Basement Force

Above Ground Extension and Subterranean Development

Operational Carbon Review and Analysis

17 March 2014



Prepared by:

Daniel Watt CIBSE Accreditation: LCCSIM084077 LCCD084077 LCEA084077

t. (44) 0161 434 4103 e. dan.w@ashmount.net

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Issue Status

Sustainability Director		Daniel Watt					
		Dalst.					
Sustainability Consultant		Jemma McLaughlan					
		Moran					
First Issue Date	Revision Issue Date	Issue Revision	Issued By				
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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 report¹.

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

Therma	l resistance	<u>e of baseme</u>	ent floor con	nstruction:			
<u>Layer</u>	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	<u>R layer</u>	<u>R bridge</u>	Description
					0.170		Rsi
1	75	1.200			0.062		screed
2	100	0.022			4.545		insulation board
	175 mm	<u>1</u>			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	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	<u>R layer</u>	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
	<u>313 mm</u>				3.296		

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

Ground parame	ters:				
Perimeter P:	30.50 m			Wall thickness:	300 mm
Area A:	75.00 m ²			Ground type:	Clay/silt ($\lambda = 1.5 \text{ W/m} \cdot \text{K}$)
P/A:	0.407			Rse:	0.04 m ² K/W
Average basem	ent depth:		2.600 m		
Area of basement walls:			79.30 m ²		
U-value U-value (round	ded)	<u>Floor</u> 0.135 0.14	<u>Walls</u> 0.240 0.24	<u>Overall</u> (area- 0.189 0.19 W/m²K	weighted average)

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	n:					
Dwelling type: Detachment: Year Completed:		House Mid-terrace 2014				
Floor Location:		Floor area:	Sto	rey height	:	
Floor 0 Floor 1 Floor 2		50 m² 34 m² 34 m²	2. 2. 2.	.8 m .8 m .8 m		
Living area: Front of dwelling fa	aces:	46 m ² (fraction 0.39) Unspecified				
Opening types:						
Name: Front Front Back Bifolds Back Rooflight	Source: SAP 2009 SAP 2009 SAP 2009 SAP 2009 SAP 2009	Type: Half glazed Windows Windows Windows Roof Windows	Glazing: Single-glazed Single-glazed double-glazed Single-glazed double-glazed		Argon: No No No No No	Frame: Wood Wood PVC-U Wood PVC-U
Name:	Gap:	Frame Factor	: q-value:	U-value:	Area:	No. of Openings:
Front Front	mm	0.7 0.7	0.85 0.85	3.9 4.8	2.6 6.8	1 1
Back Bifolds Back	16mm or more	0.7 0.7	0.76 0.85	2.7 4.8	5.4 6.1	1 1
Rooflight	16mm or more	0.7	0.76	3	13.5	1
Name: Front Front Back Bifolds Back Rooflight	Type-Name:	Location: Existing Front Walls Existing Walls Existing Walls Existing Walls Flat Roof	Orient: East East West West West		Width: 0 0 0 0 0	Height: 0 0 0 0 0
Overshading:		Average or unknown				

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
External Elements	<u>S</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

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: Ventilation: Number of chimneys: Number of open flues: Number of fans: Number of sides sheltered: Pressure test:	No (Assumed) Natural ventilation (extract fans) 1 (main: 0, secondary: 1, other: 0) 0 2 3 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: In Smoke Control Area: Conservatory: Low energy lights: Terrain type: EPC language: Wind turbine: Photovoltaics: Assess Zero Carbon Home:	standard tariff Unknown No conservatory 50% Dense urban English No None No

l	Jser Details:								
Assessor Name: Dan Watt	Stroma	STRO	000002						
Software Name: Stroma FSAP 2009	ware Name: Stroma FSAP 2009 Software Version: Version								
Pro	perty Address:	16 Radnor Wa	lk BEFOI	RE					
Address : 16, Radnor Walk, LONDON, S	SW3 4BN								
1. Overall dwelling dimensions:	A	A	- ' 1. (()) (- l				
Ground floor	Area(m ²)		eight(m)	(22) -	Volume(m ³)	7 (3a)			
			2.0	(24) –	140				
	34 (ID) X	2.8	(2D) =	95.2				
	34 (*	1c) x	2.8	(2c) =	95.2	(3c)			
$ \text{Total floor area IFA} = (1a)+(1b)+(1c)+(1d)+(1e)+\dots(1n) $	118 (4	4)				_			
Dwelling volume		(3a)+(3b)+(3c)+(3d	d)+(3e)+	.(3n) =	330.4	(5)			
2. Ventilation rate:	other	total			m ³ per bour				
heating heating						٦			
Number of chimneys 0 + 1	+ 0	= 1	× 4	+0 =	40	(6a)			
Number of open flues 0 + 0	+ 0	= 0	x 2	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 4	40 =	0	(7c)			
				Air ch	anges per hou	ır			
Infiltration due to chimneys flues and fans = $(6a)+(6b)+(7a)$	+(7b)+(7c) =	60	<u> </u>	÷ (5) =	0.19] (8)			
If a pressurisation test has been carried out or is intended, proceed to	o (17), otherwise co	ontinue from (9) to	(16)	. (0) –	0.10				
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 th deducting areas of openings): if equal user 0.35	e greater wall area	(after							
If suspended wooden floor, enter 0.2 (unsealed) or 0.1	(sealed), else e	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 sq	uare metre of e	envelope	area	15	(17)			
If based on air permeability value, then $(18) = [(17) \div 20]+(8)$,	otherwise (18) = (1	6)			0.93	(18)			
Air permeability value applies if a pressurisation test has been done of	or a degree air pern	neability is being u	ised		-				
Shelter factor	(20) = 1 - [0	0.075 x (19)] =			0.78	(19)			
Infiltration rate incorporating shelter factor	(21) = (18) x	x (20) =		l I	0.70](21)			
Infiltration rate modified for monthly wind speed				l	0.72	,			
Jan Feb Mar Apr May Jun	Jul Aug	Sep Oct	Nov	Dec					
·····									
Monthly average wind speed from Table 7									

Wind F	actor (2	2a)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		
Adjuste	ed infiltra	ation rat	e (allowi	ing for sl	nelter ar	nd wind s	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		
Calcula	ate effec	ctive air	change	rate for t	he appli	icable ca	ise							
If me	chanica	al ventila	ation:			-) F () (00-)			0	(23a)
If exha	aust air ne	eat pump	using App	endix N, (2	(23a) = (23a	a)×⊦mv (e	equation (I	N5)), otne	rwise (23b)) = (23a)			0	(23b)
ir bala	incea witr	i neat reco	overy: emic	iency in %	allowing	for in-use t	actor (from) =				0	(23c)
a) If I	balance	d mech	anical ve	entilation	with he	at recove	ery (MV	HR) (24a I	a)m = (2)	2b)m + (23b) × [1 – (23c)	÷ 100]	(240)
(24a)m=	0					0	0					0		(24a)
	balance		anical ve			i neat rec	covery (i	VIV) (240 T	m = (22)	2b)m + (i T	230)			(24b)
(240)m=	0	0			0	· ,		0		0	0	0		(240)
C) IT (wnole n f (22b)n	ouse ex า < 0.5 ง	tract ver < (23b), 1	tilation (24)	or positiv c) = (23t	b); other	ventilatio wise (24	on from (c) = (22t	outside 5) m + 0	.5 × (23t))			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) If	natural	ventilatio	on or wh	ole hous	se positi	ve input	ventilati	on from I	oft	!		•		
i	f (22b)n	n = 1, th	en (24d)	m = (22l	o)m othe	erwise (2	24d)m =	0.5 + [(2	2b)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)
Effec	ctive air	change	rate - er	nter (24a) or (24	b) or (24	c) or (24	d) in box	k (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. Hea	at losse	s and he	eat loss	paramet	er:									
ELEN	IENT	Gros area	ss (m²)	Openin rr	gs 1²	Net Ar A ,r	rea m²	U-val W/m2	ue 2K	A X U (W/	K)	k-value kJ/m²∙ł	e A K ku	X k J/K
Doors			、 ,			2.6	x	3.9	=	10.14				(26)
Window	ws Type	e 1				6.8		/[1/(4.8)+	0.04] =	27.38	=			(27)
Window	ws Type	2				5.4		/[1/(2.7)+	0.04] =	13.16	=			(27)
Window	ws Type	3				6.1		/[1/(4.8)+	0.04] =	24.56	=			(27)
Rooflia	hts					13.5	x	1/[1/(3) + ().04] =	40.5	╡			(27b)
Floor						50		0.6		30	= r			 (28)
Walls		07	,	18 3	2	78.7		1.6	<u> </u>	125.92			\dashv	$\frac{1}{29}$
Roof T	vpe1	17	,	13.5	<u></u>	3.5		0.6		2 1				$\frac{(20)}{(30)}$
Roof T	vne2	27	,		<u></u>	27		0.0		2.1				
Total a	rea of e	lements		0		202.6		0.0		22.2	L			(31)
Dorty		icinicinto	,			203.0	<u> </u>			0	— , r			
* for wind	vali dowo ond	roof wind	0,000,000,000,000	footivowi	ndow I I v	145			=	0		norograph		(32)
** include	e the area	as on both	sides of ir	nternal wal	ls and par	aiue caicui titions	aleo using	normula i	/[(1/0-vail	<i>le)+0.04] c</i>	as given in	i paragraph	3.2	
Fabric	heat los	s, W/K	= S (A x	U)				(26)(30)) + (32) =				291.63	(33)
Heat ca	Fabric heat loss, W/K = S (A x U) Heat capacity Cm = S(A x k)								((28).	(30) + (32	2) + (32a).	(32e) =	32672.8	(34)

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.

Therm	al bridge	es : S (L	x Y) cal	culated u	using Ap	pendix ł	<					[30.54	(36)
if details Total f	of therma	<i>I bridging</i> at loss	are not kn	own (36) =	= 0.15 x (3	1)			(33) +	(36) =		I	200 17	(37)
Ventila	tion hea	it loss ca	alculated	l monthly	V				(38)m	= 0.33 × (25)m x (5)	l	322.17	(37)
	Jan	Feb	Mar	Apr	Мау	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 t	ansfer c	oefficier	nt, W/K					-	(39)m	= (37) + (3	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		
Hoatk		motor (L	//// (D IL	m2k					/ (40)m	Average = $(20)m^{-1}$	Sum(39) _{1.}	12 /12=	413.35	(39)
(40)m=	3.63	3.58	3.58	3.5	3.45	3.42	3.4	3.4	3.46	- (33) 11 -	3.54	3.58		
(- /						_			/	Average =	Sum(40)1.		3.5	(40)
Numb	er of day	rs in mor	nth (Tab	le 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. Wa	ater heat	ing ener	gy requi	rement:								kWh/ye	ear:	
Assum if TF	ied occu A > 13.9	ipancy, I 9, N = 1	N + 1.76 x	[1 - exp	(-0.0003	849 x (TF	- A -13.9)2)] + 0.()013 x (⁻	ΓFA -13.	<u>2</u> . 9)	86		(42)
if TF	A £ 13.9	P, N = 1	torugo	na ia litra	o por de	v Vd ov	o.ro.g.o		. 26					(40)
Reduce	the annua	e not wa al average	hot water	usage by &	s per da 5% if the a	ay va,av Iwelling is	erage = designed	(25 X N) to achieve	+ 30 a water us	se target o	f 107	7.38		(43)
not mor	e that 125	litres per p	person per	day (all w	ater use, l	hot and co	ld)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wat	er usage ii	n litres per	day for ea	ach month	Vd,m = fa	ctor from T	Table 1c x	(43)						
(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		-
Energy	content of	hot water	used - cal	culated mo	onthly $= 4$.	190 x Vd,r	n x nm x E	OTm / 3600	kWh/mor	Total = Su hth (see Ta	m(44) ₁₁₂ = ables 1b, 1	c, 1d)	1288.57	(44)
(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		
lf instan	taneous w	ater heatir	ng at point	of use (no	hot water	r storage),	enter 0 in	boxes (46,	-) to (61)	Fotal = Su	m(45) ₁₁₂ =	-	1693.56	(45)
(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)
a) If m	anufacti	ioss. irer's de	clared lo	oss facto	r is knov	vn (kWh	/dav).					0		(47)
Tempe	erature fa	actor fro	m Table	2h			ady).					0		(48)
Energy	/ lost fro	m water	storage	 . kWh/ve	ear			(47) x (48)	=			0		(40)
If man	ufacture	r's decla	red cylir	nder loss	factor is	s not kno	own:	(,(,			Y	0		(10)
Cylind	er volum	e (litres)) includir	ng any s	olar stor	age with	in same)				0		(50)
lf cor Othe	nmunity he rwise if no	eating and stored ho	no tank in t water (th	dwelling, is includes	enter 110 instantan	litres in bo eous comb	ox (50) bi boilers)	enter '0' in	box (50)					
Hot wa	ater stora	age loss	factor fr	om Tabl	e 2 (kW	h/litre/da	ıy)					0		(51)
Volum	e factor	from Tal	ble 2a									0		(52)
Tempe	erature fa	actor fro	m Table	2b								0		(53)
Energ Enter	/ lost fro (49) or (m water 54) in (5	storage 5)	, kWh/ye	ear			((50) x (51) x (52) x	(53) =		0 0		(54) (55)

Water	storage	loss cal	culated	for each	month			((56)m = (55) × (41)	m				
(56)m=	0	0	0	0	0	0	0	0	0	0	0	0]	(56)
If cylind	er contain	s dedicate	d solar sto	orage, (57)	m = (56)m	x [(50) – (H11)] ÷ (5	0), else (5	7)m = (56)	m where ((H11) is fro	m Append	lix H	
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0		(57)
Prima	v circuit	loss (ar	nnual) fro	om Table	e 3			-		-		0		(58)
Primar	y circuit	loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m					
(mo	dified by	factor f	rom Tab	le H5 if t	there is s	solar wat	er heatii	ng and a	cylinde	r thermo	ostat)			
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0		(59)
Combi	loss ca	lculated	for each	month	(61)m =	(60) ÷ 36	65 × (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 h	neat req	uired for	water h	eating ca	alculated	l for eacl	n 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 DI	HW input	calculated	using App	endix G o	r Appendix	H (negati	ve quantity	/) (enter '0	' if no sola	r contribut	tion to wate	er heating)		
(add a	dditiona	l lines if	FGHRS	and/or \	WWHRS	applies	, see Ap	pendix (G)					
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	t from w	ater hea	ter											
(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		-
								Outp	out from w	ater heate	r (annual)₁	12	2290.2	(64)
Heat g	ains fro	m water	heating	, kWh/m	onth 0.2	5 x [0.85	× (45)m	n + (61)n	n] + 0.8	x [(46)m	+ (57)m	ı + (59)m	n]	
(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)
inclu	ude (57)	m in cale	culation	of (65)m	only if c	ylinder i	s in the o	dwelling	or hot w	vater is f	rom com	munity h	neating	
5. In	ternal ga	ains (see	e Table 5	5 and 5a):									
Metab	<u>olic gair</u>	<u>is (Table</u>	<u>e 5), Wat</u>	ts										
	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)
Lightin	ig gains	(calcula	ted in Ap	opendix	L, equat	ion L9 oi	r L9a), a	lso 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)
Applia	nces ga	ins (calc	ulated ir	n Append	dix L, eq	uation L	13 or L1	3a), also	see Ta	ble 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)
Cookir	ng gains	(calcula	ated in A	ppendix	L, equat	ion L15	or L15a)), also se	e 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	s and fa	ns gains	(Table	5a)										
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10		(70)
Losse	s e.g. ev	vaporatio	on (nega	tive valu	es) (Tab	le 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 (1	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 i	internal	gains =				(66)	m + (67)m	n + (68)m +	+ (69)m +	(70)m + (7	'1)m + (72)	m	-	
(73)m=	700.00	705.00	000.00	040.00	500.00	EE0 04	506 70	550 52	E 70 74	627.02	677.02	715 47]	(73)
1 C C	733.93	/25.26	693.39	646.32	599.08	000.21	536.76	550.53	579.71	027.03	011.92	/15.4/		(-)

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

Orienta	tion:	Access Factor Table 6d	r	Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	6.8	×	19.87	×	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	×	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	×	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	×	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	×	16.39	×	0.76	x	0.7] =	32.64	(80)
West	0.9x	0.3	x	6.1	×	16.39	×	0.85	x	0.7	=	16.06	(80)
Roofligh	ts	1	x	13.5	×	26	×	0.76	x	0.7	=	168.06	(82)
Roofligh	ts <u>0.9</u> x	1	x	13.5	×	54	×	0.76	x	0.7] =	349.05	(82)
Roofligh	ts <mark>0.9x</mark>	1	x	13.5	x	94	x	0.76	x	0.7] =	607.6	(82)

Roofligh	nts <mark>0.9x</mark>	1	x	13	.5	x [1	50	x		0.76	×	0.7	=	969.57	(82)
Roofligh	nts <mark>0.9x</mark>	1	x	13	.5	×	1	90	x		0.76	_ × [0.7	=	1228.12	(82)
Roofligh	nts <mark>0.9x</mark>	1	x	13	.5	×	2	201	x		0.76	_ × [0.7	=	1299.22	(82)
Roofligh	nts <mark>0.9x</mark>	1	x	13	.5	× [1	94	x		0.76	_ × [0.7	=	1253.98	(82)
Roofligh	nts <mark>0.9x</mark>	1	x	13	.5	×	1	64	x		0.76	_ × [0.7	=	1060.06	(82)
Roofligh	nts <mark>0.9x</mark>	1	x	13	.5	×	1	16	x		0.76	_ × [0.7	=	749.8	(82)
Roofligh	nts 0.9x	1	x	13	.5	×		68	x		0.76		0.7	=	439.54	(82)
Roofligh	nts <mark>0.9x</mark>	1	x	13	.5	×	:	33	x		0.76	_ × [0.7	=	213.31	(82)
Roofligh	nts <mark>0.9x</mark>	1	x	13	.5	×		21	x		0.76		0.7	=	135.74	(82)
	-					-			•							
Solar g	ains in	watts, ca	alculated	d for eac	h month				(83)m	n = Su	m(74)m .	(82)m				
(83)m=	282.82	571.48	963.12	1497.43	1870.38	19	69.39	1904.45	1626	5.18	1174.84	710.42	355.98	230.4		(83)
Total g	ains – i	nternal a	and sola	r (84)m =	= (73)m ·	+ (8	33)m ,	watts	i						L	
(84)m=	1016.75	1296.74	1656.51	2143.75	2469.46	25	527.6	2441.22	2176	6.71	1754.55	1337.45	1033.9	945.87		(84)
7. Me	an inter	nal temp	berature	(heating	season)										
Temp	erature	during h	neating p	periods in	n the livii	ng a	area fi	rom Tab	ole 9,	, Th1	(°C)				21	(85)
Utilisa	ation fac	tor for g	ains for	living are	ea, h1,m	(se	ee Tal	ole 9a)	_							
	Jan	Feb	Mar	Apr	May		Jun	Jul	A	ug	Sep	Oct	Nov	Dec		
(86)m=	0.99	0.98	0.96	0.92	0.83	0).71	0.56	0.0	6	0.84	0.95	0.98	0.99		(86)
Mean	interna	l temper	ature in	living ar	ea T1 (fo	ollov	w step	os 3 to 7	' in T	able	9c)					
(87)m=	17.68	17.97	18.57	19.27	20.03	20	0.56	20.84	20.	81	20.29	19.36	18.32	17.76		(87)
Temp	erature	durina h	neating r	Deriods ir	n rest of	dw	ellina	from Ta	ble 9	י א Th	2 (°C)		•			
(88)m=	18.49	18.51	18.51	18.54	18.56	18	8.57	18.58	18.	58	18.56	18.54	18.53	18.51		(88)
Litilion	tion for	tor for a	aine for	roct of d	wolling	L		o Toblo	0		I				1	
(89)m=	0.99	0.97	0.94	0.88	0 74	ΠΖ,Ι Γ ο	11 (Se		9a)	3	0.7	0.92	0.98	0.99		(89)
(00)										<u> </u>		0.02	0.00	0.00	I	()
Mean	interna	l temper	ature in	the rest	of dwelli	ng	12 (fo	allow ste	eps 3	to 7	in Tabl	e 9c)	16.40	15.05		(00)
(90)m=	15.75	10.05	10.04	17.33	18.03		6.43	16.57	10.	57	10.27 f	17.45	10.42	15.65	0.00	$\Box_{(01)}$
												_, (i i i	ig aloa . (·) –	0.39	(31)
Mean	interna	l temper	ature (fo	or the wh	ole dwe	lling	g) = fL	.A × T1	+ (1	– fL/	4) × T2		1		1	(22)
(92)m=	16.5	16.8	17.39	18.08	18.81	19	9.26	19.45	19.	44	19.06	18.19	17.16	16.6		(92)
Apply	adjustr	nent to t	he mear 17.20			atu 1	re fror	n lable	4e,	whei	re appro	priate	17.16	16.6		(03)
(95)III=	10.5	ting rogu	uiromon	10.00	10.01		9.20	19.45	19.4	44	19.00	10.19	17.16	10.0		(33)
o. Spa Sat Ti	i to the	mean int	arnal to	moeratu	re obtair	bod	at sto	n 11 of	Tabl	0 Qh	so that	Tim-	(76)m an	d re-calc	ulato.	
the ut	ilisation	factor fo	or gains	using Ta	able 9a	ieu	ai 316	prior	Tabl	6 30	, 30 114		(70)m an		ulate	
	Jan	Feb	Mar	Apr	May		Jun	Jul	A	ug	Sep	Oct	Nov	Dec		
Utilisa	ation fac	tor for g	ains, hr	1:												
(94)m=	0.98	0.97	0.93	0.87	0.75	0).59	0.39	0.4	12	0.74	0.91	0.97	0.98		(94)
Usefu	Il gains,	hmGm	, W = (9-	4)m x (8	4)m				i						1	
(95)m=	996.23	1252.48	1545.5	1862.11	1861.52	14	198.8	943.44	920	.94	1289.65	1219.31	1003.56	928.53		(95)
Month	nly aver	age exte	ernal tem	perature	e from Ta	able I	8 	10.5			1	4.5 -			1	(00)
(96)m=	4.5	5	6.8	8.7	11.7		4.6	16.9	16.	.9	14.3	10.8	1	4.9	l	(96)
	IUSS rate			al tempe	erature,	∟m [₁₀₁	, VV = 80 22	1024 17	x [(9: 1010	3)m-	- (96)m 1041 40 I	3050 02	1212 67	1015 55	1	(97)
(37)11=	5142.0	4990.00	1 ^{/ 0.00}	0012.11	2009.02	l '°	00.00	1024.17		.09	1341.12	0000.03	7242.07	+340.00	1	(01)

	Fu kW	el /h/year			Fuel P (Table	rice 12)		Fuel Cost £/year	
10a. Fuel costs - individual heating systems:									
Electricity for lighting							[667.37	(232)
Total electricity for the above, kWh/year			sum	of (230a).	(230g) =		[214	(231)
boiler with a fan-assisted flue							45		(230e)
central heating pump:							169		(230c)
Electricity for pumps, fans and electric keep-ho	t								
Water heating fuel used							[2844.15	
Space heating fuel used, main system 1								19851.32	
Annual totals					k\	Wh/year	. I	kWh/year	````
			Tota	I = Sum(2'	19a) ₁₁₂ =			2844.15	(219)
$(219)m = (64)m \times 100 \div (217)m$ $(219)m = 271.91 \ 239.71 \ 251.94 \ 226.25 \ 223.55$	216.07	207	230.13	229.88	234.91	247.51	265.28		
Fuel for water heating, kWh/month	<u> </u>								
(217)m= 83.32 83.26 83.13 82.86 82.09	75	75	75	75	82.76	83.19	83.31		(217)
Efficiency of water heater	102.00					20010		75	(216)
Output from water heater (calculated above)	162.05	155.25	172.6	172.41	194.41	205.9	221		
Water heating							L		
	<u> </u>		Tota	l (kWh/yea	ar) =Sum(2	215) _{15,1012}	=	0	(215)
$= \{ [(98)m \times (201)] + (214)m \} \times 100 \div (208) $ (215)m= 0 0 0 0 0	0	0	0	0	0	0	0		
Space heating fuel (secondary), kWh/month				, ,	, , , , , , , , , , , , , , , , , , ,	¥ 15, 1012	l		
3672.68 2990.47 2598.14 1722.92 910.6	0	0	U Tota	0 I (kWh/yea	1622.2 ar) = Sum(2	2110.38	3007.93	19851.32	7(211)
$(211)m = \{[(98)m \times (204)] + (210)m \} \times 100 \div (210)m \}$	206)	0	0	0	1600.0	0776.00	2557.02		(211)
3085.05 2512 2182.44 1447.25 764.91	0	0	0	0	1362.65	2332.16	2988.66		
Space heating requirement (calculated above)								
Jan Feb Mar Apr May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye;	_l` ar
Efficiency of secondary/supplementary heatin	a svsterr	า. %					l	0	(208)
Efficiency of main space heating system 1			() ((200)]		l	84	(206)
Fraction of space heat from main system(s)			$(202) = 1^{-1}$	- (201) - 02) x [1 - 1	(203)] =		l	1	(202)
Fraction of space heat from secondary/supple	mentary	system	(202) – 1	(201) -			[0	(201)
9a. Energy requirements – Individual heating s Space heating:	ystems II	ncluding	micro-C	HP)					
Space heating requirement in kWh/m²/year							[141.31	(99)
			Tota	l per year	(kWh/year) = Sum(9	8)15,912 =	16675.11	(98)
(98)m= 3085.05 2512 2182.44 1447.25 764.91	0	0	0	0	1362.65	2332.16	2988.66		
Space nearing requirement for each month. K	vvn/mont	un = 0.02	24 X I(97)III — (95)III] X (4	1)[[]			

Space heating - main system 1	(211)) x	3.1	x 0.01 =	615.391	(240)
Space heating - main system 2	(213)	s) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215)	i) 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 (23 Energy for lighting	30g) separately (232)	y as applicable ar	nd apply fuel price acc 11.46	cording to T x 0.01 =	Table 12a 76.48	(250)
Additional standing charges (Table 12)					106	(251)
Appendix Q items: repeat lines (253) and	d (254) as need	led 0) (254) =			910 5643	(255)
11a. SAP rating - individual heating sys	tems	0)(201) =			010.0040](200)
Energy cost deflator (Table 12)					0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4	4) + 45.0] =			2.6256	(257)
SAP rating (Section 12)					63.3735	(258)
12a. CO2 emissions – Individual heatin	g systems inclu	iding micro-CHP				-
	Ene kW	ergy ′h/year	Emission fa kg CO2/kWl	actor	Emissions kg CO2/yea	r
Space heating (main system 1)	(211)) x	0.198] =	3930.56	(261)
Space heating (secondary)	(215	i) x	0] =	0	(263)
Water heating	(219))) x	0.198] =	563.14	(264)
Space and water heating	(261)) + (262) + (263) + (2	264) =		4493.7	(265)
Electricity for pumps, fans and electric ke	eep-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 m ²			(272) ÷ (4) =		41.94	(273)
El rating (section 14)					59	(274)
13a. Primary Energy						
	Ene kW	ergy ′h/year	Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211)) x	1.02	=	20248.35	(261)
Space heating (secondary)	(215)	i) x	0	=	0	(263)
Energy for water heating	(219))) x	1.02	=	2901.03	(264)
Space and water heating	(261)) + (262) + (263) + (2	264) =		23149.38	(265)
Electricity for pumps, fans and electric ke	eep-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	1							
Dwelling type: Detachment: Year Completed:		Hous Mid-t 2014	errace					
Floor Location:		Floo	r area:		Storey height	:		
Basement floor		72 m	2		2.8 m			
Floor 1		50 m	2		2.8 m			
Floor 2		34 m	2		2.8 m			
Floor 3		34 m	2		2.8 m			
Living area: Front of dwelling fa	ices:	27 m Unsp	² (fraction 0.142) ecified					
Opening types:								
Name:	Source:		Туре:	Glazing:		Argon:	Fram	ne:
Front	SAP 2009		Half glazed	Single-glaz	ed	No	Wood	
Front	SAP 2009	,	Windows	Single-glaz	ed	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. o	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 o	r more	0.7	0.63	1.6	10.1	1	
Front	16mm o	r more	0.7	0.63	1.6	8.4	1	
Back	16mm o	r more	0.7	0.63	1.6	6.5	1	
Left	16mm o	r more	0.7	0.63	1.6	1.2	1	
Name:	Type-Nam	e:	Location:	Orient:		Width:	Heig	ht:
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:		Avera	ige or unknown					
Opaque Elements:								
Type: C	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtair	n wall:	Карра:
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
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: Ventilation: Number of chimneys: Number of open flues: Number of fans: Number of sides sheltered: Pressure test:	No (Assumed) Natural ventilation (extract fans) 1 (main: 0, secondary: 1, other: 0) 0 5 3 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: In Smoke Control Area: Conservatory: Low energy lights: Terrain type: EPC language: Wind turbine: Photovoltaics: Assess Zero Carbon Home:	standard tariff Unknown No conservatory 50% Dense urban English No None

				User [Details:						
Assessor Name:	Dan Watt				Strom	a Num	ber:		STRO	000002	
Software Name:	Stroma FS	AP 200	9		Softwa	are Vei	rsion:		Versic	on: 1.5.0.63	
			P	roperty	Address:	16 Rad	Inor Walk		२		
Address :	16, Radnor	Walk, LO	ONDON,	SW3 4	1BN						
1. Overall dwelling dime	ensions:										
Recoment				Are	a(m²)		Ave Hei	ght(m)		Volume(m ²	3)
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 = (1	a)+(1b)+(1c)+(1d)+(1e)+(1n)	190	(4)					
Dwelling volume						(3a)+(3b))+(3c)+(3d)	+(3e)+	.(3n) =	532	(5)
2. Ventilation rate:							_				
	main heating	Se h	econdar eating	у	other		total			m³ per hou	Ir
Number of chimneys	0	+	1] + [0] = [1	X 4	40 =	40	(6a)
Number of open flues	0	+	0] + [0] = [0	x 2	20 =	0	(6b)
Number of intermittent fa	ins						5	x ^	10 =	50	(7a)
Number of passive vents	5					Г	0	x ^	10 =	0	(7b)
Number of flueless gas fi	ires						0	x 4	40 =	0	(7c)
									Air ch	anges per he	our
Infiltration due to chimne	vs. flues and fa	ans = (6a	a)+(6b)+(7	a)+(7b)+	(7c) =	Г	90	<u> </u>	÷ (5) =	0.17	(8)
If a pressurisation test has b	peen carried out or	is intende	d, proceed	d to (17),	otherwise c	continue fr	rom (9) to (1	6)	. (-)	0.17	(-)
Number of storeys in the	he dwelling (ns	;)								0	(9)
Additional infiltration								[(9)	-1]x0.1 =	0	(10)
Structural infiltration: 0	.25 for steel or	timber f	rame or	0.35 fc	or masonr	y constr	uction			0	(11)
if both types of wall are p deducting areas of openii	resent, use the va ngs), if equal user	lue corresµ 0.35	oonding to	the grea	ter wall area	a (after					
If suspended wooden f	floor, enter 0.2	(unseal	ed) or 0.	1 (seal	ed), else	enter 0				0	(12)
lf no draught lobby, en	ter 0.05, else e	enter 0								0	(13)
Percentage of windows	s and doors dr	aught st	ripped							0	(14)
Window infiltration					0.25 - [0.2	x (14) ÷ 1	= [00			0	(15)
Infiltration rate					(8) + (10) ·	+ (11) + (1	12) + (13) +	(15) =		0	(16)
Air permeability value,	q50, expresse	d in cub	ic metre	s per h	our per so	quare m	etre of er	nvelope	area	15	(17)
If based on air permeabil	lity value, then	(18) = [(1	7) ÷ 20]+(8	3), otherw	/ise (18) = (16)	·	1		0.92	(18)
All permeability value applie	b shaltarad	n lest nas	been don	e or a de	gree all per	теарііцу	is being us	ea		2	(10)
Shelter factor					(20) = 1 - [[0.075 x (1	[9]] =			0.78	(20)
Infiltration rate incorporat	ting shelter fac	tor			(21) = (18)) x (20) =				0.71	(21)
Infiltration rate modified f	or monthly win	d speed									
Jan Feb	Mar Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		

Monthl	y avera	ige wind	speed fi	rom Tabl	e 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 F	actor (2	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		
Adjuste	ed infiltr	ration rat	e (allowi	ing for sh	nelter an	d wind s	peed) :	= (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		
Calcula	ate effe	ctive air	change	rate for t	he appli	cable ca	se	•				-		
lf exh	aust air h	al verilia	using App	endix N (2	3b) = (23a	a) x Emv (e		(N5)) othe	rwise (23)	(23a) = (23a)			0	(23a)
lf bala	anced wit	h heat reco	overy: effic	iency in %	allowing f	or in-use f	actor (fro	m Table 4h	i) =	o) = (200)			0	(230)
a) If	balance	ed mech	anical ve	entilation	with he	at recove	erv (M∖	/HR) (24a	′ a)m = (2	2b)m + (23b) x [[,]	1 – (23c)	÷ 100]	(200)
(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24a)
b) If	balance	ed mecha	anical ve	entilation	without	heat rec	covery (MV) (24t)m = (2	2b)m + (23b)			
(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24b)
c) If	whole h	nouse ex	tract ver	ntilation o	or positiv	ve input v	ventilati	on from a	outside					
i	f (22b)r	m < 0.5 ×	(23b), t	then (240	c) = (23k	o); otherv	wise (24	4c) = (22b	b) m + 0	.5 × (23b) 			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) lf i	natural f (22b)r	ventilation $m = 1$, the	on or wh en (24d)	ole hous $m = (22)$	e positiv c)m othe	ve input v erwise (2	ventilat 4d)m =	ion from 0.5 + [(2	loft 2b)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)
Effec	ctive air	change	rate - er	nter (24a) or (24t	o) or (24	c) or (2	4d) in box	x (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. He	at losse	es and he	eat loss i	oaramete	ər:				-	·		•		
ELEN	IENT	Gros area	ss (m²)	Openin m	gs 1 ²	Net Ar A ,r	ea n²	U-val W/m2	ue 2K	A X U (W/	K)	k-value kJ/m²·ł	e K	A X k kJ/K
Doors			. ,			2.6	x	3.9	=	10.14				(26)
Window	ws Type	e 1				6.8	×	1/[1/(4.8)+	0.04] =	27.38	=			(27)
Window	ws Type	e 2				10.1	×	1/[1/(1.6)+	0.04] =	15.19	=			(27)
Window	ws Type	e 3				8.4	×	1/[1/(1.6)+	0.04] =	12.63	=			(27)
Window	ws Type	e 4				6.5	x	1/[1/(1.6)+	0.04] =	9.77				(27)
Window	ws Type	e 5				1.2	x	1/[1/(1.6)+	0.04] =	1.8	=			(27)
Floor						72	x	0.14	=	10.08	= r			(28)
Walls 7	Гуре1	122	2	16.1		105.9) x	0.24	=	25.42	ז ר		╕	(29)
Walls 7	Гуре2	97	,	9.4		87.6	x	1.6	=	140.16			$\exists \square$	(29)
Roof 1	Type1	21		0		21	x	0.15	=	3.15	ז ר			(30)
Roof 1	Type2	17	,	0		17	×	0.6	=	10.2	ז ר			(30)
Roof 1	ГуреЗ	37	·]	0		37	×	0.6	=	22.2	ז ר			(30)
Total a	rea of e	elements	, m²			376.1					L			(31)
Party v	vall					145	x	0	=	0				(32)

* for win	dows and	l roof winde	ows, use e	effective wi	indow U-va	alue calcul	ated using	g formula 1	/[(1/U-valu	ie)+0.04] a	as given in	paragraph	3.2	
Fabric	heat los	ss. W/K -	= S (A x	U)	is and part			(26)(30)	+ (32) =			Г	288 13	(33)
Heat c	apacity	Cm = S('A x k)	0)				. , . ,	((28)	.(30) + (32	2) + (32a).	(32e) = [36/36 5	(34)
Therm	al mass	parame	ter (TMF		- TFA) ir	n k.I/m²K			Indica	tive Value	: Medium	Г	250	(35)
For desi can be t	ign assess used inste	sments wh ad of a dei	ere the de tailed calc	tails of the ulation.	construct	ion are not	t known pr	recisely the	indicative	values of	TMP in Ta	able 1f	230	(00)
Therm	al bridg	es : S (L	x Y) cal	culated	using Ap	pendix I	<					Г	56.42	(36)
if details	of therma	al bridging	are not kr	nown (36) =	= 0.15 x (3	1)						L		
Total f	abric he	at loss							(33) +	(36) =			344.54	(37)
Ventila	ation hea	at loss ca	alculated	d monthl	y	1	1	1	(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 ti	ransfer o	coefficier	nt, W/K	-	-	-	-	-	(39)m	= (37) + (3	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		_
Heat lo	oss para	meter (H	HLP), W	/m²K					ر (40)m	Average = = (39)m ÷	Sum(39) _{1.} (4)	12 /12=	489.81	(39)
(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		_
Numbe	er of day	/s in moi	nth (Tab	le 1a)		-	-	-	,	Average =	Sum(40) ₁ .	12 /12=	2.58	(40)
	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)
Assum if TF if TF	ned occu A > 13.9 A £ 13.9	upancy, I 9, N = 1 9 N = 1	N + 1.76 ×	: [1 - exp	(-0.0003	349 x (TF	-A -13.9)2)] + 0.()013 x (⁻	TFA -13.	2. 9)	99		(42)
Annua Reduce not more	l averag the annua that 125	ge hot wa al average i litres per p	ater usag hot water person pe	ge in litre usage by r day (all w	es per da 5% if the a vater use, I	ay Vd,av Iwelling is hot and co	erage = designed i ld)	(25 x N) to achieve	+ 36 a water us	se target o	11(/).72		(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	er usage i	n litres per	day for ea	ach month	Vd,m = fa	ctor from 1	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		_
Energy	content of	hot water	used - cal	culated m	onthly $= 4$.	190 x Vd.r	n x nm x D)))))))))))))))))))) kWh/mor	Total = Su hth (see Ta	m(44) ₁₁₂ = ables 1b, 1	= [c, 1d)	1328.67	(44)
(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		
(40)11-	101.00	100.00	100.4	142.40	100.00	117.55	100.0	120.42	120.02	Total = Su	m(45)1 10 =	170.04	1746.26	(45)
lf instan							enter∩in	boxes (46) to (61)			L	1140.20	
	taneous w	vater heatii	ng at point	t of use (no	hot water	r storage),								(10)
(46)m= Water	taneous w 27.16 storage	vater heatii 23.75 IOSS:	ng at point 24.51	t of use (no 21.37	20.5	17.69	16.4	18.81	19.04	22.19	24.22	26.3		(46)
(46)m= Water a) If m	taneous w 27.16 storage anufactu	vater heatii 23.75 Ioss: urer's de	ng at point 24.51 clared lo	21.37	20.5 20.5 pr is knov	vn (kWh	16.4 /day):	18.81	19.04	22.19	24.22	26.3 0		(46)
(46)m= Water a) If m Tempe	taneous w 27.16 storage anufactu erature f	vater heatii 23.75 loss: urer's de actor fro	ng at point 24.51 clared lo m Table	21.37 21.37 DSS facto	20.5 20.5 or is knov	vn (kWh	16.4 /day):	18.81	19.04	22.19	24.22	26.3 0		(46) (47) (48)
(46)m= Water a) If m Tempe Energy	taneous w 27.16 storage anufactu erature f y lost fro	vater heatin 23.75 loss: urer's de actor fro om water	24.51 clared lo m Table storage	21.37 21.37 25s facto 2b 2, kWh/ye	20.5 20.5 or is knov	17.69 vn (kWh	16.4 /day):	(47) x (48)	19.04	22.19	24.22	26.3 0 0		(46) (47) (48) (49)
(46)m= Water a) If m Tempe Energy If man	taneous w 27.16 storage anufactu erature f y lost fro ufacture	23.75 loss: urer's de actor fro om water	24.51 clared lo m Table storage	21.37 21.37 25s facto 2b 2, kWh/ye nder loss	20.5 20.5 or is know ear s factor is	17.69 17.69 wn (kWh s not kno	16.4 /day):	(47) x (48)	19.04	22.19	24.22	26.3 0 0		(46) (47) (48) (49)
(46)m= Water a) If m Tempe Energy If man Cylind	taneous w 27.16 storage anufactu erature f v lost fro ufacture er volun	23.75 loss: urer's de actor fro om water r's decla ne (litres	24.51 clared lo m Table storage ared cylin) includin	21.37 25 facto 2b a, kWh/ye nder loss ng any s	20.5 20.5 or is know ear s factor is olar stor	17.69 wn (kWh s not kno age with	/day): /own: in same	(47) x (48)	19.04	22.19	24.22	26.3 0 0 0		 (46) (47) (48) (49) (50)

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

Hot wa	ater stor	age loss	factor f	rom Tabl	le 2 (kWl	h/litre/da	ıy)					0	(51)
Volum	e factor	from Ta	ble 2a		,		.,					0	(52)
Tempe	erature f	actor fro	m Table	e 2b								0	(53)
Energ	y lost fro	m water	r storage	e, kWh/ye	ear			((50) x (5 ²	l) x (52) x	(53) =		0	(54)
Enter	, (49) or (54) in (5	5)									0	(55)
Water	storage	loss cal	culated	for each	month			((56)m = (55) × (41)	m			
(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)
If cylind	er contain	s dedicate	d solar sto	orage, (57)	m = (56)m	x [(50) – (H11)] ÷ (5	0), else (5	7)m = (56)	m where (H11) is fro	m Append	lix H
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(57)
Primar	v circuit	loss (ar	nual) fro	om Table	e 3					-		0	(58)
Primar	y circuit	loss cal	lculated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m				I
(mo	dified by	factor f	rom Tab	le H5 if t	here is s	solar wat	er heatii	ng and a	cylinde	r thermo	stat)	-	_
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)
Combi	i loss ca	lculated	for each	n month ((61)m =	(60) ÷ 36	65 × (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 h	heat req	uired for	water h	eating ca	alculated	for eac	h 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 DI	HW input	calculated	using App	endix G o	r Appendix	: H (negati	ve quantity	/) (enter '0	' if no sola	r contribut	ion to wate	er heating)	I
(add a	dditiona	l lines if	FGHRS	and/or \	NWHRS	applies	, see Ap	pendix (G)				
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)
Output	t from w	ater hea	iter										I
(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	
				•				Out	out from w	ater heate	r (annual)₁	12	2345.91 (64)
Heat g	jains fro	m water	heating	, kWh/m	onth 0.2	5 x [0.85	x (45)m	า + (61)r	n] + 0.8	x [(46)m	+ (57)m	ı + (59)m	 ו]
(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)
inclu	ude (57)	m in calo	culation	of (65)m	only if c	ylinder i	s in the o	dwelling	or hot w	ater is fr	om com	munity ł	eating
5. In	ternal ga	ains (see	e Table 5	5 and 5a):	•		-				·	-
Metab	olic gair	s (Table	5) Wat	tts	/								
motab	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)
Lightin	ng gains	(calcula	ted in A	ppendix	L, equati	ion L9 o	r L9a), a	lso see [°]	Table 5				1
(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)
Applia	nces da	ins (calc	ulated ir	n Append	dix L. ea	uation L	13 or L1	i 3a), also	see Ta	ble 5			l
(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)
Cookir	na aains	(calcula	i ated in A	n ppendix	L. equat	ion L15	u or L15a`), also se	e Table	5			1
(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	s and fa	ns dains	(Table !	1 5a)									ł
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)
		L vaporatio	n (nega	tive valu	L es) (Tab	l		I	I	I	I	I	1
(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		I										
(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	naine –					m + (67)m	L (68)m -	L + (69)m + ([(70)m + (7	1)m + (72)	I	1
(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)
·	1	1	1	1	1		I	1	1	1	1	1	/

6. Solar gains:

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

Orienta	ation:	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	×	10.73	×	0.63	×	0.7] =	1.53	(74)
North	0.9x	0.3	x	1.2	×	20.36	×	0.63	×	0.7	j =	2.91	(74)
North	0.9x	0.3	x	1.2	x	33.31	x	0.63	x	0.7	i =	4.76	(74)
North	0.9x	0.3	x	1.2	x	54.64	×	0.63	×	0.7	i =	7.81	(74)
North	0.9x	0.3	x	1.2	×	75.22	×	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	×	79.12	×	0.63	×	0.7] =	11.3	(74)
North	0.9x	0.3	x	1.2	×	61.56	×	0.63	×	0.7	=	8.8	(74)
North	0.9x	0.3	x	1.2	×	41.09	×	0.63	×	0.7] =	5.87	(74)
North	0.9x	0.3	x	1.2	×	24.81	×	0.63	×	0.7] =	3.55	(74)
North	0.9x	0.3	x	1.2	x	13.22	×	0.63	x	0.7] =	1.89	(74)
North	0.9x	0.3	x	1.2	×	8.94	×	0.63	×	0.7] =	1.28	(74)
East	0.9x	1	x	6.8	x	19.87	×	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	×	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	×	24.71	×	0.85	×	0.7] =	69.27	(76)
East	0.9x	1	x	8.4	×	24.71	x	0.63	x	0.7	=	24.71	(76)
East	0.9x	1	x	6.8	×	16.39	×	0.85	x	0.7	=	45.96	(76)
East	0.9x	1	x	8.4	×	16.39	×	0.63	x	0.7	=	16.4	(76)

West	0.9x	0.77		x	10.	1	x	1	9.87	×	0.63		× [0.7		=	61.34	(80)
West	0.9x	0.3		x	6.5	5	x	1	9.87	×	0.63		× [0.7		=	15.38	(80)
West	0.9x	0.77		x	10.	1	x	3	8.52	×	0.63		x [0.7		=	118.9	(80)
West	0.9x	0.3		x	6.5	5	x	3	8.52	x	0.63		× [0.7		=	29.81	(80)
West	0.9x	0.77		x	10.	1	x	6	1.57	×	0.63		× [0.7		=	190.03	(80)
West	0.9x	0.3		x	6.5	5	x	6	1.57	x	0.63		x [0.7		=	47.65	(80)
West	0.9x	0.77		x	10.	1	x	9	1.41	×	0.63		× [0.7		=	282.15	(80)
West	0.9x	0.3		x	6.5	5	x	9	1.41	x	0.63		x [0.7		=	70.75	(80)
West	0.9x	0.77		x	10.	1	x	1	11.22	x	0.63		× [0.7		=	343.3	(80)
West	0.9x	0.3		x	6.5	5	x	1.	11.22	x	0.63		× [0.7		=	86.08	(80)
West	0.9x	0.77		x	10.	1	x	1	16.05	x	0.63		× [0.7		=	358.22	(80)
West	0.9x	0.3		x	6.5	5	x	1	16.05	x	0.63		× [0.7		=	89.82	(80)
West	0.9x	0.77		x	10.	1	x	1	12.64	x	0.63		x [0.7		=	347.69	(80)
West	0.9x	0.3		x	6.5	5	x	1	12.64	x	0.63		× [0.7		=	87.18	(80)
West	0.9x	0.77		x	10.	1	x	9	8.03	×	0.63		× [0.7		=	302.6	(80)
West	0.9x	0.3		x	6.5	5	x	9	8.03	x	0.63		× [0.7		=	75.87	(80)
West	0.9x	0.77		x	10.	1	x	7	73.6	x	0.63		×	0.7		=	227.19	(80)
West	0.9x	0.3		x	6.5	5	x	7	73.6	x	0.63		× [0.7		=	56.97	(80)
West	0.9x	0.77		x	10.	1	x	4	6.91	x	0.63		×	0.7		=	144.79	(80)
West	0.9x	0.3		x	6.5	5	x	4	6.91	x	0.63		× [0.7		=	36.31	(80)
West	0.9x	0.77		x	10.	1	x	2	4.71	x	0.63		× [0.7		=	76.26	(80)
West	0.9x	0.3		x	6.5	5	x	2	4.71	x	0.63		×	0.7		=	19.12	(80)
West	0.9x	0.77		x	10.	1	x	1	6.39	x	0.63		×	0.7		=	50.6	(80)
West	0.9x	0.3		x	6.5	5	x	1	6.39	x	0.63		× [0.7		=	12.69	(80)
Solar g	ains in	watts, ca	alculat	ted	for each	n mont	h			(83)m	i = Sum(74)m	(82)m					
(83)m=	153.85	298.14	476.6	64	708.44	863.21	9	01.52	874.67	760	0.2 570.02	363	3.09	9 191.26	126.9	92		(83)
l otal g	ains – i	nternal a	ind so	lar	(84)m =	(73)m	$\frac{1}{2} + (1)$	83)m	, watts									(0.4)
(84)m=	1043.13	1176.36	1314.	52	1486.92	1581.6	8 15	569.65	1516.88	1418	3.18 1265.58	3 111	8.2	9 1010.24	993.3	36		(84)
7. Me	an inter	rnal temp	eratu	re (heating	seaso	n)											_
Temp	erature	during h	eating	g pe	eriods ir	the liv	/ing	area f	rom Tab	ole 9	Th1 (°C)						21	(85)
Utilisa	ation fac	ctor for g	ains fo	or li	ving are	a, h1,	m (s	ee Ta	ble 9a)									
	Jan	Feb	Ma	ır	Apr	May	′	Jun	Jul	A	ug Sep		Oct	Nov	De	C		
(86)m=	1	1	0.99)	0.98	0.97		0.92	0.82	0.8	0.96	0.	99	1	1			(86)
Mean	interna	l temper	ature	in li	iving are	ea T1 (follo	ow ste	ps 3 to 7	7 in T	able 9c)							
(87)m=	18.14	18.32	18.7	3	19.22	19.84	2	20.37	20.73	20.	71 20.2	19	.48	18.68	18.2	3		(87)
Temp	erature	during h	eating	g pe	eriods ir	rest c	of dw	velling	from Ta	able 9	9, Th2 (°C)							
(88)m=	18.92	18.94	18.94	4	18.99	19.02	1	19.03	19.05	19.	05 19.01	18	.99	18.97	18.9	4		(88)
Utilisa	ation fac	ctor for g	ains fo	or re	est of d	velling	, h2	,m (se	e Table	9a)	·							
(89)m=	1	0.99	0.99		0.98	0.94	Τ	0.84	0.58	0.6	61 0.9	0.	98	0.99	1			(89)
Mean	interna	l temper	ature	in t	he rest	of dwe	llina	T2 (f	ollow ste	eps 3	to 7 in Tal	ole 90	;)	•				
(90)m=	16.47	16.67	17.0	7	17.59	18.22		18.72	18.99	18.	99 18.57	17	.85	17.04	16.5	8		(90)
	L	I								I	I							

									f	fLA = Livin	g area ÷ (4	4) =	0.14	(91)
Mean	interna	l temper	ature (fo	or the wh	ole dwe	llina) = fl	LA x T1	+ (1 – fL	A) x 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	/ adjustn	nent to t	ne mear	internal	temper	ature fro	n Table	4e, whe	ere appro	opriate				
(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. Sp	ace hea	ting requ	uirement											
Set T	ï to the r	mean int	ernal tei	mperatu	re obtair	ned at ste	ep 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
the ut	tilisation	factor fo	or gains	using Ta	ble 9a			-			,			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisa	ation fac	tor for g	ains, hm	n:										
(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)
Usefu	ul gains,	hmGm	W = (94	4)m x (84	4)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)
Month	hly aver	age exte	rnal terr	perature	e from Ta	able 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	e for mea	an interr	al tempe	erature,	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	e heatin	g require	ement fo	r each n	honth, k	Wh/mon	th = 0.02	24 x [(97])m – (95)m] x (4 ⁻	1)m			
(98)m=	3891.01	3253.8	2983.12	2171.05	1314.01	0	0	0	0	1837.63	2951.47	3738.96		
								Tota	l per year	(kWh/year) = Sum(9	8)15,912 =	22141.05	(98)
Space	e heatin	g require	ement in	kWh/m ²	/year								116.53	(99)
00 En	oray roc	uiromor	te Ind	ividual b	ooting o	vetome i	neludina	miero (עםעי			l		
Sa. Li	e boatir	unemer va:	113 – 110	ividual II	eating s	ystems i	nciualing	micro-c	21 IF)					
Fracti	ion of sr	i g. bace hea	t from s	econdar	v/supple	mentary	system					I	0	7(201)
Eracti	ion of cr		t from n		om(c)	, normany	eyetem	(202) = 1	- (201) -				1	
				iairi syst				(202) = 1	(201) -	(000)]			I	
Fracti	ion of to	tal heatii	ng from	main sys	stem 1			(204) = (204)	02) x [1 –	(203)] =			1	(204)
Efficie	ency of r	main spa	ace heat	ing syste	em 1								84	(206)
Efficie	ency of s	seconda	ry/suppl	ementar	y heatin	g systen	ז, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/yea	ar
Space	e heatin	g require	ement (c	alculate	d above)								
	3891.01	3253.8	2983.12	2171.05	1314.01	0	0	0	0	1837.63	2951.47	3738.96		
(211)m	n – {[(98)m x (20	4)] + (21	I [()]m } x	100 <i></i> (2	206)								(211)
(211)11	4632.16	3873.57	3551.33	2584.59	1564.29	00)	0	0	0	2187.66	3513.65	4451,14		(2)
				200 100	100 1120		Ů	Tota	l (kWh/vea	ar) = Sum(2)	11)	=	26358 30	7(211)
											15,1012		20000.00	()
• • • •												-		
Space	e heatin	g fuel (s	econdar	y), kWh/	month									
Space = {[(98	e heatin)m x (20	g fuel (s)1)] + (2 ⁻	econdar 14) m } >	y), kWh/ (100 ÷ ()	month 208)	0	0	0	0	0	0	0		
Space = {[(98 (215)m=	e heatin 3)m x (20 0	g fuel (s 01)] + (2 0	econdar 14) m } > 0	y), kWh/ < 100 ÷ (: 0	month 208) 0	0	0	0 Tota	0	0	0	0		7(215)
Space = {[(98 (215)m=	e heatin)m x (20 0	g fuel (s 01)] + (2 ⁻ 0	econdar 14) m } > 0	y), kWh/ (100 ÷ (: 0	month 208) 0	0	0	0 Tota	0 I (kWh/yea	0 ar) =Sum(2	0 215) _{15,1012}	0	0	(215)
Space = {[(98 (215)m= Water	e heatin)m x (20 0 heating	g fuel (s 01)] + (2 ⁻ 0	econdar 14) m } > 0	y), kWh/ < 100 ÷ (; 0	month 208) 0	0	0	0 Tota	0 I (kWh/yea	0 ar) =Sum(2	0 215) _{15,1012}	0	0	(215)
Space = {[(98 (215)m= Water Output	e heatin)m x (20 0 heating t from war	g fuel (s)1)] + (2' 0 ater hea	econdar 14) m } > 0 ter (calc	y), kWh/ (100 ÷ (0 ulated al	month 208) 0 bove)	0	0	0 Tota	0 I (kWh/yea	0 ar) =Sum(2	0 215) _{15,1012} 210.78	0	0	(215)
Space = {[(98 (215)m= Water Output	e heatin)m x (20 0 heating 232.01	g fuel (s 01)] + (2 0 ater hea 204.37	econdar 14) m } > 0 ter (calc 214.36	y), kWh/ (100 ÷ (; 0 ulated al 191.77	month 208) 0 bove) 187.65	0	0 160.08	0 Tota 176.38	0 I (kWh/yea 176.24	0 ar) =Sum(2 198.88	0 215) _{15,1012} 210.78	0 = 226.3	0	(215)

(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/m	ionth								•		
(219)m = (04) m x 100 ÷ $(217)(219)m = 278.07 245.03 257.24$	230.52	226.74	222.79	213.44	235.18	234.98	239.53	252.93	271.25]	
					Tota	I = Sum(2	19a) ₁₁₂ =	-	-	2907.71	(219)
Annual totals							k	Wh/year	r	kWh/year	-
Space heating fuel used, mair	n system	1								26358.39	ļ
Water heating fuel used										2907.71	
Electricity for pumps, fans and	lelectric	keep-ho	t							,	
central heating pump:									169		(230c)
boiler with a fan-assisted flue	;								45		(230e)
Total electricity for the above,	kWh/yea	r			sum	of (230a).	(230g) =			214	(231)
Electricity for lighting										890.69	(232)
10a. Fuel costs - individual h	eating sy	stems:									
			Fu kW	el /h/year			Fuel P (Table	rice 12)		Fuel Cost £/year	
Space heating - main system	1		(21	1) x			3.4	1	x 0.01 =	817.11	(240)
Space heating - main system	2		(213	3) x			0		x 0.01 =	0	(241)
Space heating - secondary			(21	5) x			0		x 0.01 =	0	(242)
Water heating cost (other fuel)		(219	9)			3.	1	x 0.01 =	90.14	(247)
Pumps, fans and electric keep	o-hot		(23	1)			11.4	46	x 0.01 =	24.52	(249)
(if off-peak tariff, list each of (2 Energy for lighting	230a) to (230g) se	eparately (232	/ as app 2)	licable a	nd apply	fuel prie	ce accor 46	rding to x 0.01 =	Table 12a	(250)
Additional standing charges (Table 12)									106	(251)
Appendix Q items: repeat line	s (253) ai	nd (254)	as need	ded							
Total energy cost		(245)(247) + (25	50)(254)	=					1139.8461	(255)
11a. SAP rating - individual h	neating sy	vstems									
Energy cost deflator (Table 12	2)									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 – Individ	dual heati	ng syste	ems inclu	uding mi	cro-CHP)					
			En kW	ergy /h/year			Emiss kg CO	ion fac 2/kWh	tor	Emissions kg CO2/yea	r
Space heating (main system ?)		(21	1) x			0.1	98	=	5218.96	(261)
Space heating (secondary)			(21	5) x			0		=	0	(263)
Water heating			(219	9) x			0.1	98	=	575.73	(264)
Space and water heating			(26)	1) + (262)	+ (263) + (264) =				5794.69	(265)

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 m ²		(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	6 Radnor Walk 75sqm E	xtension				
Address:		16, Radnor Walk, LONDON	, SW3 4BN			
Located in:		England				
Region:		Thames valley				
UPRN:		3116159468				
Date of assessm	ent:	25 February 2014				
Date of certifica	te:	14 March 2014				
Assessment type	9:	New dwelling design stage				
Iransaction type	9:	New dwelling				
Tenure type:		UNKNOWN	nol dooling with	the property tro	neestion	
Related party di	sciosure:	Employed by the professio	nai dealing with	i the property tra	Insaction	
Dwelling design	ed to use less than	125 litres per Person	ner dav: Fals	e		
Dwennig design			per day. ruis	0		
Property description	n:					
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 m ² (fraction 0.142)				
Front of dwelling fa	aces:	Unspecified				
Opening types:						
Name:	Source:	Type:	Glazing:		Argon:	Frame:
Front	SAP 2009	Half glazed	Single-glaze	ed	No	Wood
Front	SAP 2009	Windows	Single-glaze	ed	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						
opaque Liements.						

Type: External Elements	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
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
Internal Elements						
Party Elements						
Party walls	145					N/A

No information on thermal bridging ($y=0.15$) ($y=0.15$)
No (Assumed) Natural ventilation (extract fans) 1 (main: 0, secondary: 1, other: 0) 0 5 3 15
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
Programmer, TRVs and bypass Control code: 2107 Boiler interlock: Yes
None
From main heating system Water code: 901 Fuel :mains gas No hot water cylinder Solar panel: False
standard tariff Unknown No conservatory 50% Dense urban English No None No

				User D	etails:						
Assessor Name: Software Name:	STRO Versio	000002 n: 1.5.0.63									
			Р	roperty ,	Address	: 16 Rad	Inor Wall	k 75sqm	Extensi	on	
Address :	16, Radnor	Walk, LO	ONDON	SW3 4	BN						
1. Overall dwelling dimer	isions:				()						
Ground floor				Area	a(m²) 125	(1a) x	Ave He	eight(m) 2.8	(2a) =	Volume(m³) 350	(3a)
First floor					34	(1b) x	2	2.8	(2b) =	95.2	(3b)
Second floor					34	(1c) x	2	2.8	(2c) =	95.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+	(1d)+(1e)+(1r	ı)	193	(4)			1		J
Dwelling volume						(3a)+(3b))+(3c)+(3d)+(3e)+	.(3n) =	540.4	(5)
2. Ventilation rate:											-
	main heating	So h	econdar eating	у	other		total			m ³ per hour	
Number of chimneys	0	+	1	+	0] = [1	x 4	40 =	40	(6a)
Number of open flues	0	+	0	+	0] = [0	x 2	20 =	0	(6b)
Number of intermittent far	S						5	x 1	0 =	50	(7a)
Number of passive vents							0	x 1	0 =	0	(7b)
Number of flueless gas fire	es						0	x 4	40 =	0	(7c)
									Air ch	anges per hou	ır
Infiltration due to chimney	s, flues and f	ans = (6	a)+(6b)+(7	a)+(7b)+(7c) =	Г	90	<u> </u>	÷ (5) =	0.17	(8)
lf a pressurisation test has be	en carried out o	r is intende	ed, procee	d to (17), d	otherwise o	continue fr	om (9) to ((16)].,
Number of storeys in the	e dwelling (n	s)								0	(9)
Additional infiltration								[(9)-	1]x0.1 =	0	(10)
Structural infiltration: 0.2	25 for steel or	r timber f	frame or	0.35 for	masonr	ry constr	ruction			0	(11)
if both types of wall are pre deducting areas of opening	esent, use the va gs); if equal user	lue corres _i 0.35	ponding to	the great	er wall are	a (after					-
If suspended wooden flo	oor, enter 0.2	(unseal	ed) or 0.	1 (seale	ed), else	enter 0				0	(12)
If no draught lobby, ente	er 0.05, else (enter 0								0	(13)
Percentage of windows	and doors dr	aught st	ripped		0.05 [0.0	··· (1.4) ··· 4	001			0	(14)
					$(8) \pm (10)$. X (14) + 1 + (11) + (1	00] =	L (15) -		0	(15)
	50 ovproces	nd in cub	io motro	e nor he			(12) + (13) +	nvolono	araa	0	(16)
If based on air permeabilit	y value then	(18) = [(1)	$7) \div 20]+(8)$	s per no 3) otherwi	se (18) = ((16)		ivelope	alea	15	$\int_{(10)}^{(17)}$
Air permeability value applies	if a pressurisati	on test has	been don	e or a dec	aree air pe	rmeabilitv	is beina us	sed		0.92	
Number of sides on which	sheltered				,	,				3	(19)
Shelter factor					(20) = 1 -	[0.075 x (1	9)] =			0.78	(20)
Infiltration rate incorporation	ng shelter fac	tor			(21) = (18)) x (20) =				0.71	(21)
Infiltration rate modified for	r monthly wir	nd speed									
Jan Feb I	Var Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind spe	ed from Tabl	e 7					r			l .	
(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	5 1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27		
Adjusted infi	iltration ra	te (allow	ing for sł	nelter ar	nd wind s	speed) =	(21a) x	(22a)m					
0.96	6 0.91	0.91	0.8	0.73	0.69	0.66	0.66	0.75	0.8	0.85	0.91		
Calculate ef	fective air	change	rate for t	he appli	cable ca	ise	•		-	-	-		(22-)
If exhaust ai	r beat pump	alion. Using Ann	ondix N (2	23h) - (23;	a) v Emv (equation (I		rwise (23t	u) – (23a)			0	(23a)
If balanced y	with heat rec	overv: effic	ciency in %	allowing i	for in-use f	factor (fror	n Table 4h) =) = (200)			0	(230)
a) If balan	iced mech	anical ve	entilation	with he	at recov	erv (MV	HR) (24a	, a)m = (2	2b)m + (23b) × [1 – (23c)	÷ 1001	(230)
(24a)m= 0	0	0	0	0	0	0	0	0	0	0	0		(24a)
b) If balan	iced mech	anical ve	entilation	without	heat red	covery (l	MV) (24b)m = (2	1 2b)m + (23b)	1	1	
(24b)m= 0	0	0	0	0	0	0	0	0	0	0	0		(24b)
c) If whole	e house ex	tract ver	ntilation of	or positiv	ve input	ventilatio	on from c	outside	-	-	-		
if (22b	o)m < 0.5	x (23b) , t	then (24	c) = (23t	o); other	wise (24	c) = (22k	o) m + 0	.5 × (23t) 	i		
(24c)m= 0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) If natur	al ventilati	on or wh	nole hous	se positi	ve input	ventilatio	on from 1	oft 2h)m² x	0.51				
(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 a	air change	rate - ei	nter (24a	ı ı) or (24l	u b) or (24	⊥ .c) or (24	d) in boy	(25)				I	
(25)m= 0.96	6 0.91	0.91	0.82	0.76	0.74	0.72	0.72	0.78	0.82	0.86	0.91		(25)
						4							
3 Heat los	eee and h	eat loss	naramet	or.									
3. Heat los	ses and h F Gro	eat loss ss	paramet Openin	er: as	Net Ar	.ea	U-valı	Je	AXU		k-value	9	AXk
3. Heat los	ses and h F Gro area	eat loss ss ı (m²)	parameto Openin m	er: Igs I ²	Net Ar A ,r	rea m²	U-valı W/m2	Je K	A X U (W/	K)	k-value kJ/m²·l	e K	A X k kJ/K
3. Heat los ELEMEN Doors	ses and h F Gro area	eat loss ss ı (m²)	parameto Openin m	er: Igs I ²	Net Ar A ,r 2.6	rea m²	U-valu W/m2 3.9	ue K	A X U (W/ 10.14	K)	k-value kJ/m²-l	e K	A X k kJ/K (26)
3. Heat los ELEMEN Doors Windows Ty	ses and h F Gro area vpe 1	eat loss ss ı (m²)	paramete Openin m	er: Igs I ²	Net Ar A ,r 2.6 6.8	rea m² X x1	U-valı W/m2 3.9 /[1/(4.8)+	ue K = 0.04] =	A X U (W/ 10.14 27.38	K)	k-value kJ/m²-I	e K	A X k kJ/K (26) (27)
3. Heat los ELEMEN Doors Windows Ty Windows Ty	ses and h Gro area vpe 1 vpe 2	eat loss ss ı (m²)	paramete Openin rr	er: Igs I ²	Net Ar A ,ı 2.6 6.8 10.1	rea m ² x x ¹ x ¹	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+	ue K = 0.04] = 0.04] =	A X U (W/ 10.14 27.38 15.19	к)	k-value kJ/m²•l	e K	A X k kJ/K (26) (27) (27)
3. Heat los ELEMEN Doors Windows Ty Windows Ty Windows Ty	ses and h Gro area vpe 1 vpe 2 vpe 3	eat loss ss ı (m²)	paramete Openin m	er: Igs I ²	Net Ar A , I 2.6 6.8 10.1 8.4	rea m ² x x x ¹ x ¹ x ¹	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+	Le K 0.04] = 0.04] = 0.04] =	A X U (W/ 10.14 27.38 15.19 12.63	K)	k-value kJ/m²-I	e K	A X k kJ/K (26) (27) (27) (27)
3. Heat los ELEMEN Doors Windows Ty Windows Ty Windows Ty Windows Ty	ses and h Gro area vpe 1 vpe 2 vpe 3 vpe 4	eat loss ss ı (m²)	paramete Openin m	er: Igs I ²	Net Ar A ,r 2.6 6.8 10.1 8.4 6.5	rea m ² x x x1 x1 x1 x1 x1	U-valu W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+	LE K = 0.04] = 0.04] = 0.04] = 0.04] =	A X U (W/ 10.14 27.38 15.19 12.63 9.77	K)	k-value kJ/m²-I	e K	A X k kJ/K (26) (27) (27) (27) (27)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Windows Ty	ses and h Gro area vpe 1 vpe 2 vpe 3 vpe 3 vpe 4 vpe 5	eat loss ss ι (m²)	paramete Openin m	er: lgs l ²	Net Ar A , 1 2.6 6.8 10.1 8.4 6.5 1.2	rea m ² x x 1 x ¹ x ¹ x ¹ x ¹ x ¹	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+	Le K = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8	к)	k-value kJ/m²·l	e K	A X k kJ/K (26) (27) (27) (27) (27) (27) (27)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 1	ses and h Gro area vpe 1 vpe 2 vpe 3 vpe 4 vpe 5 1	eat loss ss ı (m²)	parameto Openin m	er: Igs I ²	Net Ar A , 1 2.6 6.8 10.1 8.4 6.5 1.2 50	rea m ² × x1 x1 x1 x1 x1 x1 x1 x1 x1 x1 x1	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+	Je K = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30	к)	k-value kJ/m²+l		A X k kJ/K (26) (27) (27) (27) (27) (27) (27)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 1 Floor Type 2	ses and h Gro area rpe 1 rpe 2 rpe 3 rpe 4 rpe 5 1 2	eat loss ss ı (m²)	paramete Openin m	er: Igs I ²	Net Ar A ,r 2.6 6.8 10.1 8.4 6.5 1.2 50 75	rea m ² × 1 × ¹ x ¹ x ¹ x ¹ x ¹ x ¹	U-valt W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ 0.6 0.22	Je K = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] = = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5	K)	k-value kJ/m²-I		A X k kJ/K (26) (27) (27) (27) (27) (27) (28) (28)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 2 Floor Type 2 Walls Type1	ses and h I Groarea rpe 1 rpe 2 rpe 3 rpe 5 1 2 1 2 1 2 1 2 1 2 1 1 2	eat loss ss ı (m²) 2	paramete Openin m	er: lgs l ²	Net Ar A ,r 2.6 6.8 10.1 8.4 6.5 1.2 50 75 122	rea m ² × 1 × ¹ × ¹ × ¹ × ¹ × ¹ × ¹	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ 0.6 0.22 0.28	Je K = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] = = = = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5 34.16	K)	k-value kJ/m²·I		A X k kJ/K (26) (27) (27) (27) (27) (27) (27) (28) (28) (28) (29)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 2 Floor Type 2 Walls Type 2	ses and h I Groarea rpe 1 rpe 2 rpe 3 rpe 4 rpe 5 1 2 12 2 9	eat loss ss (m²) 2	Denin Openin m	er: lgs l ²	Net Ar A , r 2.6 6.8 10.1 8.4 6.5 1.2 50 75 122 87.6	rea m ² x x1 x1 x1 x1 x1 x1 x1 x1 x1 x1 x2 x x	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ 0.6 0.22 0.28 1.6	Je K = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] = = = = = = = = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5 34.16 140.16	к)	k-value kJ/m²·l		A X k kJ/K (26) (27) (27) (27) (27) (27) (27) (27) (27
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 2 Floor Type 2 Walls Type 1 Walls Type 2 Roof Type 1	ses and h I Groarea rpe 1 rpe 2 rpe 3 rpe 4 rpe 5 1 2 12 2 9 7	eat loss ss (m²) 2 7 5	Denin Openin m 0 9.4	er: lgs l ²	Net Ar A , 1 2.6 6.8 10.1 8.4 6.5 1.2 50 75 122 87.6 75	rea m ² x x1 x1 x1 x1 x1 x1 x1 x1 x1 x1 x1 x x x x x	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ 0.22 0.28 1.6 0.18	Je K = 0.04] = 0.04] = 0.04] = 0.04] = = = = = = = = = = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5 34.16 140.16 13.5	K)	k-value kJ/m²·l		A X k kJ/K (26) (27) (27) (27) (27) (27) (28) (28) (28) (29) (29) (30)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 1 Floor Type 1 Walls Type 1 Walls Type 2 Roof Type 1 Roof Type 1	ses and h I Groarea rpe 1 rpe 2 rpe 3 rpe 4 rpe 5 1 2 12 2 9 2 9 2 12 2 12 2 12 2 12 2 12 2 12 1 12 2 12 2 12 2 1	eat loss ss (m²) 2 7 5 7	paramete Openin m 0 9.4 0	er: lgs l ²	Net Ar A ,r 2.6 6.8 10.1 8.4 6.5 1.2 50 75 122 87.6 75 122	rea m ² x 1 x ¹ x ¹ x ¹ x ¹ x ¹ x ¹ x ² x x	U-valu W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ 0.22 0.28 1.6 0.18 0.6	Je K = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] = = = = = = = = = = = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5 34.16 140.16 13.5 10.2	K)	k-value kJ/m²-I		A X k kJ/K (26) (27) (27) (27) (27) (27) (27) (28) (28) (28) (29) (29) (29) (30)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 2 Valls Type 2 Walls Type 2 Roof Type 1 Roof Type 2 Roof Type 3	ses and h I Groarea rpe 1 rpe 2 rpe 3 rpe 4 rpe 5 1 2 9 7 2 9 7 3 3	eat loss ss (m²) 2 7 5 7 7	paramete Openin m 0 9.4 0 0	er: lgs l ²	Net Ar A , r 2.6 6.8 10.1 8.4 6.5 1.2 50 75 122 87.6 75 122 87.6 75 122	rea m ² x 1 x ¹ x ¹ x ¹ x ¹ x ¹ x ¹ x ¹ x ² x ² x ² x ²	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ 0.6 0.22 0.28 1.6 0.18 0.6	Je K = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] = = = = = = = = = = = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5 34.16 140.16 13.5 10.2 22.2	K)	k-value kJ/m²-I		A X k kJ/K (26) (27) (27) (27) (27) (27) (27) (27) (28) (28) (28) (29) (29) (29) (30) (30) (30)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 2 Floor Type 2 Walls Type 2 Roof Type 1 Roof Type 3 Total area o	ses and h I Groarea rpe 1 Groarea rpe 2 Groarea rpe 3 Groarea rpe 4 Groarea rpe 5 Groarea 1 Groarea 2 Groarea 2 Groarea 2 Groarea 3 Groarea 4 Groarea 5 Groarea 6 Groarea 7 Groarea 1 Groarea 1 <td>eat loss ss (m²) 2 7 5 7 5 7 5 7 5 5 7 5 5 7 5 5 7</td> <td>paramete Openin m 0 9.4 0 0 0</td> <td>er: lgs l²</td> <td>Net Ar A , r 2.6 6.8 10.1 8.4 6.5 1.2 50 75 122 87.6 75 122 87.6 75 17 37</td> <td>rea m² x 1 x¹ x¹ x¹ x¹ x¹ x¹ x²</td> <td>U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ 0.6 0.22 0.28 1.6 0.6</td> <td>Je K = 0.04] = 0.04] = 0.04] = 0.04] = = = = = = = = = = = = =</td> <td>A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5 34.16 140.16 13.5 10.2 22.2</td> <td>K)</td> <td>k-value kJ/m²-l</td> <td></td> <td>A X k kJ/K (26) (27) (27) (27) (27) (27) (27) (27) (28) (28) (28) (28) (29) (29) (29) (29) (30) (30) (30) (31)</td>	eat loss ss (m²) 2 7 5 7 5 7 5 7 5 5 7 5 5 7 5 5 7	paramete Openin m 0 9.4 0 0 0	er: lgs l ²	Net Ar A , r 2.6 6.8 10.1 8.4 6.5 1.2 50 75 122 87.6 75 122 87.6 75 17 37	rea m ² x 1 x ¹ x ¹ x ¹ x ¹ x ¹ x ¹ x ²	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ 0.6 0.22 0.28 1.6 0.6	Je K = 0.04] = 0.04] = 0.04] = 0.04] = = = = = = = = = = = = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5 34.16 140.16 13.5 10.2 22.2	K)	k-value kJ/m²-l		A X k kJ/K (26) (27) (27) (27) (27) (27) (27) (27) (28) (28) (28) (28) (29) (29) (29) (29) (30) (30) (30) (31)
3. Heat los ELEMENT Doors Windows Ty Windows Ty Windows Ty Windows Ty Windows Ty Floor Type 2 Walls Type 1 Walls Type 2 Roof Type 2 Roof Type 3 Total area o Party wall	ses and h Groarea rpe 1 rpe 2 rpe 3 rpe 4 rpe 5 1 2 9 12 9 12 9 12 13 3 3 3 3 1	eat loss ss (m²) 2 7 5 7 7 5 7 5 7 5 7 5 7 5 5 7 7 5 5 7	paramete Openin m 0 9.4 0 0 0	er: lgs l ²	Net Ar A , r 2.6 6.8 10.1 8.4 6.5 1.2 50 75 122 87.6 75 122 87.6 75 122 87.6 177 37	rea m ² x 1 x ¹ x ¹ x ¹ x ¹ x ¹ x ¹ x ² x x x x x x x x x x x x x x x x x x x	U-valı W/m2 3.9 /[1/(4.8)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ /[1/(1.6)+ [0.6 0.22 0.28 1.6 0.18 0.6 0.6	Je K = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] = = = = = = = = = = = = = = = = = = =	A X U (W/ 10.14 27.38 15.19 12.63 9.77 1.8 30 16.5 34.16 140.16 13.5 10.2 22.2	K)	k-value kJ/m²-I		A X k kJ/K (26) (27) (27) (27) (27) (27) (28) (28) (28) (29) (29) (29) (29) (30) (30) (30) (31) (31)

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

Fabric heat loss, $W/K = S (A \times U)$

(26)...(30) + (32) =

343.64 (33)

Heat c	apacity	Cm = S(Axk)						((28)	.(30) + (32	2) + (32a).	(32e) =	42897.4	(34)
Therm	al mass	parame	ter (TMF	- Cm	: TFA) ir	n kJ/m²K			Indica	tive Value:	Medium		250	(35)
For desi can be ι	gn assess Ised instea	ments wh ad of a dei	ere the de tailed calci	tails of the ulation.	construct	ion are no	t known pr	ecisely the	indicative	values of	TMP in Ta	able 1f		
Therm	al bridge	es : S (L	x Y) cal	culated u	using Ap	pendix l	K						74.88	(36)
if details	of therma	al bridging	are not kn	own (36) =	= 0.15 x (3	1)								_
Total fa	abric he	at loss							(33) +	(36) =			418.52	(37)
Ventila	tion hea	at loss ca	alculated	monthl	y I				(38)m	= 0.33 × (25)m x (5)		1	
(00)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	-	(20)
(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 tr	ansfer o	coefficier	nt, W/K				1		(39)m	= (37) + (3	38)m I		1	
(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	505.74	
Heat lo	oss para	meter (H	HLP), W/	′m²K					ہ (40)m	4verage = = (39)m ÷	Sum(39)₁. √(4)	12 /12=	565.74	(39)
(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)
NUMDE	er of day	s in moi			Mari		1.1	A	0	0	Neur	Dee	1	
(11)	Jan	Feb	Mar	Apr		Jun	JUI	Aug	Sep	Oct	NOV	Dec		(41)
(41)m=	31	20	31	30	31	30	31	31	30	31	30	31		(41)
1 \//c	tor boot	ing one		romonti									0.071	
4. 886	lier neal	ing ener	gy requ	irement.								KVV11/y	ear.	
Assum if TF	ed occu A > 13.9	ipancy, l 9, N = 1	N + 1.76 x	[1 - exp	(-0.0003	849 x (TF	FA -13.9)2)] + 0.0)013 x (1	ГFА -13.	<u>2</u> . 9)	99]	(42)
if TF	A £ 13.9	9, N = 1				,	·	, ,-	,		,		-	
Annua <i>Reduce</i>	l averag	e hot wa al average	ater usag hot water	ge in litre usage by s	es per da 5% if the o	ay Vd,av Iwelling is	erage = designed t	(25 x N) to achieve	+ 36 a water us	se target o	11().82		(43)
not more	e that 125	litres per p	person per	day (all w	vater use, l	hot and co	ld)			J				
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec]	
Hot wate	er usage ii	n litres per	day for ea	ach month	Vd,m = fa	ctor 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 = Su	m(44) ₁₁₂ =	-	1329.84	(44)
Energy o	content of	hot water	used - cal	culated mo	onthly = 4.	190 x Vd,r I	m x nm x L I	01 m / 3600	kWh/mon	oth (see Ta	ables 1b, 1 I	c, 1d)	1	
(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		-
lf instan	taneous w	ater heatii	ng at point	of use (no	o hot water	^r storage),	enter 0 in	boxes (46)) to (61)	Fotal = Su	m(45) ₁₁₂ =	=	1747.8	(45)
(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:											J	
a) If m	anufactu	urer's de	clared lo	oss facto	or is knov	vn (kWh	/day):					0]	(47)
Tempe	erature fa	actor fro	m Table	2b								0]	(48)
Energy	lost fro	m water	storage	, kWh/ye	ear			(47) x (48)	=			0]	(49)
If man Cylinde	ufacture er volum	r's decla ne (litres)	red cylir) includir	nder loss ng any s	s factor is olar stor	s not kno age with	own: ain same					0	1	(50)
If con	nmunitv he	eating and	no tank in	ng any o ndwellina.	enter 110	litres in bo	x (50)					0	J	(00)
Other	wise if no	stored ho	t water (th	is includes	instantan	eous com	bi boilers)	enter '0' in	box (50)					
Hot wa	iter stora	age loss	factor fr	om Tabl	le 2 (kWl	h/litre/da	ay)					0]	(51)
Volum	e factor	from Ta	ble 2a									0	j	(52)
Tempe	erature fa	actor fro	m Table	2b								0	1	(53)

Energy Enter (Energy lost from water storage, kWh/year Enter (49) or (54) in (55)							((50) x (51) x (52) x (53) =				0		(54)
Water	storage	loss cal	culated :	for each	month			((56)m = (55) × (41)ı	m		0		(00)
(56)m-						0	0		0	0	0	0		(56)
If cylinde	er contain	s dedicate	d solar sto	rage, (57)	m = (56)m	x [(50) – (U 0 H11)] ÷ (5	0), else (5	7)m = (56)	m where (H11) is fro	m Append	ix H	(00)
(57)m-	0	0	0		0			0	0	0	0	0		(57)
(37)11-	0	0	0		0	0	0	0	0	0		0		(01)
Primar	y circuit	loss (ar	nual) fro	om Table	∋3 maanth (F0)m		NE (44)				0		(58)
(mo	y circuit dified by	factor f	rom Tab	le H5 if f	here is s	olar wat	(oo) - oo ter heatii	o x (41) ng and a	u cylinder	r thermo	stat)			
(59)m=		0								0	0	0		(59)
Combi			for ooob	month	(61)m -	(60) · 20	L SE v (41)	l						
(61)m-	1055 Ca		50.06		(01) $(11) = 100$		50 x (41)	50.06	40.22	50.06	40.22	50.06		(61)
Totol h	50.50	uired for	unotor h			49.19	b month	(62)m	0.95/	(45)m	(46)m +	(F7)m +	(E0)m + (61)m	(01)
								(02)III =	176 25	(45)III +	(40)111 +	(57)111 +	(59)11 + (61)11	(62)
(02)III=								(optor '0	/ if no colo	r contribut		220.45		(02)
(add a	dditiona	l lines if	FGHRS	and/or \		annlies	see An	nendix (r contribut	ION IO WAIE	er neaung)		
(63)m=		0							0	0	0	0		(63)
		ator hoa	tor		Ů	Ĵ	Ů	Ů	Ů	Ů	Ů	Ů		
(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		
(0.)								Outr	but from wa	ater heate	r (annual)	12	2347.54	(64)
Heatin	ains fro	m water	heating	k\//h/m	onth 0.2	5 v [0 85	v (15)m) ⊥ (61)n	n] ± 0.8 v	v [(46)m	+ (57)m	u ⊥ (50)m	1	J, ,
(65)m=	72.99	64 2	67 12	59 74	58 23	51 55	49.08	54 48	54 57	61.97	+ (37)m	71 09	'] 	(65)
inclu	udo (57)			of (65)m					or bot w	otor ic fr		munity h		()
E lo						yinder i	Sintie	Jwennig	of not w			munity n	leating	
5. III	lemai ga	ans (see		o and ba).									
Metab	olic gair	s (Table	<u>5), Wat</u>	ts Apr	Mov	lun	1.1	Aug	Son	Oct	Nov	Dee		
(66)m-	Jan 179.57	179.57	179.57	Api 179.57	179.57	179.57	Jui 179.57	Aug	3ep	179.57	179.57	179.57		(66)
	a aoine					ion 1.0 o	r 1 0a) a			179.57	179.57	179.57		(00)
	g gains				L, equat		r L9a), a			105.22	122.02	121.04		(67)
(07)III=	127.3	113.24	92.09	09.72	JZ.12	44	47.04		02.90	105.52	122.92	131.04		(07)
Appila	nces ga	Ins (calc	ulated in				13 Or L1	3a), also 1404			402.00	540.0		(69)
(68)m=	. 543.8	, , , ,	535.22	504.95	466.73	430.82	406.82	401.18	415.4	445.67	483.89	519.8		(00)
Cookir	ng gains		ited in A	ppendix	L, equat	tion L15	or L15a)), also se	e Table	5			l	(00)
(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	s and fai	ns gains	(Table !	5a)	I								l	(70)
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10		(70)
Losses	s e.g. ev	aporatic	n (nega	tive valu	es) (Tab	ole 5)	i	i	i	i	i	i	I	
(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 (T	able 5)										l	
(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 i	internal	gains =	:			(66)	m + (67)m	n + (68)m +	+ (69)m + ((70)m + (7	1)m + (72)	m	I	
(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. So	lar gains	S:												

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

Orienta	tation: Access Factor Table 6d		r	Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c	Gains (W)		
North	0.9x	0.3	x	1.2	×	10.73	×	0.63	×	0.7] =	1.53	(74)
North	0.9x	0.3	x	1.2	x	20.36	×	0.63	×	0.7] =	2.91	(74)
North	0.9x	0.3	x	1.2	x	33.31	×	0.63	×	0.7] =	4.76	(74)
North	0.9x	0.3	x	1.2	x	54.64	×	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	×	0.63	×	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	×	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	×	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	×	0.63	x	0.7	=	98.05	(76)
East	0.9x	1	x	6.8	x	73.6	×	0.85	×	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	×	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	×	0.63	×	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	>	k	6.5	5	x	3	8.52	x		0.63	×	0.7	=		29.81	(80)
West	0.9x	0.77	,	<	10.	1	×	6	51.57	x		0.63	ا × آ	0.7	= =		190.03	(80)
West	0.9x	0.3)	ĸ	6.5	5	×	6	51.57	x		0.63	×	0.7			47.65	(80)
West	0.9x	0.77)	<	10.	1	x	g	1.41	x		0.63	×	0.7	=		282.15	(80)
West	0.9x	0.3)	< İ	6.5	5	x	g	1.41	x		0.63	×	0.7			70.75	(80)
West	0.9x	0.77)	ĸ	10.	1	×	1	11.22	x		0.63	×	0.7	_ =		343.3	(80)
West	0.9x	0.3)	<	6.5	5	x	1	11.22	x		0.63	×	0.7	= =		86.08	(80)
West	0.9x	0.77)	ĸ	10.	1	x	1	16.05	x		0.63	×	0.7	=		358.22	(80)
West	0.9x	0.3)	ĸ	6.5	5	x	1	16.05	x		0.63	×	0.7	=		89.82	(80)
West	0.9x	0.77	>	<	10.	1	×	1	12.64	x		0.63	x	0.7	=		347.69	(80)
West	0.9x	0.3)	ĸ	6.5	5	x	1	12.64	x		0.63	×	0.7	=		87.18	(80)
West	0.9x	0.77)	ĸ	10.	1	x	g	8.03	x		0.63	×	0.7	=		302.6	(80)
West	0.9x	0.3)	ĸ	6.5	5	×	g	8.03	x		0.63	×	0.7	=		75.87	(80)
West	0.9x	0.77)	<	10.	1	×	-	73.6	x		0.63	x	0.7	=		227.19	(80)
West	0.9x	0.3	>	ĸ	6.5	5	×	-	73.6	x		0.63	×	0.7	=		56.97	(80)
West	0.9x	0.77)	<	10.	1	x	4	6.91	x		0.63	×	0.7	=		144.79	(80)
West	0.9x	0.3)	ĸ	6.5	5	x	4	6.91	x		0.63	x	0.7	=		36.31	(80)
West	0.9x	0.77	>	k	10.	1	x	2	4.71	x		0.63	x	0.7	=		76.26	(80)
West	0.9x	0.3)	k	6.5	5	x	2	4.71	x		0.63	×	0.7	=		19.12	(80)
West	0.9x	0.77)	ĸ	10.	1	x	1	6.39	x		0.63	×	0.7	=		50.6	(80)
West	0.9x	0.3)	ĸ	6.5	5	×	1	6.39	x		0.63	x	0.7	=		12.69	(80)
Solar	gains in	watts, cal	culate	d	for eacl	n mon	th			(83)m	n = Su	um(74)m	.(82)m			_		
(83)m=	153.85	298.14	476.64		708.44	863.2	1 9	01.52	874.67	760).2	570.02	363.09	9 191.26	126.92	2		(83)
lotal	gains – i	nternal ar		ar - T	(84)m =	: (73)n	$\frac{1+(}{1+()}$	83)m	, watts			4000.00		7 1015 00				(0.4)
(84)m=	1049.06	1182.17	1319.97	1	1491.88	1586.1	3 1	573.74	1520.81	1422	2.21	1269.96	1123.1	7 1015.63	999.12	<u> </u>		(04)
7. M	ean intei	rnal tempe	erature	e (I	heating	seaso	on)											_
Tem	perature	during he	eating	pe	eriods ir	the li	ving	area	from Tal	ole 9	, Th1	1 (°C)					21	(85)
Utilis	ation fac	ctor for ga	ins for	· liv	ving are	ea, h1,	m (s	see Ta	ble 9a)	<u> </u>						-		
	Jan	Feb	Mar	+	Apr	Ma	/	Jun	Jul	A	ug	Sep	Oct	Nov	Dec	;		(22)
(86)m=	1	1	0.99		0.99	0.97		0.93	0.85	0.8	36	0.96	0.99	1	1			(86)
Mea	n interna	l tempera	ture in	<u>li</u>	ving are	ea T1	(follo	ow ste	ps 3 to 7	7 in T	able	e 9c)		_	r	_		
(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)
Tem	oerature	during he	eating	ре	eriods ir	rest o	of dv	velling	from Ta	able	9, Th	n2 (°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)
Utilis	ation fac	ctor for ga	ins for	· re	est of d	velling	j, h2	,m (se	e Table	9a)								
(89)m=	1	0.99	0.99	Τ	0.98	0.94		0.85	0.59	0.6	61	0.91	0.98	0.99	1			(89)
Mea	n interna	l tempera	ture in	n tł	he rest	of dwe	ellinc	1 T2 (f	ollow ste	eps 3	to 7	in Table	e 9c)	•				
(90)m=	16.08	16.28	16.71	Ţ	17.24	17.92		, <u> </u>	18.79	18.	78	18.32	17.55	16.68	16.2	٦		(90)
	L	· · · · ·		-							(fl	A = Liv	ving area ÷ (4	4) =	1	0.14	(91)
Mea	n interna	l tempera	turo (f	'n	the wh	ole du	رماllir	nu) — ti	Δ 🗸 Τ1	+ (1	_ fl .	Δ) v T2				L		
(92)m=	16.33	16.53	16.96	T	17.48	18.16		<u>וי – ופי</u> 18.72	19.05	19.	04	18.56	17.79	16.93	16.44	٦		(92)
					-	-						-	-					

/ adjustr	nent to t	he mear	n interna	l temper	ature fro	m Table	4e, whe	ere appro	opriate				
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)
ace hea	ting requ	uirement	i .				•						
i to the i	mean int	ernal ter	mperatu	re obtair	ned at ste	əp 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
tilisation	factor fo	or gains	using Ta	able 9a									
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
ation fac	tor for g	ains, hm): •										
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)
ul gains,	hmGm	W = (94	4)m x (84	4)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)
hly aver	age exte	rnal tem	perature	e from Ta	able 8								
4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9		(96)
loss rate	e for mea	an intern	al tempe	erature,	Lm , W =	=[(39)m :	x [(93)m	– (96)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)
e heatin	g require	ement fo	r each n	nonth, k	Wh/mont	th = 0.02	24 x [(97))m – (95)m] x (4 ⁻	1)m			
4415.87	3713.65	3424.1	2531.33	1569.85	0	0	0	0	2123.96	3368.94	4249.74		
							Tota	l per year	(kWh/year	.) = Sum(9	8)15,912 =	25397.43	(98)
o hoatin	a require	amont in	k \/h/m2	2/voar							ſ	121 50	
eneaun	grequit			/year							<u> </u>	131.39	(00)
ergy rec	quiremer	nts – Indi	ividual h	eating s	ystems i	ncluding	micro-C	CHP)					
e heatin ion of sp	ng: bace hea	t from s	econdar	y/supple	mentary	system					ſ	0	(201)
ion of sp	ace hea	t from m	nain syst	em(s)			(202) = 1 -	- (201) =			Ī	1	(202)
ion of to	tal heati	ng from	main sys	stem 1			(204) = (2	02) × [1 – ((203)] =			1	(204)
ency of I	main spa	ace heat	ing syste	em 1								84	(206)
ency of s	seconda	ry/suppl	ementar	y heating	g system	ו, %						0	(208)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	 ar
e heatin	a require	ement (c	alculate	d above)		<u></u>					,	
4415.87	3713.65	3424.1	2531.33	1569.85	0	0	0	0	2123.96	3368.94	4249.74		
) m x (20	4)1 + (21		100 · (2									(211)
5256.98	4421 01	4076.31	3013 49	1868 87		0	0	0	2528 53	4010 64	5059 21		(211)
0200.00	1121101	101 0.01		1000.07	Ů	Ŭ	Tota	 I (kWh/vea	r = Sum(2)	211)	=	20225.04	7(211)
								. (15,1012		30235.04	(211)
e neatin	g tuel (s	econdar	y), kvvn/	month									
$\int \frac{1}{\sqrt{2}}$)] + (2 0	(4) m	(100÷(208)	0	0	0	0	0	0			
0	0	0	0	0	0	0	U			0	0		
							Tota	r (kvri/yea	ar = 5um(2	213) _{15,1012}	Ē	0	(215)
heating	J												
t from w	ater hea	ter (calc	ulated a	bove)	407.04	400.00	470.40	470.05	100.01	040.00	000.45		
232.17	204.51	214.5	191.9	187.77	167.24	160.22	176.49	176.35	199.01	210.92	226.45		-
ncy of w	ater hea	ter		i								75	(216)
83.5	83.48	83.41	83.3	82.94	75	75	75	75	83.15	83.41	83.49		(217)
or water $n = (64)$	heating, m x 100	kWh/ma (217) ∸ (217)	onth										
· - (0+)		<u>, , , , , , , , , , , , , , , , , , , </u>	1	· · · · · · · · · · · · · · · · · · ·	i	i							
278.05	244.99	257.17	230.38	226.4	222.99	213.63	235.33	235.13	239.35	252.87	271.22		
	r adjustn adjustn 16.33 ace hea i to the r tilisation Jan Jan ation fac 0.99 al gains, 1041.45 hly avera 4.5 loss rate 6976.76 e heatin 4415.87 e heatin e heatin e heatin fon of sp ion of to e ncy of r e heatin 4415.87 n = {[(98 5256.98 e heatin 1415.87 n = {[(98 5256.98 e heatin 1415.87 n = {[(98 5256.98 e heatin 1415.87 n = {[(98 5256.98 e heatin 1415.87 n = {[(98 5256.98 e heatin 1232.17 ncy of w 1232.17 ncy of w 1232.17 ncy of w	r adjustment to till 16.33 16.53 ace heating required i to the mean intentialisation factor for Jan Feb ation factor for gr 0.99 0.99 algains, hmGm, 1041.45 1170.22 hly average extent 4.5 5 loss rate for meat 6976.76 6696.48 e heating require 4415.87 3713.65 e heating require ency of space heat ion of space heat an Feb e heating require 4415.87 3713.65 an Feb e heating require (4415.87 3713.65 an Feb e heating require (4415.87 3713.65 an (198)m x (20 5256.98 4421.01 e heating fuel (s.)m x (201)] + (2') 0 0 0	a adjustment to the mean16.3316.5316.96ace heating requirementi to the mean internal tentilisation factor for gainsJanFebMaration factor for gains, hm0.990.990.98al gains, hmGm, W = (94)1041.451170.221296.94hly average external temt4.556.8loss rate for mean interm6976.766696.485899.23e heating requirement for4415.873713.653424.1e heating requirements – Inde heating:ion of space heat from mion of secondary/supplJanFebMare heating requirement (of4415.873713.653424.1n = {[(98)m x (204)] + (21)m = (201)] + (214) m } >00000000heatingfrom water heater (calc232.17204.51214.5ncy of water heater83.583.4883.48an water heating, kWh/moan (64)m x 100 ÷ (217)	r adjustment to the mean interna16.3316.5316.9617.48ace heating requirementi to the mean internal temperaturii to the mean internal temperaturiiisation factor for gains, hm:0.990.990.990.990.980.97Il gains, hmGm , W = (94)m x (8)1041.451170.221296.941444.361041.451170.2210ss rate for mean internal temperature4.556.88.7loss rate for mean internal 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Ti,m=(76)m an illiaation factor for gains, swing Table 9a Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov 0.99 0.98 0.97 0.93 0.84 0.63 0.65 0.9 0.97 0.99 1041.46 1170.22 129.64 144.36 1475.02 1321.56 951.3 924.68 1140.61 1091.51 1005.47 hly average external temperature, torm Table 8 4.5 5 6.8 8.7 11.7 14.6 16.9 14.3 10.8 7 loss rate for mean internal temperature, torm Table 8 16.9 14.3 10.8 7 Issa 6896.45 5899.23 4960.1 3585.04 2265.2 1172.49 1167.3 2375.09 3946.31 5884.55 hetating requirement for each month, kWh/m2/year Tot	adjustment to the mean internal temperature from Table 4e, where appropriate 16.33 16.36 16.46 16.33 16.36 16.46 ace heating requirement it to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calc illaction factor for gains, using Table 9a Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 0.99 0.99 0.98 0.97 0.93 0.84 0.65 0.9 0.97 0.99	radjustment to the mean internal temperature from Table 4e, where appropriate 16.33 16.45 17.48 17.48 18.15 17.79 16.93 16.44 266 heating requirement Ito the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate iliastion factor for gains using Table 9a Ito Table 9a Ito Table 9a Ito Apr May Jun Jul Aug Sep Oct Nov Dec 10 the mean internal temperature from Table 8 Ito Ang O.99 0.99

Annual totals		kWh/year	kWh/year
Water besting fuel used			30235.04
Electricity for pumps fore and electric ke	on hot		2907.51
electricity for pumps, fans and electric ke	ep-not		()200
central heating pump.		16	39 (2300
		4	.5 (2306
I otal electricity for the above, kWh/year		sum of (230a)(230g) =	214 (231)
Electricity for lighting			900.65 (232)
10a. Fuel costs - individual heating syst	ems:		
	Fuel kWh/year	Fuel Price (Table 12)	Fuel Cost £/year
Space heating - main system 1	(211) x	3.1 × 0.0)1 = 937.2863 (240)
Space heating - main system 2	(213) x	0 × 0.0	01 = 0 (241)
Space heating - secondary	(215) x	0 × 0.0	01 = 0 (242)
Water heating cost (other fuel)	(219)	3.1 × 0.0)1 = 90.13 (247)
Pumps, fans and electric keep-hot	(231)	11.46 × 0.0)1 = 24.52 (249)
(if off-peak tariff, list each of (230a) to (23 Energy for lighting	30g) separately as applica (232)	able and apply fuel price according	to Table 12a 01 = 103.21 (250)
Additional standing charges (Table 12)			106 (251)
Appendix Q items: repeat lines (253) and Total energy cost	l (254) as needed (245)(247) + (250)(254) =		1261.1579 (255)
11a. SAP rating - individual heating sys	tems		
Energy cost deflator (Table 12)			(256)
Energy cost denator (FCE)	[(255) x (256)] ÷ [(4) + 45.0] =		2,4905 (257)
SAP rating (Section 12)			65.2572 (258)
12a. CO2 emissions – Individual heating	g systems including micro	o-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) + (2	263) + (264) =	6562.23 (265)
Electricity for pumps, fans and electric ke	ep-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 m ²		(272) ÷ (4) =	36.99 (273)

El 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)