





Energy Demand Study

Longridge

Client: Barratt Manchester Author: Michael Woodbridge



www.environmental-economics.co.uk

Revision History

Version	Date	Reason for Issue	lssued by	QA check
1	09/02/2016	Report provided in support of planning application	M-D-U Michael Woodbridge	Zach Sifakis

Contents

1 Project Overview	1
1.1 Introduction	1
1.2 Description of Site	1
1.3 Local Planning Requirements	1
2 Improvement Measures	2
2.1 Assessment Methodology	2
2.2 Design Philosophy	3
2.3 Specification Improvements	4
3 Evaluation	7
3.1 Conclusion	7
Appendix A	
Appendix B	
Appendix C	
Appendix D	
Appendix E	

1. Project Overview

1.1. Introduction

This sustainability study was prepared by Environmental Economics Ltd on behalf of Barratt Homes Manchester (BHM) to support a planning application for a proposed development. The report assesses measures to reduce the energy demand for the domestic housing on site through an improvement in materials and products used.

1.2. Description of Site

The Longridge site consists of 118 dwellings. These units comprise a range of detached, semi-detached and terraced dwellings, as well as some apartment blocks.

The current site use is shown in Appendix A. The proposed site location/boundary for the whole site is shown in Appendix B.

This energy study addresses a domestic development being undertaken by BHM, and does not include any further proposals for subsequent developments or non-residential parcels.

1.3. Client Brief

BHM intent to reduce the energy consumption on the development by a fabric first approach and as such various upgrades to the fabric specification have been made in order to reduce energy demand.

This report quantifies these improvements to the building fabric and products in context of resultant reduction in energy demand against Part L 2013.

2. Improvement Measures

2.1. Assessment Methodology

Environmental Economics have modelled the proposed dwellings using NHER Plan Assessor software. The software provides a number of outputs which can be used to assess and compare the improvements from any number of build specifications in terms of:

- Building regulations compliance
- Energy usage per year (kWh/annum)
- Carbon emissions as a measure of building regulations compliance (kg CO_2/m^2 /year)
- Energy costs per year (£/annum)
- More detailed breakdowns by end use (space heating, water heating, cooking, lighting, appliances)
- Code for Sustainable Homes compliance
- Effective air change rate

Each of these outputs can be used in different ways to analyse the performance of the dwelling. For this project the requirement as set out in the previous section relates to a reduction in energy demand.

The analysis, therefore, evaluated the regulated energy usage per year for each of the properties on site. The total regulated energy demand for each property is based upon:

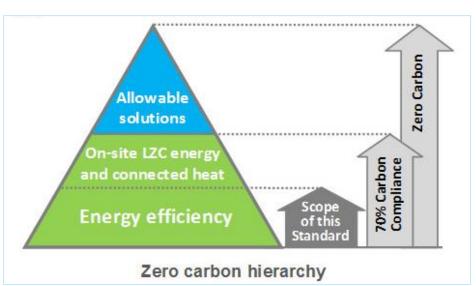
- Space heating
- Water heating
- Electricity for pumps and fans
- Electricity for lighting

Two models were created in order to calculate the difference in energy demand from the specification improvements. The total energy demand for the site is calculated for each of the models, and then the difference used to establish the level of improvement.

The energy calculation for the space and water heating, as well as the electricity for pumps, fans and lighting were all assessed using the Standard Assessment Procedure (SAP 2013) through version 6 of the NHER Plan Assessor software. An example of a SAP worksheet is shown in Appendix E.

2.2. Design Philosophy

BHM have upgraded a number of elements from their standard build specification in order to improve energy efficiency across the development. The site adopts the good design principles endorsed and promoted by The Zero Carbon Hub, the construction industries' key advisors and partners with the Governments Communities and Local Government Department. This guidance follows the general good principles of energy efficiency as the industry moves towards zero carbon. The principles are illustrated in figure 1 below.



In order to reduce the residual carbon emissions a number of improvements were made to the standard material and product specification. These improvements include:

- Upgraded heating and hot water controls
- Delayed start controls
- Design air permeability of 5.01m³/hr/m²
- Bespoke thermal bridging details

2.3. Specification Improvements

In order to improve energy efficiency the products and the fabric of the dwellings was improved to an enhanced specification.

2.3.1. Product Improvements

The systems used in a property to supply hot water and heating, as well as control it, are important to the overall energy demand of a property. The 2013 Building Regulations state that all systems and their controls must adhere to the minimum standards shown in Domestic Heating Compliance Guide.

For a mains gas fired system the minimum boiler efficiency required is 86%. BHM intend to use Ideal Logic condensing boilers throughout the site for both combination and cylinder based systems. These boilers achieve an efficiency of at least 91% and are recommended by the Energy Saving Trust.

Where installed, hot water cylinders can lose a significant amount of energy. In order to minimise this energy loss and corresponding carbon emissions BHM will utilise Kingspan Tribune Cylinders which have higher levels of insulation in comparison to typical hot water cylinders.

Finally 100% Low-E lighting fixtures shall be fitted to all properties.

2.3.2. Fabric Improvements

The building fabric for all dwellings was improved from basic compliance with Part L1A 2013 to an enhanced specification. These fabric improvements reduce the space heating requirement upon a property. The improvements have been made through a combination of upgraded materials and increased insulation thicknesses. Enhanced glazing with a larger transmittance factor allowing for increased solar gains will also be used. A summary of typical compliant specifications are given in table 1, with the proposed specifications and performance shown in table 2 below.

Table 1

Element	Typical Specification	Performance W/m ² K
Roof	300mm Mineral Wool Insulation	0.15
Floors	100mm Polystyrene Insulation	0.20 - 0.25
Doors	Standard u-PVC Doors	2.20
Glazing	Standard Double Glazed	2.20
Walls	Cavity Wall with 50mm Polystyrene Board Insulation	0.32 - 0.35

Table 2

Element	Proposed Specification	Performance W/m ² K
Roof	400mm Mineral Wool Insulation	0.11
Floors	150mm Platinum Insulation	0.12 – 0.16
Doors	Insulated composite doors	1.00 – 1.70
Glazing	High performance double glazed, low-e coated with Argon fill	1.41
Walls	Cavity wall with 50mm Alreflex Platinum Board Insulation	0.27

As improvements are made to the thermal conductivity of main elements, thermal bridging and air permeability becomes increasingly significant in the overall fabric performance. BHM utilise bespoke thermal bridging designs assessed by H&H Celcon, which achieve much lower heat loss levels in comparison with standard practice.

As a result of following these junction details and focusing on build quality air permeability will also decrease. A target air pressure rating of 5.01m³/hr.m² has been set for all houses on site which is a 50% improvement on the maximum allowable rating in the 2013 Building Regulations.

2.3.3. Hi-Therm Lintels

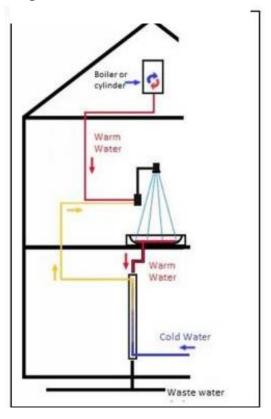
As the latest set of building regulations have incorporated a Target Fabric Energy Efficiency (TFEE) standard for all new houses, some of the bespoke thermal bridging details would not be sufficient to achieve the latter.

Since a significant amount of heating energy is lost through the dwelling's lintels, BHM intend to use IG Hi-Therm lintels on some house types. IG Hi-Therm lintels achieve a lower linear thermal transmittance (Psi value) of 0.05W/mK, in comparison to the normal IG lintels which achieve a Psi value of 0.23W/mK. More details are shown in Appendix D.

2.3.4. Waste Water Heat Recovery Systems (WWHRS)

WWHRS recovers heat from the warm waste water as it passes through a double walled heat exchanger, before going in the drainage system. The heat is transferred to the mains cold water supply, which is then supplied to the mains cold feed to the shower and/or a combination boiler or a hot water storage cylinder.

This process makes a significant reduction to the energy demand for providing hot water. The energy recovered depends on the temperature of the cold water feed to the dwelling, which varies by month, and the number of systems that are installed. The WWHRS is installed vertically below the point of demand, i.e. within the waste ducting below the shower or bath. A simple schematic of a WWHRS is shown in figure 2. The WWHRS will be installed in some of the house types. Fig. 2



3. Evaluation

3.1. Conclusion

The table presented in Appendix C shows the energy saving that the improved spec will achieve in comparison to base compliance with Part L 2013 building regulations.

The total energy demand of the Part L 2013 base compliance model is 703.6MWh/Annum. The total energy demand for the actual model with the improved specification is 683.8MWh/Annum. This results in an average energy reduction of 2.8% across the site.

Approved for Release

Date: 09/02/2016

Appendix A



Appendix B



Appendix C

Client:	Barratt Manchester										
Project:	Longridge					nomic					
Report:	Energy Reduc	ction			CCU						
House Type/ Plot Number	Space Heating Requirement	Hot Water Requirement	Lighting Requirement	Pumps and Fans Requirement	SAP Floor Area	Number of Plots	Total Energy Demand ^{#1}				
-	kWh/Annum	kWh/Annum	kWh/Annum	kWh/Annum	m²	-	kWh/Annun				
Data Set 1: Base Case	Design (Part L	2013 Complia	nt)								
Ashford End Base	2334	1773	276	75	59	16	71,343				
Ashford Mid Base	1957	1775	276	75	59	2	8,166				
Bampton Mid Base	2389	1886	305	75	69	2	9,309				
Bampton End Base	2849	1884	305	75	69	10	51,133				
Barwick End Base	3076	1969	357	75	77	12	65,719				
Beadle End Base	2350	1726	266	75	55	10	44,174				
Cheadle Det Base	4636	1790	369	75	88	6	41,225				
Faringdon Det Base	4533	2168	411	75	103	2	14,377				
Helmsley Mid Base	2967	2187	443	75	110	1	5,673				
Helmsley End Base	3872	2171	438	75	110	8	52,449				
Kennington Det Base	5457	2494	447	75	116	6	50,838				
Lincoln Det Base	4822	2172	442	75	113	9	67,594				
Norpeth Det Base	4307	2055	373	75	89	6	40,863				
Morpeth End Base	3946	2056	373	75	89	10	64,508				
Somerton Det Base	4899	2479	424	75	108	8	63,019				
Thronbury Det Base	4751	2170	440	75	112	2	14,873				
Foxton FF Base	2513	1807	292	75	62	4	18,746				
Foxton GF Base	2756	1790	276	75	60	4	19,587				
		Da	ata Set 1 Total	Energy Demar	d <i>(kWb</i>	/Annum)	703,595				
				Lifergy Demai			100,000				
Data Set 2: Actual Ca		1770	070			10	70.004				
Ashford End	2312	1773	276	75	59	16	70,991				
Ashford Mid	1813	1776	276	75	59	2	7,880				
Bampton End	2798	1884	305	75	69	2	10,125				
Bampton Mid	2158	1887	305	75	69	10	44,248				
Barwick End	2944	1970	357	75	77	12	64,141				
Beadle End	2243	1727	266	75	55	10	43,101				
Cheadle Det	4501	1791	369	75	88	6	40,413				
Farringdon Det	4383	2170	411	75	103	2	14,079				
Helmsley End	3659	2174	438	75	110	1	6,345				
Helmsley Mid	2808	2190	443	75	110	8	44,129				
Kennington Det	5186	2496	447	75	116	6	49,227				
Lincoln Det	4822	2172	442	75	113	9	67,594				
Morpeth End	3888	2056	373	75	89	6	38,355				
Morpeth Det	4213	2055	373	75	89	10	67,166				
Somerton Det	4899	2479	424	75	108	8	63,019				
Thornbury Det	4656	2171	440	75	112	2	14,684				
Foxton FF	2513	1807	292	75	62	4	18,746				
Foxton GF	2756	1790	276	75	60	4	19,587				
		Da	ata Set 2 Total	Energy Demar	nd <i>(kWh</i>	/Annum)	683,830				
					Reduc	tion in En	ergy Deman 2.8%				
Notes											

Appendix D

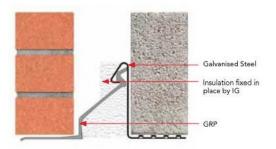
Cavity Wall

Cavity widths from 90mm to 165mm

OUTER LEAF	INNER LEAF
102mm	100mm

Hi-Therm Lintel

IG leads the way with the development of a completely unique lintel range to address the thermal requirements of new building regulations.



Psi 0.05 W/m⋅K

Building regulations require that lintels should be assessed for their effect on the thermal performance of a building. The thermal performance of a lintel is expressed in terms of Psi Values (Ψ) i.e. linear thermal transmittance.

Psi COMPARISON CHART

To help understand the immense thermal benefits of the Hi-Therm Lintel it must be compared to other lintel types.

Lintel type comparison	Values
IG Hi-Therm Lintel	0.05 W/m K
Typical IG Lintel	0.23 W/m·K
Non-plated Steel Lintel (default)	0.3 W/m-K
Plated Steel Lintel (default)	0.5 W/m·K



Testing of IG's Hi-Therm Lintel was carried out by the BRE (Building Research Establishment) using Physibel's thermal analysis software TRISCO which complies with BS EN ISO 10211-1. The modeling follows the requirements of the BRE conventions document BR497.

KEY BENEFITS

- Up to 5 times more thermally efficient than a steel cavity wall lintel, Hi-Therm outperforms other lintels.
- The significant reductions in thermal bridging due to the GRP component will assist in the building design process to achieve compliance with Part L and The Code for Sustainable Homes.
- The use of Hi-Therm will make a significant contribution to a buildings performance in respect of the Fabric Energy Efficiency Standards (FEES).
- Outperforms Stainless Steel on price and corrosion resistance.
- Hi-Therm has achieved the 1 hour fire resistance test as carried out by Exova Warringtonfire utilising the heating conditions of BS EN 1363-1 1999.

DESIGN FEATURES

- Patented GRP and Galvanised Steel hybrid design.
- Galvanised steel is used to support the heavier load on the inner leaf of the cavity wall.
- Profiled CFC free insulation ensures the continuity of insulation.

DAMP PROOFING

Not required on Hi-Therm lintels. *Check severe exposure.



If lintels are required to carry loads not indicated on the

Fax Back Enquiry Forms are also available for download. www.iglintels.com/technical

IG Fastrack CAD Database is accessible from iglintels.com

Appendix E

SAP Worksheet Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Michael Woodb	ridge				As	sessor num	ber	9636	
Client						La	st modified		15/05/2014	
Address	Faringdon 1 House	Type Detacl	hed Barratt	Developme	ents PLC, 2	010 Classic	Range			
1. Overall dwelling dimen	sions									
			A	rea (m²)		Aver	age storey		Volume (I	n³)
						he	ight (m)			
owest occupied				52.29	(1a) x		2.33	(2a) =	121.84	(3
+1				50.72	(1b) x		2.55	(2b) =	129.34	(3
Total floor area	(1a) + (1b) + (1	c) + (1d)(1	1n) = 🗌 🗄	103.01	(4)					
Owelling volume						(3a)	+ (3b) + (3d	:) + (3d)(3n	i) = 251.17	(5
2. Ventilation rate								_		
							6		m³ per ho	our
Number of chimneys							0	x 40 =	0	((
Number of open flues							0	x 20 =	0	(6
Number of intermittent fan	S						3	x 10 =	30	()
Number of passive vents							0	x 10 =	0	
Number of flueless gas fires							0	x 40 =	0	6
									Air changes	per
									Air changes hour	
		ntended. pr		+ (6b) + (7a 17). otherwi		Sandi Sananana	30 o (16)	÷ (5) =	(A) 574	
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f a pressurisation test has b Air permeability value, q50, If based on air permeability Number of sides on which t Shelter factor Infiltration rate incorporation Infiltration rate modified fo Jan Monthly average wind spece 5.10 Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a 0.40 Calculate effective air changed	accernical out or is in expressed in cubic mervalue, then (18) = [(1)] he dwelling is sheltered he dwelling is shelter he dwelling for shelter lowing for shelter and 0.39 0.39 ge rate for the applical he dir change rate throw covery: efficiency in %	etres per ho 7) ÷ 20] + (8 ed : Apr 4.40 1.10 I wind facto 0.35 ble case: Jgh system allowing fo	May 4.30 1.08 0r) (21) x (2 0.34	27), otherwi: aare metre c se (18) = (16 Jun 3.80 0.95 2a)m 0.30 ctor from Ta	ise continue of envelope 5) Jul 3.80 0.95 0.30	Aug 3.70	o (16) 1 - Sep 1.00	[0.075 x (19) (18) x (20 Oct 4.30	hour 0.12 5.01 0.37 2 0.85 0) = 0.31 Nov De 4.50 4.7 1.13 1.1 0.35 0.3 N/A	(; (; (; (; (; (; (; (; (; (; (; (; (; (



								2					
3. Heat losses	s and heat lo	oss paramet	er										
lement				Gross area, m ²	Opening m ²	s Net A,		U-value W/m²K	AxUW		/alue, /m².K	Ахк, kJ/K	
Window			G	irea, in		22.			= 29.94		/111 .K	N/K	(27)
Door						22.			= 29.94				(26)
Door						1.9			= 3.32	-			(26
Fround floor						52.			= 8.37	=			(28)
xternal wall						121			= 32.88	2			(29)
Roof						50.			= 5.58	-			(30)
Roof						1.	_		= 0.27	=			(30)
otal area of e	external elem	ents ΣA, m ²				252		0.17	0.27				(31)
abric heat los		na antina anti				2.52			(2)	5)(30) + (1	32) =	82.51	(33)
leat capacity (ess - 1992 10 ²²⁶ 11							(28)		+ (32a)(3		N/A	(34)
hermal mass			n²K					(20)(50) · (52)	. (520)(5		201.00	(35)
hermal bridge				dix K								9.08	(36)
otal fabric he	12	arculated us	Ing Appen							(33) + (36) =	91.59	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
/entilation hea				1.1.1.1.1.1.1		1000						15.5.5	
	48.10	47.85	47.59	46.40	46.18	45.14	45.14	44.95	45.54	46.18	46.63	47.10	(38)
leat transfer o			20 W W	10.10	10.10	15.11	15.11	11.55	13.51	10.10	10.00	11.10	_ (50,
	139.69	139.44	139.18	137.99	137.77	136.73	136.73	136.54	137.13	137.77	138.22	138.69	
	135.05	133.44	155.10	137.35	137.77	130.73	130.75	1	137.13	137.77	130.22	150.05	
								(e)	worago - S	(20)1 12	/12 -	127 00	(20)
leat loss nara	meter (HIP)	W/m ² K (30	$m \div (4)$						Average = 2	(39)112/	/12 =	137.99	(39)
leat loss para		-		1 34	1 34	1 22	1 33						(39)
leat loss para	meter (HLP),	W/m²K (39)m ÷ (4) 1.35	1.34	1.34	1.33	1.33	1.33	1.33	1.34	1.34	1.35]
	1.36	1.35		1.34	1.34	1.33	1.33	1.33	1.33		1.34]
	1.36 ys in month (1.35 Table 1a)	1.35					1.33	1.33 Average = 3	1.34 5(40)112/	1.34	1.35	 (40)
	1.36	1.35		1.34	1.34	1.33 30.00	1.33	1.33	1.33	1.34	1.34	1.35	 (40)
lumber of day	1.36 ys in month (31.00	1.35 Table 1a) 28.00	1.35 31.00					1.33	1.33 Average = 3	1.34 5(40)112/	1.34	1.35	 (40)
Number of day 4. Water hea	1.36 ys in month (31.00	1.35 Table 1a) 28.00	1.35 31.00					1.33	1.33 Average = 3	1.34 5(40)112/	1.34	1.35	(40) (40)
Number of day 4. Water heat	1.36 ys in month (31.00 ting energy i ipancy, N	1.35 Table 1a) 28.00	1.35 31.00	30.00	31.00	30.00		1.33	1.33 Average = 3	1.34 5(40)112/	1.34	1.35 1.34 31.00	(40) (40) (42)
Number of day 4. Water heat	1.36 ys in month (31.00 ting energy i ipancy, N	1.35 Table 1a) 28.00	1.35 31.00	30.00	31.00	30.00		1.33	1.33 Average = 3	1.34 5(40)112/	1.34	1.35 1.34 31.00 2.77	(40) (40) (42)
Number of day 4. Water heat Assumed occu	1.36 ys in month (31.00 ting energy i upancy, N te hot water Jan	1.35 Table 1a) 28.00 requirement usage in litre Feb	1.35 31.00 t es per day Mar	30.00 Vd,average Apr	31.00 = (25 x N) + May	30.00 + 36 Jun	31.00 Jul	1.33	1.33 Average = 3 30.00	1.34 5(40)112/ 31.00	 1.34 /12 = 30.00	1.35 1.34 31.00 2.77 99.89	(40) (40) (42)
Number of day 4. Water heat Assumed occu	1.36 ys in month (31.00 ting energy i upancy, N te hot water Jan	1.35 Table 1a) 28.00 requirement usage in litre Feb	1.35 31.00 t es per day Mar	30.00 Vd,average Apr	31.00 = (25 x N) + May	30.00 + 36 Jun	31.00 Jul	1.33	1.33 Average = 3 30.00	1.34 5(40)112/ 31.00	 1.34 /12 = 30.00	1.35 1.34 31.00 2.77 99.89 Dec	(40) (40) (42)
Number of day 4. Water heat Assumed occu	1.36 ys in month (31.00 ting energy pancy, N te hot water Jan ge in litres po	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea	1.35 31.00 t es per day Mar cch month	30.00 Vd,average Apr Vd,m = fact	31.00 = (25 x N) + May tor from Tal	30.00 + 36 Jun ble 1c x (43	31.00 Jul	1.33 31.00	1.33 Average = 2 30.00 Sep	1.34 5(40)112/ 31.00	1.34 /12 = 30.00 Nov	1.35 1.34 31.00 2.77 99.89 Dec] (39)] (40)] (40)] (42)] (42)] (43)] (44)
Heat loss parai Number of day 4. Water heat Assumed occu Annual average Hot water usag	1.36 ys in month (31.00 ting energy i upancy, N te hot water Jan ge in litres po 109.87	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88	1.35 31.00 t es per day Mar cch month 101.88	30.00 Vd,average Apr Vd,m = fact 97.89	31.00 = (25 x N) + May tor from Tal 93.89	30.00 + 36 Jun ble 1c x (43 89.90	31.00 Jul) 89.90	1.33 31.00 Aug 93.89	1.33 Average = 2 30.00 Sep	1.34 5(40)112/ 31.00 Oct 101.88	1.34 /12 = 30.00 Nov	1.35 1.34 31.00 2.77 99.89 Dec 109.87	(40) (40) (42) (43)
Number of day 4. Water heat Assumed occu	1.36 ys in month (31.00 ting energy i uppancy, N te hot water Jan ge in litres pe 109.87	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1	1.35 31.00 t es per day Mar cch month 101.88 8 x Vd,m >	30.00 Vd,average Apr Vd,m = fact 97.89	31.00 = (25 x N) + May tor from Tal 93.89 3600 kWh/r	30.00 + 36 Jun ble 1c x (43 89.90 month (see	31.00 Jul) 89.90 Tables 1b	1.33 31.00 Aug 93.89 , 1c 1d)	1.33 Average = 2 30.00 Sep 97.89	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1	1.34 /12 = 30.00 Nov 105.88 .12 =	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62	(40) (40) (42) (42) (43)
Number of day 4. Water heat Assumed occu Annual average Hot water usag	1.36 ys in month (31.00 ting energy i upancy, N te hot water Jan ge in litres po 109.87	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88	1.35 31.00 t es per day Mar cch month 101.88	30.00 Vd,average Apr Vd,m = fact 97.89	31.00 = (25 x N) + May tor from Tal 93.89	30.00 + 36 Jun ble 1c x (43 89.90	31.00 Jul) 89.90	1.33 31.00 Aug 93.89	1.33 Average = 2 30.00 Sep	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1 133.12	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62 157.80	(40) (40) (42) (42) (43)
Aumber of day 4. Water heat Assumed occu Annual average Hot water usag	1.36 ys in month (31.00 ting energy i upancy, N ge hot water i Jan ge in litres pr 109.87 at of hot wate 162.94	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1 142.51	1.35 31.00 t es per day Mar cch month 101.88 8 x Vd,m >	30.00 Vd,average Apr Vd,m = fact 97.89	31.00 = (25 x N) + May tor from Tal 93.89 3600 kWh/r	30.00 + 36 Jun ble 1c x (43 89.90 month (see	31.00 Jul) 89.90 Tables 1b	1.33 31.00 Aug 93.89 , 1c 1d)	1.33 Average = 2 30.00 Sep 97.89	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62	(40) (40) (42) (42) (43)
Aumber of day 4. Water heat Assumed occu Annual average Hot water usag	1.36 ys in month (31.00 ting energy upancy, N te hot water Jan ge in litres pr 109.87 tt of hot water 162.94 ss 0.15 x (45	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1 142.51 i)m	1.35 31.00 t es per day Mar cch month 101.88 8 x Vd,m > 147.06	30.00 Vd,average Apr Vd,m = fact 97.89 × nm x Tm/3 128.21	31.00 = (25 x N) + May tor from Tal 93.89 3600 kWh/r 123.02	30.00 + 36 Jun ble 1c x (43 89.90 month (see 106.15	31.00 Jul) 89.90 Tables 1b 98.37	1.33 31.00 Aug 93.89 , 1c 1d) 112.88	1.33 Average = 2 30.00 Sep 97.89 114.23	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1 133.12 Σ(45)1	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31 .12 =	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62 1571.58	(40) (40) (42) (42) (43) (43)
Aumber of day 4. Water heat Assumed occu Annual average Hot water usag Energy conten Distribution lo:	1.36 ys in month (31.00 ting energy upancy, N te hot water Jan ge in litres pe 109.87 at of hot water 162.94 uss 0.15 x (45 24.44	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1 142.51 i)m 21.38	1.35 31.00 t es per day Mar cch month 101.88 8 x Vd,m > 147.06 22.06	30.00 Vd,average Apr Vd,m = fact 97.89 × nm x Tm/3 128.21 19.23	31.00 = (25 x N) + May tor from Tal 93.89 3600 kWh/r 123.02 18.45	30.00 + 36 Jun ble 1c x (43 89.90 nonth (see 106.15 15.92	31.00 Jul) 89.90 Tables 1b	1.33 31.00 Aug 93.89 , 1c 1d)	1.33 Average = 2 30.00 Sep 97.89	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1 133.12	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62 1571.58 23.67	(40) (40) (40) (42) (42) (43) (43) (44) (44)
Aumber of day 4. Water heat Assumed occu Annual average Hot water usag Hot water usag Energy conten Distribution los	1.36 ys in month (31.00 ting energy i upancy, N ge in litres point 109.87 at of hot water 162.94 ass 0.15 x (45) 24.44 at of litres) incl	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1 142.51 i)m 21.38	1.35 31.00 t es per day Mar cch month 101.88 8 x Vd,m > 147.06 22.06	30.00 Vd,average Apr Vd,m = fact 97.89 × nm x Tm/3 128.21 19.23	31.00 = (25 x N) + May tor from Tal 93.89 3600 kWh/r 123.02 18.45	30.00 + 36 Jun ble 1c x (43 89.90 nonth (see 106.15 15.92	31.00 Jul) 89.90 Tables 1b 98.37	1.33 31.00 Aug 93.89 , 1c 1d) 112.88	1.33 Average = 2 30.00 Sep 97.89 114.23	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1 133.12 Σ(45)1	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31 .12 =	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62 1571.58	(40) (40) (40) (42) (42) (43) (43) (44) (44)
Aumber of day 4. Water heat Assumed occu Annual average Hot water usag Energy conten Distribution los Storage volum Water storage	1.36 ys in month (31.00 ting energy (upancy, N ge in litres point 109.87 at of hot water 162.94 sss 0.15 x (45) 24.44 at of litres) incl el litres) incl	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1 142.51 i)m 21.38 uding any so	1.35 31.00 t es per day Mar ch month 101.88 8 x Vd,m 3 147.06 22.06 olar or WW	30.00 Vd,average Apr Vd,m = fact 97.89 x nm x Tm/3 128.21 19.23 VHRS storag	31.00 = (25 x N) + May tor from Tai 93.89 3600 kWh/r 123.02 18.45 se within sa	30.00 + 36 Jun ble 1c x (43 89.90 nonth (see 106.15 15.92	31.00 Jul) 89.90 Tables 1b 98.37	1.33 31.00 Aug 93.89 , 1c 1d) 112.88	1.33 Average = 2 30.00 Sep 97.89 114.23	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1 133.12 Σ(45)1	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31 .12 =	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62 1571.58 23.67 150.00	(40) (40) (42) (42) (43) (43) (43) (44) (44) (44) (45) (45) (45) (45)
Aumber of day 4. Water heat Assumed occu Annual average Hot water usag Hot water usag Energy conten Distribution los Storage volum Water storage a) If manufactu	1.36 ys in month (31.00 ting energy (upancy, N ge in litres pr 109.87 at of hot water 162.94 ass 0.15 x (45) 24.44 te (litres) incl e loss: urer's declar	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1 142.51 b)m 21.38 uding any so ed loss factor	1.35 31.00 t es per day Mar ch month 101.88 8 x Vd,m 3 147.06 22.06 olar or WW	30.00 Vd,average Apr Vd,m = fact 97.89 x nm x Tm/3 128.21 19.23 VHRS storag	31.00 = (25 x N) + May tor from Tai 93.89 3600 kWh/r 123.02 18.45 se within sa	30.00 + 36 Jun ble 1c x (43 89.90 nonth (see 106.15 15.92	31.00 Jul) 89.90 Tables 1b 98.37	1.33 31.00 Aug 93.89 , 1c 1d) 112.88	1.33 Average = 2 30.00 Sep 97.89 114.23	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1 133.12 Σ(45)1	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31 .12 =	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62 157.80 1571.58 23.67 150.00 1.31	(40) (40) (40) (42) (43) (43) (43) (44) (44) (44) (45) (45) (45) (46) (47)
Aumber of day 4. Water hear Assumed occu Annual average Hot water usage Hot water usage Hot water usage Hot water usage Storage volum Water storage a) If manufactur Temperatur	1.36 ys in month (31.00 ting energy upancy, N te hot water Jan ge in litres pr 109.87 at of hot water 162.94 sss 0.15 x (45) 24.44 te (litres) incl closs: urer's declard ure factor from	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1 142.51 i)m 21.38 uding any so ed loss factor m Table 2b	1.35 31.00 t es per day Mar uch month 101.88 8 x Vd,m x 147.06 22.06 olar or WW	30.00 Vd,average Apr Vd,m = fact 97.89 × nm x Tm/3 128.21 19.23 VHRS storage h (kWh/day)	31.00 = (25 x N) + May tor from Tai 93.89 3600 kWh/r 123.02 18.45 se within sa	30.00 + 36 Jun ble 1c x (43 89.90 nonth (see 106.15 15.92	31.00 Jul) 89.90 Tables 1b 98.37	1.33 31.00 Aug 93.89 , 1c 1d) 112.88	1.33 Average = 2 30.00 Sep 97.89 114.23	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1 133.12 Σ(45)1	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31 .12 =	1.35 1.34 31.00 2.77 99.89 Dec 1198.62 1571.58 23.67 150.00 1.31 0.54	(40) (40) (42) (42) (43) (43) (43) (44) (44) (44) (44) (44
Aumber of day 4. Water hear Assumed occu Annual average Hot water usage Hot water usage Hot water usage Hot water usage Storage volum Water storage a) If manufactur Temperatur	1.36 ys in month (31.00 ting energy upancy, N ge in litres pr 109.87 at of hot water 162.94 vss 0.15 x (45) 24.44 te (litres) incl closs: urer's declard irre factor from : from water	1.35 Table 1a) 28.00 requirement usage in litre Feb er day for ea 105.88 er used = 4.1 142.51 i)m 21.38 uding any so ed loss factor m Table 2b	1.35 31.00 t es per day Mar uch month 101.88 8 x Vd,m x 147.06 22.06 olar or WW	30.00 Vd,average Apr Vd,m = fact 97.89 × nm x Tm/3 128.21 19.23 VHRS storage h (kWh/day)	31.00 = (25 x N) + May tor from Tai 93.89 3600 kWh/r 123.02 18.45 se within sa	30.00 + 36 Jun ble 1c x (43 89.90 nonth (see 106.15 15.92	31.00 Jul) 89.90 Tables 1b 98.37	1.33 31.00 Aug 93.89 , 1c 1d) 112.88	1.33 Average = 2 30.00 Sep 97.89 114.23	1.34 Σ(40)112/ 31.00 Oct 101.88 Σ(44)1 133.12 Σ(45)1	1.34 /12 = 30.00 Nov 105.88 .12 = 145.31 .12 =	1.35 1.34 31.00 2.77 99.89 Dec 109.87 1198.62 157.80 1571.58 23.67 150.00 1.31	(40) (40) (42) (42) (43)

											~		
	21.93	19.81	21.93	21.22	21.93	21.22	21.93	21.93	21.22	21.93	21.22	21.93	(56
the vessel con	tains dedic	ated solar st	orage or d	edicated V	WHRS (56	5)m x [(47) -	Vs] ÷ (47),	else (56)					
	21.93	19.81	21.93	21.22	21.93	21.22	21.93	21.93	21.22	21.93	21.22	21.93	(57
rimary circuit le	oss for each	n month fror	n Table 3										
	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59
ombi loss for e	ach month	from Table	3a, 3b or 3	c									
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61
fotal heat requi	red for wat	er heating c	alculated f	or each mo	onth 0.85	x (45)m + (4	6)m + (57)	m + (59)m	+ (61)m				
	208.13	183.33	192.25	171.94	168.21	149.89	143.56	158.07	157.96	178.31	189.05	202.99	(62
Solar DHW inpu					1			1			1		
	-29.51	-25.96	-26.50	-21.80	-20.24	-16.70	-14.13	-17.11	-17.61	-21.77	-25.22	-28.52	(63
Dutput from wa	S ar ar	20 av ²⁰	100 - 20032-010-020	38 vasistosivos	Shen manager	5	14.15	1 17.11	17.01	21.77	25.22	20.52] (05
Julput nom wa	178.63	157.36	22 - 12	1078	147.97	133.19	129.43	140.96	140.35	156.55	162.02	174.47	1°
	1/8.03	157.30	165.75	150.14	147.97	133.19	129.43	140.96	140.35		163.83		
				- 10.05	(45)	1) 1.00	1110	EZ) (50		∑(64)1	.12 =	1838.64	(64
Heat gains from			20	19 (B)	1 10 10 10 10 10 10 10 10 10 10 10 10 10	20.00	290. D	1 10 10 10	65 20	1	1	1	-
	90.33	80.04	85.05	77.62	77.06	70.28	68.86	73.69	72.97	80.42	83.30	88.62	(65
5. Internal gair	15												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains		1 CD	mar		indy	Jun		, top	Jep		nov	Dee	
vietabolic gallis	165.94	165.94	165.94	105.04	165.94	105.04	105.04	105.04	105.04	105.04	105.04	105.04	(66
iabting gains (a	Carlosophic cares	"a aasii	98	165.94	77 ₁₀ 20	165.94	165.94	165.94	165.94	165.94	165.94	165.94	00
ighting gains (c.						-yearse	24.72		1 27 22		56.45	50.05	7
	58.24	51.72	42.07	31.85	23.81	20.10	21.72	28.23	37.89	48.11	56.15	59.85	(67
Appliance gains		1 1	<u>.</u>		-	-		_					-
	389.71	393.75	383.56	361.87	334.48	308.74	291.55	287.50	297.69	319.39	346.77	372.51	(68
Cooking gains (c	alculated in	1 Appendix L	., equation	L15 or L15	5a), also se	e Table 5	. //						1
	54.36	54.36	54.36	54.36	54.36	54.36	54.36	54.36	54.36	54.36	54.36	54.36	(69
Pump and fan ga	ains (Table	5a)											
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70
Losses e.g. evap	oration (Ta	ble 5)											
	-110.63	-110.63	-110.63	-110.63	-110.63	-110.63	-110.63	-110.63	-110.63	-110.63	-110.63	-110.63	(71
Water heating g	ains (Table	5)											
	121.41	119.11	114.31	107.80	103.57	97.62	92.55	99.04	101.34	108.09	115.70	119.11	(72
Total internal ga	ins (66)m	+ (67)m + (6	8)m + (69)	m + (70)m	+ (71)m + ((72)m	50	10		\$0	20		and a
	682.03	677.26	652.61	614.19	574.53	539.13	518.49	527.44	549.60	588.25	631.29	664.16	(73
		1			1								
6. Solar gains													
			Access f	actor	Area	Sol	ar flux		g	FF		Gains	
			Table	6d	m²	v	V/m²		cific data	specific		w	
							-	or	Table 6b	or Table	3 6C		_
SouthWest			0.7	7 X	1.38	x 3	6.79 x	0.9 x	0.71 >	0.70) =	17.49	(79
NorthEast			0.7	7 x	1.38	x 1	1.28 x	0.9 x	0.71 >	0.70) =	5.36	(79
NorthWest			0.7	7 X	6.22	x 1	1.28 x	0.9 x	0.71 >	0.70) = [24.17	(81
					202223			_		[CPC/PCPW	٦

				<u> </u>		
West			0.7	7 x	5.90	x
SouthEast			0.7	7 x	3.30	_ x [
East			0.7	7 x [4.25	×
Solar gains in w	vatts ∑(74)m	ı(82)m				
	157.50	205.45	467 72	671 75	026.20	0500

 157.50
 295.45
 467.73
 671.75
 826.30
 850.08
 807.38
 689.35
 538.91
 344.49
 193.81
 131.34
 (83)

 Total gains - internal and solar (73)m + (83)m

19.64

36.79

19.64

x 0.9 x

] x 0.9 x [

x 0.9 x

0.71

0.71

0.71

] x [

x

x

0.70

0.70

0.70

=

] = [

] = [

39.91

41.82

28.75 (76)

(80)

(77)

Temperature during heating periods in the living area from Table 9, Th1(°) 1an Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Utilisation factor for gains for living area 1, 15(eps 3 to 7 in Table 9c) 1945 9.9.65 0.035 0.048 0.75 0.58 0.44 0.50 0.73 0.92 0.92 0.92 0.99 0.99 0.99 0.99 0.99	7. Mean internal temperat	ture (heatin	ig season)										
Utilisation factor for gains for living area n1, m (see Table 9a) 0.99 0.97 0.95 0.88 0.75 0.58 0.44 0.50 0.73 0.92 0.98 0.99 (86) Mean internal temp of living area 11 (steps 3 to 7 in Table 9c) 1 1 0.93 20.04 20.77 20.33 20.98 20.97 20.85 20.41 19.84 19.40 (87) Temperature during heating periods in the rest of dwelling rT 1	Temperature during heating	g periods in	the living a	rea from T	able 9, Th1	(°C)						21.00	(85)
$ \begin{array}{ $	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) 19.45 19.66 20.01 20.44 20.77 20.93 20.98 20.97 20.85 20.41 19.84 19.40 (67) Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C) 19.80 0.50 0.59 0.97 0.99 (8) Wean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) 10.81 19.81 19.81 19.81 19.81 19.81 19.80 19.81 19.81 19.80 19.81 19.80 19.81 19.80 19.92 19.92 19.92 19.92 19.92 19.92 19.92 18.62 18.02 (92) Apply adjustment to the mean internal temperature from Table 4 ewhere appropriate	Utilisation factor for gains for	or living are	a n1,m (see	e Table 9a)									
	0.99	0.97	0.95	0.88	0.75	0.58	0.44	0.50	0.73	0.92	0.98	0.99	(86)
Temperature during heating periods in the rest of dwelling from Table 9, Th2['C) 19.82 18.62 18.02 (92) 19.83 18.62 18.02 <td>Mean internal temp of living</td> <td>g area T1 (st</td> <td>teps 3 to 7</td> <td>in Table 9c</td> <td>)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Mean internal temp of living	g area T1 (st	teps 3 to 7	in Table 9c)								
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	19.45	19.66	20.01	20.44	20.77	20.93	20.98	20.97	20.85	20.41	19.84	19.40	(87)
Utilisation factor for gains for rest of dwelling n2,m 0.98 0.97 0.93 0.85 0.69 0.49 0.33 0.38 0.65 0.89 0.97 0.99 (89) Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) If 7.77 18.08 18.58 19.18 19.59 19.78 19.81 19.79 19.15 18.36 17.71 (90) Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 Iking area fracion Iking area fracion Iking area fracion Iking area fracion (91) Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 Iking area fracion	Temperature during heating	g periods in	the rest of	dwelling fr	om Table 9), Th2(°C)							
$ \begin{array}{ $	19.80	19.80	19.80	19.81	19.81	19.82	19.82	19.82	19.82	19.81	19.81	19.80	(88)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) 17.77	Utilisation factor for gains for	or rest of dv	velling n2,n	n									
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	0.98	0.97	0.93	0.85	0.69	0.49	0.33	0.38	0.65	0.89	0.97	0.99	(89)
Living area fraction Living area $+ (4) = 0.18$ (91) Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2. 18.07 18.36 18.84 19.41 19.80 19.98 20.02 20.02 19.90 19.38 18.62 18.02 (92) Apply adjustment to the mean internal temperature from Table 4e where appropriate 17.92 18.21 18.69 19.26 19.65 19.83 19.87 19.87 19.87 19.75 19.23 18.47 17.87 (93) 8. Space heating requirement Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, nmGm, W (94)m x (84)m 817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, LM, W (39)m x (193)m (96)m] 1902.79 185.55 1 1696.56 1429.22 109.560 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/month 0.024 x (97)m (95)m] x (41)m 807.70 622.82 497.92 260.26 101.39 0.00 0.00 0.00 0.00 277.15 563.76 831.60 Σ (98)5, 1012 = 3962.62 (98) Space heating requirement kWh/m ⁷ /year (98) \div (4) 38.47 (99) 92. Energy requirement kWh/m ⁷ /year 93. Energy requirement kWh/m ⁷ /year 93. Energy requirement kWh/m ⁷ /year 93. Energy requirement kWh/m ⁷ /year 94. Energy requirement kWh/m ⁷ /year 95. To for a space heat from main system 1 10.00 (201) 1. (201) = 1.00 (202) 1. (201) = 1.00 (202) 1. (201) (201) = 1.00 (202) 1. (201) (201) = 1.00 (202) 1. (201) (Mean internal temperature	in the rest o	of dwelling	T2 (follow	steps 3 to	7 in Table 9	9c)						
Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2 18.07 18.36 18.84 19.41 19.80 19.98 20.02 20.02 19.90 19.38 18.62 18.02 (92) Apply adjustment to the mean internal temperature from Table 4e where appropriate 17.92 18.21 18.69 19.26 19.65 19.83 19.87 19.75 19.23 18.47 17.87 (93) S. Space heating requirement Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, nmGm, W (94)m x (84)m 102.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature, Lm, W ([39)m x ([93)m - (96)m] 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97)	17.77	18.08	18.58	19.18	19.59	19.78	19.81	19.81	19.70	19.15	18.36	17.71	(90)
18.07 18.36 18.84 19.41 19.80 19.98 20.02 20.02 19.90 19.38 18.62 18.02 (92) Apply adjustment to the mean internal temperature from Table 4e where appropriate 17.92 18.21 18.69 19.26 19.65 19.83 19.87 19.75 19.23 18.47 17.87 (93) 8. Space heating requirement Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, nmGm, W (94)m x (84)m [817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature, trom Table U1 [1.70 14.60 16.60 16.40 14.10 10.60 7.10	Living area fraction								Liv	ving area ÷	(4) =	0.18	(91)
Apply adjustment to the mean internal temperature from Table 4e where appropriate 17.92 18.21 18.69 19.26 19.65 19.83 19.87 19.75 19.23 18.47 17.87 (93) 8. Space heating requirement Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, nmGm, W (94)m x (84)m 817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W [(39)m x [(39)m x (93)m - (95)m] 190.27 11.70 14.60 16.40 14.10 10.60 7.10 4.20 (96) Space heating requirement, Wh/month <td>Mean internal temperature</td> <td>for the who</td> <td>ole dwelling</td> <td>g fLA x T1 +</td> <td>(1 - fLA) x 1</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Mean internal temperature	for the who	ole dwelling	g fLA x T1 +	(1 - fLA) x 1	2							
17.92 18.21 18.69 19.26 19.85 19.87 19.87 19.75 19.23 18.47 17.87 (93) 8. Space heating requirement Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, npmGm, W (94)m x (84)m 817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W [(39)m x (193)m · (95)m] x (41)m 1902.79 185.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 77.14 118.8.26 1572.03 1895.38 (97) Space he	18.07	18.36	18.84	19.41	19.80	19.98	20.02	20.02	19.90	19.38	18.62	18.02	(92)
B. Space heating requirement Jun Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, nmGm, W (94)m x (84)m 817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W ((39)m x ((93)m - (96)m) 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/moth 0.024 x (197)m - (95)m] x (41)m 0.00 0.00 0.00	Apply adjustment to the me	an internal	temperatu	re from Ta	ble 4e whe	re appropr	riate	17	2				1083A 00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, nmGm, W (94)m x (84)m 817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W ((39)m x ((93)m - (96)m) 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/month 0.024 x ((97)m - (95)m) x (41)m 5(98)15, 1012 = 3962.622 (98)	17.92	18.21	18.69	19.26	19.65	19.83	19.87	19.87	19.75	19.23	18.47	17.87	(93)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, nmGm, W (94)m x (84)m 817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W ((39)m x ((93)m - (96)m) 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/month 0.024 x ((97)m - (95)m) x (41)m 5(98)15, 1012 = 3962.622 (98)	0 C			2 64									1994
Utilisation factor for gains, nm 0.97 0.96 0.92 0.83 0.68 0.49 0.33 0.38 0.64 0.87 0.96 0.98 (94) Useful gains, nmGm, W (94)m x (84)m 817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m 50.00 0.00 0.00 277.15 563.76 831.60 2(98) (4) 38.47 (99) 99 99. 52 50.26 101.39 0.00 0.00 0.00 277.15 563.76 831.60 2(98) (4) 38.47<		1000	Max	A	Mau	lum	lul.	A.u.#	fan	Ort	Mau	Des	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$			war	Арг	iviay	Jun	Ju	Aug	Sep	Oct	NOV	Dec	
Useful gains, η mGm, W (94)m x (84)m 817.16 929.69 1027.30 1067.75 959.32 686.69 442.78 465.61 698.63 815.74 789.02 777.64 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m 807.70 622.82 497.92 260.26 101.39 0.00 0.00 0.00 277.15 563.76 831.60 Σ (98)15, 1012 = 3962.62 (98) Space heating requirement kWh/m ² /year (98) ÷ (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP Space heat from secondary/supplementary system (table 11) Fraction of space heat from main system (2 Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 1 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Fraction for total spac			0.02	0.02	0.00	0.40	0.22	0.20	0.64	0.07	0.00	0.00	100
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	we a a a lite broadless	8 (94-9029)	0.92	0.83	0.68	0.49	0.33	0.38	0.64	0.87	0.96	0.98	(94)
Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m x [(93)m - (96)m] 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m 0.00 0.00 0.00 277.15 563.76 831.60 Σ (98) Σ (98)15, 1012 = 3962.62 (98) Space heating requirement kWh/m ² /year (98) \pm (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP 0.00 (201) (201) Fraction of space heat from secondary/supplementary system (table 11) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 (202) x [1 - (203]] = 1.00 (202) Fraction of total space heat from main system 1 (202) x (203] = 0.00 (204) Fraction of total space heat from main system 2 (202) x (203] = 0.00			1007.00	1003 35	050.00	606.60	442.70	405.04		015 74	700.00		1051
4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m 807.70 622.82 497.92 260.26 101.39 0.00 0.00 0.00 277.15 563.76 831.60 (98) Space heating requirement kWh/m²/year (98) \div (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP Space heat from secondary/supplementary system (table 11) Fraction of space heat from main system 2 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 (202) x [1 - (203)] = 1.00 (204) Fraction of total space heat from main system 1 (202) x (203) = (204) (204) Fraction of total space heat from main system 2 </td <td></td> <td>Sector - Low Sec</td> <td>and a second second</td> <td></td> <td>959.32</td> <td>686.69</td> <td>442.78</td> <td>465.61</td> <td>698.63</td> <td>815.74</td> <td>/89.02</td> <td>///.64</td> <td>(95)</td>		Sector - Low Sec	and a second second		959.32	686.69	442.78	465.61	698.63	815.74	/89.02	///.64	(95)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] 1902.79 1856.51 1696.56 1429.22 1095.60 715.72 447.57 473.65 775.14 1188.26 1572.03 1895.38 (97) Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m 807.70 622.82 497.92 260.26 101.39 0.00 0.00 0.00 277.15 563.76 831.60 Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m (98) (4) 38.47 (99) Space heating requirement kWh/m²/year (98) \div (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP 0.00 (201) Fraction of space heat from secondary/supplementary system (table 11) 0.00 (202) Fraction of space heat from main system 2 0.00 (202) (202) x [1- (203)] = 1.00 (202) Fraction of total space heat from main system 1 (202) x (203) = 0.00 (204) (202) x (203) = (205)		33			11.70	11.50	16.60	46.40	4440	10.50	7.10	1 4 20	(00)
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	L						16.60	16.40	14.10	10.60	7.10	4.20	(96)
Space heating requirement, kWh/month $0.024 \times [(97)m - (95)m] \times (41)m$ 807.70 622.82 497.92 260.26 101.39 0.00 0.00 277.15 563.76 831.60 Space heating requirement kWh/m ² /year (98) (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP (98) (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP Space heating (201) (201) Fraction of space heat from secondary/supplementary system (table 11) $1 - (201) =$ 1.00 (202) Fraction of space heat from main system 2 0.00 (202) $(202) \times [1 - (203)] =$ 1.00 (204) Fraction of total space heat from main system 2 $(202) \times (203) =$ $(202) \times$							447.57	470.05	775 4 4	1100.05	1572.02	1005.00	1071
807.70 622.82 497.92 260.26 101.39 0.00 0.00 0.00 277.15 563.76 831.60 Σ (98)15, 1012 = 3962.62 (98) Space heating requirement kWh/m ² /year (98) ÷ (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP 98 (98) (4) 38.47 (99) Space heating 99 99 (4) 38.47 (99) (98) (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP 0.00 (201) (201) (201) (202) (201) (202) (202) (202) (202) (202) (202) (204) (204) (204) (205)	200 B 120 B	REPORT OF STREET	8 22230-538 W	1000	States and a second		447.57	473.05	//5.14	1188.26	1572.03	1895.38] (97)
Space heating requirement kWh/m²/year Σ (98)15, 1012 = 3962.62 (98) Space heating requirement kWh/m²/year (98) ÷ (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP Space heating Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from main system(s) Fraction of space heat from main system 2 Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (202) x (203) = (202) x (203) = (202) x (203) =					5	24	0.00	0.00	0.00	077.45	562.76	021.00	1
Space heating requirement kWh/m²/year (98) ÷ (4) 38.47 (99) 9a. Energy requirements - individual heating systems including micro-CHP Space heating Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from main system(s) 1 - (201) = Fraction of space heat from main system 2 Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (202) x (203) =	807.70	622.82	497.92	260.26	101.39	0.00	0.00	0.00	0.592.9	Sex margines			
9a. Energy requirements - individual heating systems including micro-CHP Space heating Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from main system(s) 1 - (201) = Fraction of space heat from main system 2 Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x [1- (203)] = 0.00 (202) x (203) = (202) x (203) = (205)		100/h /m2/							2(90				
Space heating Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x (203) = 0.00 (204)	space neating requirement	kwn/m-/ye	ar							(98)	÷ (4)	38.47	(99)
Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)	9a. Energy requirements -	individual h	neating sys	tems inclu	ding micro	-CHP							
Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x (203) = 0.00 (204)	Space heating												
Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)	Fraction of space heat from	secondary/	supplemen	ntary syster	n (table 11)						0.00	(201)
Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)	Fraction of space heat from	main syster	m(s)							1 - (2	01) =	1.00	(202)
Fraction of total space heat from main system 2 (202) x (203) = (205)	Fraction of space heat from	main syster	m 2									0.00	(202)
	Fraction of total space heat	from main s	system 1						(20	02) x [1- (20	3)] =	1.00	(204)
Efficiency of main system 1 (%) 90.40 (206)	Fraction of total space heat	from main s	system 2							(202) x (2	03) =	0.00	(205)
	Efficiency of main system 1	(%)										90.40	(206)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	Space heating fuel (main sy	stem 1), kW	h/month										
893.48 688.96 550.80 287.90 112.15 0.00 0.00 0.00 0.00 306.59 623.63 919.91	893.48	688.96	550.80	287.90	112.15	0.00	0.00	0.00	0.00	306.59	623.63	919.91	
Σ(211)15, 1012 = 4383.43 (211)									Σ (21)	1)15, 10	.12 =	4383.43	(211)
Water heating	Water heating												

839.53 972.71 1120.35 1285.93 1400.83 1389.21 1325.88 1216.79 1088.51 932.75 825.10 795.49 (84)

Efficiency of water heater												
88.25	88.02	87.47	86.17	83.73	79.70	79.70	79.70	79.70	86.22	87.75	88.34	(217)
Water heating fuel, kWh/r	nonth											
202.40	178.79	189.50	174.24	176.72	167.12	162.40	176.87	176.10	181.56	186.70	197.49]
									∑(219a)1	.12 = 2	169.90	(219)
Annual totals												
Space heating fuel - main system 1									4	383.43]	
Water heating fuel										2	169.90	i
Electricity for pumps, fans	and electric	keep-hot (Table 4f)							-		.
central heating pump of	or water pun	np within w	arm air hea	ating unit				30.00	1			(230c)
boiler flue fan								45.00	i			(230e)
Total electricity for the ab	ove, kWh/ye	ar							•		75.00	(231)
Electricity for lighting (App											411.39	(232)
Total delivered energy for							(211)(221) + (231) +	(232)(23		039.72	(238)
57										·		1
10a. Fuel costs - individu	al heating s	ystems inclu	uding micro	o-CHP					_			
				ы	Fuel Nh/year		Fu	el price			Fuel st £/year	
Cases bastles								2.49	1	· · · · · ·		(240)
Space heating - main syste	em 1				1383.43	×		3.48	x 0.01		152.54	(240)
Water heating 2169.90					×		3.48] x 0.01		75.51	(247)	
Pumps and fans				-	75.00	х		13.19	x 0.01		9.89	(249)
Electricity for lighting					411.39	x		13.19	x 0.01		54.26	(250)
Additional standing charge	es								12101 12		120.00	(251)
Total energy cost							(24	40)(242)	+ (245)(2	54) =	412.21	(255)
11a. SAP rating - individu	al heating s	systems incl	uding micr	o-CHP								
Energy cost deflator (Table	e 12)						\sim				0.42	(256)
Energy cost factor (ECF)											1.17	(257)
SAP value											83.68]
SAP rating (section 13)											84	(258)
SAP band											В	1
				1		. Y						.
12a. CO ₂ emissions - indi	vidual heati	ng systems	including							140		
					Energy Nh/year			sion factor CO₂/kWh			nissions CO ₂ /year	
Space heating - main syste	em 1			4	1383.43	×		0.22	1 =		946.82	(261)
Water heating					2169.90	x		0.22] =		468.70	(264)
Space and water heating						6 8	(26		J + (263) + (2		415.52	(265)
Pumps and fans					75.00	l x	,==	0.52] =		38.93	(267)
Electricity for lighting					411.39	x		0.52] =		213.51	(268)
Total CO ₂ , kg/year					111.00		<u>.</u>	0.02	(265)(2		.667.95	(272)
Dwelling CO ₂ emission rate	A								(200)(2	_	16.19	(273)
El value									(272).		84.90] (27.5)
El rating (section 14)											85	(274)
El band											B	(2/4)
El Danu											D	1
13a. Primary energy - inc	lividual hea	ting system	s including	micro-CHI	P							
					Energy Nh/year		Prim	nary factor			ary Energy Nh/year	
Canada kanada ata ata ta						۱. ۱	1	1 22	1			12641
Space heating - main syste	em 1			4	1383.43	x		1.22	_ =		347.78	(261)

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Water heating	2169.90	×	1.22	= [2647.28	(264)
Space and water heating			(261) + (262) + (263) + (264) = [7995.06	(265)
Pumps and fans	75.00	×	3.07	= [230.25	(267)
Electricity for lighting	411.39	×	3.07	= [1262.95	(268)
Primary energy kWh/year				[9488.27	(272)
Dwelling primary energy rate kWh/m2/year				[92.11	(273)