





Energy Demand Study

Longridge Phase 2/3

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www.environmental-economics.co.uk

Revision History

Version	Date	Reason for Issue	lssued by	QA check
1	15/10/2018	Report provided in support of planning	M-D-W	Ingang
		application	Michael Woodbridge	Zach Sifakis

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1. Project Overview

1.1. Introduction

This energy 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 Phase 2/3 site consists of 184 dwellings. These units comprise a range of detached, semi-detached and terraced dwellings.

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:

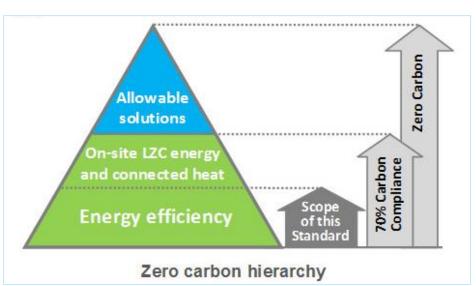
- Space heating
- Water heating
- Electricity for pumps and fans
- Electricity for lighting

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 on 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. The proposed specification is shown in table 1 below.

Element	Minimum Standard	Improved Speci	ification
-	W/m²k	Description	W/m²k
Walls	0.30	50mm Alreflex Platinum Cavity	0.27
Roof	0.20	400mm Mineral Wool Horizontal Ceiling, Loft Space	0.11
		Flat Roof	0.17
Floors	0.25	150mm TE Platinum Ground Floor	0.13 - 0.16
Doors	2.00	Double glazed Low-E, u-PVC frame	1.00 – 1.70
Glazing	2.00	Double glazed Low-E, u-PVC frame	1.41

Table 1

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

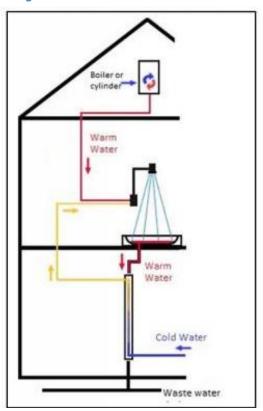
As the latest set of building regulations have incorporated a Target Fabric Energy Efficiency (TFEE) standard for all new houses, some of the bespoke thermal bridging details would not be sufficient to achieve the latter.

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

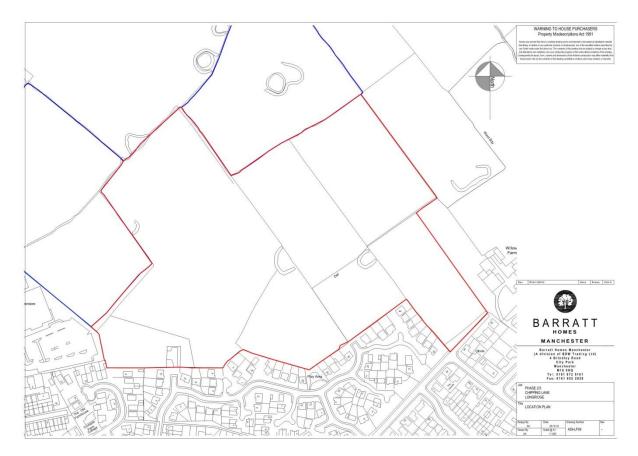
The table presented in Appendix C shows the energy saving that the improved specification will achieve in comparison to base compliance with Part L 2013 building regulations.

The total energy demand of the Part L 2013 base compliance model is 1,058.9MWh/Annum. The total energy demand for the actual model with the improved specification is 1,025.7MWh/Annum. This results in an average energy reduction of 3.1% across the site.

Approved for Release

Date: 15/10/2018

Appendix A



Appendix B



Appendix C

Client:	Barratt Manches	ster					
Project:	Longridge Phas	æ 2/3					
Report:	Energy Demand	Study					
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/Annum
Data Set 1: B	ase Case Design	(Part L 2013 Co	mpliant)				
Alderney	4659	1982	437	75	114	19	135,919
Bedale	2478	1568	257	75	55	14	61,288
Belmont	2805	1715	317	75	68	14	68,769
Brandon	2887	1896	328	75	70	20	103,726
Derwent	4412	1948	367	75	87	9	61,218
Halton	5450	1988	470	75	118	1	7,983
Kenley	2407	1588	260	75	57	21	90,908
Kingsville	3881	1955	448	75	104	14	89,025
Lutterworth	5093	1894	383	75	91	5	37,226
Maidstone	2948	1881	346	75	77	26	136,485
Moresby	3084	1898	344	75	79	18	97,213
Thornton	4645	1974	430	75	110	1	7,123
Windermere	4935	1936	415	75	100	22	161,968
			Data S	et 1 Total Energ	v Demand <i>(k</i>	Wh/Annum)	1,058,851
Data Cat 2: A	ctual Case (Impro	avad Enacificati			, ,		.,
Alderney	4290	1983	437	75	114	19	128,927
Bedale	2177	1569	257	75	55	19	57,091
Belmont	2680	1716	317	75	68	14	67,033
Brandon	2866	1896	328	75	70	20	103,316
Derwent	4389	1948	367	75	87	9	61,012
Halton	5365	1940	470	75	118	1	7,898
Kenley	2208	1588	260	75	57	21	86,759
Kingsville	3684	1955	448	75	104	14	86,268
Lutterworth	4816	1895	383	75	91	5	35,845
Maidstone	2778	1895	346	75	77	26	132,070
Moresby	2928	1898	344	75	79	18	94,417
Thornton	4389	1998	430	75	110	1	6,868
Windermere			430	75	100	22	158,221
windermere	4765	1937					
			Data S	et 2 Total Energ	y Demand <i>(k</i>	Wh/Annum)	1,025,725
						Reductio	n in Energy Demand
							3.1%
Notas						1	Î
Notes #1: Calculated	I by SAP2012 to ir	clude total energ	y demand for space	ce heating. hot wa	ater, lighting. p	umps and fan	s.

Appendix D

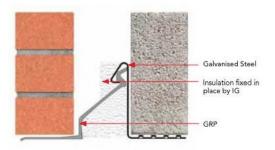
Cavity Wall

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.

	6913 Jame	es Lane					As	sessor num	ber	6913		
Client							La	st modified		09/01	/2017	
Address	BALD OOCI	D Alderney	Detached	2016 Clas	sic Range, I	Barratt Dev	elopments					
	•											
1. Overall dwelling dimens	lions				(m2)					Ve	lume (m³)	
				A	rea (m²)			age storey ight (m)		vo	iume (m [.])	
owest occupied					56.93	(1a) x		2.33	(2a) =		132.65	(3
-1					56.93	(1b) x		2.55	(2b) =		145.17	(3
Total floor area	(1a) +	(1b) + (1c) + (1d)(1	n) = 🚺 1	113.86	(4)						
Owelling volume							(3a)	+ (3b) + (3	c) + (3d)(3i	n) = 🗌	277.82	(5
2. Ventilation rate									_			
										m	³ per hour	
Number of chimneys								0) x 40 =		0	(6
Number of open flues								0	x 20 =		0	(6
Number of intermittent fans	52.							3	x 10 =		30	(7
Number of passive vents								0	x 10 =		0	(7
Number of flueless gas fires								0	x 40 =		0	(7
										Airo	changes pe	er
nfiltration due to chimneys,	, flues, fans,	PSVs		(6a)	+ (6b) + (7a	a) + (7b) + (7c) =	30) ÷ (5) =	Air d	hour 0.11	_
			tended, pro			a) + (7b) + (ise continue	Santi Stranger	< 200.000] ÷ (5) =		hour	_
f a pressurisation test has b	een carried	out or is in		oceed to (1	7), otherw	ise continu	e from (9) t	< 200.000] ÷ (5) =		hour	8)
lf a pressurisation test has b Air permeability value, q50,	<i>een carried</i> expressed in	<i>out or is in</i> n cubic me	tres per ho	oceed to (1 our per squ	7), otherw are metre	<i>ise continue</i> of envelope	e from (9) t	< 200.000] ÷ (5) =		hour 0.11) (8 (1) [
l <i>f a pressurisation test has b</i> Air permeability value, q50, If based on air permeability	een carried expressed in value, then	<i>out or is in</i> n cubic me (18) = [(17	tres per ho) ÷ 20] + (8)	oceed to (1 our per squ	7), otherw are metre	<i>ise continue</i> of envelope	e from (9) t	< 200.000] ÷ (5) =		hour 0.11 5.01	8) [(1 (1 (1
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f a pressurisation test has b Air permeability value, q50, If based on air permeability Number of sides on which th Shelter factor Infiltration rate incorporatin Infiltration rate modified for Jan Monthly average wind speer 5.10 Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (all 0.39 Calculate effective air chang	een carried expressed in value, then ne dwelling i g shelter fac monthly wi Feb d from Table 5.00 1.25 lowing for sl 0.38 i.e rate for th : air change	out or is in n cubic me (18) = [(17 is sheltered ctor ind speed: Mar e U2 4.90 1.23 helter and 0.37 he applicab rate throu	ettres per ho) ÷ 20] + (8) d Apr 4.40 1.10 wind facto 0.34 ole case: igh system	May 4.30 1.08 r) (21) x (2 0.33	7), otherw are metre e (18) = (18 Jun 3.80 0.95 2a)m 0.29	ise continue of envelope 5) Jul 3.80 0.95 0.29	(9) t e area Aug 3.70	o (16) 1 - Sep 4.00	[0.075 x (19 (18) x (20 Oct 4.30))] = [] 0) = [] Nov 4.50 1.13	hour 0.11 5.01 0.36 2 0.85 0.30 Dec 4.70 1.18 0.36	(1 (1) (1) (1) (2) (2) (2) (2) (2) (2) (2) (2) (2) (2
Monthly average wind speed 5.10 Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (all 0.39 Calculate effective air chang If mechanical ventilation	een carried expressed in value, then ne dwelling i g shelter fac monthly wi Feb d from Table 5.00 1.25 lowing for sl 0.38 te rate for th : air change overy: effici	out or is in n cubic me (18) = [(17 is sheltered tor ind speed: Mar e U2 4.90 1.23 helter and 0.37 be applicab rate throu ency in % a	Apr 4.40 1.10 0.34 ble case: lallowing for	May 4.30 1.08 r) (21) x (2 0.33	7), otherw are metre e (18) = (10 Jun 3.80 0.95 2a)m 0.29 :tor from T	ise continue of envelope 5) Jul 3.80 0.95 0.29	(9) t e area Aug 3.70	o (16) 1 - Sep 4.00	[0.075 x (19 (18) x (20 Oct 4.30))] = [] 0) = [] Nov 4.50 1.13	hour 0.11 5.01 0.36 2 0.85 0.30 Dec 4.70 1.18 0.36 N/A) (8) (1) (1) (2) (2) (2

0.58	0.57 0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55 0	0.56 0.56	(2
3. Heat losses and heat loss	parameter									
lement		Gross area, m ²	Openings m ²	s Net A,		U-value W/m²K	A x U W/	K κ-value kJ/m².	58) (MARCONSTR	
Vindow				19	85 x	1.33	= 26.49			(2
loor				1.9	93 x	1.00	= 1.93			(2
Ground floor				56.	.93 x	0.15	= 8.54			(2
xternal wall				138	.79 x	0.27	= 37.47			(2
loof				56.	.93 x	0.11	= 6.26			(3
otal area of external element	s ∑A, m²			274	.43					(3
abric heat loss, W/K = ∑(A × U	1)						(26	(30) + (32) =	80.70	(3
leat capacitγ Cm = ∑(A x κ)						(28)	.(30) + (32) +	(32a)(32e) =	N/A	(3
hermal mass parameter (TMI	P) in kJ/m²K								159.81	(3
Thermal bridges: Σ(L x Ψ) calci	ulated using Appe	ndix K							10.71	(3
otal fabric heat loss								(33) + (36) =	91.41	(3
Jan	Feb Mar	Apr	May	Jun	Jul	Aug	Sep	Oct I	lov Dec	
entilation heat loss calculate	d monthly 0.33 x	(25)m x (5)								
52.76	52.49 52.23	50.99	50.76	49.68	49.68	49.48	50.10	50.76 5	1.23 51.72	(3
leat transfer coefficient, W/K	(37)m + (38)m									
144.17	143.90 143.64	142.40	142.17	141.09	141.09	140.89	141.51	142.17 14	2.64 143.13	
							Average = ∑	39)112/12 =	142.40	(3
leat loss parameter (HLP), W/	′m²K (39)m÷(4)									
1.27	1.26 1.26	1.25	1.25	1.24	1.24	1.24	1.24	1.25 1	25 1.26	
							Average = ∑	40)112/12 =	1.25	(4
Number of days in month (Tab	le 1a)									
31.00	28.00 31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00 3	0.00 31.00	(4
4. Water heating energy req	uirement			_	-					
ssumed occupancy, N	arement	1		-					2.84	(4
Annual average hot water usa	to in litros por dos	Vd avorago	- (25 × NI) +	26					101.56	(4
Jan	Feb Mar	Apr	May	Jun	Jul	Aug	Sep	Oct I	lov Dec	(4
lot water usage in litres per d						Aug	зер	000	ov Dec	
	107.65 103.59	99.53	95.46	91.40	91.40	95.46	99.53	103.59 10	7.65 111.71	
111./1	107.05 103.59	99.55	95.40	91.40	91.40	95.40	99.55			Ξ.
nergy content of hot water u	cod = 4 19 x \/d m	v nm v Tm/2	600 W/h/m	oonth (coo	Tables 1b	1c 1d)		∑(44)112 =	1218.69	(4
		130.35	125.08			1	110.14	125.25 1/	7 74 1 100 44	2
165.67	149.52	130.35	125.08	107.93	100.01	114.77	116.14		7.74 160.44	=
Distribution loss 0.15 x (45)m								∑(45)112 =	1597.90	(4
Distribution loss 0.15 x (45)m	21 72 22 42	10 55	19.76	16 10	15.00	17.33	17.43	20.20 2	2 16 24.07	14
24.85 Vater storage loss calculated	21.73 22.43	19.55	18.76	16.19	15.00	17.22	17.42	20.30 2	2.16 24.07	(4
			0.00	0.00	0.00	0.00		0.00	00 000	1-
0.00 the vessel contains dedicate	0.00 0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0	0.00 0.00	(5
	1.67			552 5	_ B (R (2)			0.00	00 0.00	1-
0.00	0.00 0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0	0.00 0.00	(5
Primary circuit loss for each m			0.00	0.00	0.00	0.00		0.00		_
0.00	0.00 0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0	0.00 0.00	(5
Combi loss for each month fro		-			10.75	1 47	1 10 1			٦.
na an a second a second	12.77 14.12	13.62	14.04	13.55	13.98	14.02	13.59	14.08 1	3.67 14.14	(6
Fotal heat required for water I	neating calculated	for each mo	onth 0.85 x	(45)m + (40	6)m + (57)	m + (59)m -	+ (61)m			

179.82	157.67	163.63	143.98	139.12	121.48	113.99	128.79	129.73	149.43	161.41	174.58	(62)
Solar DHW input calculated	using Appe	ndix G or A	ppendix H									
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Output from water heater for	or each moi	nth (kWh/r	nonth) (62)m + (63)m	1							
179.82	157.67	163.63	143.98	139.12	121.48	113.99	128.79	129.73	149.43	161.41	174.58	
									∑(64)1	.12 = 1	763.63	(64)
Heat gains from water heati	ng (kWh/m	ionth) 0.25	× [0.85 × (45)m + (61)m] + 0.8 ×	[(46)m + (5	57)m + (59)	m]				
58.62	51.37	53.24	46.75	45.10	39.27	36.75	41.67	42.01	48.52	52.54	56.88	(65)
5. Internal gains												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
170.17	170.17	170.17	170.17	170.17	170.17	170.17	170.17	170.17	170.17	170.17	170.17	(66)
Lighting gains (calculated in	Appendix L	, equation	L9 or L9a),	also see Ta	ble 5							
61.90	54.98	44.71	33.85	25.30	21.36	23.08	30.00	40.27	51.13	59.68	63.62	(67)
Appliance gains (calculated i	in Appendix	183 (735)	n L13 or L1	.3a), also se	2011/0/06 2017	1						
413.42	417.71	406.90	383.88	354.83	327.53	309.28	304.99	315.81	338.82	367.87	395.18	(68)
Cooking gains (calculated in	service of the service ser			a), also see								
54.85	54.85	54.85	54.85	54.85	54.85	54.85	54.85	54.85	54.85	54.85	54.85	(69)
Pump and fan gains (Table 5												1
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. evaporation (Tab	CTV ARAM	5.00	5.00		0.00	0.00	0.00	5.00	5100	5.55	5.00	()
-113.44	-113.44	-113.44	-113.44	-113.44	-113.44	-113.44	-113.44	-113.44	-113.44	-113.44	-113.44	(71)
Water heating gains (Table 5	La contra doctoria de la	115.44	115.44	110.44	115.44	113.44	115.44	113.44	115.44	110.44	115.44	11+1
		71 56	64.93	60.62	54 55	19 39	56.00	58.35	65.22	72.97	76.45	(72)
78.79	76.44	71.56 8)m + (69)r	64.93	60.62	54.55	49.39	56.00	58.35	65.22	72.97	76.45	(72)
78.79 Total internal gains (66)m +	76.44 (67)m + (68	8)m + (69)r	m + (70)m +	+ (71)m + (7	72)m							i en
78.79	76.44					49.39 496.34	56.00 505.58	58.35 529.01	65.22 569.75	72.97 615.10	76.45 649.83	(72) (73)
78.79 Total internal gains (66)m +	76.44 (67)m + (68	8)m + (69)r	m + (70)m +	+ (71)m + (7	72)m							i en
78.79 Total internal gains (66)m + 668.69	76.44 (67)m + (68	8)m + (69)r 637.75 Access f	n + (70)m + 597.24	(71)m + (7 555.33 Area	72)m 518.01 Sol a	496.34 ar flux	505.58	529.01 g	569.75 FF	615.10	649.83 Gains	i en
78.79 Total internal gains (66)m + 668.69	76.44 (67)m + (68	8)m + (69)r 637.75	n + (70)m + 597.24	+ (71)m + (7 555.33	72)m 518.01 Sol a	496.34	505.58 spec	529.01 g ific data	569.75 FF specific o	615.10	649.83	i en
78.79 Total internal gains (66)m + 668.69 6. Solar gains	76.44 (67)m + (68	8)m + (69)r 637.75 Access fr Table	n + (70)m + 597.24 actor 6d	+ (71)m + (7 555.33 Area m ²	72)m 518.01 Sola W	496.34 ar flux //m²	505.58 spec	529.01 g ific data able 6b	569.75 FF specific c or Table	615.10 data e 6c	649.83 Gains W	(73)
78.79 Total internal gains (66)m + 668.69 6. Solar gains NorthEast	76.44 (67)m + (68	8)m + (69)r 637.75 Access fr Table	n + (70)m + 597.24 actor 6d	+ (71)m + (7 555.33 Area m ² 4.68	72)m 518.01 Sola W	496.34 ar flux //m ² 1.28 x	505.58 spec or T 0.9 x	g fic data able 6b	569.75 FF specific o or Table 0.70	615.10 data : 6c	649.83 Gains W 23.62	(73)
78.79 Total internal gains (66)m + 668.69 6. Solar gains NorthEast SouthEast	76.44 (67)m + (68	8)m + (69)r 637.75 Access fr Table 1.00 1.00	n + (70)m + 597.24	+ (71)m + (7 555.33 Area m ² 4.68 5.27	72)m 518.01 Sola W X 11 X 30	496.34 ar flux //m ² 1.28 x 6.79 x	505.58 spec or T 0.9 x (0 0.9 x (0	529.01 g ific data able 6b 0.71 x 0.71 x	569.75 FF specific c or Table 0.70 0.70	615.10	649.83 Gains W 23.62 86.73	(73) (75) (77)
78.79 Total internal gains (66)m + 668.69 6. Solar gains NorthEast SouthEast SouthWest	76.44 (67)m + (68	8)m + (69)r 637.75 Access fr Table 1.00 1.00	actor 6d x (2) x (+ (71)m + (7 555.33 Area m ² 4.68 5.27 6.75	72)m 518.01 Sola X X X X 30 X 30	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x	505.58 spect or Tr 0.9 x (0 0.9 x (0 0.9 x (0	g ffic data able 6b 0.71 x 0.71 x 0.71 x	569.75 FF specific c or Table 0.70 0.70	615.10 data 6c = [] = [] = [649.83 Gains W 23.62 86.73 111.09	(73) (75) (77) (79)
78.79 Total internal gains (66)m + 668.69 6. Solar gains NorthEast SouthEast SouthEast NorthWest	76.44 (67)m + (6) 663.71	8)m + (69)r 637.75 Access fr Table 1.00 1.00	actor 6d x (2) x (+ (71)m + (7 555.33 Area m ² 4.68 5.27	72)m 518.01 Sola X X X X 30 X 30	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x	505.58 spect or Tr 0.9 x (0 0.9 x (0 0.9 x (0	529.01 g ific data able 6b 0.71 x 0.71 x	569.75 FF specific c or Table 0.70 0.70	615.10	649.83 Gains W 23.62 86.73	(73) (75) (77)
78.79 Total internal gains (66)m + 668.69 6. Solar gains NorthEast SouthEast SouthWest NorthWest Solar gains in watts Σ(74)m.	76.44 (67)m + (6) 663.71 (8)m + (69)r 637.75 Access f Table 1.00 1.00 1.00	n + (70)m + 597.24 actor 6d x () x () x () x ((71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15	72)m 518.01 Sola X X 1: X 3: X 3: X 3: X 1: X 1:	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 1.28 x	505.58 spec or T 0.9 x (0.9 x	\$29.01 #fic data able 6b 0.71 x 0.71 x 0.71 x	569.75 FF specific c or Table 0.70 0.70 0.70 0.70	615.10	649.83 Gains W 23.62 86.73 111.09 15.90	(73) (75) (77) (79) (81)
$\begin{tabular}{ c c c c }\hline\hline & 78.79 \\\hline\hline & 6.50 \\\hline & 6.60 \\\hline & 6.60 \\\hline\hline & 6.60 \hline\hline \\ \hline & 6.60 \hline\hline \\ \hline & 6.60 \hline\hline \\ \hline & 6.60 \hline\hline \hline \\ \hline & 6.60 \hline\hline \hline \\ \hline \hline \hline & 6.60 \hline\hline \hline $	76.44 (67)m + (66) 663.71 (66) (82)m 417.40 (17)	8)m + (69)r 637.75 Access fr Table 1.00 1.00 1.00 605.98	actor 6d x (2) x (+ (71)m + (7 555.33 Area m ² 4.68 5.27 6.75	72)m 518.01 Sola X X X X 30 X 30	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x	505.58 spect or Tr 0.9 x (0 0.9 x (0 0.9 x (0	g ffic data able 6b 0.71 x 0.71 x 0.71 x	569.75 FF specific c or Table 0.70 0.70	615.10 data 6c = [] = [] = [649.83 Gains W 23.62 86.73 111.09	(73) (75) (77) (79)
78.79 Total internal gains (66)m + 668.69 6. Solar gains OuthEast SouthEast SouthWest NorthWest Solar gains in watts Σ(74)m. 237.34 Total gains - internal and sol	76.44 (67)m + (6/ 663.71 (682)m 417.40 ar (73)m +	8)m + (69)r 637.75 Access fr Table 1.00 1.00 1.00 605.98 (83)m	n + (70)m + 597.24 actor 6d x () x	+ (71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15 959.79	72)m 518.01 Sola W X 1: X 3: X 3: X 1: 976.31	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 1.28 x 931.51	505.58 speci or T 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 815.63	g ific data able 6b 0.71 x	569.75 FF specific c or Table 0.70 0.70 0.70 470.72	615.10	649.83 Gains W 23.62 86.73 111.09 15.90 201.57	(73) (75) (77) (79) (81) (83)
$\begin{tabular}{ c c c c }\hline\hline & 78.79 \\\hline\hline & 6.50 \\\hline & 6.60 \\\hline & 6.60 \\\hline\hline & 6.60 \hline\hline \\ \hline & 6.60 \hline\hline \\ \hline & 6.60 \hline\hline \\ \hline & 6.60 \hline\hline \hline \\ \hline & 6.60 \hline\hline \hline \\ \hline \hline \hline & 6.60 \hline\hline \hline $	76.44 (67)m + (66) 663.71 (66) (82)m 417.40 (17)	8)m + (69)r 637.75 Access fr Table 1.00 1.00 1.00 605.98 (83)m	n + (70)m + 597.24 actor 6d x () x () x () x ((71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15	72)m 518.01 Sola X X 1: X 3: X 3: X 3: X 1: X 1:	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 1.28 x	505.58 spec or T 0.9 x (0.9 x	\$29.01 #fic data able 6b 0.71 x 0.71 x 0.71 x	569.75 FF specific c or Table 0.70 0.70 0.70 0.70	615.10	649.83 Gains W 23.62 86.73 111.09 15.90	(73) (75) (77) (79) (81)
78.79 Total internal gains (66)m + 668.69 6. Solar gains Another and the set SouthEast SouthWest NorthWest Solar gains in watts Σ(74)m. 237.34 Total gains - internal and sol	76.44 (67)m + (6) 663.71 (663.71 (7) (7) 417.40 ar (73)m + 1081.11	8)m + (69)r 637.75 Access fr Table 1.00 1.00 1.00 (1.00 (1.00 (1.00 (1.00) (1.0	n + (70)m + 597.24 actor 6d x () x	+ (71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15 959.79	72)m 518.01 Sola W X 1: X 3: X 3: X 1: 976.31	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 1.28 x 931.51	505.58 speci or T 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 815.63	g ific data able 6b 0.71 x	569.75 FF specific c or Table 0.70 0.70 0.70 470.72	615.10	649.83 Gains W 23.62 86.73 111.09 15.90 201.57	(73) (75) (77) (79) (81) (83)
$\begin{tabular}{ c c c c }\hline\hline & & \hline & $	76.44 (67)m + (66 663.71 (663.71) (663.71) (663.71) (663.71) (663.71) (663.71) (663.71) (663.71) (663.71) (673.71) (73)m + (73)m + (73	8)m + (69)r 637.75 Access fr Table 1.00 1.00 1.00 (1.00 (1.00 (1.00 (1.00) (1.0	n + (70)m + 597.24 actor 6d x () x	(71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15 959.79 1515.12	72)m 518.01 Sola W X 11: X 30 X 30 X 11: 976.31 1494.33	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 1.28 x 931.51	505.58 speci or T 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 815.63	g ific data able 6b 0.71 x	569.75 FF specific c or Table 0.70 0.70 0.70 470.72	615.10	649.83 Gains W 23.62 86.73 111.09 15.90 201.57	(73) (75) (77) (79) (81) (83)
78.79 Total internal gains (66)m + 668.69 6. Solar gains Another and the set SouthEast SouthWest NorthWest Solar gains in watts Σ(74)m. 237.34 Total gains - internal and sol 906.03 7. Mean internal temperate	76.44 (67)m + (66 663.71 (663.71) (663.71) (663.71) (663.71) (663.71) (663.71) (663.71) (663.71) (663.71) (673.71) (73)m + (73)m + (73	8)m + (69)r 637.75 Access fr Table 1.00 1.00 1.00 (1.00 (1.00 (1.00 (1.00) (1.0	n + (70)m + 597.24 actor 6d x () x	(71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15 959.79 1515.12	72)m 518.01 Sola W X 11: X 30 X 30 X 11: 976.31 1494.33	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 1.28 x 931.51	505.58 speci or T 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 815.63	g ific data able 6b 0.71 x	569.75 FF specific c or Table 0.70 0.70 0.70 470.72	615.10	649.83 Gains W 23.62 86.73 111.09 15.90 201.57 851.40	(73) (75) (77) (79) (81) (83) (84)
78.79 Total internal gains (66)m + 668.69 6. Solar gains Automatic SouthEast SouthEast SouthWest NorthWest Solar gains in watts Σ(74)m. 237.34 Total gains - internal and sol 906.03 7. Mean internal temperate Temperature during heating	76.44 (67)m + (6 663.71) (82)m 417.40 ar (73)m + 1081.11] ure (heatin ; periods in Feb	8)m + (69)r 637.75 Access f Table 1.00 1.00 1.00 (1.00 (1.00 (1.00 (1.00 (1.00) (1.0) (1.00)	n + (70)m + 597.24 actor 6d x (x (x (x (x (x (x (x ((71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15 959.79 1515.12 able 9, Th1	72)m 518.01 Sola W X 11: X 34 X 34 X 12: 976.31 1494.33 (*C)	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 6.79 x 1.28 x 931.51 1427.84	505.58 spec or T 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 815.63 1321.20	8 ific data able 6b 0.71 x 0.71 x 0.71 x 0.71 x 1.71 x 1.71 x 1.71 x 1.71 x	569.75 FF specific c 0.70 0.70 0.70 0.70 0.70 470.72 1040.47	615.10 lata .6c = [= [= [= [286.67 901.77	Gains W 23.62 86.73 111.09 15.90 201.57 851.40 21.00	(73) (75) (77) (79) (81) (83) (84)
$\begin{tabular}{ c c c c }\hline\hline & & \hline & $	76.44 (67)m + (6 663.71) (82)m 417.40 ar (73)m + 1081.11] ure (heatin ; periods in Feb	8)m + (69)r 637.75 Access f Table 1.00 1.00 1.00 (1.00 (1.00 (1.00 (1.00 (1.00) (1.0) (1.00)	n + (70)m + 597.24 actor 6d x (x (x (x (x (x (x (x ((71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15 959.79 1515.12 able 9, Th1	72)m 518.01 Sola W X 11: X 34 X 34 X 12: 976.31 1494.33 (*C)	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 6.79 x 1.28 x 931.51 1427.84	505.58 spec or T 0.9 x (0 0.9 x (0 0.9 x (0 0.9 x (0 815.63 1321.20	8 ific data able 6b 0.71 x 0.71 x 0.71 x 0.71 x 1.71 x 1.71 x 1.71 x 1.71 x	569.75 FF specific c 0.70 0.70 0.70 0.70 0.70 470.72 1040.47	615.10 lata .6c = [= [= [= [286.67 901.77	Gains W 23.62 86.73 111.09 15.90 201.57 851.40 21.00	(73) (75) (77) (79) (81) (83) (84)
$\begin{tabular}{ c c c c }\hline\hline & & \hline & $	76.44 (67)m + (6) 663.71 (663.71) (82)m 417.40 ar (73)m + 1081.11 (1081.11)	8)m + (69)r 637.75 Access fr Table 1.00 1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.	n + (70)m + 597.24 actor 6d x [x [x] x] x [x] x] x] x [x] x] x] x] x] x] x] x]	(71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15 959.79 1515.12 able 9, Th1 May 0.72	72)m 518.01 Sola W X 1: X 30 X 30 X 30 X 1: 976.31 1494.33 ('C) Jun	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 1.28 x 931.51 1427.84 Jul	505.58 spec or T 0.9 x (0) 0.9 x (0) 0.9 x (0) 815.63 1321.20 Aug	529.01 g ific data able 6b 0.71 x 5.81 5.81 1204.82 5.81	569.75 FF specific c or Table 0.70 0.70 0.70 470.72 1040.47 Oct	615.10 lata 6c = [= [= [= [286.67 901.77 Nov	649.83 Gains W 23.62 86.73 111.09 15.90 201.57 851.40 21.00 Dec	(73) (75) (77) (79) (81) (83) (83) (84)
$\begin{tabular}{ c c c c }\hline\hline & & \hline & $	76.44 (67)m + (6) 663.71 (663.71) (82)m 417.40 ar (73)m + 1081.11 (1081.11)	8)m + (69)r 637.75 Access fr Table 1.00 1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.00 1.00 (1.	n + (70)m + 597.24 actor 6d x [x [x] x] x [x] x] x] x [x] x] x] x] x] x] x] x]	(71)m + (7 555.33 Area m ² 4.68 5.27 6.75 3.15 959.79 1515.12 able 9, Th1 May 0.72	72)m 518.01 Sola W X 1: X 30 X 30 X 30 X 1: 976.31 1494.33 ('C) Jun	496.34 ar flux //m ² 1.28 x 6.79 x 6.79 x 1.28 x 931.51 1427.84 Jul	505.58 spec or T 0.9 x (0) 0.9 x (0) 0.9 x (0) 815.63 1321.20 Aug	529.01 g ific data able 6b 0.71 x 5.81 5.81 1204.82 5.81	569.75 FF specific c or Table 0.70 0.70 0.70 470.72 1040.47 Oct	615.10 lata 6c = [= [= [= [286.67 901.77 Nov	649.83 Gains W 23.62 86.73 111.09 15.90 201.57 851.40 21.00 Dec	(73) (75) (77) (79) (81) (83) (83) (84)

	19.87	10.07	19.87	10.00	10.00	19.89	10.90	10.90	10.90	10.99	10.00	10.07	(88)
The state of the		19.87		19.88	19.88	19.89	19.89	19.89	19.89	19.88	19.88	19.87	(66)
Utilisation facto					1					1	1		Pares -
	0.97	0.95	0.90	0.81	0.66	0.47	0.32	0.36	0.61	0.85	0.95	0.98	(89)
Mean internal t	temperature	in the rest	of dwelling	T2 (follow	steps 3 to	7 in Table 9	∋c)						
	17.63	18.01	18.56	19.18	19.61	19.83	19.88	19.87	19.74	19.17	18.29	17.55	(90)
Living area frac	tion								Li	ving area ÷	(4) =	0.14	(91)
Mean internal t	temperature	for the wh	ole dwellin	g fLA x T1 +	+(1 - fLA) x	Г2							
	17.86	18.24	18.76	19.35	19.77	19.98	20.03	20.03	19.90	19.34	18.50	17.79	(92)
Apply adjustme	ent to the m	ean internal	temperatu	ure from Ta	ble 4e whe	re appropr	iate	Ad (15)		08 - 0	At it		tok k
14.1 11 10	17.71	18.09	18.61	19.20	19.62	19.83	19.88	19.88	19.75	19.19	18.35	17.64	(93)
8. Space heati	ing requiren	ant											
o. space near	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilication facto			mar	сф.	inay	Jun	541	100	JCP	ou	nor	Dee	
Utilisation facto		120000	0.00										1 (0.1)
1000 22 20 30	0.96	0.93	0.88	0.79	0.65	0.47	0.32	0.36	0.60	0.83	0.93	0.96	(94)
Useful gains, ηr	mGm, W (94	1)m x (84)m											-
	866.21	1003.35	1093.32	1106.93	980.02	702.46	456.43	479.27	718.71	862.22	839.82	819.67	(95)
Monthly average	ge external t	emperature	from Tabl	e 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 f	or mean inte	ernal tempe	rature, Lm	, W [(39)m	n x [(93)m -	(96)m]							
	1934.05	1897.39	1739.27	1467.32	1126.63	738.36	463.39	490.08	799.19	1221.39	1604.09	1923.83	(97)
Space heating r	equirement	, kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41)	m	80	·		\$0 /	20		tene us
	794.47	600.80	480.58	259.48	109.07	0.00	0.00	0.00	0.00	267.22	550.28	821.50	1
									5(9)	8)15, 10	12 = 3	883.40	(98)
Correction of									215	5,21115, 2011		0001.10	1-01
	oquiroment	Wh/m²/ve	aar							(98)	$\div (A)$	3/111	(00)
Space neating r	equirement	kWh/m²/ye	ear							(98)	÷ (4)	34.11	(99)
9a. Energy rec				stems inclu	ıding micro	-CHP	\geq			(98)	÷ (4)	34.11	(99)
9a. Energy rec				stems inclu	ıding micro	-СНР	2			(98)	÷ (4)	34.11) (99)
9a. Energy rec Space heating	quirements -	individual	heating sy	1						(98)	÷ (4)		
9a. Energy red Space heating Fraction of space	quirements - ce heat from	individual secondary,	heating sys /suppleme	1								0.00] (201)
9a. Energy red Space heating Fraction of space Fraction of space	quirements - ce heat from ce heat from	individual secondary, main syste	heating sys /suppleme m(s)	1						(98) 1 - (20		0.00] (201)] (202)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of space	quirements ce heat from ce heat from ce heat from	individual secondary, main syste main syste	heating sys /supplemen m(s) m 2	1						1 - (20	01) =	0.00 1.00 0.00] (201)] (202)] (202)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of space Fraction of tota	uirements ce heat from ce heat from ce heat from ce heat from ll space heat	n individual a secondary, a main syste a main syste from main	heating sys /supplemen m(s) m 2 system 1	1					(20	1 - (20)2) x [1- (20	01) =	0.00 1.00 0.00 1.00] (201)] (202)] (202)] (202)] (204)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of space	uirements ce heat from ce heat from ce heat from ce heat from ll space heat	n individual a secondary, a main syste a main syste from main	heating sys /supplemen m(s) m 2 system 1	1					(20	1 - (20	01) = 03)] = 03) =	0.00 1.00 0.00 1.00 0.00] (201)] (202)] (202)] (202)] (204)] (205)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of space Fraction of tota	uirements - ce heat from ce heat from ce heat from il space heat il space heat	n secondary, n main syste n main syste from main from main	heating sys /supplemen m(s) m 2 system 1	1					(20	1 - (20)2) x [1- (20	01) = 03)] = 03) =	0.00 1.00 0.00 1.00] (201)] (202)] (202)] (202)] (204)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota	uirements - ce heat from ce heat from ce heat from il space heat il space heat	n secondary, n main syste n main syste from main from main	heating sys /supplemen m(s) m 2 system 1	1			Jul	Aug	(20 Sep	1 - (20)2) x [1- (20	01) = 03)] = 03) =	0.00 1.00 0.00 1.00 0.00] (201)] (202)] (202)] (202)] (204)] (205)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota	quirements - ce heat from ce heat from ce heat from il space heat il space heat ain system 1 Jan	secondary, main syste main syste from main from main (%) Feb	heating sys /supplemen m(s) m 2 system 1 system 2 Mar	ntary syste	m (table 11)	lut	Aug		1 - (20 02) x [1- (20 (202) x (20	01) = []] []] []] []] []] []]] []]] []]	0.00 1.00 0.00 1.00 0.00 90.50] (201)] (202)] (202)] (202)] (204)] (205)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma	quirements - ce heat from ce heat from ce heat from il space heat il space heat ain system 1 Jan	secondary, main syste main syste from main from main (%) Feb	heating sys /supplemen m(s) m 2 system 1 system 2 Mar	ntary syste	m (table 11)	Jul	Aug 0.00		1 - (20 02) x [1- (20 (202) x (20	01) = []] []] []] []] []] []]] []]] []]	0.00 1.00 0.00 1.00 0.00 90.50] (201)] (202)] (202)] (202)] (204)] (205)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma	quirements - ce heat from ce heat from ce heat from ce heat from il space heat il space heat ain system 1 Jan uel (main sy	e individual a secondary, a main syste a main syste from main (%) Feb stem 1), kW	heating sys /supplemee m(s) m 2 system 1 system 2 Mar /h/month	ntary syste Apr	m (table 11 May) Jun			Sep 0.00	1 - (2()2) × [1- (20 (202) × (2(Oct	01) = []]] = []]] = []]] []] []] []] []] []] []] []] [0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73] (201)] (202)] (202)] (202)] (204)] (205)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma	quirements - ce heat from ce heat from ce heat from ce heat from il space heat il space heat ain system 1 Jan iuel (main sy 877.87	e individual a secondary, a main syste a main syste from main (%) Feb stem 1), kW	heating sys /supplemee m(s) m 2 system 1 system 2 Mar /h/month	ntary syste Apr	m (table 11 May) Jun			Sep 0.00	1 - (2()2) × [1- (20 (202) × (2(Oct 295.28	01) = []]] = []]] = []]] []] []] []] []] []] []] []] [0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73] (201)] (202)] (202)] (204)] (205)] (206)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Fraction of tota Efficiency of ma Space heating f	quirements - ce heat from ce heat from ce heat from ce heat from il space heat al space heat al space heat al space heat Jan fuel (main sy 877.87	e individual a secondary, a main syste a main syste from main (%) Feb stem 1), kW	heating sys /supplemee m(s) m 2 system 1 system 2 Mar /h/month	ntary syste Apr	m (table 11 May) Jun			Sep 0.00	1 - (2()2) × [1- (20 (202) × (2(Oct 295.28	01) = []]] = []]] = []]] []] []] []] []] []] []] []] [0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73] (201)] (202)] (202)] (204)] (205)] (206)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating f	quirements - ce heat from ce heat from ce heat from il space heat il space heat ain system 1 Jan fuel (main sy 877.87	individual secondary, main syste main syste from main (%) Feb stem 1), kW 663.86	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 531.03	Apr 286.72	m (table 11 May 120.52) Jun 0.00	0.00	0.00	Sep 0.00 Σ(21	1 - (20)2) x [1- (20 (202) x (20 Oct 295.28 1)15, 10	01) = 03) = 03) = Nov 608.04 .12 =4	0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73 291.05] (201)] (202)] (202)] (204)] (205)] (206)]] (211)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating f Water heating Efficiency of wa	quirements - ce heat from ce heat from ce heat from ce heat from il space heat il spac	individual secondary, main syste main syste from main (%) Feb stem 1), kW 663.86	heating sys /supplemee m(s) m 2 system 1 system 2 Mar /h/month	ntary syste Apr	m (table 11 May) Jun			Sep 0.00	1 - (2()2) × [1- (20 (202) × (2(Oct 295.28	01) = []]] = []]] = []]] []] []] []] []] []] []] []] [0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73] (201)] (202)] (202)] (204)] (205)] (206)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of main Space heating for Water heating	te heat from ce heat from space heat il space heat il space heat il space heat ce heat from space heat ce heat from ce heat from space heat space heat ce heat from ce heat from space heat space h	e individual a secondary, a main syste a main syste from main (%) Feb stem 1), kW 663.86 89.82 wonth	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 531.03	Apr 286.72 89.33	m (table 11 May 120.52 88.68) Jun 0.00 87.30	0.00	0.00	Sep 0.00 ∑(21) 87.30	1 - (2()2) × [1- (20 (202) × (2(Oct 295.28 1)15, 10 89.33	01) = (3)] = 03) = Nov 608.04 .12 =4 89.75	0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73 291.05 89.92] (201)] (202)] (202)] (204)] (205)] (206)]] (211)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating f Water heating Efficiency of wa	quirements - ce heat from ce heat from ce heat from ce heat from il space heat il spac	individual secondary, main syste main syste from main (%) Feb stem 1), kW 663.86	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 531.03	Apr 286.72	m (table 11 May 120.52) Jun 0.00	0.00	0.00	Sep 0.00 Σ(21	1 - (2()2) × (1- (20 (202) × (2(Oct 295.28 1)15, 10 89.33 167.29	01) = (3)] = (3) = (3) = (3) = (3) = (4) = (508.04) (12) = (4) = (508.04) (12) = (12) =	0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73 291.05 89.92 194.15] (201)] (202)] (202)] (204)] (205)] (206)] (206)] (211)] (217)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating f Water heating Efficiency of wa	te heat from ce heat from space heat il space heat il space heat il space heat ce heat from space heat ce heat from ce heat from space heat space heat ce heat from ce heat from space heat space h	e individual a secondary, a main syste a main syste from main (%) Feb stem 1), kW 663.86 89.82 wonth	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 531.03	Apr 286.72 89.33	m (table 11 May 120.52 88.68) Jun 0.00 87.30	0.00	0.00	Sep 0.00 ∑(21) 87.30	1 - (2()2) × [1- (20 (202) × (2(Oct 295.28 1)15, 10 89.33	01) = (3)] = (3) = (3) = (3) = (3) = (4) = (508.04) (12) = (4) = (508.04) (12) = (12) =	0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73 291.05 89.92] (201)] (202)] (202)] (204)] (205)] (206)]] (211)
9a. Energy rec Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating f Water heating Efficiency of wa	te heat from ce heat from space heat il space heat il space heat il space heat ce heat from space heat ce heat from ce heat from space heat space heat ce heat from ce heat from space heat space h	e individual a secondary, a main syste a main syste from main (%) Feb stem 1), kW 663.86 89.82 wonth	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 531.03	Apr 286.72 89.33	m (table 11 May 120.52 88.68) Jun 0.00 87.30	0.00	0.00	Sep 0.00 ∑(21) 87.30	1 - (2()2) × (1- (20 (202) × (2(Oct 295.28 1)15, 10 89.33 167.29	01) = (3)] = (3) = (3) = (3) = (3) = (4) = (508.04) (12) = (4) = (508.04) (12) = (12) =	0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73 291.05 89.92 194.15] (201)] (202)] (202)] (204)] (205)] (206)] (206)] (211)] (217)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating f Water heating Water heating	auirements - ce heat from ce heat from ce heat from ce heat from il space heat al space heat al space heat al space heat an yan fuel (main sy 877.87 ater heater <u>89.89</u> fuel, kWh/m <u>200.04</u>	individual secondary, main syste main syste from main (%) Feb stem 1), kW 663.86 89.82 onth 175.55	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 531.03	Apr 286.72 89.33	m (table 11 May 120.52 88.68) Jun 0.00 87.30	0.00	0.00	Sep 0.00 ∑(21) 87.30	1 - (2()2) × (1- (20 (202) × (2(Oct 295.28 1)15, 10 89.33 167.29	01) = 33)] = 03) = Nov 608.04 .12 =4 89.75 179.84 .12 =1	0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73 291.05 89.92 194.15] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (211)] (217)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating Water heating for Water heating for Mater heating for Annual totals	iuirements - ce heat from ce heat from ce heat from ce heat from il space heat il space heat ain system 1 Jan fuel (main sy 877.87 eter heater 89.89 fuel, kWh/m 200.04	individual secondary, main syste main syste from main (%) Feb stem 1), kW 663.86 89.82 onth 175.55	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 531.03	Apr 286.72 89.33	m (table 11 May 120.52 88.68) Jun 0.00 87.30	0.00	0.00	Sep 0.00 ∑(21) 87.30	1 - (2()2) × (1- (20 (202) × (2(Oct 295.28 1)15, 10 89.33 167.29	01) = 3)] = 03) = Nov 608.04 .12 = 89.75 179.84 .12 = 179.84 .12 =	0.00 1.00 0.00 1.00 0.00 90.50 Dec 907.73 291.05 89.92 194.15 983.26] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (211)] (217)

Energy Demand Study Longridge Phase 2/3

central heating pump or water pump within warm air heatin boiler flue fan	g unit		30.00			(230c) (230e)
Total electricity for the above, kWh/year			45.00	Г	75.00	(231)
Electricity for lighting (Appendix L)				ſ	437.29	(232)
Total delivered energy for all uses		(211	1)(221) + (231) + (2	L 32) (237h) = [6786.61	(238)
		1211	1)(221) + (231) + (2	52)(2576) - [0700.01] (250)
10a. Fuel costs - individual heating systems including micro-Cl	HP					÷
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4291.05	x	3.48	x 0.01 =	149.33	(240)
Water heating	1983.26	x	3.48	x 0.01 =	69.02	(247)
Pumps and fans	75.00	x	13.19	x 0.01 = [9.89	(249)
Electricity for lighting	437.29	x	13.19	x 0.01 =	57.68	(250)
Additional standing charges				[120.00	(251)
Total energy cost			(240)(242) + (245)(254) = [405.92	(255)
11a. SAP rating - individual heating systems including micro-C	HP	-				
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)				- i	1.07	(257)
SAP value				Ī	85.03]
SAP rating (section 13)				Ĩ	85	(258)
SAP band				Ĩ	В	1
		_				_
12a. CO2 emissions - individual heating systems including mice	O-CHP					
	and the second se		Emission faster		Facilitations	_
	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	Energy	×		= [(261)
	Energy kWh/year	x x	kg CO ₂ /kWh	= [= [kg CO ₂ /year] (261)] (264)
Space heating - main system 1	Energy kWh/year 4291.05		kg CO ₂ /kWh	= [kg CO ₂ /year 926.87	- Internation
Space heating - main system 1 Water heating	Energy kWh/year 4291.05		kg CO ₂ /kWh 0.216 0.216	= [kg CO ₂ /year 926.87 428.38	(264)
Space heating - main system 1 Water heating Space and water heating	Energy kWh/year 4291.05 1983.26	×	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2	= [263) + (264) = [kg CO ₂ /year 926.87 428.38 1355.25	(264) (265)
Space heating - main system 1 Water heating Space and water heating Pumps and fans	Energy kWh/year 4291.05 1983.26 75.00	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519	= [263) + (264) = [= [kg CO ₂ /year 926.87 428.38 1355.25 38.93) (264)) (265)] (267)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting	Energy kWh/year 4291.05 1983.26 75.00	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519	= [263) + (264) = [= [= [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95) (264)) (265)] (267)] (268)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year	Energy kWh/year 4291.05 1983.26 75.00	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519	= [263) + (264) = [= [265)(271) = [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13) (264) (265) (267) (268) (272) (272) (273)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14)	Energy kWh/year 4291.05 1983.26 75.00	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519	= [263) + (264) = [= [265)(271) = [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86	(264) (265) (267) (268) (272)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value	Energy kWh/year 4291.05 1983.26 75.00	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519	= [263) + (264) = [= [265)(271) = [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33) (264) (265) (267) (268) (272) (272) (273)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14)	Energy kWh/year 4291.05 1983.26 75.00 437.29	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519	= [263) + (264) = [= [265)(271) = [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86) (264) (265) (267) (268) (272) (272) (273)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band	Energy kWh/year 4291.05 1983.26 75.00 437.29	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519	= [263) + (264) = [= [265)(271) = [(272) + (4) = [[[kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86] (264)] (265)] (267)] (268)] (272)] (273)]] (274)]
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band	Energy kWh/year 4291.05 1983.26 75.00 437.29	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519 (= [263) + (264) = [= [265)(271) = [(272) + (4) = [[[kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86 8 Primary Energy] (264)] (265)] (267)] (268)] (272)] (273)]] (274)]
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including mi	Energy kWh/year 4291.05 1983.26 75.00 437.29 437.29	x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519 (Primary factor	= [263) + (264) = [= [265)(271) = [(272) + (4) = [[kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86 B Primary Energy kWh/year] (264)] (265)] (267)] (268)] (272)] (273)] (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including min	Energy kWh/year 4291.05 1983.26 75.00 437.29 437.29 table temps kWh/year 4291.05	x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519 (Primary factor 1.22	= [263) + (264) = [= [265)(271) = [(272) ÷ (4) = [[= [= [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86 8 8 8 8 8 8 8 8 8 8 8 8 8	(264) (265) (267) (268) (272) (273) (273) (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including mid Space heating - main system 1 Water heating	Energy kWh/year 4291.05 1983.26 75.00 437.29 437.29 table temps kWh/year 4291.05	x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519 (Primary factor 1.22 1.22	= [263) + (264) = [= [265)(271) = [(272) ÷ (4) = [[= [= [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86 B Primary Energy kWh/year 5235.09 2419.58) (264) (265) (267) (268) (272) (273) (273) (274) (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including mil Space heating - main system 1 Water heating Space and water heating	Energy kWh/year 4291.05 1983.26 75.00 437.29 437.29 Energy kWh/year 4291.05 1983.26	x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519 (Primary factor 1.22 1.22 (261) + (262) + (2 (261) + (262) + (262) + (2 (261) + (262) + (= [= [= [(272) + (264) = [= [(272) + (4) = [[= [= [263) + (264) = [= [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86 8 Primary Energy kWh/year 5235.09 2419.58 7654.67) (264)) (265)) (267)) (268)] (272)] (273)] (274)] (274)] (261)] (264)] (265)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including mi Space heating - main system 1 Water heating Space and water heating Pumps and fans	Energy kWh/year 4291.05 1983.26 75.00 437.29 437.29 Energy kWh/year 4291.05 1983.26 1983.26	x x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (2 0.519 0.519 0.519 (Primary factor 1.22 1.22 (261) + (262) + (2 3.07	= [= [= [(272) + (4) = [(272) + (4) = [= [263) + (264) = [= [kg CO ₂ /year 926.87 428.38 1355.25 38.93 226.95 1621.13 14.24 86.33 86 8 8 Primary Energy kWh/year 5235.09 2419.58 7654.67 230.25) (264)) (265)) (267)) (268)] (272)] (273)] (274)] (274)] (261)] (261)] (265)] (265)