830.41 685.39 580.5 546.93 (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
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TER WorkSheet: New dwelling design stage

(86)m=	1	0.99	0.98	0.94	0.83	0.67	0.51	0.57	0.82	0.97	0.99	1	(86)
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Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.46	19.65	19.99	20.41	20.75	20.93	20.98	20.97	20.83	20.37	19.83	19.43	(87)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(88)m=	19.74	19.74	19.75	19.76	19.76	19.77	19.77	19.77	19.76	19.76	19.75	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	1	0.99	0.97	0.91	0.78	0.56	0.37	0.43	0.73	0.95	0.99	1	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.72	18.01	18.49	19.09	19.53	19.73	19.77	19.76	19.64	19.04	18.27	17.68	(90)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

$$fLA = \text{Living area} \div (4) = 0.43 \quad (91)$$

Mean internal temperature (for the whole dwelling) = $fLA \times T1 + (1 - fLA) \times T2$

(92)m=	18.47	18.72	19.14	19.66	20.06	20.25	20.29	20.29	20.15	19.62	18.95	18.43	(92)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(93)m=	18.47	18.72	19.14	19.66	20.06	20.25	20.29	20.29	20.15	19.62	18.95	18.43	(93)
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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=	0.99	0.99	0.97	0.91	0.79	0.61	0.43	0.49	0.76	0.95	0.99	1	(94)

Useful gains, hmGm, W = (94)m x (84)m

(95)m=	578.04	689.86	808.24	896.2	856.6	650.64	444.25	462.13	634.71	649.94	573.88	544.44	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W = [(39)m x [(93)m - (96)m]

(97)m=	1779.74	1731.59	1580.11	1331.71	1031.76	690.99	451.58	474.52	743.12	1113.18	1468.62	1771.91	(97)
--------	---------	---------	---------	---------	---------	--------	--------	--------	--------	---------	---------	---------	------

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

(98)m=	894.06	700.04	574.27	313.56	130.32	0	0	0	0	344.65	644.21	913.24	(98)
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$$\text{Total per year (kWh/year)} = \text{Sum}(98)_{1..5,9..12} = 4514.36 \quad (98)$$

Space heating requirement in kWh/m²/year

$$51.3 \quad (99)$$

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 93.5 (206)

Efficiency of secondary/supplementary heating system, % 0 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
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Space heating requirement (calculated above)

(211)m = {[(98)m x (204)]} x 100 ÷ (206)	894.06	700.04	574.27	313.56	130.32	0	0	0	0	344.65	644.21	913.24	(211)
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$$\text{Total (kWh/year)} = \text{Sum}(211)_{1..5,10..12} = 4828.19 \quad (211)$$

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Space heating fuel (secondary), kWh/month

$$= \{[(98)m \times (201)]\} \times 100 \div (208)$$

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

Water heating

Output from water heater (calculated above)

	211.32	186.4	196.08	176.21	173	155.04	149.34	163.27	162.79	182.7	192.63	206.39	
Efficiency of water heater													79.8 (216)
(217)m=	88.24	88.02	87.51	86.34	84.07	79.8	79.8	79.8	79.8	86.48	87.79	88.32	(217)

Fuel for water heating, kWh/month

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

(219)m=	239.49	211.77	224.05	204.1	205.78	194.29	187.14	204.6	204	211.25	219.42	233.69	
Total = Sum(219a) _{1...12} =													2539.58 (219)

Annual totals

Space heating fuel used, main system 1

kWh/year

kWh/year

4828.19

Water heating fuel used

2539.58

Electricity for pumps, fans and electric keep-hot

central heating pump:

30

(230c)

boiler with a fan-assisted flue

45

(230e)

Total electricity for the above, kWh/year

$$\text{sum of (230a)...(230g) =}$$

75

(231)

Electricity for lighting

370.54

(232)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating (main system 1)	(211) x	0.216	= 1042.89 (261)
Space heating (secondary)	(215) x	0.519	= 0 (263)
Water heating	(219) x	0.216	= 548.55 (264)
Space and water heating	(261) + (262) + (263) + (264) =		1591.44 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	= 38.93 (267)
Electricity for lighting	(232) x	0.519	= 192.31 (268)
Total CO2, kg/year	sum of (265)...(271) =		1822.67 (272)

TER =

20.71 (273)

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User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.4.26

Property Address: 3B-MF (E-W) (Be-Lean)

Address : New Residential Development, Duke Street, READING, RG1 4SA

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	70 (1a)	2.4 (2a)	168 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	70 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	168 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.12 (8)
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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)

Additional infiltration

[(9)-1]x0.1 =

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction

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

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

0.25 - [0.2 x (14) ÷ 100] =

Infiltration rate

(8) + (10) + (11) + (12) + (13) + (15) =

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

(20) = 1 - [0.075 x (19)] =

Infiltration rate incorporating shelter factor

(21) = (18) x (20) =

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.4	0.39	0.38	0.35	0.34	0.3	0.3	0.29	0.31	0.34	0.35	0.37
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

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

0 (23b)

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

0 (23c)

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

(24a)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24a)

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

(24b)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m= 0.58 0.58 0.57 0.56 0.56 0.54 0.54 0.54 0.55 0.56 0.56 0.57 (24d)

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

(25)m= 0.58 0.58 0.57 0.56 0.56 0.54 0.54 0.54 0.55 0.56 0.56 0.57 (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	2		
Windows Type 1			7.72	$\times 1/[1/(1.4) + 0.04]$	10.23		
Windows Type 2			3.86	$\times 1/[1/(1.4) + 0.04]$	5.12		
Walls Type1	60	11.58	48.42	0.18	8.72		
Walls Type2	8.74	2	6.74	0.18	1.21		
Roof	20	0	20	0.13	2.6		
Total area of elements, m²			88.74				
Party wall			46	0	0		

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 29.88 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 4610.72 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (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 4.44 (36)

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

Total fabric heat loss (33) + (36) = 34.32 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	32.15	31.98	31.81	31.02	30.87	30.18	30.18	30.05	30.45	30.87	31.17	31.49

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

(39)m=	66.47	66.3	66.13	65.34	65.19	64.5	64.5	64.37	64.77	65.19	65.49	65.8
Average = Sum(39) _{1...12} /12=												65.34 (39)

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	0.95	0.95	0.94	0.93	0.93	0.92	0.92	0.92	0.93	0.93	0.94	0.94		
Average = Sum(40) _{1...12} /12=													0.93	(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

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

if TFA ≤ 13.9, N = 1

2.25 (42)

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

87.55 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month Vd,m = factor from Table 1c × (43)														
(44)m=	96.3	92.8	89.3	85.79	82.29	78.79	78.79	82.29	85.79	89.3	92.8	96.3		
Total = Sum(44) _{1...12} =													1050.55	(44)

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

(45)m=	142.81	124.9	128.89	112.37	107.82	93.04	86.22	98.93	100.12	116.67	127.36	138.3		
Total = Sum(45) _{1...12} =													1377.43	(45)

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

(46)m=	21.42	18.74	19.33	16.86	16.17	13.96	12.93	14.84	15.02	17.5	19.1	20.75		(46)
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Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.89 (48)

Temperature factor from Table 2b

0.54 (49)

Energy lost from water storage, kWh/year

(48) × (49) = 1.02 (50)

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

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

0 (51)

If community heating see section 4.3

Volume factor from Table 2a

0 (52)

Temperature factor from Table 2b

0 (53)

Energy lost from water storage, kWh/year

(47) × (51) × (52) × (53) = 0 (54)

Enter (50) or (54) in (55)

1.02 (55)

Water storage loss calculated for each month

((56)m = (55) × (41)m

(56)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64		(56)
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If cylinder contains dedicated solar storage, (57)m = (56)m × [(50) - (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	31.64	28.58	31.64	30.62	31.64	30.62	31.64	31.64	30.62	31.64	30.62	31.64		(57)
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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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

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

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

(62)m=	197.72	174.5	183.8	165.5	162.73	146.18	141.12	153.84	153.25	171.58	180.49	193.21	(62)
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Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)

(63)m=	0	0	0	0	0	0	0	0	0	0	0	(63)
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Output from water heater

(64)m=	197.72	174.5	183.8	165.5	162.73	146.18	141.12	153.84	153.25	171.58	180.49	193.21	
Output from water heater (annual) _{1...12}												2023.91	(64)

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

(65)m=	91.41	81.2	86.78	79.87	79.78	73.44	72.59	76.82	75.8	82.72	84.86	89.91	(65)
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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=	112.31	112.31	112.31	112.31	112.31	112.31	112.31	112.31	112.31	112.31	112.31	112.31	(66)

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

(67)m=	18.23	16.19	13.17	9.97	7.45	6.29	6.8	8.84	11.86	15.06	17.58	18.74	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	197.3	199.34	194.19	183.2	169.34	156.31	147.6	145.55	150.71	161.7	175.56	188.59	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	34.23	34.23	34.23	34.23	34.23	34.23	34.23	34.23	34.23	34.23	34.23	34.23	(69)
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Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
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Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-89.84	-89.84	-89.84	-89.84	-89.84	-89.84	-89.84	-89.84	-89.84	-89.84	-89.84	-89.84	(71)
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Water heating gains (Table 5)

(72)m=	122.86	120.84	116.64	110.93	107.23	102.01	97.57	103.25	105.27	111.18	117.85	120.85	(72)
--------	--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	------

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

(73)m=	398.08	396.07	383.69	363.8	343.71	324.3	311.66	317.34	327.54	347.63	370.69	387.87	(73)
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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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	3.86	x	11.28	x	0.63	x	0.7	=	13.31	(75)
Northeast 0.9x	0.77	x	3.86	x	22.97	x	0.63	x	0.7	=	27.09	(75)
Northeast 0.9x	0.77	x	3.86	x	41.38	x	0.63	x	0.7	=	48.81	(75)
Northeast 0.9x	0.77	x	3.86	x	67.96	x	0.63	x	0.7	=	80.17	(75)
Northeast 0.9x	0.77	x	3.86	x	91.35	x	0.63	x	0.7	=	107.76	(75)

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Northeast 0.9x	0.77	x	3.86	x	97.38	x	0.63	x	0.7	=	114.88	(75)
Northeast 0.9x	0.77	x	3.86	x	91.1	x	0.63	x	0.7	=	107.47	(75)
Northeast 0.9x	0.77	x	3.86	x	72.63	x	0.63	x	0.7	=	85.68	(75)
Northeast 0.9x	0.77	x	3.86	x	50.42	x	0.63	x	0.7	=	59.48	(75)
Northeast 0.9x	0.77	x	3.86	x	28.07	x	0.63	x	0.7	=	33.11	(75)
Northeast 0.9x	0.77	x	3.86	x	14.2	x	0.63	x	0.7	=	16.75	(75)
Northeast 0.9x	0.77	x	3.86	x	9.21	x	0.63	x	0.7	=	10.87	(75)
Northwest 0.9x	0.77	x	7.72	x	11.28	x	0.63	x	0.7	=	26.62	(81)
Northwest 0.9x	0.77	x	7.72	x	22.97	x	0.63	x	0.7	=	54.19	(81)
Northwest 0.9x	0.77	x	7.72	x	41.38	x	0.63	x	0.7	=	97.63	(81)
Northwest 0.9x	0.77	x	7.72	x	67.96	x	0.63	x	0.7	=	160.33	(81)
Northwest 0.9x	0.77	x	7.72	x	91.35	x	0.63	x	0.7	=	215.52	(81)
Northwest 0.9x	0.77	x	7.72	x	97.38	x	0.63	x	0.7	=	229.76	(81)
Northwest 0.9x	0.77	x	7.72	x	91.1	x	0.63	x	0.7	=	214.94	(81)
Northwest 0.9x	0.77	x	7.72	x	72.63	x	0.63	x	0.7	=	171.35	(81)
Northwest 0.9x	0.77	x	7.72	x	50.42	x	0.63	x	0.7	=	118.96	(81)
Northwest 0.9x	0.77	x	7.72	x	28.07	x	0.63	x	0.7	=	66.22	(81)
Northwest 0.9x	0.77	x	7.72	x	14.2	x	0.63	x	0.7	=	33.5	(81)
Northwest 0.9x	0.77	x	7.72	x	9.21	x	0.63	x	0.7	=	21.74	(81)

Solar gains in watts, calculated for each month

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

(83)m=	39.93	81.28	146.44	240.5	323.27	344.64	322.41	257.03	178.44	99.33	50.24	32.61	(83)
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Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	438.01	477.35	530.13	604.29	666.98	668.94	634.07	574.36	505.98	446.96	420.93	420.48	(84)
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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=	1	1	0.99	0.94	0.81	0.6	0.45	0.51	0.8	0.97	0.99	1	(86)

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

(87)m=	20.06	20.17	20.39	20.69	20.91	20.99	21	21	20.94	20.66	20.31	20.04	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.13	20.13	20.13	20.14	20.14	20.15	20.15	20.15	20.15	20.14	20.14	20.13	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.98	0.93	0.76	0.53	0.36	0.42	0.73	0.96	0.99	1	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.87	19.04	19.35	19.78	20.06	20.14	20.15	20.15	20.1	19.74	19.25	18.85	(90)
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fLA = Living area ÷ (4) =

0.37 (91)

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

(92)m=	19.31	19.46	19.74	20.12	20.37	20.46	20.46	20.46	20.41	20.08	19.64	19.29	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

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(93)m=	19.31	19.46	19.74	20.12	20.37	20.46	20.46	20.46	20.41	20.08	19.64	19.29	(93)
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8. Space heating requirement

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, h_m :

(94)m=	1	0.99	0.98	0.92	0.78	0.56	0.39	0.45	0.75	0.96	0.99	1	(94)
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Useful gains, $h_m G_m$, $W = (94)m \times (84)m$

(95)m=	436.06	473.5	518.94	558.89	518.48	372.34	248.7	260.36	380.65	427.03	417.04	418.99	(95)
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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)
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Heat loss rate for mean internal temperature, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	997.96	965.23	875.47	733.06	565.43	377.69	249.24	261.6	408.79	618.2	821.4	993.12	(97)
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Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	418.05	330.44	265.26	125.4	34.93	0	0	0	0	142.23	291.13	427.15	(98)
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Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 2034.6

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

29.07 (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) = $(202) \times [1 - (203)] =$

1 (204)

Efficiency of main space heating system 1

93.5 (206)

Efficiency of secondary/supplementary heating system, %

0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$kWh/year$
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Space heating requirement (calculated above)

418.05	330.44	265.26	125.4	34.93	0	0	0	0	142.23	291.13	427.15
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(211)m = $\{[(98)m \times (204)]\} \times 100 \div (206)$ (211)

447.12	353.42	283.7	134.12	37.36	0	0	0	0	152.12	311.37	456.85
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Total ($kWh/year$) = $Sum(211)_{1..5,10..12} =$ 2176.05 (211)

Space heating fuel (secondary), $kWh/month$

= $\{[(98)m \times (201)]\} \times 100 \div (208)$

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

Water heating

Output from water heater (calculated above)

197.72	174.5	183.8	165.5	162.73	146.18	141.12	153.84	153.25	171.58	180.49	193.21
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Efficiency of water heater

79.8 (216)

(217)m=	86.76	86.49	85.79	84.09	81.5	79.8	79.8	79.8	79.8	84.32	86.08	86.87	(217)
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Fuel for water heating, $kWh/month$

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

(219)m=	227.88	201.75	214.23	196.83	199.66	183.18	176.84	192.78	192.04	203.49	209.68	222.41	(219)
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Total = $Sum(219a)_{1..12} =$ 2420.77

Annual totals

$kWh/year$

$kWh/year$

Space heating fuel used, main system 1

2176.05

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Water heating fuel used			2420.77	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		75	(231)
Electricity for lighting			321.99	(232)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x		0.216	=	470.03	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	522.89	(264)
Space and water heating	(261) + (262) + (263) + (264) =				992.91	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93	(267)
Electricity for lighting	(232) x		0.519	=	167.11	(268)
Total CO2, kg/year		sum of (265)...(271) =			1198.95	(272)
TER =					17.13	(273)