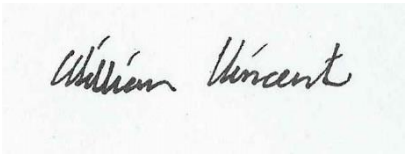
environmental economics

Client: David Wilson North West

Author: William Vincent

Revision History

Version	Date Issued	Issued by	QA Check
2	31/01/2019	 *William Vincent*	 *Michael Woodbridge*

Contents

1. Project Overview

1.1. Introduction

This sustainability study was prepared by Environmental Economics Ltd on behalf of David Wilson North West. The report assesses measures to reduce the energy demand of the domestic housing on site through an improvement in materials and products used.

1.2. Description of Site

The site consists of 208 plots. These units comprise a range of detached, semi-detached and terraced dwellings.

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

This report addresses a domestic development being undertaken by David Wilson North West, and does not include any further proposals for subsequent developments or non-residential parcels.

1.3. Client Brief

The planning authority for this site is Ribble Valley Borough Council. The relevant condition is as follows:

"12. No development shall begin until a scheme identifying how a minimum of 10% of the energy requirements generated by the development will be achieved by renewable energy production methods, has been submitted to and approved in writing by the Local Planning Authority. The scheme shall then be implemented in accordance with the approved details prior to occupation of the development and thereafter retained in a condition commensurate with delivering the agreed level of energy generation."

A fabric first approach will be used to achieve a 10% reduction in energy demand.

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 CO2/m2/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. The total regulated carbon emissions for each property is based upon:

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

Two models were created for each plot in order to calculate the different 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 emissions 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 2012) through version 6 of the NHER Plan Assessor software. An example SAP worksheet is shown in Appendix C.

2.2. Design Philosophy

David Wilson North West has upgraded a number of elements from a 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.

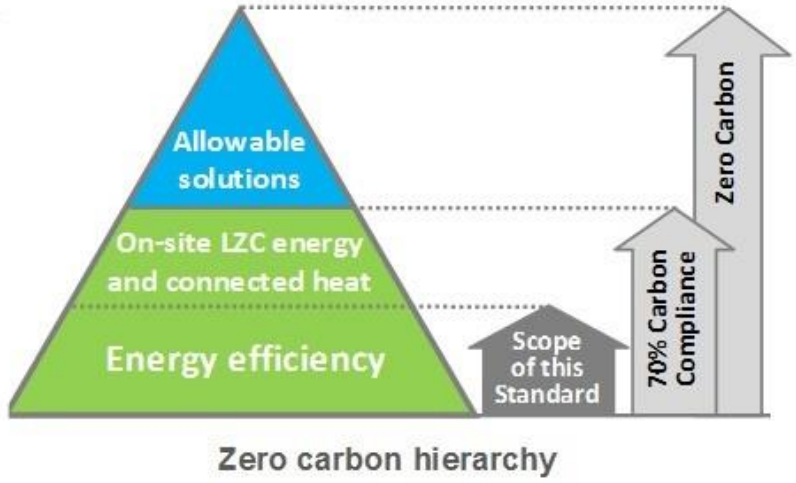


Figure 1

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 themostat*
- *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 from basic compliance with Part L1A 2013 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%. David Wilson North West intends to use Ideal Logic condensing boilers throughout the site for both combination and cylinder based systems. These boilers achieve a SAP 2012 rated efficiency of at least 89% 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 David Wilson North West 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. These fabric improvements reduce the space heating requirement for a property. Changes to the U-Value of external elements are shown in table 1 below.

Element	***Minimum Standard***	***Improved Specification***	
-	***W/m²k***	***Description***	***W/m²k***
Walls	0.30	50mm Alreflex Platinum	0.27
Roof	0.20	400mm Mineral Wool Horizontal Ceiling, Loft Space	0.11
		Flat Roof	0.18
Floors	0.25	150mm TE Platinum Beam & Block Ground Floor	0.12 - 0.15
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. David Wilson North West utilise bespoke thermal bridging designs, 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.

3. Evaluation

3.1. Conclusion

The table presented in Appendix B shows the results of the comparison between the two models. The SAP 2012 DFEE/TFEE metric has been used to demonstrate the reduction in energy demand achieved via the enhanced fabric specification.

The total energy demand of the TFEE model is 1093MWh/Annum. The total energy demand of the DFEE model, with the improved specification that surpasses Part L1A 2013 compliance, is 973MWh/Annum. This results in a 120MWh/Annum reduction in energy demand, which achieves a 10.99% saving across the site.

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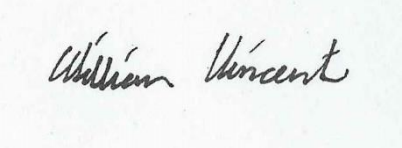

Date: 31/01/2019

Appendix A


WADDOW VIEW, CLITHEROE
Path (um)
Path (um)
Drain
Vale View Cottage
Burial Ground
Drain
Chorley House
Drain
Drain
BRUNGERLEY AVENUE
Five Fells Cottage
Selbourne House
The Bungalow
Selbourne Bungalow
Beaucourt
Eastwood
SWAN MEADOW
KIRKMOOR CLOSE
Kirkmoor House
Coniston Court
DAVID WILSON HOMES
WADDOW VIEW
CLITHEROE
PROPOSED
DRAFT LAYOUT PLAN
DWH063
PL01
P8

Appendix B

Energy Demand Reduction Study
Waddow View, Clitheroe

Client:	**David Wilson North West**
Project:	**Waddoe View, Clitheroe**
Report:	**Fabric Energy Efficiency Increase from Fabric and General Specification Improvements**

House Type/ Plot Number	Standard Regulatory Fabric Energy Efficiency Rate	Improved Model Fabric Energy Efficiency Rate	Improvement over Regulatory Model	SAP Floor Area	Number of Plots	Annual Fabric Energy Efficiency Rate from Improved Model
-	*kWh/m².yr*	*kWh/m².yr*	*%*	*m²*	-	*kWh/yr*
Alderney Det	54.50	48.50	11.0%	114	3	16,567
Beadle Mid-T	54.60	45.60	16.5%	55	4	10,079
Bedale End-T	59.20	50.50	14.7%	55	3	8,372
Buchanan Det	58.60	54.00	7.8%	81	3	13,116
H349--7 Det	61.50	53.30	13.3%	94	9	45,049
H406--7 Det	58.10	52.70	9.3%	129	9	61,313
H411--7 Det	60.50	51.30	15.2%	124	21	133,984
H417---7 Det	54.30	48.60	10.5%	135	14	91,534
H456---7 Det	55.80	49.50	11.3%	139	12	82,352
H470--7 Det	52.80	48.50	8.1%	139	11	73,980
Kenley End-T	55.80	50.00	10.4%	57	21	59,682
Kenley Mid-T	46.20	39.80	13.9%	57	8	18,098
Kingsley Det	56.40	50.90	9.8%	100	3	15,294
Maidstone End-T	51.60	46.20	10.5%	77	24	85,843
Maidstone Mid-T	43.80	37.70	13.9%	77	2	5,837
Moresby Det	60.80	54.80	9.9%	79	15	65,250
Moresby End-T	60.70	55.30	8.9%	79	6	26,338
N107-E-7 Enc End-T	56.10	50.60	9.8%	43	3	6,567
P237-E-7 Enc End-T	53.90	48.10	10.8%	60	3	8,655
Ripon Det	62.20	54.90	11.7%	103	6	33,928
Type 52 End-T	51.60	47.50	7.9%	85	24	96,398
Type 52 Mid-T	44.60	39.70	11.0%	85	3	10,071
Type 55 End-T	53.20	48.40	9.0%	87	1	4,225
	Total Fabric Energy Efficiency Rate from Improved Model (kWh/yr)					**972,534**
					Floor Area Weighted Average Improvement (%)	**10.99%**

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

Appendix C

SAP Worksheet
Design - Draft

NHER

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	5982 Hazel Black	Assessor number	5982
Client	David Wilson East Midlands	Last modified	25/01/2019
Address	Plot Warwick Road, Kibworth, LE8		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)		Volume (m³)	
Lowest occupied		70.15	(1a)	x	2.33	(2a) =	163.45	(3a)
+1		64.38	(1b)	x	2.64	(2b) =	169.96	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	134.53	(4)					
Dwelling volume						(3a) + (3b) + (3c) + (3d)...(3n) =	333.41	(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	5	x 10 =	50	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	50	÷ (5) =	0.15	(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)	0.40	(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) =	0.34	(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													
	0.43	0.43	0.42	0.37	0.37	0.32	0.32	0.31	0.34	0.37	0.38	0.40	(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	
0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(24d)

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

0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58

(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	
Door			2.12	x	1.10	=	2.33			(26)
Door			1.97	x	1.50	=	2.96			(26)
Window			26.73	x	1.33	=	35.68			(27)
Ground floor			70.15	x	0.14	=	9.82			(28a)
External wall			135.31	x	0.27	=	36.53			(29a)
Roof			64.38	x	0.11	=	7.08			(30)
Roof			5.80	x	0.17	=	0.99			(30)
Total area of external elements ∑A, m²			306.46							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	95.39 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		130.81 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		12.27 (36)
Total fabric heat loss	(33) + (36) =	107.65 (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)	65.38	64.97	64.58	62.73	62.38	60.77	60.77	60.47	61.39	62.38	63.08	63.81	(38)
Heat transfer coefficient, W/K (37)m + (38)m	173.03	172.63	172.23	170.38	170.03	168.42	168.42	168.12	169.04	170.03	170.73	171.47	

Average = ∑(39)1...12/12 = 170.38 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.29	1.28	1.28	1.27	1.26	1.25	1.25	1.25	1.26	1.26	1.27	1.27	
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)

Average = ∑(40)1...12/12 = 1.27 (40)

4. Water heating energy requirement

Assumed occupancy, N	2.91 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	103.21 (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)	113.54	109.41	105.28	101.15	97.02	92.89	92.89	97.02	101.15	105.28	109.41	113.54	

∑(44)1...12 = 1238.57 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	168.37	147.26	151.96	132.48	127.12	109.69	101.65	116.64	118.03	137.56	150.15	163.06	

∑(45)1...12 = 1623.96 (45)

Distribution loss 0.15 x (45)m	25.26	22.09	22.79	19.87	19.07	16.45	15.25	17.50	17.71	20.63	22.52	24.46	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00 (47)
Water storage loss:	
a) If manufacturer's declared loss factor is known (kWh/day)	0.96 (48)
Temperature factor from Table 2b	0.54 (49)
Energy lost from water storage (kWh/day) (48) x (49)	0.52 (50)
Enter (50) or (54) in (55)	0.52 (55)

Water storage loss calculated for each month (55) x (41)m

16.07	14.52	16.07	15.55	16.07	15.55	16.07	16.07	15.55	16.07	15.55	16.07	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

16.07	14.52	16.07	15.55	16.07	15.55	16.07	16.07	15.55	16.07	15.55	16.07	(57)

Primary circuit loss for each month from 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)

Combi loss for each month from Table 3a, 3b or 3c

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)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

207.70	182.78	191.29	170.54	166.45	147.76	140.98	155.97	156.10	176.89	188.22	202.39	(62)

Solar DHW input calculated using Appendix G or Appendix H

-52.37	-46.08	-47.03	-38.68	-35.91	-29.62	-25.06	-30.35	-31.24	-38.62	-44.75	-50.62	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

155.33	136.70	144.26	131.86	130.54	118.13	115.92	125.63	124.86	138.27	143.47	151.77	

∑(64)1...12 = 1616.74 (64)

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

87.45	77.38	81.99	74.50	73.73	66.92	65.26	70.25	69.70	77.20	80.38	85.68	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	174.35	174.35	174.35	174.35	174.35	174.35	174.35	174.35	174.35	174.35	174.35	174.35	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	68.08	60.47	49.17	37.23	27.83	23.49	25.39	33.00	44.29	56.24	65.64	69.97	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	452.39	457.08	445.26	420.07	388.28	358.40	338.44	333.75	345.58	370.76	402.55	432.43	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	55.34	55.34	55.34	55.34	55.34	55.34	55.34	55.34	55.34	55.34	55.34	55.34	(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)	-116.23	-116.23	-116.23	-116.23	-116.23	-116.23	-116.23	-116.23	-116.23	-116.23	-116.23	-116.23	(71)
Water heating gains (Table 5)	117.54	115.16	110.20	103.47	99.10	92.95	87.72	94.42	96.80	103.77	111.64	115.16	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	754.47	749.16	721.09	677.23	631.67	591.30	568.01	577.62	603.13	647.22	696.28	734.02	(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	
South	0.77	x	12.58	x	46.75	x 0.9 x	0.71	x	0.70	=	202.57	(78)
East	0.77	x	3.36	x	19.64	x 0.9 x	0.71	x	0.70	=	22.73	(76)
West	0.77	x	3.36	x	19.64	x 0.9 x	0.71	x	0.70	=	22.73	(80)
North	0.77	x	5.75	x	10.63	x 0.9 x	0.71	x	0.70	=	21.06	(74)
NorthEast	0.77	x	0.84	x	11.28	x 0.9 x	0.71	x	0.70	=	3.26	(75)
NorthWest	0.77	x	0.84	x	11.28	x 0.9 x	0.71	x	0.70	=	3.26	(81)

Solar gains in watts ∑(74)m...(82)m

275.61	474.21	661.37	840.37	960.29	961.69	923.70	832.97	723.17	527.49	330.99	235.31	(83)

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

1030.08	1223.38	1382.46	1517.60	1591.96	1552.99	1491.71	1410.60	1326.30	1174.71	1027.27	969.33	(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)	0.97	0.95	0.91	0.85	0.74	0.60	0.46	0.50	0.70	0.87	0.95	0.97	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	18.96	19.25	19.66	20.16	20.57	20.84	20.94	20.93	20.74	20.19	19.49	18.90	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	19.85	19.85	19.86	19.87	19.87	19.88	19.88	19.88	19.88	19.87	19.87	19.86	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.96	0.94	0.89	0.82	0.69	0.52	0.36	0.40	0.62	0.84	0.94	0.97	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	17.17	17.58	18.17	18.87	19.41	19.75	19.85	19.84	19.64	18.94	17.94	17.09	(90)

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

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	17.41	17.81	18.38	19.04	19.57	19.89	20.00	19.99	19.79	19.11	18.15	17.34	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	17.26	17.66	18.23	18.89	19.42	19.74	19.85	19.84	19.64	18.96	18.00	17.19	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.94	0.91	0.86	0.79	0.67	0.51	0.35	0.39	0.61	0.81	0.91	0.95	(94)
Useful gains, ηmGm, W (94)m x (84)m	967.95	1112.60	1193.53	1192.12	1065.21	789.66	528.34	552.22	802.73	952.36	936.62	918.31	(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]	2242.53	2202.95	2019.64	1702.54	1312.62	866.51	546.92	577.74	935.79	1421.17	1860.51	2227.13	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	948.28	732.71	614.63	367.51	184.08	0.00	0.00	0.00	0.00	348.79	665.20	973.76	

∑(98)1...5, 10...12 = 4834.96 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 35.94 (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 (%) 90.40 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	1048.99	810.53	679.90	406.54	203.62	0.00	0.00	0.00	0.00	385.83	735.84	1077.17	

∑(211)1...5, 10...12 = 5348.41 (211)

Water heating

Efficiency of water heater

88.72	88.53	88.15	87.31	85.63	79.70	79.70	79.70	79.70	87.08	88.30	88.79

(217)

Water heating fuel, kWh/month

175.08	154.41	163.65	151.03	152.44	148.22	145.44	157.62	156.66	158.78	162.48	170.93

∑(219a)1...12 = 1896.76 (219)

Annual totals

Space heating fuel - main system 1		5348.41
Water heating fuel		1896.76
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)		480.91 (232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	7801.08 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	5348.41	x	3.48	x 0.01 =	186.12	(240)
Water heating	1896.76	x	3.48	x 0.01 =	66.01	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	480.91	x	13.19	x 0.01 =	63.43	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		445.46	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.04	(257)
SAP value	85.46	
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	5348.41	x	0.216	=	1155.26	(261)
Water heating	1896.76	x	0.216	=	409.70	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1564.96	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	480.91	x	0.519	=	249.59	(268)
Total CO_2, kg/year				(265)...(271) =	1853.47	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	13.78	(273)
EI value					86.17	
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	5348.41	x	1.22	=	6525.06	(261)

Water heating	1896.76	x	1.22	=	2314.05	(264)
Space and water heating			(261) + (262) + (263) + (264) =		8839.11	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	480.91	x	3.07	=	1476.39	(268)
Primary energy kWh/year					10545.75	(272)
Dwelling primary energy rate kWh/m2/year					78.39	(273)