Basement Force

Above Ground Extension and Subterranean Development

Operational Carbon Review and Analysis

17 March 2014

Prepared by:

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Index

Issue Status

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1. Executive Summary

Ashmount Consulting Engineers have been appointed by Basement Force to undertake an independent review of the Operational Carbon calculations detailed within the latest RBK&C Life Cycle Carbon Analysis Extensions and Subterranean Developments in RBKC report[1].

In summary the RBKC report draws conclusions from case studies comparing Operational Carbon emissions from above ground "extensions" against "single basements" and "large basements" of varying floor area.

The RBK&C case studies considered result in an average "extension" floor area of 25.1sqm against an average "single basement" floor area of 142.8sqm and "large basement" area of 470.8sqm. This report demonstrates that to directly compare developments of such different floor area is neither a valid nor accurate method of analysis.

This report demonstrates that when comparing developments with like-for-like floor areas the Operational Carbon emissions for an above ground extension is significantly greater than those of a basement development.

This report specifically considers the 16 Radnor Walk case study and calculates the Operational Carbon from this 75sqm basement and compares this with a like-for-like above ground extension of the same floor area. This provides a direct comparison of both development types and importantly an extension of the same property.

In conclusion the basement at 16 Radnor Walk resulted in an overall 28.6% increase in Operational Carbon emissions and an equivalent above ground extension results in a 44.2% increase in Operational Carbon. Basements therefore result in significantly lower Operational Carbon emissions.

[1] *Life Cycle Carbon Analysis Extensions and Subterranean Developments in RBK&C – E642 RBKJC FinalReport 1402-10rm.docx*

2. Introduction

Ashmount Consulting Engineers have been appointed by Basement Force to undertake an independent review of the Operational Carbon calculations provided within the latest RBK&C Life Cycle Carbon Analysis Extensions and Subterranean Developments in RBKC report.

This review provides an appraisal of the Operational Carbon calculations and associated conclusions presented within the RBK&C report. In summary RBKC report draws conclusions from case studies comparing Operational Carbon emissions from above ground "extensions" against "single basements" and "large basements" or varying floor area.

The RBK&C case studies considered result in an average "extension" floor area of 25.1sqm against an average "single basement" floor area of 142.8sqm and "large basement" area of 470.8sqm. This report demonstrates that to directly compare developments of such different floor area is neither a valid nor accurate method of analysis.

This report demonstrates that when comparing a like-for-like development floor area the Operational Carbon emissions for an above ground extension is significantly greater than a basement development. This can be simply explained by the fact that a basement has a reduced heat loss due to the added benefit of the surrounding ground.

3. Results

In line with the RBKC report all heights and areas were measured from the drawings available on the RBKC Planning Portal. All building services specifications were in accordance with RdSAP for the existing elements and UK 2010 Building Regulations and the Domestic Building Services Compliance Guide 2010 for the new elements.

For basements the rate of heat loss diminishes as the depth of the basement increases. This is due to the insulation value of the ground behind the basement wall. The U-values for the basement have been calculated using BS EN ISO: 13370 complaint software. The U-values achieved in the basement are summarised below and the calculations can be found in Appendix A.

External Element	16 Radnor Walk Equivalent above ground 75sqm extension U-values (W/m2K)	16 Radnor Walk Basement U-value (W/m2K)
Wall	0.28	**0.24**
Floor	0.22	**0.14**
Roof	0.18	**0.15**
Glazing	1.6	**1.6**

Furthermore the deeper the basement the better the U-value, therefore multi-storey basements would be result an in improved U-values.

The below table shows the resultant Operation Carbon Impact when comparing a basement against an equivalent above ground extension of the same floor area.

The SAP calculations that have been used to calculate this can be found in Appendix B.

Case Study	Total Existing Operational Carbon	Total Post Operation Carbon	Increase in Gross Internal Area	Carbon Impact for Increase in Gross Internal Area
16 Radnor Walk (75sqm basement)	4949	6365	75	**18.88**
16 Radnor Walk (Equivalent above ground 75sqm extension)	4949	7138	75	**29.19**

4. Conclusion

As can be seen from the 16 Radnor Walk case study analysis results, the Operational Carbon for a 75sqm basement will increase the properties Carbon Emissions by 28.6%.

An above ground extension of the same 75sqm floor area and incorporating the same existing dwelling with result in a 44.2% increase in operational carbon emissions.

Therefore it is logically concluded that below ground basements results in significantly lower Operational Carbon emissions than an equivalent like-for-like above ground extension.

For larger basements the like-for-like comparison will be better for the basement development as with depth the external envelope U-values of a basement are improved.

A like-for-like comparison in this manner is the only true way to analyse a true comparison between the Operational Carbon emissions of an above ground extension and subterranean development.

Appendices

- **A – Basement U-value Calculations**

U-value calculation
by BRE U-value Calculator version 2.03
Printed on 17 Mar 2014 at 09:09

Filename: M:\FILES\CONFIDENTIAL\WORK\SAPs\Basement Force\Radnor Basement.uva (File saved: 14 Mar 2014 11:04)

Element type: Heated basement
Calculation Method: BS EN ISO 6946, BS EN ISO 13370

Radnor Basement

Thermal resistance of basement floor construction:

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.170		Rsi
1	75	1.200			0.062		screed
2	100	0.022			4.545		insulation board
	175 mm				4.778		

Total resistance: Upper limit: 4.778 Lower limit: 4.778 Ratio: 1.000 Average: 4.778 m²K/W

Thermal resistance of basement wall construction:

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	12.5	0.210			0.060		Plasterboard
2							Vapour control layer
3	100	0.034	0.130	0.118	2.941	0.769	insulation between battens
4	200	1.210			0.165		masonry
	313 mm				3.296		

Total resistance: Upper limit: 2.684 Lower limit: 2.561 Ratio: 1.048 Average: 2.622 m²K/W

Ground parameters:

Perimeter P: 30.50 m
Area A: 75.00 m²
P/A: 0.407
Average basement depth: 2.600 m
Area of basement walls: 79.30 m²

Wall thickness: 300 mm
Ground type: Clay/silt (λ = 1.5 W/m·K)
Rse: 0.04 m²K/W

	Floor	Walls	Overall (area-weighted average)
U-value	0.135	0.240	0.189
U-value (rounded)	**0.14**	**0.24**	**0.19 W/m²K**

Calculated by:
Dan Watt

- **B – Operational Carbon SAP Calculations**

SAP Input

Property Details: 16 Radnor Walk BEFORE

Address:	16, Radnor Walk, LONDON, SW3 4BN
Located in:	England
Region:	Thames valley
UPRN:	3116159468
Date of assessment:	25 February 2014
Date of certificate:	14 March 2014
Assessment type:	New dwelling design stage
Transaction type:	New dwelling
Tenure type:	Unknown
Related party disclosure:	Employed by the professional dealing with the property transaction
Thermal Mass Parameter:	Indicative Value Medium
Dwelling designed to use less than 125 litres per Person per day:	False

Property description:

Dwelling type:	House
Detachment:	Mid-terrace
Year Completed:	2014

Floor Location:	Floor area:	Storey height:
Floor 0	50 m²	2.8 m
Floor 1	34 m²	2.8 m
Floor 2	34 m²	2.8 m

Living area:	46 m² (fraction 0.39)
Front of dwelling faces:	Unspecified

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
Front	SAP 2009	Half glazed	Single-glazed	No	Wood
Front	SAP 2009	Windows	Single-glazed	No	Wood
Back Bifolds	SAP 2009	Windows	double-glazed	No	PVC-U
Back	SAP 2009	Windows	Single-glazed	No	Wood
Rooflight	SAP 2009	Roof Windows	double-glazed	No	PVC-U

Name:	**Gap:**	**Frame Factor:**	**g-value:**	**U-value:**	**Area:**	**No. of Openings:**
Front	mm	0.7	0.85	3.9	2.6	1
Front		0.7	0.85	4.8	6.8	1
Back Bifolds	16mm or more	0.7	0.76	2.7	5.4	1
Back		0.7	0.85	4.8	6.1	1
Rooflight	16mm or more	0.7	0.76	3	13.5	1

Name:	Type-Name:	Location:	Orient:	Width:	Height:
Front		Existing Front Walls	East	0	0
Front		Existing Walls	East	0	0
Back Bifolds		Existing Walls	West	0	0
Back		Existing Walls	West	0	0
Rooflight		Flat Roof	West	0	0

Overshading: Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
<u>External Elements</u>							
Existing Walls	97	18.3	78.7	1.6	0	False	N/A
Flat Roof	17	13.5	3.5	0.6	0		N/A
Flat Ceiling	37	0	37	0.6	0		N/A
Existing Groud floor	50			0.6			N/A

SAP Input

Internal Elements

Party Elements

Party walls	145	N/A

Thermal bridges:

Thermal bridges:	No information on thermal bridging (y=0.15) (y =0.15)

Ventilation:

Pressure test:	No (Assumed)
Ventilation:	Natural ventilation (extract fans)
Number of chimneys:	1 (main: 0, secondary: 1, other: 0)
Number of open flues:	0
Number of fans:	2
Number of sides sheltered:	3
Pressure test:	15

Main heating system:

Main heating system:	Central heating systems with radiators or underfloor heating Gas boilers and oil boilers Fuel: mains gas Info Source: SAP Tables SAP Table: 104 Condensing combi with automatic ignition Systems with radiators Pump in heat space: Yes

Main heating Control:

Main heating Control:	Programmer, TRVs and bypass Control code: 2107 Boiler interlock: Yes

Secondary heating system:

Secondary heating system:	None

Water heating:

Water heating:	From main heating system Water code: 901 Fuel :mains gas No hot water cylinder Solar panel: False

Others:

Electricity tariff:	standard tariff
In Smoke Control Area:	Unknown
Conservatory:	No conservatory
Low energy lights:	50%
Terrain type:	Dense urban
EPC language:	English
Wind turbine:	No
Photovoltaics:	None
Assess Zero Carbon Home:	No

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Dan Watt	**Stroma Number:**	STRO000002
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.63

Property Address: 16 Radnor Walk BEFORE

Address : 16, Radnor Walk, LONDON, SW3 4BN

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	50	(1a)	x	2.8	(2a)	=	140	(3a)
First floor	34	(1b)	x	2.8	(2b)	=	95.2	(3b)
Second floor	34	(1c)	x	2.8	(2c)	=	95.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	118	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	330.4	(5)

2. Ventilation rate:

	main heating		Secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	1	+	0	=	1	x 40 =	40	(6a)
Number of open flues	0	+	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)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	60	÷ (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)		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		15	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.93	(18)

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

Number of sides on which sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.72	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.97	0.92	0.92	0.81	0.74	0.7	0.67	0.67	0.76	0.81	0.87	0.92

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=	0.98	0.92	0.92	0.83	0.77	0.75	0.72	0.72	0.79	0.83	0.88	0.92	(24d)

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

(25)m=	0.98	0.92	0.92	0.83	0.77	0.75	0.72	0.72	0.79	0.83	0.88	0.92	(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			2.6	x	3.9	=	10.14			(26)
Windows Type 1			6.8	x1/[1/(4.8)+ 0.04]		=	27.38			(27)
Windows Type 2			5.4	x1/[1/(2.7)+ 0.04]		=	13.16			(27)
Windows Type 3			6.1	x1/[1/(4.8)+ 0.04]		=	24.56			(27)
Rooflights			13.5	x 1/[1/(3) + 0.04]		=	40.5			(27b)
Floor			50	x	0.6	=	30			(28)
Walls	97	18.3	78.7	x	1.6	=	125.92			(29)
Roof Type1	17	13.5	3.5	x	0.6	=	2.1			(30)
Roof Type2	37	0	37	x	0.6	=	22.2			(30)
Total area of elements, m²			203.6							(31)
Party wall			145	x	0	=	0			(32)

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 291.63 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 32672.8 (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 | 30.54 | (36)

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

Total fabric heat loss (33) + (36) = | 322.17 | (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=	106.31	100.71	100.71	90.48	84.37	81.53	78.83	78.83	85.85	90.48	95.44	100.71	(38)

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

(39)m=	428.47	422.88	422.88	412.65	406.54	403.7	401	401	408.01	412.65	417.6	422.88	

Average = $Sum(39)_{1...12}$ /12= | 413.35 | (39)

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

(40)m=	3.63	3.58	3.58	3.5	3.45	3.42	3.4	3.4	3.46	3.5	3.54	3.58	

Average = $Sum(40)_{1...12}$ /12= | 3.5 | (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 | 2.86 | (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 | 107.38 | (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	118.12	113.82	109.53	105.23	100.94	96.64	96.64	100.94	105.23	109.53	113.82	118.12	

Total = $Sum(44)_{1...12}$ = | 1288.57 | (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=	175.59	153.57	158.47	138.16	132.57	114.39	106	121.64	123.09	143.45	156.59	170.05	

Total = $Sum(45)_{1...12}$ = | 1693.56 | (45)

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

(46)m=	26.34	23.04	23.77	20.72	19.88	17.16	15.9	18.25	18.46	21.52	23.49	25.51	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): | 0 | (47)

Temperature factor from Table 2b | 0 | (48)

Energy lost from water storage, kWh/year (47) x (48) = | 0 | (49)

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

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

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

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

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

Volume factor from Table 2a | 0 | (52)

Temperature factor from Table 2b | 0 | (53)

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

Enter (49) or (54) in (55) | 0 | (55)

SAP WorkSheet: New dwelling design stage

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

(61)m=	50.96	46.03	50.96	49.32	50.96	47.66	49.25	50.96	49.32	50.96	49.32	50.96	(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=	226.55	199.6	209.43	187.47	183.52	162.05	155.25	172.6	172.41	194.41	205.9	221	(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=	226.55	199.6	209.43	187.47	183.52	162.05	155.25	172.6	172.41	194.41	205.9	221	

Output from water heater (annual)$_{1...12}$ | 2290.2 | (64)

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

(65)m=	71.12	62.57	65.43	58.27	56.82	49.95	47.56	53.18	53.26	60.44	64.39	69.28	(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=	171.31	171.31	171.31	171.31	171.31	171.31	171.31	171.31	171.31	171.31	171.31	171.31	(66)

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

(67)m=	94.47	83.91	68.24	51.66	38.62	32.6	35.23	45.79	61.46	78.04	91.08	97.1	(67)

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

(68)m=	421.77	426.15	415.12	391.64	362	334.14	315.53	311.16	322.19	345.67	375.3	403.16	(68)

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

(69)m=	54.99	54.99	54.99	54.99	54.99	54.99	54.99	54.99	54.99	54.99	54.99	54.99	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

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

(71)m=	-114.21	-114.21	-114.21	-114.21	-114.21	-114.21	-114.21	-114.21	-114.21	-114.21	-114.21	-114.21	(71)

Water heating gains (Table 5)

(72)m=	95.59	93.11	87.94	80.93	76.37	69.38	63.92	71.49	73.97	81.23	89.44	93.12	(72)

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

(73)m=	733.93	725.26	693.39	646.32	599.08	558.21	536.78	550.53	579.71	627.03	677.92	715.47	(73)

6. Solar gains:

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

SAP WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	6.8	x	19.87	x	0.85	x	0.7	=	55.72	(76)
East	0.9x	1	x	6.8	x	38.52	x	0.85	x	0.7	=	108	(76)
East	0.9x	1	x	6.8	x	61.57	x	0.85	x	0.7	=	172.62	(76)
East	0.9x	1	x	6.8	x	91.41	x	0.85	x	0.7	=	256.3	(76)
East	0.9x	1	x	6.8	x	111.22	x	0.85	x	0.7	=	311.85	(76)
East	0.9x	1	x	6.8	x	116.05	x	0.85	x	0.7	=	325.4	(76)
East	0.9x	1	x	6.8	x	112.64	x	0.85	x	0.7	=	315.83	(76)
East	0.9x	1	x	6.8	x	98.03	x	0.85	x	0.7	=	274.88	(76)
East	0.9x	1	x	6.8	x	73.6	x	0.85	x	0.7	=	206.38	(76)
East	0.9x	1	x	6.8	x	46.91	x	0.85	x	0.7	=	131.53	(76)
East	0.9x	1	x	6.8	x	24.71	x	0.85	x	0.7	=	69.27	(76)
East	0.9x	1	x	6.8	x	16.39	x	0.85	x	0.7	=	45.96	(76)
West	0.9x	0.77	x	5.4	x	19.87	x	0.76	x	0.7	=	39.56	(80)
West	0.9x	0.3	x	6.1	x	19.87	x	0.85	x	0.7	=	19.47	(80)
West	0.9x	0.77	x	5.4	x	38.52	x	0.76	x	0.7	=	76.68	(80)
West	0.9x	0.3	x	6.1	x	38.52	x	0.85	x	0.7	=	37.75	(80)
West	0.9x	0.77	x	5.4	x	61.57	x	0.76	x	0.7	=	122.57	(80)
West	0.9x	0.3	x	6.1	x	61.57	x	0.85	x	0.7	=	60.33	(80)
West	0.9x	0.77	x	5.4	x	91.41	x	0.76	x	0.7	=	181.98	(80)
West	0.9x	0.3	x	6.1	x	91.41	x	0.85	x	0.7	=	89.58	(80)
West	0.9x	0.77	x	5.4	x	111.22	x	0.76	x	0.7	=	221.42	(80)
West	0.9x	0.3	x	6.1	x	111.22	x	0.85	x	0.7	=	108.99	(80)
West	0.9x	0.77	x	5.4	x	116.05	x	0.76	x	0.7	=	231.04	(80)
West	0.9x	0.3	x	6.1	x	116.05	x	0.85	x	0.7	=	113.73	(80)
West	0.9x	0.77	x	5.4	x	112.64	x	0.76	x	0.7	=	224.25	(80)
West	0.9x	0.3	x	6.1	x	112.64	x	0.85	x	0.7	=	110.38	(80)
West	0.9x	0.77	x	5.4	x	98.03	x	0.76	x	0.7	=	195.17	(80)
West	0.9x	0.3	x	6.1	x	98.03	x	0.85	x	0.7	=	96.07	(80)
West	0.9x	0.77	x	5.4	x	73.6	x	0.76	x	0.7	=	146.53	(80)
West	0.9x	0.3	x	6.1	x	73.6	x	0.85	x	0.7	=	72.13	(80)
West	0.9x	0.77	x	5.4	x	46.91	x	0.76	x	0.7	=	93.39	(80)
West	0.9x	0.3	x	6.1	x	46.91	x	0.85	x	0.7	=	45.97	(80)
West	0.9x	0.77	x	5.4	x	24.71	x	0.76	x	0.7	=	49.19	(80)
West	0.9x	0.3	x	6.1	x	24.71	x	0.85	x	0.7	=	24.21	(80)
West	0.9x	0.77	x	5.4	x	16.39	x	0.76	x	0.7	=	32.64	(80)
West	0.9x	0.3	x	6.1	x	16.39	x	0.85	x	0.7	=	16.06	(80)
Rooflights	0.9x	1	x	13.5	x	26	x	0.76	x	0.7	=	168.06	(82)
Rooflights	0.9x	1	x	13.5	x	54	x	0.76	x	0.7	=	349.05	(82)
Rooflights	0.9x	1	x	13.5	x	94	x	0.76	x	0.7	=	607.6	(82)

Rooflights 0.9x	1	x	13.5	x	150	x	0.76	x	0.7	=	969.57	(82)
Rooflights 0.9x	1	x	13.5	x	190	x	0.76	x	0.7	=	1228.12	(82)
Rooflights 0.9x	1	x	13.5	x	201	x	0.76	x	0.7	=	1299.22	(82)
Rooflights 0.9x	1	x	13.5	x	194	x	0.76	x	0.7	=	1253.98	(82)
Rooflights 0.9x	1	x	13.5	x	164	x	0.76	x	0.7	=	1060.06	(82)
Rooflights 0.9x	1	x	13.5	x	116	x	0.76	x	0.7	=	749.8	(82)
Rooflights 0.9x	1	x	13.5	x	68	x	0.76	x	0.7	=	439.54	(82)
Rooflights 0.9x	1	x	13.5	x	33	x	0.76	x	0.7	=	213.31	(82)
Rooflights 0.9x	1	x	13.5	x	21	x	0.76	x	0.7	=	135.74	(82)

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

(83)m=	282.82	571.48	963.12	1497.43	1870.38	1969.39	1904.45	1626.18	1174.84	710.42	355.98	230.4	(83)

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

(84)m=	1016.75	1296.74	1656.51	2143.75	2469.46	2527.6	2441.22	2176.71	1754.55	1337.45	1033.9	945.87	(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	0.92	0.83	0.71	0.56	0.6	0.84	0.95	0.98	0.99	(86)

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

(87)m=	17.68	17.97	18.57	19.27	20.03	20.56	20.84	20.81	20.29	19.36	18.32	17.76	(87)

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

(88)m=	18.49	18.51	18.51	18.54	18.56	18.57	18.58	18.58	18.56	18.54	18.53	18.51	(88)

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

(89)m=	0.99	0.97	0.94	0.88	0.74	0.53	0.27	0.3	0.7	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=	15.75	16.05	16.64	17.33	18.03	18.43	18.57	18.57	18.27	17.45	16.42	15.85	(90)

fLA = Living area ÷ (4) = 0.39 (91)

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

(92)m=	16.5	16.8	17.39	18.08	18.81	19.26	19.45	19.44	19.06	18.19	17.16	16.6	(92)

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

(93)m=	16.5	16.8	17.39	18.08	18.81	19.26	19.45	19.44	19.06	18.19	17.16	16.6	(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=	0.98	0.97	0.93	0.87	0.75	0.59	0.39	0.42	0.74	0.91	0.97	0.98	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	996.23	1252.48	1545.5	1862.11	1861.52	1498.8	943.44	920.94	1289.65	1219.31	1003.56	928.53	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	5142.8	4990.58	4478.88	3872.17	2889.62	1880.33	1024.17	1018.69	1941.12	3050.83	4242.67	4945.55	(97)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(98)m=	3085.05	2512	2182.44	1447.25	764.91	0	0	0	0	1362.65	2332.16	2988.66

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 16675.11 (98)

Space heating requirement in kWh/m²/year 141.31 (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		84	(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)	3085.05	2512	2182.44	1447.25	764.91	0	0	0	0	1362.65	2332.16	2988.66	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206) (211)	3672.68	2990.47	2598.14	1722.92	910.6	0	0	0	0	1622.2	2776.38	3557.93	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 19851.32 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] + (214) m } x 100 ÷ (208)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Output from water heater (calculated above)	226.55	199.6	209.43	187.47	183.52	162.05	155.25	172.6	172.41	194.41	205.9	221

Efficiency of water heater 75 (216)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(217)m=	83.32	83.26	83.13	82.86	82.09	75	75	75	75	82.76	83.19	83.31	(217)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(219)m=	271.91	239.71	251.94	226.25	223.55	216.07	207	230.13	229.88	234.91	247.51	265.28

Total = Sum(219a)$_{1...12}$ = 2844.15 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			19851.32	
Water heating fuel used			2844.15	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		169		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		214	(231)
Electricity for lighting			667.37	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)	**Fuel Cost** £/year

SAP WorkSheet: New dwelling design stage

Space heating - main system 1	(211) x	3.1	x 0.01 =	615.391	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	88.17	(247)
Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	24.52	(249)

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

Energy for lighting	(232)	11.46	x 0.01 =	76.48	(250)
Additional standing charges (Table 12)				106	(251)

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

Total energy cost	(245)...(247) + (250)...(254) =	910.5643	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	2.6256	(257)
SAP rating (Section 12)		63.3735	(258)

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	0.198	=	3930.56	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	563.14	(264)
Space and water heating	(261) + (262) + (263) + (264) =			4493.7	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	110.64	(267)
Electricity for lighting	(232) x	0.517	=	345.03	(268)
Total CO2, kg/year		sum of (265)…(271) =		4949.37	(272)
CO2 emissions per m²		(272) ÷ (4) =		41.94	(273)
EI rating (section 14)				59	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.02	=	20248.35	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2901.03	(264)
Space and water heating	(261) + (262) + (263) + (264) =			23149.38	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	624.88	(267)
Electricity for lighting	(232) x	0	=	1948.71	(268)
'Total Primary Energy		sum of (265)…(271) =		25722.97	(272)

Primary energy kWh/m²/year	(272) ÷ (4) =	217.99	(273)

SAP Input

Property Details: 16 Radnor Walk AFTER

Address:	16, Radnor Walk, LONDON, SW3 4BN
Located in:	England
Region:	Thames valley
UPRN:	3116159468
Date of assessment:	25 February 2014
Date of certificate:	14 March 2014
Assessment type:	New dwelling design stage
Transaction type:	New dwelling
Tenure type:	Unknown
Related party disclosure:	Employed by the professional dealing with the property transaction
Thermal Mass Parameter:	Indicative Value Medium
Dwelling designed to use less than 125 litres per Person per day:	False

Property description:

Dwelling type:	House
Detachment:	Mid-terrace
Year Completed:	2014

Floor Location:	Floor area:	Storey height:
Basement floor	72 m²	2.8 m
Floor 1	50 m²	2.8 m
Floor 2	34 m²	2.8 m
Floor 3	34 m²	2.8 m

Living area:	27 m² (fraction 0.142)
Front of dwelling faces:	Unspecified

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
Front	SAP 2009	Half glazed	Single-glazed	No	Wood
Front	SAP 2009	Windows	Single-glazed	No	Wood
Back	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Wood
Front	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Wood
Back	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Wood
Left	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Wood

Name:	**Gap:**	**Frame Factor:**	**g-value:**	**U-value:**	**Area:**	**No. of Openings:**
Front	mm	0.7	0.85	3.9	2.6	1
Front		0.7	0.85	4.8	6.8	1
Back	16mm or more	0.7	0.63	1.6	10.1	1
Front	16mm or more	0.7	0.63	1.6	8.4	1
Back	16mm or more	0.7	0.63	1.6	6.5	1
Left	16mm or more	0.7	0.63	1.6	1.2	1

Name:	Type-Name:	Location:	Orient:	Width:	Height:
Front		Existing Front Walls	East	0	0
Front		Existing Front Walls	East	0	0
Back		New Back walls	West	0	0
Front		New Basement Walls	East	0	0
Back		New Basement Walls	West	0	0
Left		New Basement Walls	North	0	0

Overshading: Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
<u>External Elements</u>							
New Basement Walls	122	16.1	105.9	0.24	0	False	N/A
Existing Front Walls	97	9.4	87.6	1.6	0	False	N/A

SAP Input

Flat Roof to Basement	21	0	21	0.15	0	N/A
Flat Roof	17	0	17	0.6	0	N/A
Flat Ceiling	37	0	37	0.6	0	N/A
Basement	72			0.14		N/A
<u>Internal Elements</u>						
<u>Party Elements</u>						
Party walls	145					N/A

Thermal bridges:

Thermal bridges:	No information on thermal bridging (y=0.15) (y =0.15)

Ventilation:

Pressure test:	No (Assumed)
Ventilation:	Natural ventilation (extract fans)
Number of chimneys:	1 (main: 0, secondary: 1, other: 0)
Number of open flues:	0
Number of fans:	5
Number of sides sheltered:	3
Pressure test:	15

Main heating system:

Main heating system:

Central heating systems with radiators or underfloor heating
Gas boilers and oil boilers
Fuel: mains gas
Info Source: SAP Tables
SAP Table: 104
Condensing combi with automatic ignition
Systems with radiators
Pump in heat space: Yes

Main heating Control:

Main heating Control:

Programmer, TRVs and bypass
Control code: 2107
Boiler interlock: Yes

Secondary heating system:

Secondary heating system: None

Water heating:

Water heating:

From main heating system
Water code: 901
Fuel :mains gas
No hot water cylinder
Solar panel: False

Others:

Electricity tariff:	standard tariff
In Smoke Control Area:	Unknown
Conservatory:	No conservatory
Low energy lights:	50%
Terrain type:	Dense urban
EPC language:	English
Wind turbine:	No
Photovoltaics:	None
Assess Zero Carbon Home:	No

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Dan Watt	**Stroma Number:**	STRO000002
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.63

Property Address: 16 Radnor Walk AFTER

Address : 16, Radnor Walk, LONDON, SW3 4BN

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Basement	72	(1a)	x	2.8	(2a)	=	201.6	(3a)
Ground floor	50	(1b)	x	2.8	(2b)	=	140	(3b)
First floor	34	(1c)	x	2.8	(2c)	=	95.2	(3c)
Second floor	34	(1d)	x	2.8	(2d)	=	95.2	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	190	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	532	(5)

2. Ventilation rate:

	main heating		Secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	1	+	0	=	1	x 40 =	40	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							5	x 10 =	50	(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) =	90	÷ (5) =	0.17	(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		15	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.92	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides on which sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.71	(21)

Infiltration rate modified for monthly wind speed

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

SAP WorkSheet: New dwelling design stage

Monthly average wind speed from Table 7

(22)m=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.96	0.91	0.91	0.8	0.73	0.69	0.66	0.66	0.75	0.8	0.85	0.91

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=	0.96	0.91	0.91	0.82	0.77	0.74	0.72	0.72	0.78	0.82	0.87	0.91	(24d)

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

(25)m=	0.96	0.91	0.91	0.82	0.77	0.74	0.72	0.72	0.78	0.82	0.87	0.91	(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			2.6	x	3.9	=	10.14			(26)
Windows Type 1			6.8	x1/[1/(4.8)+ 0.04]		=	27.38			(27)
Windows Type 2			10.1	x1/[1/(1.6)+ 0.04]		=	15.19			(27)
Windows Type 3			8.4	x1/[1/(1.6)+ 0.04]		=	12.63			(27)
Windows Type 4			6.5	x1/[1/(1.6)+ 0.04]		=	9.77			(27)
Windows Type 5			1.2	x1/[1/(1.6)+ 0.04]		=	1.8			(27)
Floor			72	x	0.14	=	10.08			(28)
Walls Type1	122	16.1	105.9	x	0.24	=	25.42			(29)
Walls Type2	97	9.4	87.6	x	1.6	=	140.16			(29)
Roof Type1	21	0	21	x	0.15	=	3.15			(30)
Roof Type2	17	0	17	x	0.6	=	10.2			(30)
Roof Type3	37	0	37	x	0.6	=	22.2			(30)
Total area of elements, m²			376.1							(31)
Party wall			145	x	0	=	0			(32)

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

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	288.13	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	36436.5	(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 x Y) calculated using Appendix K		56.42	(36)

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

Total fabric heat loss	(33) + (36) =	344.54	(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=	168.96	160.19	160.19	144.16	134.58	130.12	125.89	125.89	136.89	144.16	151.92	160.19	(38)

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

(39)m=	513.5	504.73	504.73	488.7	479.12	474.67	470.44	470.44	481.43	488.7	496.47	504.73	

Average = Sum(39)1…12 /12= 489.81 (39)

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

(40)m=	2.7	2.66	2.66	2.57	2.52	2.5	2.48	2.48	2.53	2.57	2.61	2.66

Average = Sum(40)1…12 /12= 2.58 (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 2.99 (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) + 36 110.72 (43)
Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

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

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

(44)m=	121.79	117.37	112.94	108.51	104.08	99.65	99.65	104.08	108.51	112.94	117.37	121.79

Total = Sum(44)1…12 = 1328.67 (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=	181.05	158.35	163.4	142.46	136.69	117.95	109.3	125.42	126.92	147.92	161.46	175.34

Total = Sum(45)1…12 = 1746.26 (45)

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

(46)m=	27.16	23.75	24.51	21.37	20.5	17.69	16.4	18.81	19.04	22.19	24.22	26.3	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		0	(47)
Temperature factor from Table 2b		0	(48)
Energy lost from water storage, kWh/year	(47) x (48) =	0	(49)
If manufacturer's declared cylinder loss factor is not known:			
Cylinder volume (litres) including any solar storage within same		0	(50)

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

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

SAP WorkSheet: New dwelling design stage

Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)
Volume factor from Table 2a	0	(52)
Temperature factor from Table 2b	0	(53)
Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) =	0	(54)
Enter (49) or (54) in (55)	0	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

(61)m=	50.96	46.03	50.96	49.32	50.96	49.14	50.78	50.96	49.32	50.96	49.32	50.96	(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=	232.01	204.37	214.36	191.77	187.65	167.1	160.08	176.38	176.24	198.88	210.78	226.3	(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=	232.01	204.37	214.36	191.77	187.65	167.1	160.08	176.38	176.24	198.88	210.78	226.3	

Output from water heater (annual)$_{1...12}$ | 2345.91 | (64)

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

(65)m=	72.94	64.16	67.07	59.7	58.19	51.51	49.04	54.44	54.53	61.92	66.01	71.04	(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=	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33	(66)

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

(67)m=	126.09	111.99	91.08	68.95	51.54	43.51	47.02	61.11	82.03	104.15	121.56	129.59	(67)

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

(68)m=	539.46	545.06	530.95	500.92	463.01	427.38	403.58	397.98	412.09	442.12	480.03	515.66	(68)

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

(69)m=	55.92	55.92	55.92	55.92	55.92	55.92	55.92	55.92	55.92	55.92	55.92	55.92	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

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

(71)m=	-119.56	-119.56	-119.56	-119.56	-119.56	-119.56	-119.56	-119.56	-119.56	-119.56	-119.56	-119.56	(71)

Water heating gains (Table 5)

(72)m=	98.04	95.47	90.15	82.91	78.21	71.53	65.91	73.18	75.74	83.23	91.69	95.48	(72)

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

(73)m=	889.28	878.22	837.88	778.48	718.47	668.13	642.21	657.97	695.55	755.2	818.98	866.43	(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	0.3	x	1.2	x	10.73	x	0.63	x	0.7	=	1.53	(74)
North	0.9x	0.3	x	1.2	x	20.36	x	0.63	x	0.7	=	2.91	(74)
North	0.9x	0.3	x	1.2	x	33.31	x	0.63	x	0.7	=	4.76	(74)
North	0.9x	0.3	x	1.2	x	54.64	x	0.63	x	0.7	=	7.81	(74)
North	0.9x	0.3	x	1.2	x	75.22	x	0.63	x	0.7	=	10.75	(74)
North	0.9x	0.3	x	1.2	x	84.09	x	0.63	x	0.7	=	12.01	(74)
North	0.9x	0.3	x	1.2	x	79.12	x	0.63	x	0.7	=	11.3	(74)
North	0.9x	0.3	x	1.2	x	61.56	x	0.63	x	0.7	=	8.8	(74)
North	0.9x	0.3	x	1.2	x	41.09	x	0.63	x	0.7	=	5.87	(74)
North	0.9x	0.3	x	1.2	x	24.81	x	0.63	x	0.7	=	3.55	(74)
North	0.9x	0.3	x	1.2	x	13.22	x	0.63	x	0.7	=	1.89	(74)
North	0.9x	0.3	x	1.2	x	8.94	x	0.63	x	0.7	=	1.28	(74)
East	0.9x	1	x	6.8	x	19.87	x	0.85	x	0.7	=	55.72	(76)
East	0.9x	1	x	8.4	x	19.87	x	0.63	x	0.7	=	19.88	(76)
East	0.9x	1	x	6.8	x	38.52	x	0.85	x	0.7	=	108	(76)
East	0.9x	1	x	8.4	x	38.52	x	0.63	x	0.7	=	38.53	(76)
East	0.9x	1	x	6.8	x	61.57	x	0.85	x	0.7	=	172.62	(76)
East	0.9x	1	x	8.4	x	61.57	x	0.63	x	0.7	=	61.58	(76)
East	0.9x	1	x	6.8	x	91.41	x	0.85	x	0.7	=	256.3	(76)
East	0.9x	1	x	8.4	x	91.41	x	0.63	x	0.7	=	91.43	(76)
East	0.9x	1	x	6.8	x	111.22	x	0.85	x	0.7	=	311.85	(76)
East	0.9x	1	x	8.4	x	111.22	x	0.63	x	0.7	=	111.24	(76)
East	0.9x	1	x	6.8	x	116.05	x	0.85	x	0.7	=	325.4	(76)
East	0.9x	1	x	8.4	x	116.05	x	0.63	x	0.7	=	116.07	(76)
East	0.9x	1	x	6.8	x	112.64	x	0.85	x	0.7	=	315.83	(76)
East	0.9x	1	x	8.4	x	112.64	x	0.63	x	0.7	=	112.66	(76)
East	0.9x	1	x	6.8	x	98.03	x	0.85	x	0.7	=	274.88	(76)
East	0.9x	1	x	8.4	x	98.03	x	0.63	x	0.7	=	98.05	(76)
East	0.9x	1	x	6.8	x	73.6	x	0.85	x	0.7	=	206.38	(76)
East	0.9x	1	x	8.4	x	73.6	x	0.63	x	0.7	=	73.62	(76)
East	0.9x	1	x	6.8	x	46.91	x	0.85	x	0.7	=	131.53	(76)
East	0.9x	1	x	8.4	x	46.91	x	0.63	x	0.7	=	46.92	(76)
East	0.9x	1	x	6.8	x	24.71	x	0.85	x	0.7	=	69.27	(76)
East	0.9x	1	x	8.4	x	24.71	x	0.63	x	0.7	=	24.71	(76)
East	0.9x	1	x	6.8	x	16.39	x	0.85	x	0.7	=	45.96	(76)
East	0.9x	1	x	8.4	x	16.39	x	0.63	x	0.7	=	16.4	(76)

West	0.9x	0.77	x	10.1	x	19.87	x	0.63	x	0.7	=	61.34	(80)
West	0.9x	0.3	x	6.5	x	19.87	x	0.63	x	0.7	=	15.38	(80)
West	0.9x	0.77	x	10.1	x	38.52	x	0.63	x	0.7	=	118.9	(80)
West	0.9x	0.3	x	6.5	x	38.52	x	0.63	x	0.7	=	29.81	(80)
West	0.9x	0.77	x	10.1	x	61.57	x	0.63	x	0.7	=	190.03	(80)
West	0.9x	0.3	x	6.5	x	61.57	x	0.63	x	0.7	=	47.65	(80)
West	0.9x	0.77	x	10.1	x	91.41	x	0.63	x	0.7	=	282.15	(80)
West	0.9x	0.3	x	6.5	x	91.41	x	0.63	x	0.7	=	70.75	(80)
West	0.9x	0.77	x	10.1	x	111.22	x	0.63	x	0.7	=	343.3	(80)
West	0.9x	0.3	x	6.5	x	111.22	x	0.63	x	0.7	=	86.08	(80)
West	0.9x	0.77	x	10.1	x	116.05	x	0.63	x	0.7	=	358.22	(80)
West	0.9x	0.3	x	6.5	x	116.05	x	0.63	x	0.7	=	89.82	(80)
West	0.9x	0.77	x	10.1	x	112.64	x	0.63	x	0.7	=	347.69	(80)
West	0.9x	0.3	x	6.5	x	112.64	x	0.63	x	0.7	=	87.18	(80)
West	0.9x	0.77	x	10.1	x	98.03	x	0.63	x	0.7	=	302.6	(80)
West	0.9x	0.3	x	6.5	x	98.03	x	0.63	x	0.7	=	75.87	(80)
West	0.9x	0.77	x	10.1	x	73.6	x	0.63	x	0.7	=	227.19	(80)
West	0.9x	0.3	x	6.5	x	73.6	x	0.63	x	0.7	=	56.97	(80)
West	0.9x	0.77	x	10.1	x	46.91	x	0.63	x	0.7	=	144.79	(80)
West	0.9x	0.3	x	6.5	x	46.91	x	0.63	x	0.7	=	36.31	(80)
West	0.9x	0.77	x	10.1	x	24.71	x	0.63	x	0.7	=	76.26	(80)
West	0.9x	0.3	x	6.5	x	24.71	x	0.63	x	0.7	=	19.12	(80)
West	0.9x	0.77	x	10.1	x	16.39	x	0.63	x	0.7	=	50.6	(80)
West	0.9x	0.3	x	6.5	x	16.39	x	0.63	x	0.7	=	12.69	(80)

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

(83)m=	153.85	298.14	476.64	708.44	863.21	901.52	874.67	760.2	570.02	363.09	191.26	126.92	(83)

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

(84)m=	1043.13	1176.36	1314.52	1486.92	1581.68	1569.65	1516.88	1418.18	1265.58	1118.29	1010.24	993.36	(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	1	0.99	0.98	0.97	0.92	0.82	0.84	0.96	0.99	1	1	(86)

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

(87)m=	18.14	18.32	18.73	19.22	19.84	20.37	20.73	20.71	20.2	19.48	18.68	18.23	(87)

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

(88)m=	18.92	18.94	18.94	18.99	19.02	19.03	19.05	19.05	19.01	18.99	18.97	18.94	(88)

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

(89)m=	1	0.99	0.99	0.98	0.94	0.84	0.58	0.61	0.9	0.98	0.99	1	(89)

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

(90)m=	16.47	16.67	17.07	17.59	18.22	18.72	18.99	18.99	18.57	17.85	17.04	16.58	(90)

SAP WorkSheet: New dwelling design stage

fLA = Living area ÷ (4) = 0.14 (91)

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

(92)m=	16.7	16.9	17.31	17.82	18.45	18.95	19.24	19.23	18.8	18.08	17.27	16.81	(92)

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

(93)m=	16.7	16.9	17.31	17.82	18.45	18.95	19.24	19.23	18.8	18.08	17.27	16.81	(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	0.98	0.97	0.93	0.83	0.61	0.64	0.9	0.97	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1036.42	1165.54	1292.83	1440.34	1468.07	1306.07	931.35	907.81	1133.63	1087.9	1001.11	987.41	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	6266.27	6007.49	5302.4	4455.7	3234.21	2066.32	1100.47	1096.23	2166.86	3557.84	5100.37	6012.89	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	3891.01	3253.8	2983.12	2171.05	1314.01	0	0	0	0	1837.63	2951.47	3738.96	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 22141.05 (98)

Space heating requirement in kWh/m²/year 116.53 (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 84 (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)													
	3891.01	3253.8	2983.12	2171.05	1314.01	0	0	0	0	1837.63	2951.47	3738.96	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)													(211)
	4632.16	3873.57	3551.33	2584.59	1564.29	0	0	0	0	2187.66	3513.65	4451.14	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 26358.39 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] + (214) m } x 100 ÷ (208)

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

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

Water heating

Output from water heater (calculated above)

232.01	204.37	214.36	191.77	187.65	167.1	160.08	176.38	176.24	198.88	210.78	226.3

Efficiency of water heater 75 (216)

SAP WorkSheet: New dwelling design stage

(217)m=	83.44	83.41	83.33	83.19	82.76	75	75	75	75	83.03	83.33	83.43	(217)

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

(219)m=	278.07	245.03	257.24	230.52	226.74	222.79	213.44	235.18	234.98	239.53	252.93	271.25

Total = Sum(219a)$_{1...12}$ = 2907.71 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			26358.39	
Water heating fuel used			2907.71	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		169		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		214	(231)
Electricity for lighting			890.69	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	817.11	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	90.14	(247)
Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	24.52	(249)

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

Energy for lighting	(232)	11.46	x 0.01 =	102.07	(250)
Additional standing charges (Table 12)				106	(251)

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

Total energy cost (245)...(247) + (250)…(254) = 1139.8461 (255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	2.2797	(257)
SAP rating (Section 12)		68.1983	(258)

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	0.198	=	5218.96	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	575.73	(264)
Space and water heating	(261) + (262) + (263) + (264) =			5794.69	(265)

SAP WorkSheet: New dwelling design stage

Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	110.64	(267)
Electricity for lighting	(232) x	0.517	=	460.49	(268)
Total CO2, kg/year		sum of (265)…(271) =		6365.81	(272)
CO2 emissions per m²		(272) ÷ (4) =		33.5	(273)
EI rating (section 14)				64	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.02	=	26885.56	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2965.86	(264)
Space and water heating	(261) + (262) + (263) + (264) =			29851.42	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	624.88	(267)
Electricity for lighting	(232) x	0	=	2600.8	(268)
‘Total Primary Energy		sum of (265)…(271) =		33077.1	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		174.09	(273)

SAP Input

Property Details: 16 Radnor Walk 75sqm Extension

Address:	16, Radnor Walk, LONDON, SW3 4BN
Located in:	England
Region:	Thames valley
UPRN:	3116159468
Date of assessment:	25 February 2014
Date of certificate:	14 March 2014
Assessment type:	New dwelling design stage
Transaction type:	New dwelling
Tenure type:	Unknown
Related party disclosure:	Employed by the professional dealing with the property transaction
Thermal Mass Parameter:	Indicative Value Medium
Dwelling designed to use less than 125 litres per Person per day:	False

Property description:

Dwelling type:	House
Detachment:	Mid-terrace
Year Completed:	2014

Floor Location:	Floor area:	Storey height:
Floor 0	125 m²	2.8 m
Floor 1	34 m²	2.8 m
Floor 2	34 m²	2.8 m

Living area:	27 m² (fraction 0.142)
Front of dwelling faces:	Unspecified

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
Front	SAP 2009	Half glazed	Single-glazed	No	Wood
Front	SAP 2009	Windows	Single-glazed	No	Wood
Back	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Wood
Front	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Wood
Back	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Wood
Left	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	Wood

Name:	**Gap:**	**Frame Factor:**	**g-value:**	**U-value:**	**Area:**	**No. of Openings:**
Front	mm	0.7	0.85	3.9	2.6	1
Front		0.7	0.85	4.8	6.8	1
Back	16mm or more	0.7	0.63	1.6	10.1	1
Front	16mm or more	0.7	0.63	1.6	8.4	1
Back	16mm or more	0.7	0.63	1.6	6.5	1
Left	16mm or more	0.7	0.63	1.6	1.2	1

Name:	Type-Name:	Location:	Orient:	Width:	Height:
Front		Existing Front Walls	East	0	0
Front		Existing Front Walls	East	0	0
Back		New Back walls	West	0	0
Front		New Basement Walls	East	0	0
Back		New Basement Walls	West	0	0
Left		New Basement Walls	North	0	0

Overshading:	Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
<u>External Elements</u>							
NEW	122	0	122	0.28	0	False	N/A
Existing Front Walls	97	9.4	87.6	1.6	0	False	N/A

SAP Input

NEW	75	0	75	0.18	0	N/A
Flat Roof	17	0	17	0.6	0	N/A
Flat Ceiling	37	0	37	0.6	0	N/A
Basement	50			0.6		N/A
NEW	75			0.22		N/A
<u>Internal Elements</u>						
<u>Party Elements</u>						
Party walls	145					N/A

Thermal bridges:

Thermal bridges:	No information on thermal bridging (y=0.15) (y =0.15)

Ventilation:

Pressure test:	No (Assumed)
Ventilation:	Natural ventilation (extract fans)
Number of chimneys:	1 (main: 0, secondary: 1, other: 0)
Number of open flues:	0
Number of fans:	5
Number of sides sheltered:	3
Pressure test:	15

Main heating system:

Main heating system:	Central heating systems with radiators or underfloor heating Gas boilers and oil boilers Fuel: mains gas Info Source: SAP Tables SAP Table: 104 Condensing combi with automatic ignition Systems with radiators Pump in heat space: Yes

Main heating Control:

Main heating Control:	Programmer, TRVs and bypass Control code: 2107 Boiler interlock: Yes

Secondary heating system:

Secondary heating system:	None

Water heating:

Water heating:	From main heating system Water code: 901 Fuel :mains gas No hot water cylinder Solar panel: False

Others:

Electricity tariff:	standard tariff
In Smoke Control Area:	Unknown
Conservatory:	No conservatory
Low energy lights:	50%
Terrain type:	Dense urban
EPC language:	English
Wind turbine:	No
Photovoltaics:	None
Assess Zero Carbon Home:	No

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Dan Watt	**Stroma Number:**	STRO000002
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.63

Property Address: 16 Radnor Walk 75sqm Extension

Address : 16, Radnor Walk, LONDON, SW3 4BN

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	125	(1a)	x	2.8	(2a)	=	350	(3a)
First floor	34	(1b)	x	2.8	(2b)	=	95.2	(3b)
Second floor	34	(1c)	x	2.8	(2c)	=	95.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	193	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	540.4	(5)

2. Ventilation rate:

	main heating		Secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	1	+	0	=	1	x 40 =	40	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							5	x 10 =	50	(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) =	90	÷ (5) =	0.17	(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		15	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.92	(18)

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

Number of sides on which sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.71	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.96	0.91	0.91	0.8	0.73	0.69	0.66	0.66	0.75	0.8	0.85	0.91

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=	0.96	0.91	0.91	0.82	0.76	0.74	0.72	0.72	0.78	0.82	0.86	0.91	(24d)

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

(25)m=	0.96	0.91	0.91	0.82	0.76	0.74	0.72	0.72	0.78	0.82	0.86	0.91	(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			2.6	x	3.9	=	10.14			(26)
Windows Type 1			6.8	x1/[1/(4.8)+ 0.04]		=	27.38			(27)
Windows Type 2			10.1	x1/[1/(1.6)+ 0.04]		=	15.19			(27)
Windows Type 3			8.4	x1/[1/(1.6)+ 0.04]		=	12.63			(27)
Windows Type 4			6.5	x1/[1/(1.6)+ 0.04]		=	9.77			(27)
Windows Type 5			1.2	x1/[1/(1.6)+ 0.04]		=	1.8			(27)
Floor Type 1			50	x	0.6	=	30			(28)
Floor Type 2			75	x	0.22	=	16.5			(28)
Walls Type1	122	0	122	x	0.28	=	34.16			(29)
Walls Type2	97	9.4	87.6	x	1.6	=	140.16			(29)
Roof Type1	75	0	75	x	0.18	=	13.5			(30)
Roof Type2	17	0	17	x	0.6	=	10.2			(30)
Roof Type3	37	0	37	x	0.6	=	22.2			(30)
Total area of elements, m²			499.2							(31)
Party wall			145	x	0	=	0			(32)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 343.64 (33)

SAP WorkSheet: New dwelling design stage

Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	42897.4	(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		74.88	(36)

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

Total fabric heat loss	(33) + (36) =	418.52	(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=	171.16	162.3	162.3	146.11	136.43	131.93	127.66	127.66	138.77	146.11	153.95	162.3	(38)

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

(39)m=	589.68	580.82	580.82	564.63	554.95	550.46	546.18	546.18	557.29	564.63	572.47	580.82

Average = Sum(39)$_{1…12}$ /12= 565.74 (39)

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

(40)m=	3.06	3.01	3.01	2.93	2.88	2.85	2.83	2.83	2.89	2.93	2.97	3.01

Average = Sum(40)$_{1…12}$ /12= 2.93 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.99 (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) + 36 110.82 (43)

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

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

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

(44)m=	121.9	117.47	113.04	108.6	104.17	99.74	99.74	104.17	108.6	113.04	117.47	121.9

Total = Sum(44)$_{1…12}$ = 1329.84 (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=	181.21	158.49	163.54	142.58	136.81	118.06	109.4	125.54	127.03	148.05	161.6	175.49

Total = Sum(45)$_{1…12}$ = 1747.8 (45)

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

(46)m=	27.18	23.77	24.53	21.39	20.52	17.71	16.41	18.83	19.06	22.21	24.24	26.32	(46)

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day):		0	(47)
Temperature factor from Table 2b		0	(48)
Energy lost from water storage, kWh/year	(47) x (48) =	0	(49)

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

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

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

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

Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)
Volume factor from Table 2a	0	(52)
Temperature factor from Table 2b	0	(53)

Energy lost from water storage, kWh/year	((50) x (51) x (52) x (53) =	0	(54)
Enter (49) or (54) in (55)		0	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

(61)m=	50.96	46.03	50.96	49.32	50.96	49.19	50.83	50.96	49.32	50.96	49.32	50.96	(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=	232.17	204.51	214.5	191.9	187.77	167.24	160.22	176.49	176.35	199.01	210.92	226.45	(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=	232.17	204.51	214.5	191.9	187.77	167.24	160.22	176.49	176.35	199.01	210.92	226.45

Output from water heater (annual)1…12 | 2347.54 | (64)

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

(65)m=	72.99	64.2	67.12	59.74	58.23	51.55	49.08	54.48	54.57	61.97	66.06	71.09	(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=	179.57	179.57	179.57	179.57	179.57	179.57	179.57	179.57	179.57	179.57	179.57	179.57	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	127.5	113.24	92.09	69.72	52.12	44	47.54	61.8	82.95	105.32	122.92	131.04	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	543.8	549.44	535.22	504.95	466.73	430.82	406.82	401.18	415.4	445.67	483.89	519.8	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	55.95	55.95	55.95	55.95	55.95	55.95	55.95	55.95	55.95	55.95	55.95	55.95	(69)
Pumps and fans gains (Table 5a)													
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-119.71	-119.71	-119.71	-119.71	-119.71	-119.71	-119.71	-119.71	-119.71	-119.71	-119.71	-119.71	(71)
Water heating gains (Table 5)													
(72)m=	98.11	95.54	90.21	82.97	78.27	71.6	65.97	73.23	75.79	83.29	91.75	95.55	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	895.21	884.03	843.33	783.44	722.92	672.22	646.14	662.01	699.94	760.08	824.37	872.2	(73)

6. Solar gains:

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

SAP WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x	0.3	x	1.2	x	10.73	x	0.63	x	0.7	=	1.53	(74)
North	0.9x	0.3	x	1.2	x	20.36	x	0.63	x	0.7	=	2.91	(74)
North	0.9x	0.3	x	1.2	x	33.31	x	0.63	x	0.7	=	4.76	(74)
North	0.9x	0.3	x	1.2	x	54.64	x	0.63	x	0.7	=	7.81	(74)
North	0.9x	0.3	x	1.2	x	75.22	x	0.63	x	0.7	=	10.75	(74)
North	0.9x	0.3	x	1.2	x	84.09	x	0.63	x	0.7	=	12.01	(74)
North	0.9x	0.3	x	1.2	x	79.12	x	0.63	x	0.7	=	11.3	(74)
North	0.9x	0.3	x	1.2	x	61.56	x	0.63	x	0.7	=	8.8	(74)
North	0.9x	0.3	x	1.2	x	41.09	x	0.63	x	0.7	=	5.87	(74)
North	0.9x	0.3	x	1.2	x	24.81	x	0.63	x	0.7	=	3.55	(74)
North	0.9x	0.3	x	1.2	x	13.22	x	0.63	x	0.7	=	1.89	(74)
North	0.9x	0.3	x	1.2	x	8.94	x	0.63	x	0.7	=	1.28	(74)
East	0.9x	1	x	6.8	x	19.87	x	0.85	x	0.7	=	55.72	(76)
East	0.9x	1	x	8.4	x	19.87	x	0.63	x	0.7	=	19.88	(76)
East	0.9x	1	x	6.8	x	38.52	x	0.85	x	0.7	=	108	(76)
East	0.9x	1	x	8.4	x	38.52	x	0.63	x	0.7	=	38.53	(76)
East	0.9x	1	x	6.8	x	61.57	x	0.85	x	0.7	=	172.62	(76)
East	0.9x	1	x	8.4	x	61.57	x	0.63	x	0.7	=	61.58	(76)
East	0.9x	1	x	6.8	x	91.41	x	0.85	x	0.7	=	256.3	(76)
East	0.9x	1	x	8.4	x	91.41	x	0.63	x	0.7	=	91.43	(76)
East	0.9x	1	x	6.8	x	111.22	x	0.85	x	0.7	=	311.85	(76)
East	0.9x	1	x	8.4	x	111.22	x	0.63	x	0.7	=	111.24	(76)
East	0.9x	1	x	6.8	x	116.05	x	0.85	x	0.7	=	325.4	(76)
East	0.9x	1	x	8.4	x	116.05	x	0.63	x	0.7	=	116.07	(76)
East	0.9x	1	x	6.8	x	112.64	x	0.85	x	0.7	=	315.83	(76)
East	0.9x	1	x	8.4	x	112.64	x	0.63	x	0.7	=	112.66	(76)
East	0.9x	1	x	6.8	x	98.03	x	0.85	x	0.7	=	274.88	(76)
East	0.9x	1	x	8.4	x	98.03	x	0.63	x	0.7	=	98.05	(76)
East	0.9x	1	x	6.8	x	73.6	x	0.85	x	0.7	=	206.38	(76)
East	0.9x	1	x	8.4	x	73.6	x	0.63	x	0.7	=	73.62	(76)
East	0.9x	1	x	6.8	x	46.91	x	0.85	x	0.7	=	131.53	(76)
East	0.9x	1	x	8.4	x	46.91	x	0.63	x	0.7	=	46.92	(76)
East	0.9x	1	x	6.8	x	24.71	x	0.85	x	0.7	=	69.27	(76)
East	0.9x	1	x	8.4	x	24.71	x	0.63	x	0.7	=	24.71	(76)
East	0.9x	1	x	6.8	x	16.39	x	0.85	x	0.7	=	45.96	(76)
East	0.9x	1	x	8.4	x	16.39	x	0.63	x	0.7	=	16.4	(76)
West	0.9x	0.77	x	10.1	x	19.87	x	0.63	x	0.7	=	61.34	(80)
West	0.9x	0.3	x	6.5	x	19.87	x	0.63	x	0.7	=	15.38	(80)
West	0.9x	0.77	x	10.1	x	38.52	x	0.63	x	0.7	=	118.9	(80)

West	0.9x	0.3	x	6.5	x	38.52	x	0.63	x	0.7	=	29.81	(80)
West	0.9x	0.77	x	10.1	x	61.57	x	0.63	x	0.7	=	190.03	(80)
West	0.9x	0.3	x	6.5	x	61.57	x	0.63	x	0.7	=	47.65	(80)
West	0.9x	0.77	x	10.1	x	91.41	x	0.63	x	0.7	=	282.15	(80)
West	0.9x	0.3	x	6.5	x	91.41	x	0.63	x	0.7	=	70.75	(80)
West	0.9x	0.77	x	10.1	x	111.22	x	0.63	x	0.7	=	343.3	(80)
West	0.9x	0.3	x	6.5	x	111.22	x	0.63	x	0.7	=	86.08	(80)
West	0.9x	0.77	x	10.1	x	116.05	x	0.63	x	0.7	=	358.22	(80)
West	0.9x	0.3	x	6.5	x	116.05	x	0.63	x	0.7	=	89.82	(80)
West	0.9x	0.77	x	10.1	x	112.64	x	0.63	x	0.7	=	347.69	(80)
West	0.9x	0.3	x	6.5	x	112.64	x	0.63	x	0.7	=	87.18	(80)
West	0.9x	0.77	x	10.1	x	98.03	x	0.63	x	0.7	=	302.6	(80)
West	0.9x	0.3	x	6.5	x	98.03	x	0.63	x	0.7	=	75.87	(80)
West	0.9x	0.77	x	10.1	x	73.6	x	0.63	x	0.7	=	227.19	(80)
West	0.9x	0.3	x	6.5	x	73.6	x	0.63	x	0.7	=	56.97	(80)
West	0.9x	0.77	x	10.1	x	46.91	x	0.63	x	0.7	=	144.79	(80)
West	0.9x	0.3	x	6.5	x	46.91	x	0.63	x	0.7	=	36.31	(80)
West	0.9x	0.77	x	10.1	x	24.71	x	0.63	x	0.7	=	76.26	(80)
West	0.9x	0.3	x	6.5	x	24.71	x	0.63	x	0.7	=	19.12	(80)
West	0.9x	0.77	x	10.1	x	16.39	x	0.63	x	0.7	=	50.6	(80)
West	0.9x	0.3	x	6.5	x	16.39	x	0.63	x	0.7	=	12.69	(80)

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

(83)m=	153.85	298.14	476.64	708.44	863.21	901.52	874.67	760.2	570.02	363.09	191.26	126.92	(83)

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

(84)m=	1049.06	1182.17	1319.97	1491.88	1586.13	1573.74	1520.81	1422.21	1269.96	1123.17	1015.63	999.12	(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	1	0.99	0.99	0.97	0.93	0.85	0.86	0.96	0.99	1	1	(86)

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

(87)m=	17.86	18.05	18.48	18.99	19.66	20.23	20.65	20.62	20.07	19.29	18.44	17.96	(87)

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

(88)m=	18.74	18.76	18.76	18.8	18.83	18.84	18.85	18.85	18.82	18.8	18.78	18.76	(88)

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

(89)m=	1	0.99	0.99	0.98	0.94	0.85	0.59	0.61	0.91	0.98	0.99	1	(89)

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

(90)m=	16.08	16.28	16.71	17.24	17.92	18.47	18.79	18.78	18.32	17.55	16.68	16.2	(90)

fLA = Living area ÷ (4) = 0.14 (91)

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

(92)m=	16.33	16.53	16.96	17.48	18.16	18.72	19.05	19.04	18.56	17.79	16.93	16.44	(92)

SAP WorkSheet: New dwelling design stage

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

(93)m=	16.33	16.53	16.96	17.48	18.16	18.72	19.05	19.04	18.56	17.79	16.93	16.44	(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	0.99	0.98	0.97	0.93	0.84	0.63	0.65	0.9	0.97	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1041.45	1170.22	1296.94	1444.36	1475.02	1321.56	951.3	924.68	1140.61	1091.51	1005.47	992.34	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	6976.76	6696.48	5899.23	4960.1	3585.04	2265.2	1172.49	1167.3	2375.09	3946.31	5684.55	6704.36	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	4415.87	3713.65	3424.1	2531.33	1569.85	0	0	0	0	2123.96	3368.94	4249.74	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 25397.43 (98)

Space heating requirement in kWh/m²/year 131.59 (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		84	(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)													
	4415.87	3713.65	3424.1	2531.33	1569.85	0	0	0	0	2123.96	3368.94	4249.74	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)													(211)
	5256.98	4421.01	4076.31	3013.49	1868.87	0	0	0	0	2528.53	4010.64	5059.21	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 30235.04 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] + (214) m } x 100 ÷ (208)

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

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

Water heating

Output from water heater (calculated above)													
	232.17	204.51	214.5	191.9	187.77	167.24	160.22	176.49	176.35	199.01	210.92	226.45	
Efficiency of water heater												75	(216)
(217)m=	83.5	83.48	83.41	83.3	82.94	75	75	75	75	83.15	83.41	83.49	(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m													
(219)m=	278.05	244.99	257.17	230.38	226.4	222.99	213.63	235.33	235.13	239.35	252.87	271.22	

Total = Sum(219a)$_{1...12}$ = 2907.51 (219)

SAP WorkSheet: New dwelling design stage

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			30235.04	
Water heating fuel used			2907.51	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		169		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		214	(231)
Electricity for lighting			900.65	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year		**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211)	x	3.1	x 0.01 =	937.2863	(240)
Space heating - main system 2	(213)	x	0	x 0.01 =	0	(241)
Space heating - secondary	(215)	x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)		3.1	x 0.01 =	90.13	(247)
Pumps, fans and electric keep-hot	(231)		11.46	x 0.01 =	24.52	(249)

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

Energy for lighting	(232)		11.46	x 0.01 =	103.21	(250)
Additional standing charges (Table 12)					106	(251)

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

Total energy cost	(245)...(247) + (250)…(254) =	1261.1579	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	2.4905	(257)
SAP rating (Section 12)		65.2572	(258)

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	0.198	=	5986.54	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	575.69	(264)
Space and water heating	(261) + (262) + (263) + (264) =				6562.23	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	110.64	(267)
Electricity for lighting	(232)	x	0.517	=	465.64	(268)
Total CO2, kg/year			sum of (265)…(271) =		7138.5	(272)
CO2 emissions per m²			(272) ÷ (4) =		36.99	(273)

SAP WorkSheet: New dwelling design stage

EI rating (section 14)				60	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.02	=	30839.74	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2965.66	(264)
Space and water heating	(261) + (262) + (263) + (264) =			33805.4	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	624.88	(267)
Electricity for lighting	(232) x	0	=	2629.89	(268)
‘Total Primary Energy		sum of (265)…(271) =		37060.18	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		192.02	(273)