

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Software Name: Stroma FSAP 2012

Stroma Number:
Software Version: Version: 1.0.5.56

Property Address: A.01-02.02 x2

Address :

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	54.94 (1a) x	2.5 (2a) =	137.35 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	54.94 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	137.35 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0 x 40 =	0 (6a)
Number of open flues	0	0	0	0 x 20 =	0 (6b)
Number of intermittent fans				0 x 10 =	0 (7a)
Number of passive vents				0 x 10 =	0 (7b)
Number of flueless gas fires				0 x 40 =	0 (7c)

Air changes per hour

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

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

Number of storeys in the dwelling (ns) 0 (9)

Additional infiltration [(9)-1]x0.1 = 0 (10)

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction 0 (11)

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 0 (12)

If no draught lobby, enter 0.05, else enter 0 0 (13)

Percentage of windows and doors draught stripped 0 (14)

Window infiltration 0.25 - [0.2 x (14) + 100] = 0 (15)

Infiltration rate (8) + (10) + (11) + (12) + (13) + (15) = 0 (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area 2 (17)

If based on air permeability value, then (18) = [(17) + 20]÷(8), otherwise (18) = (16) 0.1 (18)

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

Number of sides sheltered 2 (19)

Shelter factor 0.85 (20)

Infiltration rate incorporating shelter factor (21) = (18) x (20) = 0.08 (21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

Wind Factor (22a)m = (22)m ÷ 4

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

0.11	0.11	0.1	0.09	0.09	0.08	0.08	0.08	0.08	0.09	0.1	0.1
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0.5 (23a)

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

0.5 (23b)

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

75.65 (23c)

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

(24a)m= 0.23 0.23 0.23 0.22 0.21 0.2 0.2 0.2 0.21 0.21 0.22 0.22 (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 × 0.5]

(24d)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24d)

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

(25)m= 0.23 0.23 0.23 0.22 0.21 0.2 0.2 0.2 0.21 0.21 0.22 0.22 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m ²)	Openings m ²	Net Area A ,m ²	U-value W/m ² K	A X U (W/K)	k-value kJ/m ² ·K	A X k kJ/K
Windows Type 1			1.35	x 1/[1/(1.3) + 0.04] =	1.67		(27)
Windows Type 2			4.84	x 1/[1/(1.3) + 0.04] =	5.98		(27)
Windows Type 3			1.67	x 1/[1/(1.3) + 0.04] =	2.06		(27)
Walls	42.92	7.86	35.06	x 0.15 =	5.26		(29)
Total area of elements, m ²			42.92				(31)
Party wall			31.83	x 0 =	0		(32)
Party floor			54.95				(32a)
Party ceiling			54.94				(32b)

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

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

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 14.97 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 16237.05 (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 6.44 (36)

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

Total fabric heat loss (33) + (36) = 21.41 (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=	10.43	10.33	10.24	9.76	9.66	9.18	9.18	9.08	9.37	9.66	9.85	10.05

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

(39)m= 31.84 31.75 31.65 31.17 31.07 30.59 30.59 30.49 30.78 31.07 31.26 31.46

Average = Sum(39) ÷ 12 = 31.14 (39)

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Heat loss parameter (HLP), W/m²K

$$(40)m = (39)m + (4)$$

(40)m=	0.58	0.58	0.58	0.57	0.57	0.56	0.56	0.56	0.56	0.57	0.57	0.57		
Average = Sum(40) _{1..12} /12=													0.57	(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 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

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		
(44)m=	85.58	82.46	79.35	76.24	73.13	70.02	70.02	73.13	76.24	79.35	82.46	85.58		

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

Total = Sum(44) _{1..12} =													933.55	(44)
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Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x D Tm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	126.91	110.99	114.53	99.85	95.81	82.68	76.61	87.92	88.97	103.68	113.18	122.9		
Total = Sum(45) _{1..12} =													1224.03	(45)

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

(46)m=	19.04	16.65	17.18	14.98	14.37	12.4	11.49	13.19	13.34	15.55	16.98	18.44		(46)
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Water storage loss:

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

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):

Temperature factor from Table 2b

Energy lost from water storage, kWh/year

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

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

If community heating see section 4.3

Volume factor from Table 2a

Temperature factor from Table 2b

Energy lost from water storage, kWh/year

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

Water storage loss calculated for each month

(56)m=	29.76	26.88	29.76	28.8	29.76	28.8	29.76	29.76	28.8	29.76	28.8	29.76		(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=	29.76	26.88	29.76	28.8	29.76	28.8	29.76	29.76	28.8	29.76	28.8	29.76		(57)
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Primary circuit loss (annual) from Table 3

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	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=	179.93	158.88	167.56	151.17	148.83	133.99	129.64	140.94	140.28	156.7	164.49	175.92		(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	0		(63)
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WWHRS

(64)m=	142.53	125.99	133.98	123.49	123.12	112.76	111.64	119.16	117.87	129.04	132.49	139.79		(64)
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Output from water heater

Output from water heater (annual) _{1..12} =													1511.84	(64)
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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=	84.61	75.22	80.5	74.25	74.28	68.54	67.89	71.65	70.63	76.89	78.68	83.28		(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=	91.78	91.78	91.78	91.78	91.78	91.78	91.78	91.78	91.78	91.78	91.78	91.78		(66)

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

(67)m=	14.82	13.16	10.71	8.11	6.06	5.12	5.53	7.18	9.64	12.24	14.29	15.23		(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	160.03	161.69	157.51	148.6	137.35	126.78	119.72	118.06	122.25	131.15	142.4	152.97		(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	32.18	32.18	32.18	32.18	32.18	32.18	32.18	32.18	32.18	32.18	32.18	32.18		(69)
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Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0		(70)
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Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-73.42	-73.42	-73.42	-73.42	-73.42	-73.42	-73.42	-73.42	-73.42	-73.42	-73.42	-73.42		(71)
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Water heating gains (Table 5)

(72)m=	113.73	111.93	108.2	103.13	99.83	95.19	91.25	96.3	98.1	103.35	109.28	111.94		(72)
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Total internal gains =

(73)m=	339.12	337.32	326.95	310.36	293.78	277.63	267.04	272.08	280.52	297.28	316.5	330.68		(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 m²		Flux Table 6a		g _L Table 6b		FF Table 6c		Gains (W)		
South	0.9x	0.77	x	1.67	x	46.75	x	0.4	x	0.8	=	17.31	(78)
South	0.9x	0.77	x	1.67	x	76.57	x	0.4	x	0.8	=	28.36	(78)
South	0.9x	0.77	x	1.67	x	97.53	x	0.4	x	0.8	=	36.12	(78)
South	0.9x	0.77	x	1.67	x	110.23	x	0.4	x	0.8	=	40.82	(78)

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South	0.9x	0.77	x	1.67	x	114.87	x	0.4	x	0.8	=	42.54	(78)
South	0.9x	0.77	x	1.67	x	110.55	x	0.4	x	0.8	=	40.94	(78)
South	0.9x	0.77	x	1.67	x	108.01	x	0.4	x	0.8	=	40	(78)
South	0.9x	0.77	x	1.67	x	104.89	x	0.4	x	0.8	=	38.85	(78)
South	0.9x	0.77	x	1.67	x	101.89	x	0.4	x	0.8	=	37.73	(78)
South	0.9x	0.77	x	1.67	x	82.59	x	0.4	x	0.8	=	30.58	(78)
South	0.9x	0.77	x	1.67	x	55.42	x	0.4	x	0.8	=	20.52	(78)
South	0.9x	0.77	x	1.67	x	40.4	x	0.4	x	0.8	=	14.96	(78)
Southwest	0.9x	0.77	x	1.35	x	36.79	x	0.4	x	0.8	=	11.02	(79)
Southwest	0.9x	0.77	x	1.35	x	62.67	x	0.4	x	0.8	=	18.76	(79)
Southwest	0.9x	0.77	x	1.35	x	85.75	x	0.4	x	0.8	=	25.67	(79)
Southwest	0.9x	0.77	x	1.35	x	106.25	x	0.4	x	0.8	=	31.81	(79)
Southwest	0.9x	0.77	x	1.35	x	119.01	x	0.4	x	0.8	=	35.63	(79)
Southwest	0.9x	0.77	x	1.35	x	118.15	x	0.4	x	0.8	=	35.37	(79)
Southwest	0.9x	0.77	x	1.35	x	113.91	x	0.4	x	0.8	=	34.1	(79)
Southwest	0.9x	0.77	x	1.35	x	104.39	x	0.4	x	0.8	=	31.25	(79)
Southwest	0.9x	0.77	x	1.35	x	92.85	x	0.4	x	0.8	=	27.8	(79)
Southwest	0.9x	0.77	x	1.35	x	69.27	x	0.4	x	0.8	=	20.74	(79)
Southwest	0.9x	0.77	x	1.35	x	44.07	x	0.4	x	0.8	=	13.19	(79)
Southwest	0.9x	0.77	x	1.35	x	31.49	x	0.4	x	0.8	=	9.43	(79)
West	0.9x	0.77	x	4.84	x	19.64	x	0.4	x	0.3	=	21.08	(80)
West	0.9x	0.77	x	4.84	x	38.42	x	0.4	x	0.8	=	41.24	(80)
West	0.9x	0.77	x	4.84	x	63.27	x	0.4	x	0.8	=	67.91	(80)
West	0.9x	0.77	x	4.84	x	92.28	x	0.4	x	0.8	=	99.05	(80)
West	0.9x	0.77	x	4.84	x	113.09	x	0.4	x	0.8	=	121.38	(80)
West	0.9x	0.77	x	4.84	x	115.77	x	0.4	x	0.8	=	124.26	(80)
West	0.9x	0.77	x	4.84	x	110.22	x	0.4	x	0.8	=	118.3	(80)
West	0.9x	0.77	x	4.84	x	94.68	x	0.4	x	0.8	=	101.62	(80)
West	0.9x	0.77	x	4.84	x	73.59	x	0.4	x	0.8	=	78.98	(80)
West	0.9x	0.77	x	4.84	x	45.59	x	0.4	x	0.8	=	48.93	(80)
West	0.9x	0.77	x	4.84	x	24.49	x	0.4	x	0.8	=	26.28	(80)
West	0.9x	0.77	x	4.84	x	16.15	x	0.4	x	0.8	=	17.34	(80)

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

(83)m=	49.41	88.36	129.71	171.68	199.55	200.57	192.4	171.72	144.51	100.25	60	41.72	(83)
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Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	388.52	425.68	456.65	482.04	493.33	478.2	459.44	443.8	425.04	397.53	376.5	372.4	(84)
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7. Mean internal temperature (heating season)

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

(85)	21	(85)
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Utilisation factor for gains for living area, h1,m (see Table 9a)

(86)m=	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(86)
	0.98	0.96	0.9	0.76	0.58	0.41	0.29	0.32	0.5	0.79	0.95	0.99	

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

(87)m=	20.71	20.81	20.91	20.98	21	21	21	21	21	20.98	20.86	20.69	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.45	20.45	20.45	20.46	20.46	20.47	20.47	20.47	20.47	20.46	20.46	20.45	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.98	0.95	0.88	0.73	0.55	0.38	0.26	0.28	0.46	0.75	0.94	0.98	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	20.07	20.2	20.35	20.44	20.46	20.47	20.47	20.47	20.47	20.44	20.28	20.05	(90)	
	fLA = Living area + (4) =												0.41	(91)

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

(92)m=	20.34	20.45	20.58	20.67	20.68	20.69	20.69	20.69	20.69	20.67	20.52	20.32	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	20.34	20.45	20.58	20.67	20.68	20.69	20.69	20.69	20.69	20.67	20.52	20.32	(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:	0.98	0.95	0.89	0.74	0.56	0.39	0.27	0.29	0.48	0.77	0.94	0.98

(94)m=

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

(95)m=	380.01	405.76	405.97	359.06	278.47	186.25	125.09	130.82	202.66	304.68	354.93	366.13	(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=	510.74	493.77	445.64	366.7	279.12	186.27	125.09	130.82	202.77	312.74	419.54	506.97	(97)
--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	------

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

(98)m=	97.26	59.14	29.51	5.5	0.48	0	0	0	0	6	46.51	104.79	(98)
--------	-------	-------	-------	-----	------	---	---	---	---	---	-------	--------	------

Total per year (kWh/year) = Sum(98)m,5,9...12 =

(99)	349.2	(99)
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Space heating requirement in kWh/m²/year

(99)	6.36	(99)
------	------	------

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme. Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none

(301)	0	(301)
-------	---	-------

Fraction of space heat from community system 1 – (301) =

(302)	1	(302)
-------	---	-------

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers

(303a)	1	(303a)
--------	---	--------

Fraction of total space heat from Community boilers (302) x (303a) =

(304a)	1	(304a)
--------	---	--------

Factor for control and charging method (Table 4c(3)) for community heating system

(305)	1	(305)
-------	---	-------

Distribution loss factor (Table 12c) for community heating system

(306)	1.05	(306)
-------	------	-------

Space heating
Annual space heating requirement

	kWh/year
349.2	

DER WorkSheet: New dwelling design stage

Space heat from Community boilers	$(98) \times (304a) \times (305) \times (306) =$	366.66	(307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308)
Space heating requirement from secondary/supplementary system	$(98) \times (301) \times 100 \div (308) =$	0	(309)

Water heating

Annual water heating requirement		1511.84	
If DHW from community scheme:			
Water heat from Community boilers	$(64) \times (303a) \times (305) \times (306) =$	1587.43	(310a)
Electricity used for heat distribution	$0.01 \times [(307a) \dots (307e) + (310a) \dots (310e)] =$	19.54	(313)
Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	$= (107) \div (314) =$	0	(315)

Electricity for pumps and fans within dwelling (Table 4f):
mechanical ventilation - balanced, extract or positive input from outside

warm air heating system fans		98.45	(330a)
pump for solar water heating		0	(330b)
		0	(330g)
Total electricity for the above, kWh/year	$= (330a) + (330b) + (330g) =$	98.45	(331)
Energy for lighting (calculated in Appendix L)		261.76	(332)
Total delivered energy for all uses $(307) + (309) + (310) + (312) + (315) + (331) + (332) \dots (237b) =$		2314.29	(338)

12b. CO2 Emissions – Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP)				
Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel		93.5	(367a)
CO2 associated with heat source 1	$[(307b) + (310b)] \times 100 \div (367b) \times$	0.22	451.43	(367)
Electrical energy for heat distribution	$[(313) \times$	0.52	10.14	(372)
Total CO2 associated with community systems	$(363) \dots (366) + (368) \dots (372)$		461.57	(373)
CO2 associated with space heating (secondary)	$(309) \times$	0	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	$(312) \times$	0.22	0	(375)
Total CO2 associated with space and water heating	$(373) + (374) + (375) =$		461.57	(376)
CO2 associated with electricity for pumps and fans within dwelling	$(331)) \times$	0.52	51.09	(378)
CO2 associated with electricity for lighting	$(332))) \times$	0.52	135.85	(379)
Total CO2, kg/year	$\text{sum of } (376) \dots (382) =$		648.51	(383)
Dwelling CO2 Emission Rate	$(383) \div (4) =$		11.8	(384)
EI rating (section 14)			91.3	(385)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Stroma Number:
Software Name: Stroma FSAP 2012	Software Version: Version: 1.0.5.56
Property Address: B-C.01-02.01 x4	

Address :**1. Overall dwelling dimensions:**

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	89.5 (1a) x	2.5 (2a) =	223.75 (3a)
Total floor area TFA = $(1a) + (1b) + (1c) + (1d) + (1e) + \dots (1n)$	89.5 (4)		
Dwelling volume		$(3a) + (3b) + (3c) + (3d) + (3e) + \dots (3n) =$	223.75 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0 x 40 =	0 (6a)
Number of open flues	0	0	0	0 x 20 =	0 (6b)
Number of intermittent fans				0 x 10 =	0 (7a)
Number of passive vents				0 x 10 =	0 (7b)
Number of flueless gas fires				0 x 40 =	0 (7c)

	Air changes per hour
Infiltration due to chimneys, flues and fans = $(6a) + (6b) + (7a) + (7b) + (7c) =$	0 + (5) = 0 (8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)	
Number of storeys in the dwelling (ns)	0 (9)
Additional infiltration	$[(9) - 1] \times 0.1 =$
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	$0.25 - [0.2 \times (14) \div 100] =$
Infiltration rate	$(8) + (10) + (11) + (12) + (13) + (15) =$
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	2 (17)
If based on air permeability value, then $(18) = [(17) \div 20] + (8)$, otherwise $(18) = (16)$	0.1 (18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used	
Number of sides sheltered	2 (19)
Shelter factor	$(20) = 1 - [0.075 \times (19)] =$
Infiltration rate incorporating shelter factor	$(21) = (18) \times (20) =$

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 $(22a)m = (22)m \div 4$

(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
---------	------	------	------	-----	------	------	------	------	---	------	------	------

DER WorkSheet: New dwelling design stage

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

0.11	0.11	0.1	0.09	0.09	0.08	0.08	0.08	0.08	0.09	0.1	0.1
------	------	-----	------	------	------	------	------	------	------	-----	-----

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0.5 (23a)

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

0.5 (23b)

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

74.8 (23c)

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

(24a)m= 0.23 0.23 0.23 0.22 0.22 0.21 0.21 0.2 0.21 0.22 0.22 0.23 (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 0 0 0 0 0 0 0 0 0 0 0 (24d)

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

(25)m= 0.23 0.23 0.23 0.22 0.22 0.21 0.21 0.2 0.21 0.22 0.22 0.23 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m2K	A X U (W/K)	k-value kJ/m².K	A X k kJ/K
Windows Type 1			1.73	$\times 1/[1/(1.3) + 0.04] =$	2.14		(27)
Windows Type 2			1.73	$\times 1/[1/(1.3) + 0.04] =$	2.14		(27)
Windows Type 3			1.35	$\times 1/[1/(1.3) + 0.04] =$	1.67		(27)
Windows Type 4			4.94	$\times 1/[1/(1.3) + 0.04] =$	6.1		(27)
Windows Type 5			1.35	$\times 1/[1/(1.3) + 0.04] =$	1.67		(27)
Walls	66.85	15.91	50.94	$\times$ 0.15 =	7.64		(29)
Total area of elements, m²			66.85				(31)
Party wall			33.4	$\times$ 0 =	0		(32)
Party floor			89.5				(32a)
Party ceiling			89.5				(32b)

* 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) = 27.3 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 21955.6 (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 10.03 (36)

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

Total fabric heat loss (33) + (36) = 37.33 (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
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DER WorkSheet: New dwelling design stage

(38)m= 17.31 17.15 16.99 16.21 16.05 15.27 15.27 15.11 15.58 16.05 16.36 16.68 (38)

Heat transfer coefficient, W/K

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

(39)m= 54.63 54.48 54.32 53.54 53.38 52.6 52.6 52.44 52.91 53.38 53.69 54.01 (39)

Average = Sum(39) ÷ 12 = 53.5 (39)

Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m= 0.61 0.61 0.61 0.6 0.6 0.59 0.59 0.59 0.59 0.6 0.6 0.6 (40)

Average = Sum(40) ÷ 12 = 0.6 (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

2.62 (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

96.4 (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)	106.04	102.18	98.32	94.47	90.61	86.76	86.76	90.61	94.47	98.32	102.18	106.04
(44)m=	106.04	102.18	98.32	94.47	90.61	86.76	86.76	90.61	94.47	98.32	102.18	106.04
Total = Sum(44) ÷ 12 =	1156.76											
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)	157.25	137.53	141.92	123.73	118.72	102.45	94.93	108.94	110.24	128.47	140.24	152.29
(45)m=	157.25	137.53	141.92	123.73	118.72	102.45	94.93	108.94	110.24	128.47	140.24	152.29
Total = Sum(45) ÷ 12 =	1516.7											

 (45)

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

(46)m= 23.59 20.63 21.29 18.56 17.81 15.37 14.24 16.34 16.54 19.27 21.04 22.84 (46)

Water storage loss:

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

172 (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):

1.6 (48)

Temperature factor from Table 2b

0.6 (49)

Energy lost from water storage, kWh/year

(48) x (49) = 0.96 (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)

0.96 (55)

Water storage loss calculated for each month

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

(56)m= 29.76 26.88 29.76 28.8 29.76 28.8 29.76 29.76 28.8 29.76 28.8 29.76 (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= 29.76 26.88 29.76 28.8 29.76 28.8 29.76 29.76 28.8 29.76 28.8 29.76 (57)

DER WorkSheet: New dwelling design stage

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	23.26	22.51	23.26	22.51	23.26
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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
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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=

210.27	185.42	194.94	175.04	171.74	153.76	147.95	161.96	161.55	181.49	191.55	205.31
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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 VVHRS applies, see Appendix G)

(63)m=

0	0	0	0	0	0	0	0	0	0	0	0
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VVHRS -50.32 -44.27 -45.19 -37.18 -34.53 -28.48 -24.11 -29.19 -30.04 -37.13 -43.01 -48.64 (63) (G10)

Output from water heater

(64)m=

159.95	141.15	149.75	137.86	137.22	125.28	123.85	132.77	131.51	144.36	148.54	156.67
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Output from water heater (annual) = 1688.9 (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=

94.7	84.04	89.61	82.19	81.89	75.11	73.98	78.64	77.7	85.13	87.68	93.05
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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

(66)m=

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
130.94	130.94	130.94	130.94	130.94	130.94	130.94	130.94	130.94	130.94	130.94	130.94

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

(67)m=

21.35	18.96	15.42	11.67	8.73	7.37	7.96	10.35	13.89	17.63	20.58	21.94
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=

238.15	240.63	234.4	221.14	204.41	188.68	178.17	175.7	181.92	195.18	211.92	227.65
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=

36.09	36.09	36.09	36.09	36.09	36.09	36.09	36.09	36.09	36.09	36.09	36.09
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Pumps and fans gains (Table 5a)

(70)m=

0	0	0	0	0	0	0	0	0	0	0	0
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Losses e.g. evaporation (negative values) (Table 5)

(71)m=

-104.75	-104.75	-104.75	-104.75	-104.75	-104.75	-104.75	-104.75	-104.75	-104.75	-104.75	-104.75
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Water heating gains (Table 5)

(72)m=

127.29	125.06	120.44	114.15	110.07	104.32	99.44	105.7	107.92	114.43	121.78	125.07
--------	--------	--------	--------	--------	--------	-------	-------	--------	--------	--------	--------

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

(73)m=

449.07	446.93	432.54	409.25	385.48	362.65	347.85	354.02	366.02	389.53	416.56	436.94
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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 m² Flux Table 6a g_a Table 6b FF Table 6c Gains (W)

North 0.9x 0.77 x 1.73 x 10.63 x 0.4 x 0.8 = 12.24 (74)

DER WorkSheet: New dwelling design stage

North	0.9x	0.77	x	1.73	x	20.32	x	0.4	x	0.8	=	23.39	(74)
North	0.9x	0.77	x	1.73	x	34.53	x	0.4	x	0.8	=	39.74	(74)
North	0.9x	0.77	x	1.73	x	55.46	x	0.4	x	0.8	=	63.84	(74)
North	0.9x	0.77	x	1.73	x	74.72	x	0.4	x	0.8	=	85.99	(74)
North	0.9x	0.77	x	1.73	x	79.99	x	0.4	x	0.8	=	92.06	(74)
North	0.9x	0.77	x	1.73	x	74.68	x	0.4	x	0.8	=	85.95	(74)
North	0.9x	0.77	x	1.73	x	59.25	x	0.4	x	0.8	=	68.19	(74)
North	0.9x	0.77	x	1.73	x	41.52	x	0.4	x	0.8	=	47.78	(74)
North	0.9x	0.77	x	1.73	x	24.19	x	0.4	x	0.8	=	27.84	(74)
North	0.9x	0.77	x	1.73	x	13.12	x	0.4	x	0.8	=	15.1	(74)
North	0.9x	0.77	x	1.73	x	8.86	x	0.4	x	0.8	=	10.2	(74)
South	0.9x	0.77	x	1.73	x	46.75	x	0.4	x	0.8	=	17.94	(78)
South	0.9x	0.77	x	1.35	x	46.75	x	0.4	x	0.8	=	14	(78)
South	0.9x	0.77	x	1.73	x	76.57	x	0.4	x	0.8	=	29.37	(78)
South	0.9x	0.77	x	1.35	x	76.57	x	0.4	x	0.8	=	22.92	(78)
South	0.9x	0.77	x	1.73	x	97.53	x	0.4	x	0.8	=	37.42	(78)
South	0.9x	0.77	x	1.35	x	97.53	x	0.4	x	0.8	=	29.2	(78)
South	0.9x	0.77	x	1.73	x	110.23	x	0.4	x	0.8	=	42.29	(78)
South	0.9x	0.77	x	1.35	x	110.23	x	0.4	x	0.8	=	33	(78)
South	0.9x	0.77	x	1.73	x	114.87	x	0.4	x	0.8	=	44.07	(78)
South	0.9x	0.77	x	1.35	x	114.87	x	0.4	x	0.8	=	34.39	(78)
South	0.9x	0.77	x	1.73	x	110.55	x	0.4	x	0.8	=	42.41	(78)
South	0.9x	0.77	x	1.35	x	110.55	x	0.4	x	0.8	=	33.1	(78)
South	0.9x	0.77	x	1.73	x	108.01	x	0.4	x	0.8	=	41.44	(78)
South	0.9x	0.77	x	1.35	x	108.01	x	0.4	x	0.8	=	32.34	(78)
South	0.9x	0.77	x	1.73	x	104.89	x	0.4	x	0.8	=	40.24	(78)
South	0.9x	0.77	x	1.35	x	104.89	x	0.4	x	0.8	=	31.4	(78)
South	0.9x	0.77	x	1.73	x	101.89	x	0.4	x	0.8	=	39.09	(78)
South	0.9x	0.77	x	1.35	x	101.89	x	0.4	x	0.8	=	30.5	(78)
South	0.9x	0.77	x	1.73	x	82.59	x	0.4	x	0.8	=	31.68	(78)
South	0.9x	0.77	x	1.35	x	82.59	x	0.4	x	0.8	=	24.72	(78)
South	0.9x	0.77	x	1.73	x	55.42	x	0.4	x	0.8	=	21.26	(78)
South	0.9x	0.77	x	1.35	x	55.42	x	0.4	x	0.8	=	16.59	(78)
South	0.9x	0.77	x	1.73	x	40.4	x	0.4	x	0.8	=	15.5	(78)
South	0.9x	0.77	x	1.35	x	40.4	x	0.4	x	0.8	=	12.09	(78)
West	0.9x	0.77	x	1.35	x	19.64	x	0.4	x	0.8	=	11.76	(80)
West	0.9x	0.77	x	4.94	x	19.64	x	0.4	x	0.8	=	21.52	(80)
West	0.9x	0.77	x	1.35	x	38.42	x	0.4	x	0.8	=	23	(80)
West	0.9x	0.77	x	4.94	x	38.42	x	0.4	x	0.8	=	42.09	(80)
West	0.9x	0.77	x	1.35	x	63.27	x	0.4	x	0.8	=	37.88	(80)
West	0.9x	0.77	x	4.94	x	63.27	x	0.4	x	0.8	=	69.32	(80)

DER WorkSheet: New dwelling design stage

West	0.9x	0.77	x	1.35	x	92.28	x	0.4	x	0.8	=	55.25	(80)
West	0.9x	0.77	x	4.94	x	92.28	x	0.4	x	0.8	=	101.09	(80)
West	0.9x	0.77	x	1.35	x	113.09	x	0.4	x	0.8	=	67.71	(80)
West	0.9x	0.77	x	4.94	x	113.09	x	0.4	x	0.8	=	123.89	(80)
West	0.9x	0.77	x	1.35	x	115.77	x	0.4	x	0.8	=	69.32	(80)
West	0.9x	0.77	x	4.94	x	115.77	x	0.4	x	0.8	=	126.83	(80)
West	0.9x	0.77	x	1.35	x	110.22	x	0.4	x	0.8	=	65.99	(80)
West	0.9x	0.77	x	4.94	x	110.22	x	0.4	x	0.8	=	120.74	(80)
West	0.9x	0.77	x	1.35	x	94.68	x	0.4	x	0.8	=	56.69	(80)
West	0.9x	0.77	x	4.94	x	94.68	x	0.4	x	0.8	=	103.72	(80)
West	0.9x	0.77	x	1.35	x	73.59	x	0.4	x	0.8	=	44.06	(80)
West	0.9x	0.77	x	4.94	x	73.59	x	0.4	x	0.8	=	80.62	(80)
West	0.9x	0.77	x	1.35	x	45.59	x	0.4	x	0.8	=	27.3	(80)
West	0.9x	0.77	x	4.94	x	45.59	x	0.4	x	0.8	=	49.94	(80)
West	0.9x	0.77	x	1.35	x	24.49	x	0.4	x	0.8	=	14.66	(80)
West	0.9x	0.77	x	4.94	x	24.49	x	0.4	x	0.8	=	26.83	(80)
West	0.9x	0.77	x	1.35	x	16.15	x	0.4	x	0.8	=	9.67	(80)
West	0.9x	0.77	x	4.94	x	16.15	x	0.4	x	0.8	=	17.69	(80)

Solar gains in watts, calculated for each month													(83)m = Sum(74)m ... (82)m
(83)m=	77.45	140.73	213.56	295.47	356.06	363.71	346.46	300.24	242.05	161.49	94.44	65.16	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts													(84)
(84)m=	526.52	587.71	646.1	704.72	741.54	726.36	694.31	654.26	608.07	551.01	511	502.1	(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)													(86)
(86)m=	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(86)
	1	0.99	0.96	0.86	0.66	0.46	0.33	0.37	0.6	0.9	0.99	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)													(87)
(87)m=	20.55	20.66	20.81	20.95	20.99	21	21	21	21	20.93	20.72	20.53	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)													(88)
(88)m=	20.42	20.42	20.42	20.43	20.43	20.44	20.44	20.44	20.44	20.43	20.43	20.43	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)													(89)
(89)m=	1	0.99	0.95	0.83	0.62	0.42	0.29	0.32	0.55	0.87	0.98	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													(90)
(90)m=	19.81	19.97	20.18	20.37	20.43	20.44	20.44	20.44	20.44	20.36	20.07	19.79	(90)

fLA = Living area + (4) =												0.3	(91)
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Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2													(92)
(92)m=	20.03	20.18	20.37	20.55	20.6	20.61	20.61	20.61	20.61	20.53	20.26	20.01	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate													(93)
(93)m=	20.03	20.18	20.37	20.55	20.6	20.61	20.61	20.61	20.61	20.53	20.26	20.01	(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	
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	--

DER WorkSheet: New dwelling design stage

Utilisation factor for gains, hm:

(94)m=	0.99	0.98	0.95	0.83	0.64	0.43	0.3	0.34	0.56	0.88	0.98	1	(94)
--------	------	------	------	------	------	------	-----	------	------	------	------	---	------

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

(95)m=	523.46	578.74	614.46	588.17	471.53	315.96	210.89	220.8	343.24	484.57	502.25	500.02	(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=	859.65	832.2	753.48	623.58	475.02	316.07	210.89	220.81	344.23	530.17	706.78	853.78	(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=	250.13	170.33	103.43	25.49	2.6	0	0	0	0	33.93	147.26	263.2	(98)
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Total per year (kWh/year) = Sum(98)m...12 =												996.37	(98)
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Space heating requirement in kWh/m²/year

11.13	(99)
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9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none	0	(301)
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Fraction of space heat from community system 1 – (301) =	1	(302)
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The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers	1	(303a)
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Fraction of total space heat from Community boilers	(302) x (303a) =	1	(304a)
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Factor for control and charging method (Table 4c(3)) for community heating system	1	(305)
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Distribution loss factor (Table 12c) for community heating system	1.05	(306)
---	------	-------

Space heating	kWh/year	
Annual space heating requirement	996.37	

Space heat from Community boilers	(98) x (304a) x (305) x (306) =	1046.19	(307a)
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Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)	0	(308)
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Space heating requirement from secondary/supplementary system	(98) x (301) x 100 + (308) =	0	(309)
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Water heating

Annual water heating requirement	1688.9	
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If DHW from community scheme:			
Water heat from Community boilers	$(64) \times (303a) \times (305) \times (306) =$	<table border="1"><tr><td>1773.35</td></tr></table> (310a)	1773.35
1773.35			

Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	28.2	(313)
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Cooling System Energy Efficiency Ratio	0	(314)
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Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) + (314) =	0	(315)
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Electricity for pumps and fans within dwelling (Table 4f):		
mechanical ventilation - balanced, extract or positive input from outside	184.26	(330a)

warm air heating system fans	0	(330b)
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pump for solar water heating	0	(330g)
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Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =	184.26	(331)
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DER WorkSheet: New dwelling design stage

Energy for lighting (calculated in Appendix L) (332)Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(237b) = (338)

12b. CO2 Emissions – Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%) <i>If there is CHP using two fuels repeat (363) to (366) for the second fuel</i>			93.5 (367a)
CO2 associated with heat source 1 <i>[(307b)+(310b)] x 100 ÷ (367b) x</i>	0.22	=	651.36 (367)
Electrical energy for heat distribution <i>[(313) x</i>	0.52	=	14.63 (372)
Total CO2 associated with community systems <i>(363)...(366) + (368)...(372)</i>		=	665.99 (373)
CO2 associated with space heating (secondary) <i>(309) x</i>	0	=	0 (374)
CO2 associated with water from immersion heater or instantaneous heater <i>(312) x</i>	0.22	=	0 (375)
Total CO2 associated with space and water heating <i>(373) + (374) + (375) =</i>			665.99 (376)
CO2 associated with electricity for pumps and fans within dwelling <i>(331)) x</i>	0.52	=	95.63 (378)
CO2 associated with electricity for lighting <i>(332))) x</i>	0.52	=	195.67 (379)
Total CO2, kg/year <i>sum of (376)...(382) =</i>			957.29 (383)
Dwelling CO2 Emission Rate <i>(383) ÷ (4) =</i>			10.7 (384)
EI rating (section 14)			90.46 (385)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name: **Stroma Number:**
Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.5.56

Property Address: B-C.03.02 x2

Address :

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground floor	74.4 (1a) x	2.5 (2a) =	186 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	74.4 (4)		
Dwelling volume		<i>(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =</i>	186 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	+ 0	+ 0	= 0 x 40 =	0 (6a)
Number of open flues	0	+ 0	+ 0	= 0 x 20 =	0 (6b)
Number of intermittent fans				0 x 10 =	0 (7a)
Number of passive vents				0 x 10 =	0 (7b)
Number of flueless gas fires				0 x 40 =	0 (7c)

Air changes per hour
Infiltration due to chimneys, flues and fans = *(6a)+(6b)+(7a)+(7b)+(7c) =* + (5) = (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) (9)
Additional infiltration *[(9)-1]x0.1 =* (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction (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 (12)
If no draught lobby, enter 0.05, else enter 0 (13)
Percentage of windows and doors draught stripped (14)
Window infiltration *0.25 - [0.2 x (14) ÷ 100] =* (15)
Infiltration rate *(8) + (10) + (11) + (12) + (13) + (15) =* (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area (17)
If based on air permeability value, then *(18) = [(17) ÷ 20] + (8), otherwise (18) = (16)* (18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used
Number of sides sheltered (19)
Shelter factor *(20) = 1 - [0.075 x (19)] =* (20)
Infiltration rate incorporating shelter factor *(21) = (18) x (20) =* (21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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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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DER WorkSheet: New dwelling design stage

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

0.11	0.11	0.1	0.09	0.09	0.08	0.08	0.08	0.08	0.09	0.1	0.1
------	------	-----	------	------	------	------	------	------	------	-----	-----

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0.5 (23a)

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

0.5 (23b)

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

74.8 (23c)

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

(24a)m= 0.23 0.23 0.23 0.22 0.22 0.21 0.21 0.2 0.21 0.22 0.22 0.23 (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 0 0 0 0 0 0 0 0 0 0 0 (24d)

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

(25)m= 0.23 0.23 0.23 0.22 0.22 0.21 0.21 0.2 0.21 0.22 0.22 0.23 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m2K	A X U (W/K)	k-value kJ/m².K	A X k kJ/K
Windows Type 1			4.94	x1/[1/(1.3)+ 0.04] =	6.1		
Windows Type 2			1.35	x1/[1/(1.3)+ 0.04] =	1.67		
Windows Type 3			1.35	x1/[1/(1.3)+ 0.04] =	1.67		
Windows Type 4			3.11	x1/[1/(1.3)+ 0.04] =	3.84		
Walls	58.25	14.8	43.45	x 0.15 =	6.52		
Roof	74.4	0	74.4	x 0.1 =	7.44		
Total area of elements, m²			132.65				
Party wall			42.5	x 0 =	0		
Party floor			74.4				

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

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

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 32.25 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 19551.1 (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 19.9 (36)

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

Total fabric heat loss (33) + (36) = 52.14 (37)

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

(38)m= 14.39 14.26 14.13 13.47 13.34 12.69 12.69 12.56 12.95 13.34 13.6 13.86 (38)

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

(39)m= 66.53 66.4 66.27 65.62 65.49 64.83 64.83 64.7 65.1 65.49 65.75 66.01 (39)

Stroma FSAP 2012 Version: 1.0.5.56 (SAP 9.92) - http://www.stroma.com Average = Sum(39)1..12 /12= 65.56 (40) Page 2 of 8

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m= 0.89 0.89 0.89 0.88 0.88 0.87 0.87 0.87 0.87 0.88 0.88 0.89 Average = Sum(40)1..12 /12= 0.88 (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

2.35 (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

89.97 (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= 98.96 95.36 91.77 88.17 84.57 80.97 80.97 84.57 88.17 91.77 95.36 98.96 Total = Sum(44)1..12 = 1079.59 (44)

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

(45)m= 146.76 128.36 132.45 115.47 110.8 95.61 88.6 101.67 102.88 119.9 130.88 142.13 Total = Sum(45)1..12 = 1415.52 (45)

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

(46)m= 22.01 19.25 19.87 17.32 16.62 14.34 13.29 15.25 15.43 17.99 19.63 21.32 (46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 172 (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): 1.6 (48)

Temperature factor from Table 2b 0.6 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.96 (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) 0.96 (55)

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

(56)m= 29.76 26.88 29.76 28.8 29.76 28.8 29.76 29.76 28.8 29.76 28.8 29.76 (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= 29.76 26.88 29.76 28.8 29.76 28.8 29.76 29.76 28.8 29.76 28.8 29.76 (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)

DER WorkSheet: New dwelling design stage

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)
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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=	199.78	176.25	185.47	166.79	163.82	146.92	141.62	154.69	154.2	172.92	182.19	195.15	(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	0	(63)
--------	---	---	---	---	---	---	---	---	---	---	---	---	------

WWHRs	-45.85	-40.34	-41.18	-33.89	-31.48	-25.98	-22	-26.63	-27.4	-33.86	-39.2	-44.31	(63) (G10)
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Output from water heater

(64)m=	153.93	135.91	144.3	132.89	132.34	120.95	119.63	128.06	126.8	139.06	142.99	150.84	(64)
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Output from water heater (annual)_{1...12} 1627.69

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=	91.22	80.99	86.46	79.45	79.26	72.84	71.88	76.22	75.26	82.28	84.57	89.68	(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=	117.4	117.4	117.4	117.4	117.4	117.4	117.4	117.4	117.4	117.4	117.4	117.4	(66)

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

(67)m=	18.48	16.42	13.35	10.11	7.56	6.38	6.89	8.96	12.03	15.27	17.82	19	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	207.34	209.49	204.07	192.53	177.96	164.26	155.12	152.96	158.39	169.93	184.5	198.19	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	34.74	34.74	34.74	34.74	34.74	34.74	34.74	34.74	34.74	34.74	34.74	34.74	(69)
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Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)
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Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-93.92	-93.92	-93.92	-93.92	-93.92	-93.92	-93.92	-93.92	-93.92	-93.92	-93.92	-93.92	(71)
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Water heating gains (Table 5)

(72)m=	122.6	120.52	116.21	110.34	106.53	101.17	96.61	102.45	104.53	110.6	117.45	120.53	(72)
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Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	406.65	404.65	391.85	371.2	350.27	330.03	316.84	322.59	333.16	354.02	378	395.94	(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		q _L Table 6b		FF Table 6c		Gains (W)	
East	0.9x	0.77	x	1.35	x	19.64	x	0.4	x	0.8	=	11.76 (76)
East	0.9x	0.77	x	1.35	x	38.42	x	0.4	x	0.8	=	23 (76)
East	0.9x	0.77	x	1.35	x	63.27	x	0.4	x	0.8	=	37.88 (76)
East	0.9x	0.77	x	1.35	x	92.28	x	0.4	x	0.8	=	55.25 (76)

DER WorkSheet: New dwelling design stage

East	0.9x	0.77	x	1.35	x	113.09	x	0.4	x	0.8	=	67.71	(76)
East	0.9x	0.77	x	1.35	x	115.77	x	0.4	x	0.8	=	69.32	(76)
East	0.9x	0.77	x	1.35	x	110.22	x	0.4	x	0.8	=	65.99	(76)
East	0.9x	0.77	x	1.35	x	94.68	x	0.4	x	0.8	=	56.69	(76)
East	0.9x	0.77	x	1.35	x	73.59	x	0.4	x	0.8	=	44.06	(76)
East	0.9x	0.77	x	1.35	x	45.59	x	0.4	x	0.8	=	27.3	(76)
East	0.9x	0.77	x	1.35	x	24.49	x	0.4	x	0.8	=	14.66	(76)
East	0.9x	0.77	x	1.35	x	16.15	x	0.4	x	0.8	=	9.67	(76)
South	0.9x	0.77	x	1.35	x	46.75	x	0.4	x	0.8	=	41.99	(78)
South	0.9x	0.77	x	3.11	x	46.75	x	0.4	x	0.8	=	32.24	(78)
South	0.9x	0.77	x	1.35	x	76.57	x	0.4	x	0.8	=	68.77	(78)
South	0.9x	0.77	x	3.11	x	76.57	x	0.4	x	0.8	=	52.81	(78)
South	0.9x	0.77	x	1.35	x	97.53	x	0.4	x	0.8	=	87.6	(78)
South	0.9x	0.77	x	3.11	x	97.53	x	0.4	x	0.8	=	67.27	(78)
South	0.9x	0.77	x	1.35	x	110.23	x	0.4	x	0.8	=	99	(78)
South	0.9x	0.77	x	3.11	x	110.23	x	0.4	x	0.8	=	76.03	(78)
South	0.9x	0.77	x	1.35	x	114.87	x	0.4	x	0.8	=	103.17	(78)
South	0.9x	0.77	x	3.11	x	114.87	x	0.4	x	0.8	=	79.22	(78)
South	0.9x	0.77	x	1.35	x	110.55	x	0.4	x	0.8	=	99.29	(78)
South	0.9x	0.77	x	3.11	x	110.55	x	0.4	x	0.8	=	76.24	(78)
South	0.9x	0.77	x	1.35	x	108.01	x	0.4	x	0.8	=	97.01	(78)
South	0.9x	0.77	x	3.11	x	108.01	x	0.4	x	0.8	=	74.49	(78)
South	0.9x	0.77	x	1.35	x	104.89	x	0.4	x	0.8	=	94.21	(78)
South	0.9x	0.77	x	3.11	x	104.89	x	0.4	x	0.8	=	72.34	(78)
South	0.9x	0.77	x	1.35	x	101.89	x	0.4	x	0.8	=	91.51	(78)
South	0.9x	0.77	x	3.11	x	101.89	x	0.4	x	0.8	=	70.27	(78)
South	0.9x	0.77	x	1.35	x	82.59	x	0.4	x	0.8	=	74.17	(78)
South	0.9x	0.77	x	3.11	x	82.59	x	0.4	x	0.8	=	56.96	(78)
South	0.9x	0.77	x	1.35	x	55.42	x	0.4	x	0.8	=	49.77	(78)
South	0.9x	0.77	x	3.11	x	55.42	x	0.4	x	0.8	=	38.22	(78)
South	0.9x	0.77	x	1.35	x	40.4	x	0.4	x	0.8	=	36.28	(78)
South	0.9x	0.77	x	3.11	x	40.4	x	0.4	x	0.8	=	27.86	(78)
West	0.9x	0.77	x	4.94	x	19.64	x	0.4	x	0.8	=	21.52	(80)
West	0.9x	0.77	x	4.94	x	38.42	x	0.4	x	0.8	=	42.09	(80)
West	0.9x	0.77	x	4.94	x	63.27	x	0.4	x	0.8	=	69.32	(80)
West	0.9x	0.77	x	4.94	x	92.28	x	0.4	x	0.8	=	101.09	(80)
West	0.9x	0.77	x	4.94	x	113.09	x	0.4	x	0.8	=	123.89	(80)
West	0.9x	0.77	x	4.94	x	115.77	x	0.4	x	0.8	=	126.83	(80)
West	0.9x	0.77	x	4.94	x	110.22	x	0.4	x	0.8	=	120.74	(80)
West	0.9x	0.77	x	4.94	x	94.68	x	0.4	x	0.8	=	103.72	(80)
West	0.9x	0.77	x	4.94	x	73.59	x	0.4	x	0.8	=	80.62	(80)