Energy Demand Study

Longridge Phase 2/3

Client: Barratt Manchester

Author: Michael Woodbridge

www.environmental-economics.co.uk

Revision History

Version	*Date*	*Reason for Issue*	*Issued by*	*QA check*
1	15/10/2018	Report provided in support of planning application	*Michael Woodbridge*	*Zach Sifakis*

Contents

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*

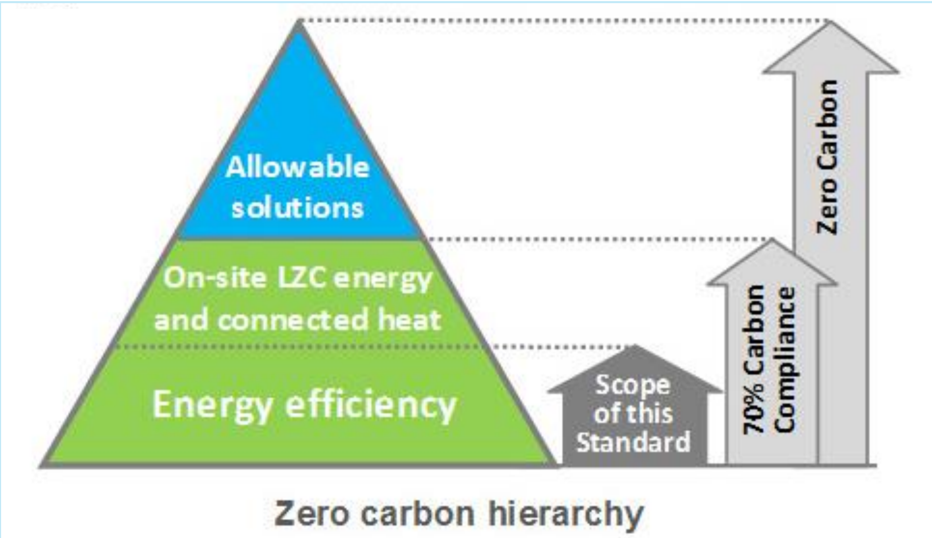
Two models were created in order to calculate the difference in energy demand from the specification improvements. The total energy demand for the site is calculated for each of the models, and then the difference used to establish the level of improvement.

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.

Fig. 1



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 5.01m^3/hr/m^2
- 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.

Table 1

Element	*Minimum Standard*	*Improved Specification*	
-	***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

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 $5.01m^3/hr.m^2$ 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.

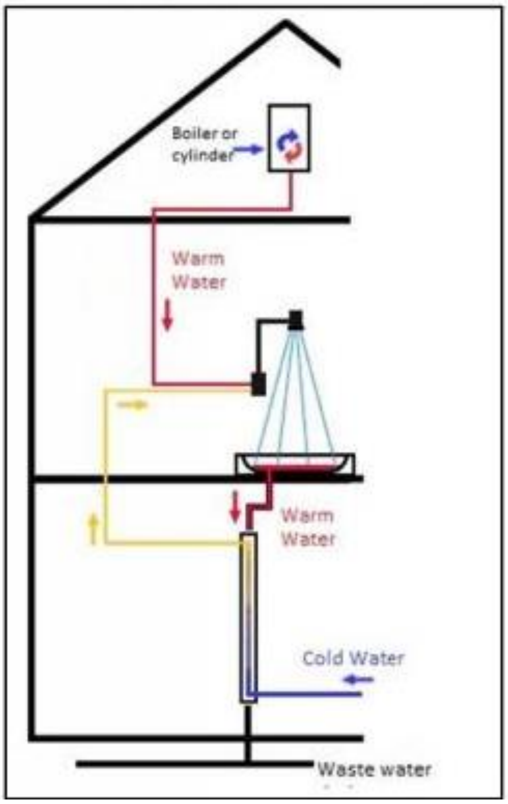
Since a significant amount of heating energy is lost through the dwelling's lintels, BHM intend to use IG Hi-Therm lintels on some house types. IG Hi-Therm lintels achieve a lower linear thermal transmittance (Psi value) of 0.05W/mK, in comparison to the normal IG lintels which achieve a Psi value of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

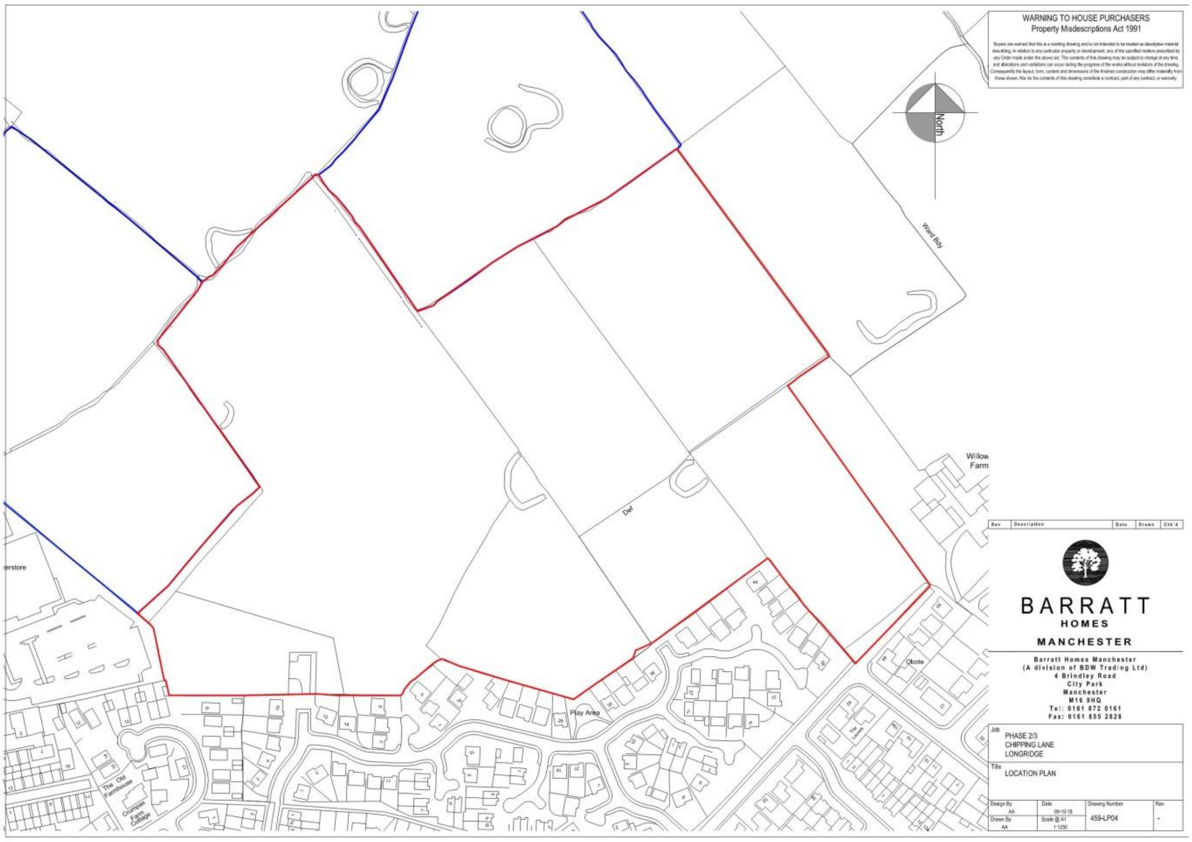
The table presented in Appendix C shows the energy saving that the improved specification will achieve in comparison to base compliance with Part L 2013 building regulations.

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.

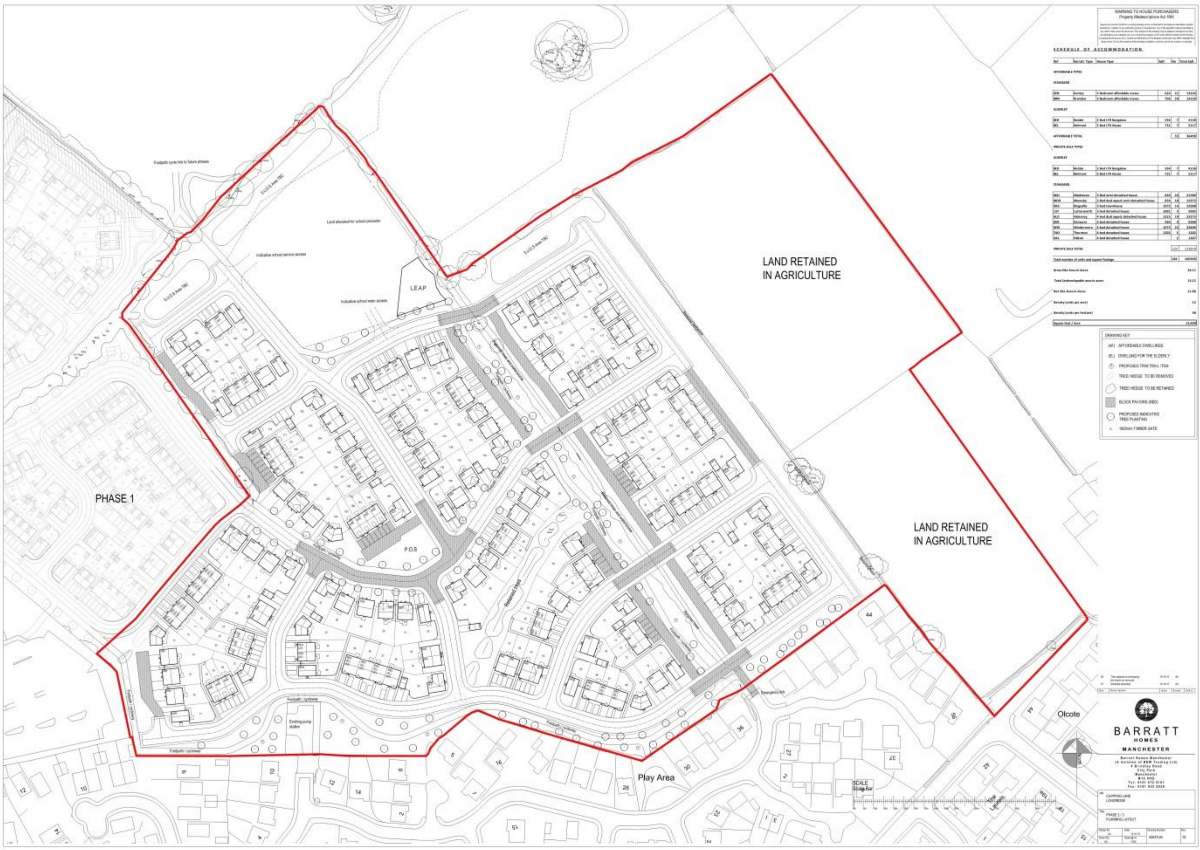
Approved for Release

Date: 15/10/2018

Appendix A


WARNING TO HOUSE PURCHASERS
Property Misdescriptions Act 1991
North
Willow Farm
Play Area
The Old Farmhouse
Rev
Description
Date
Drawn
Chk'd
BARRATT
HOMES
MANCHESTER
Barratt Homes Manchester
(A division of BDW Trading Ltd)
4 Brindley Road
City Park
Manchester
M16 9HQ
Tel: 0161 872 0161
Fax: 0161 855 2828
Job
PHASE 2/3
CHIPPING LANE
LONGRIDGE
Title
LOCATION PLAN
Design By
AA
Date
09-10-18
Drawing Number
459-LP04
Rev
-
Drawn By
AA
Scale @ A1
1:1250

Appendix B


LAND RETAINED
IN AGRICULTURE
LAND RETAINED
IN AGRICULTURE
PHASE 1
LEAP
P.O.S
Play Area
Oilcote
BARRATT
HOMES
MANCHESTER

Appendix C

Client:	**Barratt Manchester**
Project:	**Longridge Phase 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*	m^2	-	*kWh/Annum*
Data Set 1: Base Case Design (Part L 2013 Compliant)							
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 Set 1 Total Energy Demand *(kWh/Annum)*	**1,058,851**
Data Set 2: Actual Case (Improved Specification)							
Alderney	4290	1983	437	75	114	19	128,927
Bedale	2177	1569	257	75	55	14	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	1988	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	1881	346	75	77	26	132,070
Moresby	2928	1898	344	75	79	18	94,417
Thornton	4389	1975	430	75	110	1	6,868
Windermere	4765	1937	415	75	100	22	158,221
						Data Set 2 Total Energy Demand *(kWh/Annum)*	**1,025,725**
							Reduction in Energy Demand
							3.1%

Notes

#1: Calculated by SAP2012 to include total energy demand for space heating, hot water, lighting, pumps and fans.

Appendix D

IG LINTEL GUIDE

If lintels are required to carry loads not indicated on the load tables, please contact IG's Technical Department.

LINTEL HOTLINE
01633 486486

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

IG Fastrack CAD Database is accessible from iglintels.com

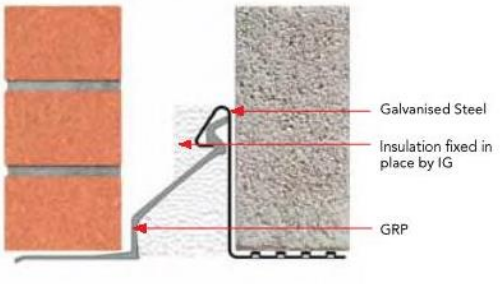
Cavity Wall

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

bre
THERMAL PERFORMANCE TESTING

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.

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	6913 James Lane	Assessor number	6913
Client		Last modified	09/01/2017
Address	BALD 00CD Alderney Detached 2016 Classic Range, Barratt Developments		

1. Overall dwelling dimensions

		Area (m^2)			Average storey height (m)			Volume (m^3)	
Lowest occupied		56.93	(1a)	x	2.33	(2a)	=	132.65	(3a)
+1		56.93	(1b)	x	2.55	(2b)	=	145.17	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	113.86	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	277.82	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		3	x 10 =	30	(7a)
Number of passive vents		0	x 10 =	0	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	30	÷ (5) =	0.11	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.01	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.36	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.30	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.39	0.38	0.37	0.34	0.33	0.29	0.29	0.28	0.30	0.33	0.34	0.36	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

d) natural ventilation or whole house positive input ventilation from loft

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(24d)

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

0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			19.85	x	1.33	=	26.49			(27)
Door			1.93	x	1.00	=	1.93			(26)
Ground floor			56.93	x	0.15	=	8.54			(28a)
External wall			138.79	x	0.27	=	37.47			(29a)
Roof			56.93	x	0.11	=	6.26			(30)
Total area of external elements ∑A, m²			274.43							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	80.70	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		159.81	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		10.71	(36)
Total fabric heat loss	(33) + (36) =	91.41	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated 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	51.23	51.72	(38)
Heat 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	142.64	143.13	
Average = ∑(39)1...12/12 =												142.40	(39)
Heat 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)1...12/12 =												1.25	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	2.84	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	101.56	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	111.71	107.65	103.59	99.53	95.46	91.40	91.40	95.46	99.53	103.59	107.65	111.71	
∑(44)1...12 =												1218.69	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	165.67	144.89	149.52	130.35	125.08	107.93	100.01	114.77	116.14	135.35	147.74	160.44	
∑(45)1...12 =												1597.90	(45)
Distribution loss 0.15 x (45)m	24.85	21.73	22.43	19.55	18.76	16.19	15.00	17.22	17.42	20.30	22.16	24.07	(46)
Water storage loss calculated for each month (55) x (41)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	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c	14.15	12.77	14.12	13.62	14.04	13.55	13.98	14.02	13.59	14.08	13.67	14.14	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)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 Appendix G or Appendix 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 each month (kWh/month) (62)m + (63)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	

∑(64)1...12 = 1763.63 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (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 Table 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 in Appendix L, equation L13 or L13a), also see Table 5													
	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 Appendix L, equation L15 or L15a), also see Table 5													
	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 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. evaporation (Table 5)													
	-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)													
	78.79	76.44	71.56	64.93	60.62	54.55	49.39	56.00	58.35	65.22	72.97	76.45	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	668.69	663.71	637.75	597.24	555.33	518.01	496.34	505.58	529.01	569.75	615.10	649.83	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
NorthEast	1.00	x	4.68	x	11.28	x 0.9 x	0.71	x	0.70	=	23.62	(75)
SouthEast	1.00	x	5.27	x	36.79	x 0.9 x	0.71	x	0.70	=	86.73	(77)
SouthWest	1.00	x	6.75	x	36.79	x 0.9 x	0.71	x	0.70	=	111.09	(79)
NorthWest	1.00	x	3.15	x	11.28	x 0.9 x	0.71	x	0.70	=	15.90	(81)

Solar gains in watts ∑(74)m...(82)m

237.34	417.40	605.98	809.27	959.79	976.31	931.51	815.63	675.81	470.72	286.67	201.57	(83)

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

906.03	1081.11	1243.73	1406.51	1515.12	1494.33	1427.84	1321.20	1204.82	1040.47	901.77	851.40	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)													
	0.98	0.96	0.92	0.84	0.72	0.56	0.42	0.47	0.69	0.88	0.96	0.98	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
	19.29	19.56	19.95	20.39	20.73	20.92	20.98	20.97	20.83	20.37	19.74	19.24	(87)

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

19.87	19.87	19.87	19.88	19.88	19.89	19.89	19.89	19.89	19.88	19.88	19.87	(88)

Utilisation factor for gains for rest of dwelling n2,m

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

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 fraction — Living area ÷ (4) = 0.14 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

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

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 heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	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, ηmGm, W (94)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 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]	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 requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	794.47	600.80	480.58	259.48	109.07	0.00	0.00	0.00	0.00	267.22	550.28	821.50	

∑(98)1...5, 10...12 = 3883.40 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 34.11 (99)

9a. Energy requirements - individual heating systems including micro-CHP

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	(205)
Efficiency of main system 1 (%)		90.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	877.87	663.86	531.03	286.72	120.52	0.00	0.00	0.00	0.00	295.28	608.04	907.73

∑(211)1...5, 10...12 = 4291.05 (211)

Water heating

Efficiency of water heater

89.89	89.82	89.67	89.33	88.68	87.30	87.30	87.30	87.30	89.33	89.75	89.92	(217)

Water heating fuel, kWh/month

200.04	175.55	182.49	161.17	156.88	139.15	130.57	147.52	148.60	167.29	179.84	194.15

∑(219a)1...12 = 1983.26 (219)

Annual totals

Space heating fuel - main system 1	4291.05
Water heating fuel	1983.26

Electricity for pumps, fans and electric keep-hot (Table 4f)

central heating pump or water pump within warm air heating unit		30.00			(230c)
boiler flue fan		45.00			(230e)
Total electricity for the above, kWh/year				75.00	(231)
Electricity for lighting (Appendix L)				437.29	(232)
Total delivered energy for all uses			(211)...(221) + (231) + (232)...(237b) =	6786.61	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	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-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.07	(257)
SAP value	85.03	
SAP rating (section 13)	85	(258)
SAP band	B	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	4291.05	x	0.216	=	926.87	(261)
Water heating	1983.26	x	0.216	=	428.38	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1355.25	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	437.29	x	0.519	=	226.95	(268)
Total CO_2, kg/year				(265)...(271) =	1621.13	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	14.24	(273)
EI value					86.33	
EI rating (section 14)					86	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	4291.05	x	1.22	=	5235.09	(261)
Water heating	1983.26	x	1.22	=	2419.58	(264)
Space and water heating				(261) + (262) + (263) + (264) =	7654.67	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	437.29	x	3.07	=	1342.48	(268)
Primary energy kWh/year					9227.40	(272)
Dwelling primary energy rate kWh/m2/year					81.04	(273)