

**Taylor Wimpey
(Manchester)**

**Land Off Chapel Close,
Low Moor, Clitheroe**

**Carbon Reduction
Report**

**320120629P
July 2012**

Ref: 2012-028-002b

Taylor Wimpey (Manchester)

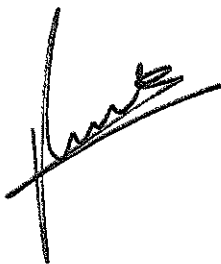
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Authorised for and on behalf NJL Consulting LLP



320120629P

**Rob White
Partner**

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1.0 Introduction

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1.1 Application Background

An outline application (ref: 3/2011/0247) was submitted to Ribble Valley Borough Council (RVBC) by Strategic Land Group in March 2011 for a proposed residential development of 54 dwellings (38 private and 16 affordable) at Land off Chapel Close, Low Moor, Clitheroe. Outline planning permission was granted by RVBC on 15th March 2012.

Planning condition 4 of the outline permission states:

4 Prior to commencement of development a scheme identifying how a minimum of 10% of the energy requirements generated by the development will be achieved by renewable energy production methods, shall be submitted to and approved in writing by the Local Planning Authority. The scheme shall then be provided in accordance with the approved details prior to occupation of the development and thereafter retained.

REASON: In order to encourage renewable energy and to comply with Policy G1 of the Ribble Valley Districtwide Local Plan.

Taylor Wimpey (Manchester) is now applying to RVBC for reserved matters and has received a pre-application advice letter from RVBC dated 12 March 2012 (ref: SW/CMS/RV/2012/ENQ/00052). The letter states that:

Condition 4 requires submission of a scheme identifying how a minimum of 10% of the energy requirements generated by the development will be achieved by renewable energy production methods. We discussed the possibility of a joint approach of fabric first and more visible signs of this i.e. solar thermal roof panels to the most prominent dwellings upon the site from public vantage points. This approach has been adopted on a site elsewhere within the borough and provided a technical report is provided to demonstrate that the percentage to be achieved across the site is greater than 10% as specified in the condition, I consider this would be an acceptable way forward.

1.2 Purpose of this Document

This document is a Carbon Reduction Report and has been produced by NJL Consulting (NJL). The purpose of this document is to describe the approach being taken by Taylor Wimpey to reduce the site-wide energy demand of the proposed development.

The report then aims to demonstrate that a 10% reduction in site-wide energy demand is achievable in accordance with the requirements of planning condition 4 and the pre-application advice provided by RVBC.

2.0 Development Proposals

The proposed development is located at Land off Chapel Close, Low Moor, Clitheroe. The site location is shown in *Figure 1.1*.

Figure 1.1 – Pre-development Site with Orientation



The scheme is for the construction of 54 residential dwellings (38 private and 16 affordable). The private dwellings will be a mixture of three and four-bed detached houses, with the affordable dwellings comprising a mixture of detached, terraced mews and apartments. The proposed layout is shown in *Figure 1.2*.

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Figure 1.2 - Development Proposals, Provisional Layout



Taylor Wimpey intends to design and build the dwellings to address the issue of climate change along with the need to reduce energy consumption and associated carbon dioxide emissions. The aim is to achieve a minimum site wide reduction in energy demand of 10% compared to Building Regulations (Part L, 2010).

This energy demand reduction will primarily be achieved through a fabric-led approach, increasing the thermal performance of the materials and construction techniques. An element of renewable energy technology will supplement this approach.

3.0 Achieving Carbon Reduction

3.1 Taylor Wimpey and Carbon Reduction

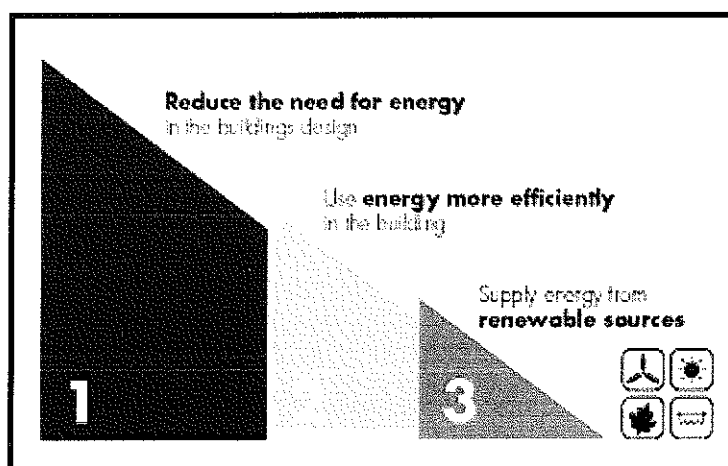
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Taylor Wimpey is committed to offer new designs and techniques for improving the energy efficiency of the houses they build. The proposed construction and design specification for this scheme will deliver dwellings that are inherently efficient and cost effective during occupation.

Taylor Wimpey will construct these dwellings with material and design specifications which exceed Building Regulations, Part L standards in order to reduce energy demand and associated carbon dioxide emissions. With respect to the air permeability performance standard, Taylor Wimpey dwellings routinely perform significantly beyond the regulatory requirement.

This approach is in accordance with the first principle of the energy hierarchy (see *Figure 3.1*) which states that reduction in energy demand should be achieved initially by energy efficiency.

Figure 3.1 – Energy Hierarchy



3.2 Approach at Chapel Close, Low Moor, Clitheroe

Taylor Wimpey will deliver the target 10% energy demand reduction compared to a Building Regulations, Part L (2010) compliant build in accordance with RVBC's aspirations for the site.

This will be achieved primarily by enhancing the insulation of the building fabric for all dwellings at the site, incorporating materials with high thermal performance and careful construction techniques to ensure low air permeability, thereby limiting heat loss from the buildings.

Additionally, seven (13%) of the dwellings at the site will be specified with solar thermal water heating systems to further reduce energy demand.

It should be noted that this approach was recently accepted by RVBC for Phase 3 of Taylor Wimpey's proposed development at Land off Pendle Drive, Calderstones.

3.3 Build Fabric And Thermal Performance

The standard measurement of heat transfer through a given building material or construction type is the U-value. The lower the U-value, the more slowly heat transfers and hence, is lost out of a building. In buildings, heat loss generally takes effect through:

- Ground Floor;
- External Walls;
- Roofs;
- Doors and windows;
- Thermal Bridging (heat loss through construction joints); and
- Uncontrolled ventilation.

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Taylor Wimpey's material selection and build methods which will be incorporated within this development provide the following benefits:

- Good levels of thermal insulation to heat loss elements;
 - Efficient double glazing units and external doors;
 - An element of dedicated low energy light fixtures;
- Detailing to limit heat losses through thermal bridging; and
- Detailing to limit heat losses through air permeability.

Table 3.1 shows the Taylor Wimpey enhanced specification proposed for this scheme.

Table 3.1 – Proposed Material Specification

Construction Elements	Proposed Specification
Ground Floor (W/m ² K)	0.15
Ext Wall (W/m ² K)	0.25
Roof (W/m ² K)	0.11
Windows (W/m ² K)	1.4
Doors (W/m ² K)	0.55
Air Permeability	5
Thermal Bridge	$\psi=0.06$

The thermal bridge details are subject to calculation and therefore, the value shown in *Table 3.1* is based upon performance of similar properties within the Taylor Wimpey house type range

The build specification shown in *Table 3.1* is significantly beyond that required by Building Regulations.

3.4 Solar Thermal

Solar collectors absorb the sun's energy and typically provide heat for domestic hot water (although they can also contribute to space heating in some cases, especially when coupled to under floor heating systems). The system transfers heat from the collectors to storage tanks. Such technology is suited to the UK climate and will work effectively on overcast days with diffuse sunlight. Their efficiency depends upon positioning; ensuring the panels are orientated approximately due south and mounted between 30° and 50° will deliver good performance.

As presented in *Figure 1.2*, the proposed site plan indicates a number of properties will have correctly orientated and sufficient area of roof space to accommodate solar collectors and facilitate efficient operation. The solar store (hot water cylinder) may be accommodated within the store cupboard on the first floor of the dwellings.

An example solar thermal specification is presented in *Table 3.2* and has been utilised in the representative SAP calculations for the site.

Table 3.2 – Example Solar Thermal Specification

Manufacturer	Kingspan Solar
Collector	Marvel, Flat Plate 2108
Cylinder	Tribune Solar, 250 litre

It is proposed that solar thermal systems will be incorporated within plots 1, 2, 3, 17, 18, 27 and 28. This equates to 13% of the total number of dwellings proposed for the site.

Each of these units has suitable roof space and is specified with a 'system boiler' which facilitates simple integration of the solar thermal technology to the heating system.

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3.5 SAP Calculations

Approved SAP 2009 software (NHER Plan Assessor v5.4) has been used to generate representative energy demand models for the proposed development. This software calculates the regulated energy demand of the dwellings and associated carbon dioxide emissions, in accordance with the requirements of Building Regulations, Part L (2010).

Representative SAP calculations have been undertaken to demonstrate that the RVBC requirement for a site wide energy demand reduction of at least 10% can be achieved.

Unit type PD410 has been used in the SAP calculations to be representative of the proposed private dwellings and the Vendor Plots. This unit has been selected as it is the largest of the Taylor Wimpey private dwellings and therefore, represents a 'worst case' scenario in terms of energy demand.

SAP calculations of RSL unit types J, H, K, L have also been used, along with calculations for both the ground floor and first floor apartments.

Using the proposed material specification detailed in *Table 3.1*, energy demand results for the representative SAP calculations are presented in *Table 3.3*. In order to represent a worst case scenario, a south-east alignment has been used.

Table 3.3 – Representative SAP Calculations

Unit Type	Part L (2010) Compliant Spec – Energy Demand (kWh/yr)	Enhanced Spec – Energy Demand (kWh/yr)	% Energy Demand Reduction over Part L (2010) Compliant Spec	No of Units Represented
Detached (PD410)	9064	8102	13.3%	29
Detached with solar thermal (PD410)	9064	7894	12.9%	7
Unit H	7478	6655	11.0%	1
Unit J	6046	5529	8.6%	3
Unit K	5257	4897	6.8%	3
Unit L	5941	5327	10.3%	3
Apartment - GF	5198	4748	8.7%	3
Apartment – FF	4943	4629	6.4%	3
TOTAL	415,937	372,261	10.5%	54

Based on the results in *Table 3.3*, a total site-wide reduction in energy demand of **10.5%** is achievable against a Building Regulations, Part L (2010) compliant build.

Based on the results of the SAP calculations for the representative unit types, the proposed development at Chapel Close, Low Moor, Clitheroe can be deemed capable of achieving the requirement for a site-wide 10% reduction in energy demand.

4.0 Conclusion

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Taylor Wimpey (Manchester) is applying to Ribble Valley Borough Council (RVBC) for reserved matters for the proposed residential development of 54 dwellings at Land off Chapel Close, Low Moor, Clitheroe.

Condition 4 of outline planning permission (ref: 3/2011/0247) requires 10% of the site's energy demand to be met through renewable energy sources. However, subsequent pre-application advice from RVBC (ref: SW/CMS/RV/2012/ENQ/00052) has stated that an approach that reduces site-wide energy demand by 10% through a combination of fabric energy efficiency improvements and solar thermal water heating will be acceptable.

This document is a Carbon Reduction Report and has described the building material specification enhancements and solar thermal water heating proposed by Taylor Wimpey in order for the development to achieve the target of a 10% site-wide energy reduction against Building Regulations, Part L (2010).

SAP calculations have been undertaken for representative unit types with enhanced material specification and also with integration of solar thermal water heating. The calculations show that a total site-wide reduction in energy demand of **10.5%** is achievable against a Building Regulations, Part L (2010) compliant build.

Based on the results of the SAP calculations for the representative unit types, the proposed development at Chapel Close, Low Moor, Clitheroe can be deemed capable of achieving the requirement for a site-wide 10% reduction in energy demand.

COMPLIANT SPEC

kWh/yr.	
HEATING	2020
WATER	2337
PUMPS / FANS ETC	245
LIGHTS	341
TOTAL =	4943

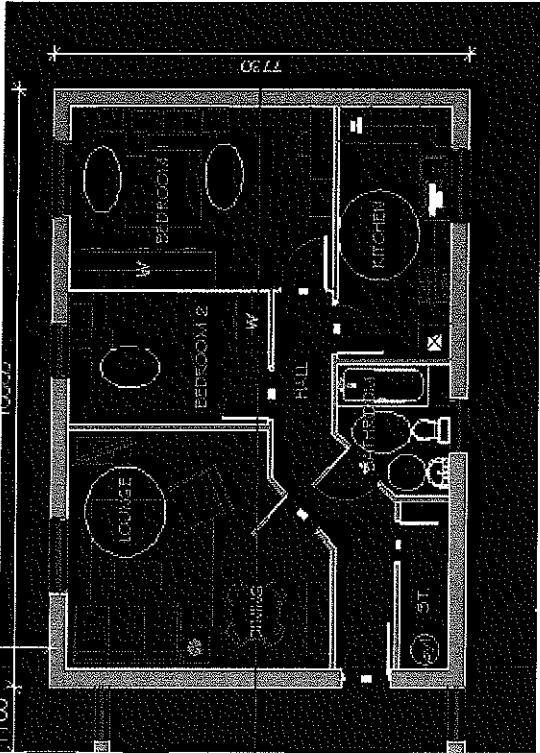
ENHANCED SPEC

kWh/yr.	
HEATING	1706
WATER	2337
PUMPS / FANS ETC	245
LIGHTS	341
TOTAL =	4629

Reduction in energy demand = 6.4%

DER:TER = 5.05%

Plot calculated -



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COMPLIANT SPEC

HEATING	kwh/yr.	2279
WATER		2333
PUMPS / FANS ETC		245
LIGHTS		341
TOTAL =		5198

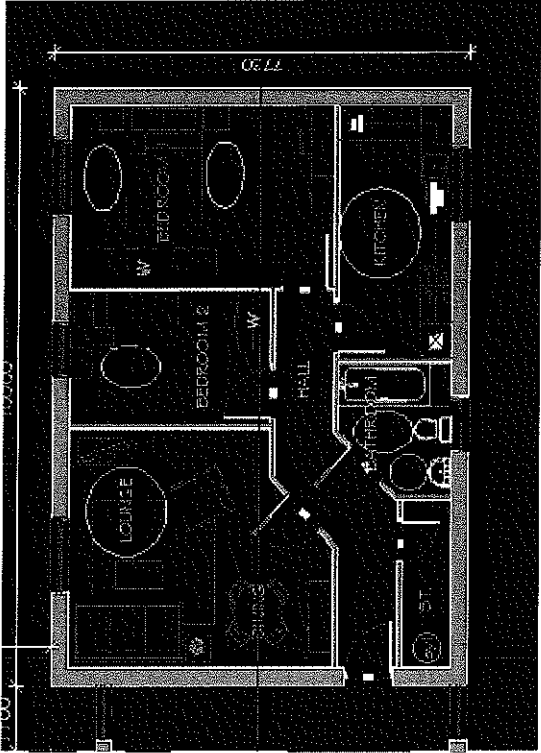
ENHANCED SPEC

HEATING	kwh/yr.	1829
WATER		2333
PUMPS / FANS ETC		245
LIGHTS		341
TOTAL =		4748

Reduction in energy demand = 8.7%

DER:TER = 6.75%

Plot calculated -



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COMPLIANT SPEC

Plot 41

HEATING	3092
WATER	2301
PUMPS / FANS ETC	243
LIGHTS	305
TOTAL =	5941

kWh/yr.

ENHANCED SPEC

HEATING	2478
WATER	2301
PUMPS / FANS ETC	243
LIGHTS	305
TOTAL =	5327

kWh/yr.

Reduction in energy demand = 10.3%

DER:TER = 8.27%

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COMPLIANT SPEC

Plot 46

kWh/yr.	
HEATING	2377
WATER	2329
PUMPS / FANS ETC	249
LIGHTS	302
TOTAL =	5257

ENHANCED SPEC

kWh/yr.	
HEATING	2017
WATER	2329
PUMPS / FANS ETC	249
LIGHTS	302
TOTAL =	4897

Reduction in energy demand = 6.8%

DER:TER = 5.38%

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COMPLIANT SPEC

Plot 45

	kWh/yr.
HEATING	2940
WATER	2469
PUMPS / FANS ETC	266
LIGHTS	371
TOTAL =	6046

ENHANCED SPEC

	kWh/yr.
HEATING	2423
WATER	2469
PUMPS / FANS ETC	266
LIGHTS	371
TOTAL =	5529

Reduction in energy demand = 8.6%

DER:TER = 6.72%

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Plot 34

COMPLIANT SPEC

kWh/yr.	
HEATING	4258
WATER	2534
PUMPS / FANS ETC	280
LIGHTS	406
TOTAL =	7478

ENHANCED SPEC

kWh/yr.	
HEATING	3437
WATER	2532
PUMPS / FANS ETC	280
LIGHTS	406
TOTAL =	6655

Reduction in energy demand = 11.0%

DER:TER = 8.74%

COMPLIANT SPEC (SAP v5)

HEATING	5827
WATER	2599
PUMPS / FANS ETC	175
LIGHTS	463
TOTAL =	9064

SOLAR THERMAL SPEC (SAP v6)

HEATING	5654
WATER	1602
PUMPS / FANS ETC	175
LIGHTS	463
TOTAL =	7894

Reduction in energy demand = 12.9%

DER:TER = 6.98%

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Ground Floor	0.15
Floor over garage	0.2
External Wall	0.25
Garage Wall	0.29
Roof	0.11
Windows	1.4
Door	1.5
Ventilation	decentralised, whole house (Greenwood CV2GIP type)
Air perm	5.5
Boiler	Ideal Logic System
Boiler control	Programmer, TRV & 'stat
Water heating	from main, 180l. Cyl (Tribune)
Renewables	single Kingspan 2108 flat plate
Thermal Bridge	ACD
Low E lighting	100%

Orientation	Front, SE
-------------	-----------

COMPLIANT SPEC (SAP v5)

kWh/yr.	
HEATING	5827
WATER	2599
PUMPS / FANS ETC	175
LIGHTS	463
TOTAL =	9064

ENHANCED SPEC (SAP v5)

kWh/yr.	
HEATING	4618
WATER	2600
PUMPS / FANS ETC	175
LIGHTS	463
TOTAL =	7856

Reduction in energy demand = 13.3%

DER:TER = 10.69%

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Ground Floor	0.15
Floor over garage	0.2
External Wall	0.25
Garage Wall	0.29
Part Wall	0.0 (full fill & seal)
Roof	0.11
Windows	1.4
Door	0.55
Ventilation	decentralised, whole house (Greenwood CV2GIP type)
Air perm	5
Boiler	Ideal Logic System
Boiler control	time & temp, weather compensator
Water heating	from main, 180l. Cyl
Renewables	n/a
Thermal Bridge	$\gamma=0.06$
Low E lighting	100%

Assessor name	Mr Laurie Wills	Assessor number	3906
Client		Last modified	10/05/2012
Address	Apartment, 2 bed. First floor Chapel Close , Clitheroe, Lancs , BB7		

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	67.20 (1a)	x	2.31 (2a)	=	155.23 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d) (1n) = 67.20 (4)				
Dwelling volume			(3a) + (3b) + (3c) + (3d) (3n) =		155.23 (5)

			m ³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(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) = 0	÷ (5) =	0.00	(8)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>				
Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area			5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.25	(18)
<i>Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used</i>				
Number of sides on which dwelling is sheltered			0	(19)
Shelter factor		1 - [0.075 x (19)] =	1.00	(20)
Adjusted infiltration rate		(18) x (20) =	0.25	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
	$\Sigma(22)_{1-12} = 54.10$											(22)

$$(22a)m \quad \begin{array}{|c|c|c|c|c|c|c|c|c|c|c|c|} \hline 1.35 & 1.27 & 1.27 & 1.12 & 1.02 & 0.98 & 0.92 & 0.92 & 1.05 & 1.12 & 1.20 & 1.27 \\ \hline \end{array} \quad \sum(22a)1..12 = \boxed{13.52} \quad (22a)$$

{22b)m	0.34	0.32	0.32	0.28	0.26	0.24	0.23	0.23	0.26	0.28	0.30	0.32	$\sum\{22b\}_{1...12} =$	3.38	(22b)
--------	------	------	------	------	------	------	------	------	------	------	------	------	--------------------------	------	-------

If mechanical ventilation: air change rate through system	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	0.5	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4b) =

N/A (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if $(22b)m < 0.5 \times (23b)$, then $(24c) = (23b)$; otherwise $(24c) = (22b)m + 0.5 \times (23b)$

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
------	------	------	------	------	------	------	------	------	------	------	------

(24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
------	------	------	------	------	------	------	------	------	------	------	------

(25)

3. Heat losses and heat loss parameter

The k -value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A x U, W/K	k -value, kJ/m ² K	A x k , kJ/K
Doors			1.89	0.55	1.04	N/A	N/A
Window*			6.01	1.33	7.96	N/A	N/A
External wall			53.67	0.25	13.42	N/A	N/A
External wall			14.56	0.23	3.35	N/A	N/A
Roof			67.20	0.11	7.39	N/A	N/A
Total area of external elements ΣA , m ²			143.33				

* for windows and roof windows, effective window U-value is calculated using formula $1/[(1/U_{value}) + 0.04]$ paragraph 3.2

Fabric heat loss, W/K = $\Sigma(A \times U)$ (26) (30) + (32) = 33.16 (33)

Heat capacity $C_m = \Sigma(A \times k)$ (28) (30) + (32) + (32a) (32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: $\Sigma(L \times \Psi)$ calculated using Appendix K 8.60 (36)

if details of thermal bridging are not known then (36) = $0.15 \times (31)$

Total fabric heat loss (33) + (36) = 41.76 (37)

Ventilation heat loss calculated monthly $0.33 \times (25)m \times (5)$

(38)m

30.10	29.14	29.14	27.21	25.93	25.61	25.61	25.61	26.25	27.21	28.17	29.14
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(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

71.86	70.90	70.90	68.98	67.69	67.37	67.37	67.37	68.01	68.98	69.94	70.90
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Average = $\Sigma(39)12/12 = 69.19$ (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.07	1.06	1.06	1.03	1.01	1.00	1.00	1.00	1.01	1.03	1.04	1.06
------	------	------	------	------	------	------	------	------	------	------	------

Average = $\Sigma(40)12/12 = 1.03$ (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N

2.18 (42)

If $TFA > 13.9$, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

If $TFA \leq 13.9$, $N = 1$

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$

85.89 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)												
(44)m	94.48	91.04	87.60	84.17	80.73	77.30	77.30	80.73	84.17	87.60	91.04	94.48
	$\Sigma(44)12 = 1030.64$ (44)											

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times T_m/3600$ kWh/month (see Tables 1b, 1c 1d)

(45)m

140.44	122.83	126.75	110.50	106.03	91.50	84.78	97.29	98.45	114.74	125.24	136.01
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$\Sigma(45)12 = 1354.56$ (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss $0.15 \times (45)m$

(46)m	21.07	18.42	19.01	16.58	15.90	13.72	12.72	14.59	14.77	17.21	18.79	20.40	(46)
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Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

1.19 (47)

Temperature factor from Table 2b

0.54 (48)

Energy lost from water storage, kWh/day (47) $\times$ (48)

0.64 (49)

Enter (49) or (54) in (55)

0.64 (55)

Water storage loss calculated for each month = (55) $\times$ (41)m

(56)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92	(56)
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If cylinder contains dedicated solar storage, = (56)m $\times$ [(50) - (H11)] $\div$ (50), else = (56)m where (H11) is from Appendix H

(57)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92	(57)
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Primary circuit loss (annual) from Table 3

360.00 (58)

Primary circuit loss for each month (58) $\div$ 365 $\times$ (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)
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Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)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	(61)
-------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(62)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50	(62)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)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	(63)
-------	------	------	------	------	------	------	------	------	------	------	------	------	------

 $\Sigma(63)12 = 0.00$

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

(64)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50	(64)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

 $\Sigma(64)12 = 1949.11$

if (64)m < 0 then set to 0

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

(65)m	87.09	77.33	82.54	75.84	75.65	69.52	68.59	72.75	71.83	78.55	80.74	85.62	(65)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
--	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Metabolic gains (Table 5), Watts

(66)m	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	(66)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m	48.30	42.90	34.89	26.41	19.75	16.67	18.01	23.41	31.43	39.90	46.57	49.65	(67)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m	284.59	287.54	280.10	264.26	244.26	225.46	212.91	209.95	217.40	233.24	253.24	272.03	(68)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	(69)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Pumps and fans gains (Table 5a)

(70)m	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	(70)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Losses e.g. evaporation (negative values) (Table 5)

(71)m	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	(71)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m	117.06	115.07	110.94	105.33	101.68	96.55	92.19	97.78	99.76	105.57	112.14	115.08	(72)
-------	--------	--------	--------	--------	--------	-------	-------	-------	-------	--------	--------	--------	------

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	553.71	549.28	529.69	499.76	469.45	442.44	426.87	434.90	452.34	482.47	515.70	540.52	(73)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

6. Solar gains

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
Southwest	1.00	x	2.38	x	37.39	x 0.9 x	0.63	x	0.70	=	35.26	(79)
Southeast	1.00	x	3.63	x	37.39	x 0.9 x	0.63	x	0.70	=	53.87	(77)

Solar gains in watts, calculated for each month $\Sigma(74)m \dots (82)m$

(83)m	89.12	151.93	200.75	246.69	270.17	274.24	268.87	251.11	221.45	172.50	106.85	76.16	(83)
-------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	------

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

(84)m	642.84	701.21	730.45	746.46	739.62	716.68	695.74	686.01	673.79	654.97	622.56	616.68	(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, $\eta_{1,m}$ (see Table 9a)													
(86)m	0.90	0.88	0.84	0.78	0.68	0.54	0.38	0.38	0.58	0.76	0.87	0.91	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

(87)m	19.35	19.58	19.92	20.27	20.64	20.87	20.97	20.96	20.82	20.43	19.80	19.40	(87)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Temperature during heating periods in the living area from Table 9, Th2(°C)

(88)m	20.03	20.04	20.04	20.06	20.08	20.08	20.08	20.07	20.06	20.05	20.04	(88)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Utilisation factor for gains for rest of dwelling $\eta_{2,m}$ (see Table 9a)

(89)m	0.89	0.86	0.82	0.75	0.64	0.47	0.30	0.30	0.52	0.73	0.86	0.89	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m	17.86	18.19	18.67	19.17	19.68	19.96	20.06	20.06	19.91	19.40	18.52	17.94	(90)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Living area fraction

fLA 18.00 ÷ (4) = 0.27 (91)

Mean internal temperature for the whole dwelling $fLA \times T1 + (1 - fLA) \times T2$

(92)m	18.26	18.56	19.00	19.46	19.94	20.20	20.30	20.30	20.15	19.68	18.86	18.33	(92)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(93)m	18.11	18.41	18.85	19.31	19.79	20.05	20.15	20.15	20.00	19.53	18.71	18.18	(93)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that $t_{im} = (93)m$ and recalculate the utilisation factor for gains using Table 9a													
Utilisation factor for gains, η_{im}													
(94)m	0.86	0.83	0.79	0.73	0.62	0.47	0.31	0.31	0.52	0.71	0.83	0.86	(94)

Useful gains, $\eta_{im}G_m$, W = (94)m x (84)m

(95)m	554.28	584.40	575.77	544.79	459.03	338.55	213.53	213.28	348.69	462.01	514.55	533.36	(95)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
-------	------	------	------	------	-------	-------	-------	-------	-------	-------	------	------	------

Heat loss rate for mean internal temperature, L_m , W

(97)m	977.63	950.56	854.32	731.91	547.45	367.51	219.20	219.14	387.94	602.11	818.85	941.49	(97)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Space heating requirement for each month, kWh/month = $0.024 \times [(97)m - (95)m] \times (41)m$

(98)m	314.97	246.06	207.24	134.72	65.78	0.00	0.00	0.00	0.00	104.24	219.10	303.65	(98)
-------	--------	--------	--------	--------	-------	------	------	------	------	--------	--------	--------	------

Total per year (kWh/year) = $\Sigma(98)1 \dots 12 = 1595.76$ (98)

Space heating requirement in kWh/m²/year

(98) ÷ (4) = 23.75 (99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)

0.00 (201)

Fraction of space heating from main system(s) 1 - (201)

1.00 (202)

Fraction of main heating from main system 2

0.00 (203)

320120629P

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 space heating system 1 (%)

93.50 (206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement, kWh/month (as calculated above)													
(98)m	314.97	246.06	207.24	134.72	65.78	0.00	0.00	0.00	0.00	104.24	219.10	303.65	
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)													
(211)m	336.87	263.17	221.65	144.09	70.36	0.00	0.00	0.00	0.00	111.49	234.33	324.76	
Total per year (kWh/year) = Σ(211)1..12 =	1706.70												(211)

Water heating:

Output from water heater, kWh/month (calculated above)

(64)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50	
Σ(64)1..12 =	1949.11												(64)

Efficiency of water heater per month

(217)m	86.14	85.82	85.23	84.37	82.69	79.80	79.80	79.80	79.80	83.62	85.43	86.11	
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Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m

(219)m	221.65	196.26	207.96	188.89	189.29	175.89	169.52	185.20	184.61	197.59	203.81	216.60	
Total per year (kWh/year) = Σ(219)1..12 =	2337.27												(219)

Annual Totals Summary:

Space heating fuel used, main system 1

kWh/year	1706.70	(211)
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Water heating fuel used

kWh/year	2337.27	(219)
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Electricity for pumps, fans and electric keep-hot (Table 4f):

mechanical ventilation fans - balanced, extract or positive input from outside	70.07	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	0.00	(230g)
Total electricity for the above	Σ(230a) (230g)	245.07 (231)

Electricity for lighting (calculated in Appendix L):

341.22	(232)
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10a. Fuel costs - Individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	1706.70	x	3.10	x 0.01 =	52.91	(240)
Water heating cost (other fuel)	2337.27	x	3.10	x 0.01 =	72.46	(247)
Pumps, fans and electric keep-hot	245.07	x	11.46	x 0.01 =	28.09	(249)
Energy for lighting	341.22	x	11.46	x 0.01 =	39.10	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost			(240) (242) + (245) (254)		298.55	(255)

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

Energy cost deflator (Table 12)	0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.25 (257)
SAP value	82.55	
SAP rating	83	(258)
SAP band	B	

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	1706.70	x	0.198	=	337.93	(261)
Water heating	2337.27	x	0.198	=	462.78	(264)
Space and water heating			(261) + (262) + (263) + (264) =		800.71	(265)
Pumps, fans and electric keep-hot	245.07	x	0.517	=	126.70	(267)
Lighting	341.22	x	0.517	=	176.41	(268)
Total carbon dioxide emissions			$\Sigma(261)$	(271) =	1103.82	(272)
Dwelling carbon dioxide emissions rate			(272) ÷ (4) =		16.43	(273)
EI value					86.82	
EI rating (see section 14)					87	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	1706.70	x	1.02	=	1740.83	(261*)
Water heating	2337.27	x	1.02	=	2384.02	(264*)
Space and water heating			(261*) + (262*) + (263*) + (264*) =		4124.85	(265*)
Pumps, fans and electric keep-hot	245.07	x	2.92	=	715.61	(267*)
Lighting	341.22	x	2.92	=	996.37	(268*)
Total primary energy kWh/year			$\Sigma(261^*)$	(271*) =	5836.84	(272*)
Primary energy kWh/m ² /year			(272*) ÷ (4) =		86.86	(273*)

SAP 2009 Worksheet

Design - Draft

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

Assessor name	Mr Laurie Wills	Assessor number	3906
Client		Last modified	10/05/2012
Address	Apartment, 2 bed Ground floor Chapel Close, Clitheroe, Lancs, BB7		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	67.20 (1a) x	2.31 (2a) =	155.23 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d) + (1n) = 67.20 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d) + (3n) =	155.23 (5)

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	0 x 10 =	0 (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) = 0 ÷ (5) = 0.00 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25 (18)
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Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered	0 (19)
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Shelter factor	1 - [0.075 x (19)] = 1.00 (20)
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Adjusted infiltration rate	(18) x (20) = 0.25 (21)
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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 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
	Σ(22)1 ÷ 12 = 54.10 (22)											

Wind Factor (22a)m = (22)m ÷ 4

(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27
	Σ(22a)1 ÷ 12 = 13.52 (22a)											

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) x (22a)m

(22b)m	0.34	0.32	0.32	0.28	0.26	0.24	0.23	0.23	0.26	0.28	0.30	0.32
	Σ(22b)1 ÷ 12 = 3.38 (22b)											

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.5 (23a)
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If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5 (23b)
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If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4b) = (23c)

c) If whole house extract ventilation or positive input ventilation from outside
if $(22b)m < 0.5 \times (23b)$, then $(24c) = (23b)$; otherwise $(24c) = (22b)m + 0.5 \times (23b)$

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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 (24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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 (25)

3. Heat losses and heat loss parameter

The κ -value is the heat capacity per unit area, see Table 1e

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A x U, W/K	κ -value, kJ/m ² .K	A x κ , kJ/K	
Doors			1.89	x 0.55	= 1.04	N/A	N/A	(26)
Window*			6.01	x 1.33	= 7.96	N/A	N/A	(27)
Ground floor			67.20	x 0.15	= 10.08	N/A	N/A	(28a)
External wall			53.67	x 0.25	= 13.42	N/A	N/A	(29a)
External wall			14.56	x 0.23	= 3.35	N/A	N/A	(29a)
Total area of external elements ΣA , m ²			143.33		(31)			

* for windows and roof windows, effective window U-value is calculated using formula $1/[(1/U_{\text{value}})+0.04]$ paragraph 3.2

Fabric heat loss, W/K = $\Sigma(A \times U)$ (26) (30) + (32) = (33)

Heat capacity $C_m = \Sigma(A \times \kappa)$ (28) (30) + (32) + (32a) (32e) = (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = (35)

Thermal bridges: $\Sigma(L \times \Psi)$ calculated using Appendix K (36)

if details of thermal bridging are not known then (36) = $0.15 \times (31)$

Total fabric heat loss (33) + (36) = (37)

Ventilation heat loss calculated monthly $0.33 \times (25)m \times (5)$

(38)m

30.10	29.14	29.14	27.21	25.93	25.61	25.61	25.61	26.25	27.21	28.17	29.14
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 (38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

74.54	73.58	73.58	71.66	70.38	70.06	70.06	70.06	70.70	71.66	72.62	73.58
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Average = $\Sigma(39)12/12 =$ (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.11	1.10	1.10	1.07	1.05	1.04	1.04	1.04	1.05	1.07	1.08	1.10
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Average = $\Sigma(40)12/12 =$ (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N (42)

If $TFA > 13.9$, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

If $TFA \leq 13.9$, $N = 1$

Annual average hot water usage in litres per day $V_{d, \text{average}} = (25 \times N) + 36$ (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)												
(44)m	94.48	91.04	87.60	84.17	80.73	77.30	77.30	80.73	84.17	87.60	91.04	94.48
	$\Sigma(44)12 =$ 1030.64 (44)											

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times T_m/3600$ kWh/month (see Tables 1b, 1c 1d)

(45)m

140.44	122.83	126.75	110.50	106.03	91.50	84.78	97.29	98.45	114.74	125.24	136.01
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 $\Sigma(45)12 =$ (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss $0.15 \times (45)m$

(46)m	21.07	18.42	19.01	16.58	15.90	13.72	12.72	14.59	14.77	17.21	18.79	20.40	(46)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

1.19 (47)

Temperature factor from Table 2b

0.54 (48)

Energy lost from water storage, kWh/day (47) $\times$ (48)

0.64 (49)

Enter (49) or (54) in (55)

0.64 (55)

Water storage loss calculated for each month = (55) $\times$ (41)m

(56)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92	(56)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

If cylinder contains dedicated solar storage, = (56)m $\times$ [(50) - (H11)] $\div$ (50), else = (56)m where (H11) is from Appendix H

(57)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92	(57)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Primary circuit loss (annual) from Table 3

360.00 (58)

Primary circuit loss for each month (58) $\div$ 365 $\times$ (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)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	(61)
-------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(62)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50	(62)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)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	(63)
-------	------	------	------	------	------	------	------	------	------	------	------	------	------

 $\Sigma(63)_{1-12} = 0.00$

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

(64)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50	(64)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

 $\Sigma(64)_{1-12} = 1949.11$

If (64)m < 0 then set to 0

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

(65)m	87.09	77.33	82.54	75.84	75.65	69.52	68.59	72.75	71.83	78.55	80.74	85.62	(65)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	48.30	42.90	34.89	26.41	19.75	16.67	18.01	23.41	31.43	39.90	46.57	49.65	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	284.59	287.54	280.10	264.26	244.26	225.46	212.91	209.95	217.40	233.24	253.24	272.03	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	(69)
Pumps and fans gains (Table 5a)													
(70)m	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	(71)
Water heating gains (Table 5)													
(72)m	117.06	115.07	110.94	105.33	101.68	96.55	92.19	97.78	99.76	105.57	112.14	115.08	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m	553.71	549.28	529.69	499.76	469.45	442.44	426.87	434.90	452.34	482.47	515.70	540.52	(73)

6. Solar gains

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)
Southwest	1.00	x	2.38	x	37.39	x 0.9 x	0.63	x	0.70	=	35.26 (79)
Southeast	1.00	x	3.63	x	37.39	x 0.9 x	0.63	x	0.70	=	53.87 (77)

Solar gains in watts, calculated for each month $\Sigma(74)m \dots (82)m$

(83)m	89.12	151.93	200.75	246.69	270.17	274.24	268.87	251.11	221.45	172.50	106.85	76.16	(83)
-------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	------

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

(84)m	642.84	701.21	730.45	746.46	739.62	716.68	695.74	686.01	673.79	654.97	622.56	616.68	(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, $\eta_{1,m}$ (see Table 9a)													
(86)m	0.91	0.88	0.84	0.79	0.69	0.55	0.39	0.40	0.60	0.77	0.88	0.91	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

(87)m	19.26	19.49	19.84	20.20	20.60	20.85	20.96	20.96	20.80	20.38	19.72	19.31	(87)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Temperature during heating periods in the living area from Table 9, Th2(°C)

(88)m	20.00	20.01	20.01	20.03	20.05	20.05	20.05	20.05	20.04	20.03	20.02	20.01	(88)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Utilisation factor for gains for rest of dwelling $\eta_{2,m}$ (see Table 9a)

(89)m	0.89	0.87	0.82	0.76	0.65	0.48	0.31	0.31	0.53	0.74	0.86	0.90	(89)
-------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(90)m	17.71	18.04	18.54	19.06	19.60	19.91	20.02	20.02	19.85	19.31	18.38	17.79	(90)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Living area fraction f_{LA} $\frac{18.00}{\div (4)} = 0.27$ (91)

Mean internal temperature for the whole dwelling $f_{LA} \times T1 + (1 - f_{LA}) \times T2$

(92)m	18.12	18.43	18.88	19.36	19.87	20.16	20.27	20.27	20.11	19.60	18.74	18.20	(92)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(93)m	17.97	18.28	18.73	19.21	19.72	20.01	20.12	20.12	19.96	19.45	18.59	18.05	(93)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that $t_{im} = (93)m$ and recalculate the utilisation factor for gains using Table 9a													
Utilisation factor for gains, η_{im}													
(94)m	0.86	0.84	0.79	0.74	0.63	0.48	0.31	0.32	0.53	0.71	0.83	0.87	(94)

Useful gains, $\eta_{im}G_m$, W = (94)m x (84)m

(95)m	555.51	586.37	578.73	549.20	465.38	345.67	219.10	218.81	355.13	466.21	516.45	534.54	(95)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
-------	------	------	------	------	-------	-------	-------	-------	-------	-------	------	------	------

Heat loss rate for mean internal temperature, L_m , W

(97)m	1004.16	976.93	878.21	753.39	564.37	379.19	225.92	225.85	399.96	619.71	841.82	967.41	(97)
-------	---------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Space heating requirement for each month, kWh/month = $0.024 \times [(97)m - (95)m] \times (41)m$

(98)m	333.80	262.46	222.81	147.01	73.65	0.00	0.00	0.00	0.00	114.21	234.27	322.06	(98)
-------	--------	--------	--------	--------	-------	------	------	------	------	--------	--------	--------	------

Total per year (kWh/year) = $\Sigma(98)1 \dots 12 = 1710.27$ (98)

Space heating requirement in kWh/m²/year $(98) \div (4) = 25.45$ (99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)

	0.00	(201)
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Fraction of space heating from main system(s) 1 - (201)

	1.00	(202)
--	------	-------

Fraction of main heating from main system 2

	0.00	(203)
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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 space heating system 1 (%)

93.50 (206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement, kWh/month (as calculated above)													
(98)m	333.80	262.46	222.81	147.01	73.65	0.00	0.00	0.00	0.00	114.21	234.27	322.06	
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)													
(211)m	357.00	280.71	238.30	157.24	78.77	0.00	0.00	0.00	0.00	122.15	250.56	344.44	
Total per year (kWh/year) = Σ(211)1 5, 10 12 =													1829.16 (211)

Water heating:

Output from water heater, kWh/month (calculated above)

(64)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50	
Σ(64)1 12 =													1949.11 (64)

Efficiency of water heater per month

(217)m	86.29	85.99	85.43	84.60	82.94	79.80	79.80	79.80	79.80	83.85	85.61	86.26	
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Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m

(219)m	221.27	195.87	207.48	188.38	188.73	175.89	169.52	185.20	184.61	197.05	203.39	216.22	
Total per year (kWh/year) = Σ(219)1 12 =													2333.62 (219)

Annual Totals Summary:

Space heating fuel used, main system 1

kWh/year	1829.16 (211)
----------	---------------

Water heating fuel used

kWh/year	2333.62 (219)
----------	---------------

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

mechanical ventilation fans - balanced, extract or positive input from outside	70.07	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	0.00	(230g)
Total electricity for the above	Σ(230a) - (230g) 245.07	(231)

Electricity for lighting (calculated in Appendix L):

341.22 (232)

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

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	1829.16	x	3.10	x 0.01 =	56.70	(240)
Water heating cost (other fuel)	2333.62	x	3.10	x 0.01 =	72.34	(247)
Pumps, fans and electric keep-hot	245.07	x	11.46	x 0.01 =	28.09	(249)
Energy for lighting	341.22	x	11.46	x 0.01 =	39.10	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost				(240) (242) + (245) (254)	302.24	(255)

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

Energy cost deflator (Table 12)	0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45 0] =	1.27 (257)
SAP value	82.34	
SAP rating	82	(258)
SAP band	B	

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	1829.16	x	0.198	=	362.17	(261)
Water heating	2333.62	x	0.198	=	462.06	(264)
Space and water heating				(261) + (262) + (263) + (264) =	824.23	(265)
Pumps, fans and electric keep-hot	245.07	x	0.517	=	126.70	(267)
Lighting	341.22	x	0.517	=	176.41	(268)
Total carbon dioxide emissions				$\Sigma(261) \dots (271) =$	1127.35	(272)
Dwelling carbon dioxide emissions rate				$(272) \div (4) =$	16.78	(273)
EI value					86.54	
EI rating (see section 14)					87	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	1829.16	x	1.02	=	1865.75	(261*)
Water heating	2333.62	x	1.02	=	2380.29	(264*)
Space and water heating				$(261*) + (262*) + (263*) + (264*) =$	4246.04	(265*)
Pumps, fans and electric keep-hot	245.07	x	2.92	=	715.61	(267*)
Lighting	341.22	x	2.92	=	996.37	(268*)
Total primary energy kWh/year				$\Sigma(261*) \dots (271*) =$	5958.02	(272*)
Primary energy kWh/m ² /year				$(272*) \div (4) =$	88.66	(273*)

SAP 2009 Worksheet

Design - Draft

320120629 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	Mr Laurie Wills	Assessor number	3906
Client		Last modified	10/05/2012
Address	Type L - single storey, 2 bed Chapel Close, Clitheroe, Lancs, BB7		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	65.80 (1a)	2.31 (2a)	152.00 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d) (1n) = 65.80 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d) (3n) = 152.00 (5)	

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	0 x 10 =	0 (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) = 0 ÷ (5) = 0.00 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25 (18)
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Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered	0 (19)
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Shelter factor	1 - [0.075 x (19)] = 1.00 (20)
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Adjusted infiltration rate	(18) x (20) = 0.25 (21)
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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 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
	Σ(22)1..12 = 54.10 (22)											

Wind Factor (22a)m = (22)m ÷ 4

(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27
	Σ(22a)1..12 = 13.52 (22a)											

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) x (22a)m

(22b)m	0.34	0.32	0.32	0.28	0.26	0.24	0.23	0.23	0.26	0.28	0.30	0.32
	Σ(22b)1..12 = 3.38 (22b)											

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.5 (23a)
---	-----------

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5 (23b)
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If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

N/A (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if $(22b)m < 0.5 \times (23b)$, then $(24c) = (23b)$; otherwise $(24c) = (22b)m + 0.5 \times (23b)$

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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(24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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(25)

3. Heat losses and heat loss parameter

The κ -value is the heat capacity per unit area, see Table 1e

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A x U, W/K	κ -value, kJ/m ² .K	A x κ , kJ/K
Doors			1.89	0.55	1.04	N/A	N/A
Window*			9.12	1.33	12.09	N/A	N/A
Ground floor			65.80	0.15	9.87	N/A	N/A
External wall			64.43	0.25	16.11	N/A	N/A
Roof			65.80	0.11	7.24	N/A	N/A
Total area of external elements ΣA , m ²			207.04		(31)		

* for windows and roof windows, effective window U-value is calculated using formula $1/[(1/U_{\text{Value}})+0.04]$ paragraph 3.2

Fabric heat loss, W/K = $\Sigma(A \times U)$ (26) (30) + (32) = 46.34 (33)

Heat capacity $C_m = \Sigma(A \times \kappa)$ (28) (30) + (32) + (32a) (32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: $\Sigma(L \times \Psi)$ calculated using Appendix K 12.42 (36)

If details of thermal bridging are not known then (36) = $0.15 \times (31)$

Total fabric heat loss (33) + (36) = 58.77 (37)

Ventilation heat loss calculated monthly $0.33 \times (25)m \times (5)$

(38)m

29.47	28.53	28.53	26.65	25.39	25.08	25.08	25.08	25.71	26.65	27.59	28.53
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

88.23	87.29	87.29	85.41	84.16	83.85	83.85	83.85	84.47	85.41	86.35	87.29
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Average = $\Sigma(39)1 \ 12/12 = 85.62$ (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.34	1.33	1.33	1.30	1.28	1.27	1.27	1.27	1.28	1.30	1.31	1.33
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Average = $\Sigma(40)1 \ 12/12 = 1.30$ (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N

2.14 (42)

If $TFA > 13.9$, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

If $TFA \leq 13.9$, $N = 1$

Annual average hot water usage in litres per day $V_{d, \text{average}} = (25 \times N) + 36$

85.03 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)												
(44)m	93.53	90.13	86.73	83.32	79.92	76.52	76.52	79.92	83.32	86.73	90.13	93.53
	$\Sigma(44)1 \ 12 = 1020.30$ (44)											

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times T_m/3600$ kWh/month (see Tables 1b, 1c 1d)

(45)m

139.03	121.60	125.48	109.39	104.97	90.58	83.93	96.32	97.47	113.59	123.99	134.64
--------	--------	--------	--------	--------	-------	-------	-------	-------	--------	--------	--------

$\Sigma(45)1 \ 12 = 1340.98$ (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

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Distribution loss $0.15 \times (45)m$

(46)m	20.85	18.24	18.82	16.41	15.74	13.59	12.59	14.45	14.62	17.04	18.60	20.20	(46)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

1.19 (47)

Temperature factor from Table 2b

0.54 (48)

Energy lost from water storage, kWh/day (47) $\times$ (48)

0.64 (49)

Enter (49) or (54) in (55)

0.64 (55)

Water storage loss calculated for each month = (55) $\times$ (41)m

(56)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92	(56)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

If cylinder contains dedicated solar storage, = (56)m $\times$ [(50) - (H11)] $\div$ (50), else = (56)m where (H11) is from Appendix H

(57)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92	(57)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Primary circuit loss (annual) from Table 3

360.00 (58)

Primary circuit loss for each month (58) $\div$ 365 $\times$ (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)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	(61)
-------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(62)m	189.53	167.21	175.97	158.26	155.46	139.45	134.43	146.81	146.33	164.08	172.86	185.14	(62)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)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	
-------	------	------	------	------	------	------	------	------	------	------	------	------	--

 $\Sigma(63)12 = 0.00$ (63)

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

(64)m	189.53	167.21	175.97	158.26	155.46	139.45	134.43	146.81	146.33	164.08	172.86	185.14	
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--

 $\Sigma(64)12 = 1935.53$ (64)

If (64)m < 0 then set to 0

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

(65)m	86.62	76.92	82.12	75.47	75.30	69.21	68.30	72.42	71.50	78.16	80.32	85.17	(65)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
--	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Metabolic gains (Table 5), Watts

(66)m	128.40	128.40	128.40	128.40	128.40	128.40	128.40	128.40	128.40	128.40	128.40	128.40	(66)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m	43.20	38.37	31.20	23.62	17.66	14.91	16.11	20.94	28.10	35.68	41.65	44.40	(67)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m	279.56	282.46	275.15	259.59	239.94	221.48	209.14	206.24	213.55	229.11	248.76	267.22	(68)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m	49.98	49.98	49.98	49.98	49.98	49.98	49.98	49.98	49.98	49.98	49.98	49.98	(69)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Pumps and fans gains (Table 5a)

(70)m	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	(70)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Losses e.g. evaporation (negative values) (Table 5)

(71)m	-85.60	-85.60	-85.60	-85.60	-85.60	-85.60	-85.60	-85.60	-85.60	-85.60	-85.60	-85.60	(71)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m	116.43	114.46	110.37	104.82	101.21	96.13	91.81	97.34	99.31	105.06	111.56	114.47	(72)
-------	--------	--------	--------	--------	--------	-------	-------	-------	-------	--------	--------	--------	------

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	541.97	538.07	519.51	490.80	461.59	435.29	419.84	427.30	443.74	472.64	504.74	528.87	(73)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

6. Solar gains

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below.

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)
Southwest	1.00	x	2.88	x	37.39	x 0.9 x	0.63	x	0.70	=	42.74 (79)
Southeast	1.00	x	0.96	x	37.39	x 0.9 x	0.63	x	0.70	=	14.29 (77)
Northeast	1.00	x	4.59	x	11.51	x 0.9 x	0.63	x	0.70	=	20.97 (75)
Northwest	1.00	x	0.68	x	11.51	x 0.9 x	0.63	x	0.70	=	3.13 (81)

Solar gains in watts, calculated for each month $\Sigma(74)m \dots (82)m$

(83)m	81.12	146.53	214.56	299.79	360.80	379.60	366.70	318.57	248.98	172.34	98.78	68.33	(83)
-------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	-------	------

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

(84)m	623.09	684.60	734.06	790.59	822.39	814.89	786.53	745.87	692.72	644.98	603.52	597.20	(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, $\eta_{1,m}$ (see Table 9a)													
(86)m	0.92	0.90	0.86	0.80	0.69	0.55	0.40	0.42	0.63	0.81	0.90	0.92	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

(87)m	18.75	19.00	19.44	19.92	20.45	20.78	20.93	20.92	20.67	20.09	19.28	18.81	(87)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Temperature during heating periods in the living area from Table 9, Th2(°C)

(88)m	19.81	19.82	19.82	19.85	19.86	19.86	19.86	19.86	19.86	19.85	19.83	19.82	(88)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Utilisation factor for gains for rest of dwelling $\eta_{2,m}$ (see Table 9a)

(89)m	0.91	0.88	0.84	0.77	0.64	0.48	0.30	0.32	0.56	0.77	0.88	0.91	(89)
-------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

(90)m	16.88	17.24	17.87	18.55	19.26	19.67	19.82	19.82	19.56	18.80	17.66	16.98	(90)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Living area fraction

fLA 21.90 ÷ (4) = 0.33 (91)

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

(92)m	17.50	17.83	18.40	19.01	19.66	20.04	20.19	20.19	19.93	19.23	18.20	17.59	(92)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(93)m	17.35	17.68	18.25	18.86	19.51	19.89	20.04	20.04	19.78	19.08	18.05	17.44	(93)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a

Utilisation factor for gains, $\eta_{1,m}$

(94)m	0.88	0.85	0.80	0.74	0.63	0.48	0.32	0.33	0.56	0.74	0.85	0.88	(94)
-------	------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, $\eta_{1,m}G_m$, W = (94)m x (84)m

(95)m	545.39	581.87	590.68	585.22	515.43	391.60	251.23	249.46	386.31	477.27	510.54	524.33	(95)
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Monthly average external temperature from Table 8

(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
-------	------	------	------	------	-------	-------	-------	-------	-------	-------	------	------	------

Heat loss rate for mean internal temperature, Lm, W

(97)m	1134.23	1106.67	999.09	867.42	656.87	443.32	263.48	263.03	462.67	707.14	954.24	1094.54	(97)
-------	---------	---------	--------	--------	--------	--------	--------	--------	--------	--------	--------	---------	------

Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m

(98)m	438.10	352.67	303.85	203.19	105.23	0.00	0.00	0.00	0.00	171.02	319.47	424.23	
-------	--------	--------	--------	--------	--------	------	------	------	------	--------	--------	--------	--

Total per year (kWh/year) = $\Sigma(98)1 \dots 12 = 2317.76$ (98)

Space heating requirement in kWh/m²/year

(98) ÷ (4) 35.22 (99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)

0.00 (201)

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Fraction of space heating from main system(s) 1 - (201)

1.00 (202)

Fraction of main heating from main system 2

0.00 (203)

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 space heating system 1 (%)

93.50 (206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement, kWh/month (as calculated above)													
(98)m	438.10	352.67	303.85	203.19	105.23	0.00	0.00	0.00	0.00	171.02	319.47	424.23	
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)													
(211)m	468.56	377.18	324.98	217.31	112.55	0.00	0.00	0.00	0.00	182.91	341.68	453.73	
Total per year (kWh/year) = $\sum(211)1 \dots 12 =$	2478.89												(211)

Water heating:

Output from water heater, kWh/month (calculated above)

(64)m	189.53	167.21	175.97	158.26	155.46	139.45	134.43	146.81	146.33	164.08	172.86	185.14	
$\sum(64)1 \dots 12 =$	1935.53												(64)

Efficiency of water heater per month

(217)m	86.98	86.76	86.26	85.48	83.80	79.80	79.80	79.80	79.80	84.92	86.43	86.96	
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--

Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m

(219)m	217.90	192.73	204.01	185.14	185.52	174.74	168.46	183.97	183.37	193.21	199.99	212.91	
Total per year (kWh/year) = $\sum(219)1 \dots 12 =$	2301.96												(219)

Annual Totals Summary:

Space heating fuel used, main system 1

kWh/year	kWh/year
	2478.89 (211)

Water heating fuel used

2301.96 (219)

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

mechanical ventilation fans - balanced, extract or positive input from outside	68.61	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	0.00	(230g)
Total electricity for the above	$\sum(230a) \dots (230g) =$ 243.61	(231)

Electricity for lighting (calculated in Appendix L):

305.16 (232)

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

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	2478.89	x	3.10	x 0 01 =	76.85	(240)
Water heating cost (other fuel)	2301.96	x	3.10	x 0 01 =	71.36	(247)
Pumps, fans and electric keep-hot	243.61	x	11.46	x 0 01 =	27.92	(249)
Energy for lighting	305.16	x	11.46	x 0 01 =	34.97	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost				(240) (242) + (245) (254) =	317.10	(255)

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

Energy cost deflator (Table 12)	0.47	(256)
Energy cost factor (ECF)	$[(255) \times (256)] \div [(4) + 45 0] =$	1.35 (257)
SAP value	81.24	

SAP rating

SAP band

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81

(258)

B

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	2478.89	x	0.198	=	490.82	(261)
Water heating	2301.96	x	0.198	=	455.79	(264)
Space and water heating			(261) + (262) + (263) + (264) =		946.61	(265)
Pumps, fans and electric keep-hot	243.61	x	0.517	=	125.95	(267)
Lighting	305.16	x	0.517	=	157.77	(268)
Total carbon dioxide emissions			$\Sigma(261) \dots (271) =$		1230.32	(272)
Dwelling carbon dioxide emissions rate			$(272) \div (4) =$		18.70	(273)
EI value					85.12	
EI rating (see section 14)					85	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	2478.89	x	1.02	=	2528.47	(261*)
Water heating	2301.96	x	1.02	=	2348.00	(264*)
Space and water heating			$(261*) + (262*) + (263*) + (264*) =$		4876.46	(265*)
Pumps, fans and electric keep-hot	243.61	x	2.92	=	711.35	(267*)
Lighting	305.16	x	2.92	=	891.06	(268*)
Total primary energy kWh/year			$\Sigma(261*) \dots (271*) =$		6478.87	(272*)
Primary energy kWh/m ² /year			$(272*) \div (4) =$		98.46	(273*)

SAP 2009 Worksheet

Design - Draft

320120629 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	Mr Laurie Wills	Assessor number	3906
Client		Last modified	26/04/2012
Address	PD410 - 2 storey, 4 bed Chapel Close, Clitheroe, Lancs, BB7		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	54.19 (1a)	x	2.31 (2a)	=	125.18 (3a)
+1	68.00 (1b)	x	2.61 (2b)	=	177.48 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d) (1n) = 122.19 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d) (3n) = 302.66 (5)				

2. Ventilation rate

Number of chimneys	0	x 40 =	0	(6a)									
Number of open flues	0	x 20 =	0	(6b)									
Number of intermittent fans	0	x 10 =	0	(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) = 0												
		÷ (5) =	0.00	(8)									
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>													
Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area			5.00	(17)									
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.25	(18)									
<i>Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used</i>													
Number of sides on which dwelling is sheltered			0	(19)									
Shelter factor		1 - [0.075 x (19)] =	1.00	(20)									
Adjusted infiltration rate		(18) x (20) =	0.25	(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 7													
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10	
	Σ(22)1..12 = 54.10											(22)	
Wind Factor (22a)m = (22)m ÷ 4													
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27	
	Σ(22a)1..12 = 13.52											(22a)	
Adjusted infiltration rate (allowing for shelter and wind speed) = (21) x (22a)m													
(22b)m	0.34	0.32	0.32	0.28	0.26	0.24	0.23	0.23	0.26	0.28	0.30	0.32	
	Σ(22b)1..12 = 3.38											(22b)	
Calculate effective air change rate for the applicable case:													
If mechanical ventilation: air change rate through system													
												0.5	(23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)

0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

N/A (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 × (23b)

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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(24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
------	------	------	------	------	------	------	------	------	------	------	------

(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A × U, W/K	κ-value, kJ/m ² .K	A × κ, kJ/K
Doors			1.89	0.55	1.04	N/A	N/A
Window*			18.28	1.33	24.24	N/A	N/A
Ground floor			50.90	0.15	7.64	N/A	N/A
Exposed floor			12.50	0.20	2.50	N/A	N/A
External wall			128.15	0.25	32.04	N/A	N/A
External wall			17.95	0.29	5.21	N/A	N/A
Roof			68.00	0.11	7.48	N/A	N/A
Total area of external elements ΣA, m ²			297.67				

* for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2

Fabric heat loss, W/K = Σ(A × U) (26) (30) + (32) = 80.14 (33)

Heat capacity Cm = Σ(A × κ) (28) (30) + (32) + (32a) (32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: Σ(L × Ψ) calculated using Appendix K 17.86 (36)

if details of thermal bridging are not known then (36) = 0.15 × (31)

Total fabric heat loss (33) + (36) = 98.00 (37)

Ventilation heat loss calculated monthly 0.33 × (25)m × (5)

(38)m

58.68	56.81	56.81	53.06	50.56	49.94	49.94	49.94	51.19	53.06	54.93	56.81
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

156.67	154.80	154.80	151.06	148.56	147.93	147.93	147.93	149.18	151.06	152.93	154.80
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Average = Σ(39)1 12/12 = 151.47 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.28	1.27	1.27	1.24	1.22	1.21	1.21	1.21	1.22	1.24	1.25	1.27
------	------	------	------	------	------	------	------	------	------	------	------

Average = Σ(40)1 12/12 = 1.24 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N

2.87 (42)

If TFA > 13.9, N = 1 + 1.76 × [1 - exp(-0.000349 × (TFA - 13.9)²)] + 0.0013 × (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 × N) + 36

102.40 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c × (43)

(44)m

112.64	108.54	104.44	100.35	96.25	92.16	92.16	96.25	100.35	104.44	108.54	112.64
--------	--------	--------	--------	-------	-------	-------	-------	--------	--------	--------	--------

Σ(44)1 12 = 1228.75 (44)

Energy content of hot water used - calculated monthly = 4.190 × Vd,m × nm × Tm/3600 kWh/month (see Tables 1b, 1c 1d)

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(45)m	167.43	146.44	151.11	131.74	126.41	109.08	101.08	115.99	117.38	136.79	149.32	162.15
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

$$\Sigma(45)12 = 1614.94 \quad (45)$$

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss $0.15 \times (45)m$

(46)m	25.12	21.97	22.67	19.76	18.96	16.36	15.16	17.40	17.61	20.52	22.40	24.32
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

1.19 (47)

Temperature factor from Table 2b

0.54 (48)

Energy lost from water storage, kWh/day (47) $\times$ (48)

0.64 (49)

Enter (49) or (54) in (55)

0.64 (55)

Water storage loss calculated for each month = (55) $\times$ (41)m

(56)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

If cylinder contains dedicated solar storage, = (56)m $\times$ [(50) - (H11)] $\div$ (50), else = (56)m where (H11) is from Appendix H

(57)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Primary circuit loss (annual) from Table 3

360.00 (58)

Primary circuit loss for each month (58) $\div$ 365 $\times$ (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)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
-------	------	------	------	------	------	------	------	------	------	------	------	------

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

(62)m	217.93	192.05	201.61	180.61	176.91	157.95	151.58	166.49	166.24	187.29	198.19	212.65
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)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
-------	------	------	------	------	------	------	------	------	------	------	------	------

$$\Sigma(63)12 = 0.00 \quad (63)$$

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

(64)m	217.93	192.05	201.61	180.61	176.91	157.95	151.58	166.49	166.24	187.29	198.19	212.65
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

$$\Sigma(64)12 = 2209.48 \quad (64)$$

if (64)m < 0 then set to 0

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

(65)m	96.07	85.18	90.64	82.90	82.43	75.36	74.01	78.96	78.12	85.88	88.74	94.31
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Metabolic gains (Table 5), Watts

(66)m	172.28	172.28	172.28	172.28	172.28	172.28	172.28	172.28	172.28	172.28	172.28	172.28
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m	65.55	58.22	47.35	35.85	26.80	22.62	24.44	31.77	42.65	54.15	63.20	67.37
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m	429.91	434.37	423.13	399.19	368.98	340.59	321.62	317.16	328.40	352.33	382.54	410.94
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m	55.10	55.10	55.10	55.10	55.10	55.10	55.10	55.10	55.10	55.10	55.10	55.10
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Pumps and fans gains (Table 5a)

(70)m	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Losses e.g. evaporation (negative values) (Table 5)

(71)m	-114.86	-114.86	-114.86	-114.86	-114.86	-114.86	-114.86	-114.86	-114.86	-114.86	-114.86	-114.86
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Water heating gains (Table 5)

(72)m	129.12	126.75	121.83	115.14	110.79	104.67	99.47	106.13	108.50	115.43	123.25	126.76
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m

747.11	741.87	714.83	672.70	629.10	590.41	568.06	577.60	602.08	644.44	691.91	727.60
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(73)

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6. Solar gains

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
Southeast	1.00	x	6.89	x	37.39	x 0.9 x	0.63	x	0.70	=	102.30	(77)
Southwest	1.00	x	0.66	x	37.39	x 0.9 x	0.63	x	0.70	=	9.74	(79)
Northwest	1.00	x	10.08	x	11.51	x 0.9 x	0.63	x	0.70	=	46.03	(81)
Northeast	1.00	x	0.66	x	11.51	x 0.9 x	0.63	x	0.70	=	3.00	(75)

Solar gains in watts, calculated for each month $\Sigma(74)m \dots (82)m$

(83)m	161.07	291.33	427.56	598.93	722.02	760.09	734.07	636.94	496.68	342.93	196.20	135.62
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(83)

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

(84)m	908.18	1033.20	1142.39	1271.63	1351.12	1350.50	1302.14	1214.53	1098.75	987.38	887.73	863.22
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(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, $\eta_{1,m}$ (see Table 9a)

(86)m	0.95	0.93	0.89	0.83	0.72	0.58	0.43	0.45	0.68	0.85	0.93	0.95
-------	------	------	------	------	------	------	------	------	------	------	------	------

(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

(87)m	18.59	18.87	19.34	19.87	20.42	20.77	20.93	20.92	20.64	20.00	19.14	18.65
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(87)

Temperature during heating periods in the living area from Table 9, Th2(°C)

(88)m	19.86	19.87	19.87	19.89	19.91	19.91	19.91	19.91	19.91	19.89	19.88	19.87
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(88)

Utilisation factor for gains for rest of dwelling $\eta_{2,m}$ (see Table 9a)

(89)m	0.94	0.92	0.88	0.81	0.68	0.51	0.33	0.35	0.61	0.82	0.92	0.94
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(89)

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

(90)m	16.68	17.08	17.77	18.51	19.28	19.71	19.87	19.87	19.57	18.72	17.49	16.78
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(90)

Living area fraction

fLA	18.60	÷ (4) =	0.15
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(91)

Mean internal temperature for the whole dwelling $fLA \times T1 + (1 - fLA) \times T2$

(92)m	16.97	17.36	18.01	18.72	19.45	19.87	20.03	20.03	19.73	18.92	17.74	17.06
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(92)

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

(93)m	16.82	17.21	17.86	18.57	19.30	19.72	19.88	19.88	19.58	18.77	17.59	16.91
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(93)

8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

Utilisation factor for gains, η_m

(94)m	0.91	0.88	0.84	0.77	0.65	0.50	0.32	0.34	0.59	0.78	0.88	0.91
-------	------	------	------	------	------	------	------	------	------	------	------	------

(94)

Useful gains, $\eta_m G_m$, W = (94)m x (84)m

(95)m	825.90	912.30	955.97	977.04	877.46	668.86	421.95	418.06	647.73	770.89	784.76	788.00
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(95)

Monthly average external temperature from Table 8

(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90
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(96)

Heat loss rate for mean internal temperature, Lm, W

(97)m	1930.25	1889.51	1711.51	1490.64	1129.15	757.37	441.26	440.22	787.56	1203.36	1620.24	1859.31
-------	---------	---------	---------	---------	---------	--------	--------	--------	--------	---------	---------	---------

(97)

Space heating requirement for each month, kWh/month = $0.024 \times [(97)m - (95)m] \times (41)m$

(98)m	821.64	656.68	562.12	369.80	187.26	0.00	0.00	0.00	0.00	321.76	601.55	797.06
-------	--------	--------	--------	--------	--------	------	------	------	------	--------	--------	--------

Total per year (kWh/year) = $\Sigma(98)1 \dots 12 =$ 4317.86 (98)

Space heating requirement in kWh/m²/year

(98) ÷ (4) = 35.34 (99)

9a. Energy Requirements - Individual heating systems including micro-CHP**Space heating:**

Fraction of space heating from secondary/supplementary system (Table 11)	0.00	(201)
Fraction of space heating from main system(s) 1 - (201)	1.00	(202)
Fraction of main heating from main system 2	0.00	(203)
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 space heating system 1 (%)	93.50	(206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement, kWh/month (as calculated above)													
(98)m	821.64	656.68	562.12	369.80	187.26	0.00	0.00	0.00	0.00	321.76	601.55	797.06	
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)													
(211)m	878.76	702.34	601.20	395.51	200.27	0.00	0.00	0.00	0.00	344.13	643.36	852.47	
Total per year (kWh/year) = $\Sigma(211)1 \dots 12 =$												4618.03	(211)

Water heating:

Output from water heater, kWh/month (calculated above)

(64)m	217.93	192.05	201.61	180.61	176.91	157.95	151.58	166.49	166.24	187.29	198.19	212.65	
$\Sigma(64)1 \dots 12 =$												2209.48	(64)

Efficiency of water heater per month

(217)m	88.03	87.84	87.41	86.69	84.97	79.80	79.80	79.80	79.80	86.25	87.59	88.01	
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Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m

(219)m	247.58	218.65	230.66	208.35	208.21	197.93	189.95	208.63	208.33	217.16	226.27	241.60	
Total per year (kWh/year) = $\Sigma(219)1 \dots 12 =$												2603.30	(219)

Annual Totals Summary:

	kWh/year	kWh/year	
Space heating fuel used, main system 1	4618.03	(211)	
Water heating fuel used	2603.30	(219)	

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

mechanical ventilation fans - balanced, extract or positive input from outside	87.79	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	0.00	(230g)
Total electricity for the above	$\Sigma(230a) \dots (230g) =$	262.79 (231)

Electricity for lighting (calculated in Appendix L):

463.07 (232)

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

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	4618.03	x	3.10	x 0.01 =	143.16	(240)
Water heating cost (other fuel)	2603.30	x	3.10	x 0.01 =	80.70	(247)
Pumps, fans and electric keep-hot	262.79	x	11.46	x 0.01 =	30.12	(249)
Energy for lighting	463.07	x	11.46	x 0.01 =	53.07	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost				(240) + (242) + (245) (254)	413.04	(255)

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

Energy cost deflator (Table 12)				0.47	(256)
Energy cost factor (ECF)			$[(255) \times (256)] \div [(4) + 450] =$	1.16	(257)
SAP value				83.80	
SAP rating				84	(258)
SAP band				B	

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	4618.03	x	0.198	=	914.37	(261)
Water heating	2603.30	x	0.198	=	515.45	(264)
Space and water heating			$(261) + (262) + (263) + (264) =$		1429.82	(265)
Pumps, fans and electric keep-hot	262.79	x	0.517	=	135.86	(267)
Lighting	463.07	x	0.517	=	239.41	(268)
Total carbon dioxide emissions				$\Sigma(261) \quad (271) =$	1805.09	(272)
Dwelling carbon dioxide emissions rate				$(272) \div (4) =$	14.77	(273)
EI value					85.53	
EI rating (see section 14)					86	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	4618.03	x	1.02	=	4710.39	(261*)
Water heating	2603.30	x	1.02	=	2655.37	(264*)
Space and water heating			$(261*) + (262*) + (263*) + (264*) =$		7365.76	(265*)
Pumps, fans and electric keep-hot	262.79	x	2.92	=	767.35	(267*)
Lighting	463.07	x	2.92	=	1352.16	(268*)
Total primary energy kWh/year				$\Sigma(261*) \quad (271*) =$	9485.27	(272*)
Primary energy kWh/m ² /year				$(272*) \div (4) =$	77.63	(273*)

SAP 2009 Worksheet

Design - Draft

32012062 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	Mr Laurie Wills	Assessor number	3906
Client		Last modified	26/04/2012
Address	PD410 - 2 storey, 4 bed Chapel Close , SOLAR THERMAL SPEC, Clitheroe, Lancs , BB7		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	54.19 (1a) x	2.31 (2a) =	125.18 (3a)
+1	68.00 (1b) x	2.61 (2b) =	177.48 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d) (1n) =		
Dwelling volume		(3a) + (3b) + (3c) + (3d) (3n) =	302.66 (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		0	x 10 =	0	(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) =	0	÷ (5) =	0.00	(8)																																																									
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>																																																																		
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area										5.00	(17)																																																							
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)										0.25	(18)																																																							
<i>Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used</i>																																																																		
Number of sides on which dwelling is sheltered										0	(19)																																																							
Shelter factor										1 - [0.075 x (19)] =		1.00	(20)																																																					
Adjusted infiltration rate										(18) x (20) =		0.25	(21)																																																					
Infiltration rate modified for monthly wind speed:																																																																		
<table><tr><td></td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr><tr><td>Monthly average wind speed from Table 7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>(22)m</td><td>5.40</td><td>5.10</td><td>5.10</td><td>4.50</td><td>4.10</td><td>3.90</td><td>3.70</td><td>3.70</td><td>4.20</td><td>4.50</td><td>4.80</td><td>5.10</td></tr><tr><td></td><td colspan="11">Σ(22)1..12 =</td><td>54.10</td><td>(22)</td></tr></table>															Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly average wind speed from Table 7													(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10		Σ(22)1..12 =											54.10	(22)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec																																																						
Monthly average wind speed from Table 7																																																																		
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10																																																						
	Σ(22)1..12 =											54.10	(22)																																																					
Wind Factor (22a)m = (22)m ÷ 4																																																																		
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27	Σ(22a)1..12 = 13.52 (22a)																																																					
Adjusted infiltration rate (allowing for shelter and wind speed) = (21) x (22a)m																																																																		
(22b)m	0.34	0.32	0.32	0.28	0.26	0.24	0.23	0.23	0.26	0.28	0.30	0.32	Σ(22b)1..12 = 3.38 (22b)																																																					
Calculate effective air change rate for the applicable case:																																																																		
If mechanical ventilation: air change rate through system												0.5	(23a)																																																					

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)

0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

N/A (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 × (23b)

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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(24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
------	------	------	------	------	------	------	------	------	------	------	------

(25)

3. Heat losses and heat loss parameter

The k-value is the heat capacity per unit area, see Table 1e

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A × U, W/K	k-value, kJ/m ² .K	A × k, kJ/K
Doors			1.89	1.50	2.84	N/A	N/A
Window*			18.28	1.33	24.24	N/A	N/A
Ground floor			50.90	0.15	7.64	N/A	N/A
Exposed floor			12.50	0.20	2.50	N/A	N/A
External wall			128.15	0.25	32.04	N/A	N/A
External wall			17.95	0.29	5.21	N/A	N/A
Roof			68.00	0.11	7.48	N/A	N/A
Total area of external elements ΣA, m ²			297.67		(31)		

* for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2

Fabric heat loss, W/K = Σ(A × U) (26) (30) + (32) = 81.93 (33)

Heat capacity Cm = Σ(A × k) (28) (30) + (32) + (32a) (32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: Σ(L × Ψ) calculated using Appendix K 23.81 (36)

if details of thermal bridging are not known then (36) = 0.15 × (31)

Total fabric heat loss (33) + (36) = 105.74 (37)

Ventilation heat loss calculated monthly 0.33 × (25)m × (5)

(38)m

58.68	56.81	56.81	53.06	50.56	49.94	49.94	49.94	51.19	53.06	54.93	56.81
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(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

164.42	162.55	162.55	158.80	156.31	155.68	155.68	155.68	156.93	158.80	160.68	162.55
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Average = Σ(39)12/12 = 159.22 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.35	1.33	1.33	1.30	1.28	1.27	1.27	1.27	1.28	1.30	1.31	1.33
------	------	------	------	------	------	------	------	------	------	------	------

Average = Σ(40)12/12 = 1.30 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N

2.87 (42)

If TFA > 13.9, N = 1 + 1.76 × [1 - exp(-0.000349 × (TFA - 13.9)²)] + 0.0013 × (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 × N) + 36

102.40 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c × (43)

(44)m

112.64	108.54	104.44	100.35	96.25	92.16	92.16	96.25	100.35	104.44	108.54	112.64
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Σ(44)12 = 1228.75 (44)

Energy content of hot water used - calculated monthly = 4.190 × Vd,m × nm × Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(73)m

745.69	740.45	711.44	661.42	609.60	570.58	548.23	559.08	592.77	641.05	690.41	726.18
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(73)

6. Solar gains

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
Southeast	1.00	x	6.89	x	37.39	x 0.9 x	0.63	x	0.70	=	102.30	(77)
Southwest	1.00	x	0.66	x	37.39	x 0.9 x	0.63	x	0.70	=	9.74	(79)
Northwest	1.00	x	10.08	x	11.51	x 0.9 x	0.63	x	0.70	=	46.03	(81)
Northeast	1.00	x	0.66	x	11.51	x 0.9 x	0.63	x	0.70	=	3.00	(75)

Solar gains in watts, calculated for each month $\Sigma(74)m...(82)m$

(83)m

161.07	291.33	427.56	598.93	722.02	760.09	734.07	636.94	496.68	342.93	196.20	135.62
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(83)

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

(84)m

906.76	1031.78	1139.00	1260.35	1331.62	1330.67	1282.30	1196.02	1089.44	983.98	886.31	861.80
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(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, $\eta_{1,m}$ (see Table 9a)												
(86)m	0.95	0.93	0.90	0.84	0.74	0.60	0.45	0.47	0.70	0.86	0.93	0.95

(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

(87)m

18.46	18.74	19.23	19.76	20.35	20.73	20.91	20.90	20.59	19.92	19.03	18.53
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(87)

Temperature during heating periods in the living area from Table 9, Th2(°C)

(88)m

19.81	19.82	19.82	19.84	19.86	19.86	19.86	19.86	19.86	19.86	19.84	19.83	19.82
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(88)

Utilisation factor for gains for rest of dwelling $\eta_{2,m}$ (see Table 9a)

(89)m

0.94	0.92	0.88	0.82	0.69	0.53	0.34	0.36	0.63	0.83	0.92	0.94
------	------	------	------	------	------	------	------	------	------	------	------

(89)

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

(90)m

17.53	17.81	18.29	18.81	19.37	19.70	19.83	19.82	19.59	18.98	18.11	17.60
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(90)

Living area fraction

fLA 18.60 ÷ (4) = 0.15 (91)

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

(92)m

17.67	17.95	18.43	18.96	19.52	19.86	19.99	19.99	19.74	19.12	18.25	17.74
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(92)

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

(93)m

17.52	17.80	18.28	18.81	19.37	19.71	19.84	19.84	19.59	18.97	18.10	17.59
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(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a

Utilisation factor for gains, η_m

(94)m

0.92	0.90	0.85	0.79	0.67	0.52	0.34	0.36	0.61	0.80	0.90	0.92
------	------	------	------	------	------	------	------	------	------	------	------

(94)

Useful gains, $\eta_m G_m$, W = (94)m x (84)m

(95)m

834.96	924.76	971.37	992.92	894.45	686.05	434.01	429.63	663.07	785.43	795.13	796.23
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(95)

Monthly average external temperature from Table 8

(96)m

4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90
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(96)

Heat loss rate for mean internal temperature, Lm, W

(97)m

2141.25	2081.19	1866.25	1605.17	1198.53	794.77	458.30	457.34	830.85	1297.69	1783.48	2063.25
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(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m

(98)m

971.88	777.12	665.79	440.82	226.23	0.00	0.00	0.00	0.00	381.12	711.61	942.66
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Total per year (kWh/year) = $\Sigma(98)1 \dots 12 = 5117.24$ (98)

Space heating requirement in kWh/m²/year

(98) ÷ (4) 41.88 (99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)	0.00	(201)
Fraction of space heating from main system(s) 1 - (201)	1.00	(202)
Fraction of main heating from main system 2	0.00	(203)
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 space heating system 1 (%)	90.50	(206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement, kWh/month (as calculated above)													
(98)m	971.88	777.12	665.79	440.82	226.23	0.00	0.00	0.00	0.00	381.12	711.61	942.66	
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)													
(211)m	1073.90	858.70	735.68	487.10	249.98	0.00	0.00	0.00	0.00	421.13	786.31	1041.62	
Total per year (kWh/year) = Σ(211)1 5, 10... 12 =												5654.41	(211)

Water heating:

Output from water heater, kWh/month (calculated above)													
(64)m	192.81	152.82	140.48	95.45	66.01	45.02	38.54	67.49	94.08	135.92	168.56	191.19	
Σ(64)1 12 =												1388.36	(64)

Efficiency of water heater per month													
(217)m	88.53	88.55	88.43	88.39	87.84	79.80	79.80	79.80	79.80	87.42	88.23	88.50	

Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m													
(219)m	217.78	172.58	158.85	107.99	75.14	56.41	48.30	84.57	117.90	155.48	191.04	216.03	
Total per year (kWh/year) = Σ(219)1 12 =												1602.07	(219)

Annual Totals Summary:

Space heating fuel used, main system 1	kWh/year	5654.41	(211)
Water heating fuel used	kWh/year	1602.07	(219)

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

mechanical ventilation fans - balanced, extract or positive input from outside	91.20	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	75.00	(230g)
Total electricity for the above	Σ(230a) - (230g)	341.20 (231)

Electricity for lighting (calculated in Appendix L):	463.07	(232)
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10a. Fuel costs - Individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	5654.41	x	3.10	x 0 01 =	175.29	(240)
Water heating cost (other fuel)	1602.07	x	3.10	x 0 01 =	49.66	(247)
Pumps, fans and electric keep-hot	341.20	x	11.46	x 0 01 =	39.10	(249)
Energy for lighting	463.07	x	11.46	x 0 01 =	53.07	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost				(240) - (242) + (245) - (254)	423.12	(255)

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

Energy cost deflator (Table 12)				0.47	(256)
Energy cost factor (ECF)			$[(255) \times (256)] \div [(4) + 45.0] =$	1.19	(257)
SAP value				83.41	
SAP rating				83	(258)
SAP band				B	

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	5654.41	x	0.198	=	1119.57	(261)
Water heating	1602.07	x	0.198	=	317.21	(264)
Space and water heating				$(261) + (262) + (263) + (264) =$	1436.78	(265)
Pumps, fans and electric keep-hot	341.20	x	0.517	=	176.40	(267)
Lighting	463.07	x	0.517	=	239.41	(268)
Total carbon dioxide emissions				$\Sigma(261) \dots (271) =$	1852.59	(272)
Dwelling carbon dioxide emissions rate				$(272) \div (4) =$	15.16	(273)
EI value					85.15	
EI rating (see section 14)					85	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	5654.41	x	1.02	=	5767.50	(261*)
Water heating	1602.07	x	1.02	=	1634.11	(264*)
Space and water heating				$(261*) + (262*) + (263*) + (264*) =$	7401.61	(265*)
Pumps, fans and electric keep-hot	341.20	x	2.92	=	996.31	(267*)
Lighting	463.07	x	2.92	=	1352.16	(268*)
Total primary energy kWh/year				$\Sigma(261*) \dots (271*) =$	9750.08	(272*)
Primary energy kWh/m ² /year				$(272*) \div (4) =$	79.79	(273*)

SAP 2009 Worksheet

Design - Draft

320120629 R 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	Mr Laurie Wills	Assessor number	3906
Client		Last modified	10/05/2012
Address	Apartment, 2 bed Ground floor Chapel Close, Clitheroe, Lancs, BB7		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	67.20 (1a) x	2.31 (2a) =	155.23 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d) (1n) =	67.20 (4)	
Dwelling volume		(3a) + (3b) + (3c) + (3d) (3n) =	155.23 (5)

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	0 x 10 =	0 (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) = 0 ÷ (5) = 0.00 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25 (18)
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Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered	0 (19)
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Shelter factor	1 - [0.075 x (19)] = 1.00 (20)
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Adjusted infiltration rate	(18) x (20) = 0.25 (21)
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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 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
	Σ(22)1 12 = 54.10 (22)											

Wind Factor (22a)m = (22)m ÷ 4

(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27
	Σ(22a)1 12 = 13.52 (22a)											

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) x (22a)m

(22b)m	0.34	0.32	0.32	0.28	0.26	0.24	0.23	0.23	0.26	0.28	0.30	0.32
	Σ(22b)1 12 = 3.38 (22b)											

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.5 (23a)
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If exhaust air heat pump using Appendix N, (23b) = (23a) x F _{mv} (equation (N5)), otherwise (23b) = (23a)	0.5 (23b)
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If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

N/A (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 x (23b)

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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 (24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
------	------	------	------	------	------	------	------	------	------	------	------

 (25)

3. Heat losses and heat loss parameter

The κ -value is the heat capacity per unit area, see Table 1e

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A x U, W/K	κ -value, kJ/m ² .K	A x κ , kJ/K
Doors			1.89	0.55	1.04	N/A	N/A
Window*			6.01	1.33	7.96	N/A	N/A
Ground floor			67.20	0.15	10.08	N/A	N/A
External wall			53.67	0.25	13.42	N/A	N/A
External wall			14.56	0.23	3.35	N/A	N/A
Total area of external elements ΣA , m ²			143.33		(31)		

* for windows and roof windows, effective window U-value is calculated using formula $1/[(1/U_{\text{Value}})+0.04]$ paragraph 3.2

Fabric heat loss, W/K = $\Sigma(A \times U)$ (26) (30) + (32) = 35.85 (33)

Heat capacity Cm = $\Sigma(A \times \kappa)$ (28) (30) + (32) + (32a) (32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: $\Sigma(L \times \Psi)$ calculated using Appendix K 8.60 (36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 44.45 (37)

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)

(38)m

30.10	29.14	29.14	27.21	25.93	25.61	25.61	25.61	26.25	27.21	28.17	29.14
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

74.54	73.58	73.58	71.66	70.38	70.06	70.06	70.06	70.70	71.66	72.62	73.58
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Average = $\Sigma(39)12/12 = 71.88$ (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.11	1.10	1.10	1.07	1.05	1.04	1.04	1.04	1.05	1.07	1.08	1.10
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Average = $\Sigma(40)12/12 = 1.07$ (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N

2.18 (42)

If TFA > 13.9, N = $1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 85.89 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	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)												
(44)m	94.48	91.04	87.60	84.17	80.73	77.30	77.30	80.73	84.17	87.60	91.04	94.48
	$\Sigma(44)12 = 1030.64$ (44)											

Energy content of hot water used - calculated monthly = $4.190 \times Vd,m \times n_m \times T_m/3600$ kWh/month (see Tables 1b, 1c 1d)

(45)m

140.44	122.83	126.75	110.50	106.03	91.50	84.78	97.29	98.45	114.74	125.24	136.01
--------	--------	--------	--------	--------	-------	-------	-------	-------	--------	--------	--------

 $\Sigma(45)12 = 1354.56$ (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

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Distribution loss $0.15 \times (45)m$ (46)m

21.07	18.42	19.01	16.58	15.90	13.72	12.72	14.59	14.77	17.21	18.79	20.40
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

1.19

 (47)

Temperature factor from Table 2b

0.54

 (48)Energy lost from water storage, kWh/day (47) $\times$ (48)

0.64

 (49)

Enter (49) or (54) in (55)

0.64

 (55)Water storage loss calculated for each month = (55) $\times$ (41)m(56)m

19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (56)If cylinder contains dedicated solar storage, = (56)m $\times$ [(50) - (H11)] $\div$ (50), else = (56)m where (H11) is from Appendix H(57)m

19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (57)

Primary circuit loss (annual) from Table 3

360.00

 (58)Primary circuit loss for each month (58) $\div$ 365 $\times$ (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m

30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)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
------	------	------	------	------	------	------	------	------	------	------	------

 (61)Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$ (62)m

190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (62)

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)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
------	------	------	------	------	------	------	------	------	------	------	------

 $\Sigma(63)1..12 =$

0.00

 (63)

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

(64)m

190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 $\Sigma(64)1..12 =$

1949.11

 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$ (65)m

87.09	77.33	82.54	75.84	75.65	69.52	68.59	72.75	71.83	78.55	80.74	85.62
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
--	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Metabolic gains (Table 5), Watts

(66)m

130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m

48.30	42.90	34.89	26.41	19.75	16.67	18.01	23.41	31.43	39.90	46.57	49.65
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m

284.59	287.54	280.10	264.26	244.26	225.46	212.91	209.95	217.40	233.24	253.24	272.03
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m

50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (69)

Pumps and fans gains (Table 5a)

(70)m

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m

-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (71)

Water heating gains (Table 5)

(72)m

117.06	115.07	110.94	105.33	101.68	96.55	92.19	97.78	99.76	105.57	112.14	115.08
--------	--------	--------	--------	--------	-------	-------	-------	-------	--------	--------	--------

 (72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m

553.71	549.28	529.69	499.76	469.45	442.44	426.87	434.90	452.34	482.47	515.70	540.52
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (73)**6. Solar gains**

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
Southwest	1.00	x	2.38	x	37.39	x 0.9 x	0.63	x	0.70	=	35.26	(79)
Southeast	1.00	x	3.63	x	37.39	x 0.9 x	0.63	x	0.70	=	53.87	(77)
Solar gains in watts, calculated for each month $\sum(74)m \dots (82)m$												
(83)m	89.12		151.93		200.75		246.69		270.17		274.24	(83)
Total gains - internal and solar (73)m + (83)m												
(84)m	642.84		701.21		730.45		746.46		739.62		716.68	(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, $\eta_{1,m}$ (see Table 9a)													
(86)m	0.91	0.88	0.84	0.79	0.69	0.55	0.39	0.40	0.60	0.77	0.88	0.91	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.26	19.49	19.84	20.20	20.60	20.85	20.96	20.96	20.80	20.38	19.72	19.31	(87)
Temperature during heating periods in the living area from Table 9, Th2(°C)													
(88)m	20.00	20.01	20.01	20.03	20.05	20.05	20.05	20.05	20.04	20.03	20.02	20.01	(88)
Utilisation factor for gains for rest of dwelling $\eta_{2,m}$ (see Table 9a)													
(89)m	0.89	0.87	0.82	0.76	0.65	0.48	0.31	0.31	0.53	0.74	0.86	0.90	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	17.71	18.04	18.54	19.06	19.60	19.91	20.02	20.02	19.85	19.31	18.38	17.79	(90)
Living area fraction								fLA	18.00	÷ (4) =		0.27	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	18.12	18.43	18.88	19.36	19.87	20.16	20.27	20.27	20.11	19.60	18.74	18.20	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	17.97	18.28	18.73	19.21	19.72	20.01	20.12	20.12	19.96	19.45	18.59	18.05	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Set T_i to the mean internal temperature obtained at step 11 of Table 9b, so that $t_{im} = (93)m$ and recalculate the utilisation factor for gains using Table 9a														
Utilisation factor for gains, η_m														
(94)m	0.86	0.84	0.79	0.74	0.63	0.48	0.31	0.32	0.53	0.71	0.83	0.87	(94)	
Useful gains, $\eta_m G_m$, W = (94)m x (84)m														
(95)m	555.51	586.37	578.73	549.20	465.38	345.67	219.10	218.81	355.13	466.21	516.45	534.54	(95)	
Monthly average external temperature from Table 8														
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)	
Heat loss rate for mean internal temperature, L_m , W														
(97)m	1004.16	976.93	878.21	753.39	564.37	379.19	225.92	225.85	399.96	619.71	841.82	967.41	(97)	
Space heating requirement for each month, kWh/month = $0.024 \times [(97)m - (95)m] \times (41)m$														
(98)m	333.80	262.46	222.81	147.01	73.65	0.00	0.00	0.00	0.00	114.21	234.27	322.06		
Total per year (kWh/year) = $\sum(98)1 \dots 12 =$												1710.27	(98)	
Space heating requirement in kWh/m ² /year												(98) ÷ (4)	25.45	(99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)	0.00	(201)
Fraction of space heating from main system(s) 1 - (201)	1.00	(202)
Fraction of main heating from main system 2	0.00	(203)

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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 space heating system 1 (%)

93.50 (206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement, kWh/month (as calculated above)													
(98)m	333.80	262.46	222.81	147.01	73.65	0.00	0.00	0.00	0.00	114.21	234.27	322.06	
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)													
(211)m	357.00	280.71	238.30	157.24	78.77	0.00	0.00	0.00	0.00	122.15	250.56	344.44	
Total per year (kWh/year) = Σ(211)1..12 =	1829.16												(211)

Water heating:

Output from water heater, kWh/month (calculated above)

(64)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50	
Σ(64)1..12 =	1949.11												(64)

Efficiency of water heater per month

(217)m	86.29	85.99	85.43	84.60	82.94	79.80	79.80	79.80	79.80	83.85	85.61	86.26	
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Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m

(219)m	221.27	195.87	207.48	188.38	188.73	175.89	169.52	185.20	184.61	197.05	203.39	216.22	
Total per year (kWh/year) = Σ(219)1..12 =	2333.62												(219)

Annual Totals Summary:

Space heating fuel used, main system 1

kWh/year	kWh/year
	1829.16 (211)

Water heating fuel used

2333.62 (219)

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

mechanical ventilation fans - balanced, extract or positive input from outside	70.07	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	0.00	(230g)
Total electricity for the above	Σ(230a) ..(230g) 245.07	(231)

Electricity for lighting (calculated in Appendix L):

341.22 (232)

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

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	1829.16	x	3.10	x 0.01 =	56.70	(240)
Water heating cost (other fuel)	2333.62	x	3.10	x 0.01 =	72.34	(247)
Pumps, fans and electric keep-hot	245.07	x	11.46	x 0.01 =	28.09	(249)
Energy for lighting	341.22	x	11.46	x 0.01 =	39.10	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost				(240) (242) + (245) (254) =	302.24	(255)

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

Energy cost deflator (Table 12)	0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.27 (257)
SAP value	82.34	
SAP rating	82	(258)
SAP band	B	

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	1829.16	x	0.198	=	362.17	(261)
Water heating	2333.62	x	0.198	=	462.06	(264)
Space and water heating			(261) + (262) + (263) + (264) =		824.23	(265)
Pumps, fans and electric keep-hot	245.07	x	0.517	=	126.70	(267)
Lighting	341.22	x	0.517	=	176.41	(268)
Total carbon dioxide emissions			$\Sigma(261) \dots (271) =$		1127.35	(272)
Dwelling carbon dioxide emissions rate			$(272) \div (4) =$		16.78	(273)
EI value					86.54	
EI rating (see section 14)					87	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	1829.16	x	1.02	=	1865.75	(261*)
Water heating	2333.62	x	1.02	=	2380.29	(264*)
Space and water heating			$(261*) + (262*) + (263*) + (264*) =$		4246.04	(265*)
Pumps, fans and electric keep-hot	245.07	x	2.92	=	715.61	(267*)
Lighting	341.22	x	2.92	=	996.37	(268*)
Total primary energy kWh/year			$\Sigma(261*) \dots (271*) =$		5958.02	(272*)
Primary energy kWh/m ² /year			$(272*) \div (4) =$		88.66	(273*)

SAP 2009 Worksheet

Design - Draft

320120629 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	Mr Laurie Wills	Assessor number	3906
Client		Last modified	10/05/2012
Address	Type H - 2 storey, 4 bed Chapel Close, Clitheroe, Lancs, BB7		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	47.50 (1a) x	2.31 (2a) =	109.72 (3a)
+1	47.50 (1b) x	2.61 (2b) =	123.98 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d) = (1n) = 95.00 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d) = (3n) =	233.70 (5)

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	0 x 10 =	0 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 0	÷ (5) =	0.00 (8)
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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	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25 (18)
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Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered	0 (19)
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Shelter factor	1 - [0.075 x (19)] =	1.00 (20)
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Adjusted infiltration rate	(18) x (20) =	0.25 (21)
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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 7 (22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
	Σ(22)1..12 = 54.10 (22)											

Wind Factor (22a)m = (22)m ÷ 4

(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27
	Σ(22a)1..12 = 13.52 (22a)											

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

(22b)m	0.34	0.32	0.32	0.28	0.26	0.24	0.23	0.23	0.26	0.28	0.30	0.32
	Σ(22b)1..12 = 3.38 (22b)											

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.5 (23a)
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If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)

0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

N/A (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 × (23b)

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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(24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
------	------	------	------	------	------	------	------	------	------	------	------

(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A × U, W/K	κ-value, kJ/m ² K	A × κ, kJ/K
Doors			1.89	0.55	1.04	N/A	N/A
Window*			12.70	1.33	16.84	N/A	N/A
Ground floor			47.50	0.15	7.12	N/A	N/A
External wall			124.51	0.25	31.13	N/A	N/A
Roof			47.50	0.11	5.22	N/A	N/A
Total area of external elements ΣA, m ²			234.10				

* for windows and roof windows, effective window U-value is calculated using formula $1/[(1/U_{\text{Value}})+0.04]$ paragraph 3.2

Fabric heat loss, W/K = Σ(A × U) (26) (30) + (32) = 61.36 (33)

Heat capacity Cm = Σ(A × κ) (28) (30) + (32) + (32a) (32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: Σ(L × Ψ) calculated using Appendix K 18.73 (36)

if details of thermal bridging are not known then (36) = 0.15 × (31)

Total fabric heat loss (33) + (36) = 80.09 (37)

Ventilation heat loss calculated monthly 0.33 × (25)m × (5)

(38)m

45.31	43.86	43.86	40.97	39.04	38.56	38.56	38.56	39.52	40.97	42.42	43.86
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(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

125.40	123.95	123.95	121.06	119.13	118.65	118.65	118.65	119.61	121.06	122.50	123.95
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Average = Σ(39)1. 12/12 = 121.38 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.32	1.30	1.30	1.27	1.25	1.25	1.25	1.25	1.26	1.27	1.29	1.30
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Average = Σ(40)1. 12/12 = 1.28 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N

2.69 (42)

If TFA > 13.9, N = 1 + 1.76 × [1 - exp(-0.000349 × (TFA - 13.9)²)] + 0.0013 × (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 × N) + 36

98.04 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	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 × (43)												
(44)m	107.85	103.93	100.00	96.08	92.16	88.24	88.24	92.16	96.08	100.00	103.93	107.85
	Σ(44)1. 12 = 1176.53 (44)											

Energy content of hot water used - calculated monthly = 4.190 × Vd,m × nm × Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m

160.32	140.22	144.69	126.14	121.04	104.45	96.79	111.06	112.39	130.98	142.97	155.26
--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------

Σ(45)1. 12 = 1546.30 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss $0.15 \times (45)m$

(46)m

24.05	21.03	21.70	18.92	18.16	15.67	14.52	16.66	16.86	19.65	21.45	23.29
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

1.19

 (47)

Temperature factor from Table 2b

0.54

 (48)

Energy lost from water storage, kWh/day (47) $\times$ (48)

0.64

 (49)

Enter (49) or (54) in (55)

0.64

 (55)

Water storage loss calculated for each month = (55) $\times$ (41)m

(56)m

19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (56)

If cylinder contains dedicated solar storage, = (56)m $\times$ [(50) - (H11)] $\div$ (50), else = (56)m where (H11) is from Appendix H

(57)m

19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (57)

Primary circuit loss (annual) from Table 3

360.00

 (58)

Primary circuit loss for each month (58) $\div$ 365 $\times$ (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m

30.58	27.62	30.58	29.59	30.58	29.59	30.58	29.59	30.58	29.59	30.58	29.59
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)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
------	------	------	------	------	------	------	------	------	------	------	------

 (61)

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

(62)m

210.81	185.83	195.19	175.01	171.53	153.31	147.28	161.56	161.26	181.47	191.84	205.76
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (62)

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)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
------	------	------	------	------	------	------	------	------	------	------	------

$\Sigma(63)12 =$

0.00

 (63)

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

(64)m

210.81	185.83	195.19	175.01	171.53	153.31	147.28	161.56	161.26	181.47	191.84	205.76
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

$\Sigma(64)12 =$

2140.85

 (64)

if (64)m < 0 then set to 0

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

(65)m

93.70	83.11	88.51	81.04	80.64	73.82	72.58	77.33	76.46	83.95	86.63	92.02
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Metabolic gains (Table 5), Watts

(66)m

161.29	161.29	161.29	161.29	161.29	161.29	161.29	161.29	161.29	161.29	161.29	161.29
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m

57.58	51.14	41.59	31.49	23.54	19.87	21.47	27.91	37.46	47.57	55.52	59.18
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m

370.12	373.96	364.28	343.68	317.67	293.23	276.90	273.05	282.73	303.34	329.35	353.79
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m

53.82	53.82	53.82	53.82	53.82	53.82	53.82	53.82	53.82	53.82	53.82	53.82
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (69)

Pumps and fans gains (Table 5a)

(70)m

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m

-107.53	-107.53	-107.53	-107.53	-107.53	-107.53	-107.53	-107.53	-107.53	-107.53	-107.53	-107.53
---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------

 (71)

Water heating gains (Table 5)

(72)m

125.94	123.67	118.96	112.55	108.39	102.53	97.55	103.93	106.20	112.83	120.32	123.68
--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------

 (72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m

671.23	666.36	642.42	605.30	567.18	533.21	513.50	522.48	543.97	581.32	622.77	654.24
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (73)

6. Solar gains

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
Southeast	1.00	x	12.70	x	37.39	x 0.9 x	0.63	x	0.70	=	188.52	(77)
Solar gains in watts, calculated for each month $\sum(74)m \dots (82)m$												
(83)m	188.52	321.37	424.63	521.81	571.47	580.08	568.72	531.15	468.41	364.87	226.02	161.10 (83)
Total gains - internal and solar (73)m + (83)m												
(84)m	859.75	987.73	1067.05	1127.11	1138.65	1113.29	1082.22	1053.63	1012.38	946.19	848.79	815.34 (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, η _{1,m} (see Table 9a)													
(86)m	0.93	0.90	0.86	0.80	0.70	0.57	0.41	0.42	0.62	0.80	0.90	0.93	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	18.74	19.04	19.49	19.94	20.44	20.77	20.93	20.93	20.69	20.13	19.29	18.79	(87)
Temperature during heating periods in the living area from Table 9, Th2(°C)													
(88)m	19.83	19.84	19.84	19.86	19.88	19.88	19.88	19.88	19.88	19.86	19.85	19.84	(88)
Utilisation factor for gains for rest of dwelling η _{2,m} (see Table 9a)													
(89)m	0.91	0.88	0.84	0.77	0.66	0.49	0.31	0.32	0.55	0.76	0.88	0.92	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	16.87	17.31	17.95	18.59	19.27	19.68	19.84	19.84	19.59	18.87	17.69	16.96	(90)
Living area fraction								fLA	22.10	÷ (4) =	0.23	(91)	
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	17.31	17.71	18.31	18.91	19.54	19.93	20.10	20.09	19.85	19.16	18.06	17.38	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	17.16	17.56	18.16	18.76	19.39	19.78	19.95	19.94	19.70	19.01	17.91	17.23	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a												
Utilisation factor for gains, η_m												
(94)m	0.88	0.85	0.80	0.74	0.63	0.49	0.32	0.33	0.54	0.73	0.85	0.88 (94)
Useful gains, $\eta_m G_m$, W = (94)m x (84)m												
(95)m	756.64	835.60	851.26	830.95	719.37	542.84	345.21	344.03	548.39	688.60	719.04	721.20 (95)
Monthly average external temperature from Table 8												
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90 (96)
Heat loss rate for mean internal temperature, Lm, W												
(97)m	1587.17	1557.36	1407.50	1217.38	916.58	615.09	361.37	361.06	645.91	994.15	1336.53	1528.60 (97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m												
(98)m	617.92	485.02	413.85	278.22	146.72	0.00	0.00	0.00	0.00	227.33	444.59	600.71 (98)
Total per year (kWh/year) = $\sum(98)1 \dots 12 =$												3214.36 (98)
Space heating requirement in kWh/m ² /year												(98) ÷ (4) 33.84 (99)

9a. Energy Requirements - Individual heating systems including micro-CHP**Space heating:**

Fraction of space heating from secondary/supplementary system (Table 11)	0.00 (201)
Fraction of space heating from main system(s) 1 - (201)	1.00 (202)

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Fraction of main heating from main system 2

0.00 (203)

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 space heating system 1 (%)

93.50 (206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating requirement, kWh/month (as calculated above)												
(98)m	617.92	485.02	413.85	278.22	146.72	0.00	0.00	0.00	0.00	227.33	444.59	600.71
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)												
(211)m	660.88	518.74	442.62	297.57	156.92	0.00	0.00	0.00	0.00	243.13	475.50	642.47
Total per year (kWh/year) = Σ(211)1 ... 12 =	3437.82 (211)											

Water heating:

Output from water heater, kWh/month (calculated above)

(64)m	210.81	185.83	195.19	175.01	171.53	153.31	147.28	161.56	161.26	181.47	191.84	205.76
Σ(64)1 ... 12 =	2140.85 (64)											

Efficiency of water heater per month

(217)m	87.51	87.26	86.77	86.04	84.40	79.80	79.80	79.80	79.80	85.42	86.98	87.51
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Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m

(219)m	240.89	212.96	224.94	203.40	203.24	192.12	184.56	202.45	202.08	212.46	220.55	235.13
Total per year (kWh/year) = Σ(219)1 ... 12 =	2534.78 (219)											

Annual Totals Summary:

Space heating fuel used, main system 1

kWh/year	kWh/year
	3437.82 (211)

Water heating fuel used

2534.78 (219)

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

mechanical ventilation fans - balanced, extract or positive input from outside	105.49	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	0.00	(230g)
Total electricity for the above	Σ(230a) (230g)	280.49 (231)

Electricity for lighting (calculated in Appendix L):

406.77 (232)

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

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	3437.82	x	3.10	x 0.01 =	106.57	(240)
Water heating cost (other fuel)	2534.78	x	3.10	x 0.01 =	78.58	(247)
Pumps, fans and electric keep-hot	280.49	x	11.46	x 0.01 =	32.14	(249)
Energy for lighting	406.77	x	11.46	x 0.01 =	46.62	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost				(240) (242) + (245) (254) =	369.91	(255)

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

Energy cost deflator (Table 12)	0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.24 (257)
SAP value	82.68	
SAP rating	83	(258)

SAP band

B

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	3437.82	x	0.198	=	680.69	(261)
Water heating	2534.78	x	0.198	=	501.89	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1182.58	(265)
Pumps, fans and electric keep-hot	280.49	x	0.517	=	145.01	(267)
Lighting	406.77	x	0.517	=	210.30	(268)
Total carbon dioxide emissions			$\Sigma(261) \dots (271) =$		1537.89	(272)
Dwelling carbon dioxide emissions rate			$(272) \div (4) =$		16.19	(273)
EI value					85.28	
EI rating (see section 14)					85	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	3437.82	x	1.02	=	3506.58	(261*)
Water heating	2534.78	x	1.02	=	2585.48	(264*)
Space and water heating			$(261*) + (262*) + (263*) + (264*) =$		6092.05	(265*)
Pumps, fans and electric keep-hot	280.49	x	2.92	=	819.04	(267*)
Lighting	406.77	x	2.92	=	1187.77	(268*)
Total primary energy kWh/year			$\Sigma(261*) \dots (271*) =$		8098.87	(272*)
Primary energy kWh/m ² /year			$(272*) \div (4) =$		85.25	(273*)

SAP 2009 Worksheet

Design - Draft

320120629 PLANHER

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

Assessor name	Mr Laurie Wills	Assessor number	3906
Client		Last modified	10/05/2012
Address	Type J - 2 storey, 3 bed Chapel Close, Clitheroe, Lancs, BB7		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	41.15 (1a) x	2.31 (2a) =	95.06 (3a)
+1	41.15 (1b) x	2.61 (2b) =	107.40 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d) (1n) =		
Dwelling volume		(3a) + (3b) + (3c) + (3d) (3n) =	202.46 (5)

2. Ventilation rate

												m ³ per hour	
Number of chimneys		0	x 40 =	0	(6a)								
Number of open flues		0	x 20 =	0	(6b)								
Number of intermittent fans		0	x 10 =	0	(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) =	0	÷ (5) =	0.00	(8)								
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>													
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area				5.00	(17)								
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)				0.25	(18)								
<i>Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used</i>													
Number of sides on which dwelling is sheltered				0	(19)								
Shelter factor			1 - [0.075 x (19)] =	1.00	(20)								
Adjusted infiltration rate			(18) x (20) =	0.25	(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 7													
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10	
										Σ(22)1	12 =	54.10	(22)
Wind Factor (22a)m = (22)m ÷ 4													
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27	
										Σ(22a)1	12 =	13.52	(22a)
Adjusted infiltration rate (allowing for shelter and wind speed) = (21) x (22a)m													
(22b)m	0.34	0.32	0.32	0.28	0.26	0.24	0.23	0.23	0.26	0.28	0.30	0.32	
										Σ(22b)1	12 =	3.38	(22b)
Calculate effective air change rate for the applicable case:													
If mechanical ventilation: air change rate through system											0.5	(23a)	

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (23)), otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4.1) N/A (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 × (23b)

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
------	------	------	------	------	------	------	------	------	------	------	------

 (24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
------	------	------	------	------	------	------	------	------	------	------	------

 (25)

3. Heat losses and heat loss parameter

The κ -value is the heat capacity per unit area, see Table 1e

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A × U, W/K	κ -value, kJ/m ² K	A × κ , kJ/K
Doors			1.89	0.55	1.04	N/A	N/A
Window*			10.51	1.33	13.93	N/A	N/A
Ground floor			41.15	0.15	6.17	N/A	N/A
External wall			76.80	0.25	19.20	N/A	N/A
Party Wall			44.10	0.00	0.00	N/A	N/A
Roof			41.50	0.11	4.57	N/A	N/A
Total area of external elements ΣA , m ²			171.85				

* for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2

Fabric heat loss, W/K = $\Sigma(A \times U)$ (26) (30) + (32) = 44.91 (33)

Heat capacity Cm = $\Sigma(A \times \kappa)$ (28) (30) + (32) + (32a) (32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: $\Sigma(L \times \Psi)$ calculated using Appendix K 10.31 (36)

if details of thermal bridging are not known then (36) = 0.15 × (31)

Total fabric heat loss (33) + (36) = 55.22 (37)

Ventilation heat loss calculated monthly 0.33 × (25)m × (5)

(38)m

39.25	38.00	38.00	35.49	33.82	33.41	33.41	33.41	34.24	35.49	36.75	38.00
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 (38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

94.47	93.22	93.22	90.71	89.04	88.63	88.63	88.63	89.46	90.71	91.97	93.22
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Average = $\Sigma(39)1 \ 12/12 = 90.99$ (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.15	1.13	1.13	1.10	1.08	1.08	1.08	1.08	1.09	1.10	1.12	1.13
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Average = $\Sigma(40)1 \ 12/12 = 1.11$ (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 2.51 (42)

If TFA > 13.9, N = 1 + 1.76 × [1 - exp(-0.000349 × (TFA - 13.9)²)] + 0.0013 × (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 × N) + 36 93.70 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	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 × (43)												
(44)m	103.06	99.32	95.57	91.82	88.07	84.33	84.33	88.07	91.82	95.57	99.32	103.06
	$\Sigma(44)1 \dots 12 = 1124.34$ (44)											

Energy content of hot water used - calculated monthly = 4.190 × Vd,m × nm × Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m

153.21	134.00	138.27	120.55	115.67	99.81	92.49	106.14	107.40	125.17	136.63	148.37
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 $\Sigma(45)1 \quad 12 = 1477.71 \quad (45)$

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss $0.15 \times (45)m$

(46)m	22.98	20.10	20.74	18.08	17.35	14.97	13.87	15.92	16.11	18.78	20.49	22.26
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

1.19 (47)

Temperature factor from Table 2b

0.54 (48)

Energy lost from water storage, kWh/day (47) $\times$ (48)

0.64 (49)

Enter (49) or (54) in (55)

0.64 (55)

Water storage loss calculated for each month = (55) $\times$ (41)m

(56)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(56)
If cylinder contains dedicated solar storage, = (56)m $\times$ [(50) - (H11)] $\div$ (50), else = (56)m where (H11) is from Appendix H

(57)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(57)

Primary circuit loss (annual) from Table 3

360.00 (58)

Primary circuit loss for each month (58) $\div$ 365 $\times$ (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)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
-------	------	------	------	------	------	------	------	------	------	------	------	------

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

(62)m	203.70	179.61	188.77	169.42	166.17	148.68	142.99	156.63	156.27	175.66	185.50	198.87
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(62)

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)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
-------	------	------	------	------	------	------	------	------	------	------	------	------

 $\Sigma(63)1 \quad 12 = 0.00 \quad (63)$

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

(64)m	203.70	179.61	188.77	169.42	166.17	148.68	142.99	156.63	156.27	175.66	185.50	198.87
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 $\Sigma(64)1 \quad 12 = 2072.26 \quad (64)$

if (64)m < 0 then set to 0

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

(65)m	91.34	81.04	86.37	79.18	78.86	72.28	71.15	75.69	74.81	82.02	84.52	89.73
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
--	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Metabolic gains (Table 5), Watts

(66)m	150.30	150.30	150.30	150.30	150.30	150.30	150.30	150.30	150.30	150.30	150.30	150.30
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m	52.54	46.67	37.95	28.73	21.48	18.13	19.59	25.47	34.18	43.40	50.66	54.00
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m	334.60	338.07	329.32	310.69	287.18	265.08	250.32	246.85	255.60	274.22	297.74	319.83
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m	52.54	52.54	52.54	52.54	52.54	52.54	52.54	52.54	52.54	52.54	52.54	52.54
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(69)

Pumps and fans gains (Table 5a)

(70)m	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m	-100.20	-100.20	-100.20	-100.20	-100.20	-100.20	-100.20	-100.20	-100.20	-100.20	-100.20	-100.20
-------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------

(71)

Water heating gains (Table 5)

(72)m	122.77	120.60	116.09	109.97	105.99	100.39	95.63	101.73	103.90	110.24	117.39	120.61
-------	--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------

(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	622.54	617.97	596.00	562.03	527.29	496.24	478.18	486.68	506.31	540.50	578.42	607.08
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(73)

6. Solar gains

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)
Southeast	1.00	x	5.30	x	37.39	x 0.9 x	0.63	x	0.70	=	78.65 (77)
Northwest	1.00	x	3.86	x	11.51	x 0.9 x	0.63	x	0.70	=	17.65 (81)
Northeast	1.00	x	1.34	x	11.51	x 0.9 x	0.63	x	0.70	=	6.14 (75)
Solar gains in watts, calculated for each month $\Sigma(74)m \dots (82)m$											
(83)m	102.44	182.76	262.17	357.84	423.96	443.54	429.46	377.48	301.34	213.40	124.32 86.56 (83)
Total gains - internal and solar (73)m + (83)m											
(84)m	724.98	800.73	858.17	919.87	951.25	939.79	907.64	864.16	807.65	753.90	702.74 693.64 (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, $\eta_{1,m}$ (see Table 9a)											
(86)m	0.92	0.90	0.86	0.79	0.68	0.53	0.38	0.40	0.61	0.80	0.90 0.93 (86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)											
(87)m	19.07	19.32	19.72	20.15	20.59	20.85	20.96	20.95	20.77	20.29	19.56 19.12 (87)
Temperature during heating periods in the living area from Table 9, Th2(°C)											
(88)m	19.96	19.98	19.98	20.00	20.02	20.02	20.02	20.02	20.01	20.00	19.99 19.98 (88)
Utilisation factor for gains for rest of dwelling $\eta_{2,m}$ (see Table 9a)											
(89)m	0.91	0.89	0.84	0.77	0.63	0.47	0.30	0.31	0.55	0.76	0.88 0.91 (89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)											
(90)m	17.42	17.78	18.35	18.97	19.57	19.89	20.00	19.99	19.80	19.17	18.14 17.51 (90)
Living area fraction											fLA 14.60 ÷ (4) = 0.18 (91)
Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2											
(92)m	17.71	18.05	18.59	19.18	19.75	20.06	20.17	20.16	19.97	19.36	18.39 17.80 (92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate											
(93)m	17.56	17.90	18.44	19.03	19.60	19.91	20.02	20.01	19.82	19.21	18.24 17.65 (93)

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a											
Utilisation factor for gains, η_m											
(94)m	0.88	0.85	0.80	0.73	0.61	0.46	0.30	0.31	0.54	0.73	0.85 0.88 (94)
Useful gains, $\eta_m G_m$, W = (94)m x (84)m											
(95)m	637.72	682.08	689.68	675.96	583.52	431.69	268.61	267.42	433.25	552.41	596.08 612.22 (95)
Monthly average external temperature from Table 8											
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00 4.90 (96)
Heat loss rate for mean internal temperature, Lm, W											
(97)m	1234.02	1202.83	1085.39	936.71	703.56	470.41	276.27	275.97	493.77	763.25	1033.99 1188.21 (97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m											
(98)m	443.65	349.94	294.41	187.74	89.31	0.00	0.00	0.00	0.00	156.86	315.30 428.54 (98)
Total per year (kWh/year) = $\Sigma(98)1 \dots 12 =$											2265.74 (98)
Space heating requirement in kWh/m ² /year											(98) ÷ (4) 27.53 (99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)

0.00 (201)

Fraction of space heating from main system(s) 1 - (201)

1.00 (202)

Fraction of main heating from main system 2

0.00 (203)

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 space heating system 1 (%)

93.50 (206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement, kWh/month (as calculated above)													
(98)m	443.65	349.94	294.41	187.74	89.31	0.00	0.00	0.00	0.00	156.86	315.30	428.54	
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)													
(211)m	474.49	374.27	314.87	200.79	95.52	0.00	0.00	0.00	0.00	167.77	337.21	458.33	
Total per year (kWh/year) = Σ(211)1 5, 10 12 =	2423.26												(211)

Water heating:

Output from water heater, kWh/month (calculated above)

(64)m	203.70	179.61	188.77	169.42	166.17	148.68	142.99	156.63	156.27	175.66	185.50	198.87	
Σ(64)1...12 =	2072.26												(64)

Efficiency of water heater per month

(217)m	86.84	86.56	86.00	85.09	83.24	79.80	79.80	79.80	79.80	84.51	86.22	86.81	
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Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m

(219)m	234.58	207.48	219.51	199.11	199.62	186.32	179.18	196.28	195.83	207.85	215.15	229.08	
Total per year (kWh/year) = Σ(219)1 12 =	2470.00												(219)

Annual Totals Summary:

Space heating fuel used, main system 1

kWh/year	kWh/year
	2423.26 (211)

Water heating fuel used

2470.00 (219)

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

mechanical ventilation fans - balanced, extract or positive input from outside	91.39	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	0.00	(230g)
Total electricity for the above	Σ(230a) (230g)	266.39 (231)

Electricity for lighting (calculated in Appendix L):

371.16 (232)

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

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	2423.26	x	3.10	x 0 01 =	75.12	(240)
Water heating cost (other fuel)	2470.00	x	3.10	x 0 01 =	76.57	(247)
Pumps, fans and electric keep-hot	266.39	x	11.46	x 0 01 =	30.53	(249)
Energy for lighting	371.16	x	11.46	x 0 01 =	42.54	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost				(240)...(242) + (245) (254)	330.75	(255)

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

Energy cost deflator (Table 12)	0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45 0] =	1.22 (257)

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SAP value

82.96

SAP rating

83

(258)

SAP band

B

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	2423.26	x	0.198	=	479.80	(261)
Water heating	2470.00	x	0.198	=	489.06	(264)
Space and water heating			(261) + (262) + (263) + (264) =		968.87	(265)
Pumps, fans and electric keep-hot	266.39	x	0.517	=	137.72	(267)
Lighting	371.16	x	0.517	=	191.89	(268)
Total carbon dioxide emissions			$\Sigma(261)$	(271) =	1298.48	(272)
Dwelling carbon dioxide emissions rate			(272) ÷ (4) =		15.78	(273)
EI value					86.33	
EI rating (see section 14)					86	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	2423.26	x	1.02	=	2471.72	(261*)
Water heating	2470.00	x	1.02	=	2519.40	(264*)
Space and water heating			(261*) + (262*) + (263*) + (264*) =		4991.13	(265*)
Pumps, fans and electric keep-hot	266.39	x	2.92	=	777.86	(267*)
Lighting	371.16	x	2.92	=	1083.79	(268*)
Total primary energy kWh/year			$\Sigma(261*)$	(271*) =	6852.77	(272*)
Primary energy kWh/m ² /year			(272*) ÷ (4) =		83.27	(273*)

Assessor name	Mr Laurie Wills	Assessor number	3906
Client		Last modified	10/05/2012
Address	Type K - 2 storey, 2 bed Chapel Close, Clitheroe, Lancs, BB7		

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	33.60	(1a) x	2.31	(2a) =	77.62 (3a)
+1	33.60	(1b) x	2.61	(2b) =	87.70 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d) ... (1n) =		67.20	(4)	
Dwelling volume				(3a) + (3b) + (3c) + (3d) ... (3n) =	165.31 (5)

		m ³ per hour	
Number of chimneys	0	x 40 =	0 (6a)
Number of open flues	0	x 20 =	0 (6b)
Number of intermittent fans	0	x 10 =	0 (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) = 0	÷ (5) =	0.00 (8)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>			
Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area			5.00 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.25 (18)
<i>Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used</i>			
Number of sides on which dwelling is sheltered			0 (19)
Shelter factor	1 - [0.075 x (19)] =		1.00 (20)
Adjusted infiltration rate	(18) x (20) =		0.25 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table 7													
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10	
	$\Sigma(22)1 \quad 12 =$											54.10	(22)

$$\begin{array}{|c|c|c|c|c|c|c|c|c|c|c|c|} \hline (22a)m & 1.35 & 1.27 & 1.27 & 1.12 & 1.02 & 0.98 & 0.92 & 0.92 & 1.05 & 1.12 & 1.20 & 1.27 \\ \hline \end{array} \quad \sum(22a)1 \dots 12 = \boxed{13.52} \quad (22a)$$

$$(22b)m \quad \begin{array}{|c|c|c|c|c|c|c|c|c|c|c|c|} \hline 0.34 & 0.32 & 0.32 & 0.28 & 0.26 & 0.24 & 0.23 & 0.23 & 0.26 & 0.28 & 0.30 & 0.32 \\ \hline \end{array} \quad \sum(22b)1..12 = \boxed{3.38} \quad (22b)$$

If mechanical ventilation: air change rate through system	0.5	(23a)
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If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a) (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 × (23b)

(24c)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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 (24c)

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

(25)m

0.59	0.57	0.57	0.53	0.51	0.50	0.50	0.50	0.51	0.53	0.55	0.57
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 (25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e

Element	Gross Area, m ²	Openings, m ²	Net area A, m ²	U-value, W/m ² K	A × U, W/K	κ-value, kJ/m ² .K	A × κ, kJ/K
Doors			1.89	x 0.55	= 1.04	N/A	N/A (26)
Window*			10.94	x 1.33	= 14.51	N/A	N/A (27)
Ground floor			33.60	x 0.15	= 5.04	N/A	N/A (28a)
External wall			67.53	x 0.25	= 16.88	N/A	N/A (29a)
Party Wall			38.22	x 0.00	= 0.00	N/A	N/A (32)
Roof			33.60	x 0.11	= 3.70	N/A	N/A (30)
Total area of external elements ΣA, m ²			147.56 (31)				

* for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2

Fabric heat loss, W/K = Σ(A × U) (26) + (30) + (32) = (33)

Heat capacity Cm = Σ(A × κ) (28) + (30) + (32) + (32a) (32e) = (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = (35)

Thermal bridges: Σ(L × Ψ) calculated using Appendix K (36)

if details of thermal bridging are not known then (36) = 0.15 × (31)

Total fabric heat loss (33) + (36) = (37)

Ventilation heat loss calculated monthly 0.33 × (25)m × (5)

(38)m

32.05	31.03	31.03	28.98	27.62	27.28	27.28	27.28	27.96	28.98	30.00	31.03
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 (38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m

82.07	81.05	81.05	79.00	77.64	77.30	77.30	77.30	77.98	79.00	80.02	81.05
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Average = Σ(39)1 12/12 = (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m

1.22	1.21	1.21	1.18	1.16	1.15	1.15	1.15	1.16	1.18	1.19	1.21
------	------	------	------	------	------	------	------	------	------	------	------

Average = Σ(40)1 12/12 = (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N (42)

If TFA > 13.9, N = 1 + 1.76 × [1 - exp(-0.000349 × (TFA - 13.9)²)] + 0.0013 × (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 × N) + 36 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	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 × (43)												
(44)m	94.48	91.04	87.60	84.17	80.73	77.30	77.30	80.73	84.17	87.60	91.04	94.48
	Σ(44)1 12 = 1030.64 (44)											

Energy content of hot water used - calculated monthly = 4.190 × Vd,m × nm × Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m

140.44	122.83	126.75	110.50	106.03	91.50	84.78	97.29	98.45	114.74	125.24	136.01
--------	--------	--------	--------	--------	-------	-------	-------	-------	--------	--------	--------

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 $\Sigma(57)12 = 1354.56$ (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	21.07	18.42	19.01	16.58	15.90	13.72	12.72	14.59	14.77	17.21	18.79	20.40
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):

1.19 (47)

Temperature factor from Table 2b

0.54 (48)

Energy lost from water storage, kWh/day (47) x (48)

0.64 (49)

Enter (49) or (54) in (55)

0.64 (55)

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

(56)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(57)

Primary circuit loss (annual) from Table 3

360.00 (58)

Primary circuit loss for each month (58) ÷ 365 x (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)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
-------	------	------	------	------	------	------	------	------	------	------	------	------

(61)

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

(62)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(62)

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)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
-------	------	------	------	------	------	------	------	------	------	------	------	------

 $\Sigma(63)12 = 0.00$ (63)

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

(64)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 $\Sigma(64)12 = 1949.11$ (64)

if (64)m < 0 then set to 0

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

(65)m	87.09	77.33	82.54	75.84	75.65	69.52	68.59	72.75	71.83	78.55	80.74	85.62
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains (Table 5), Watts												
(66)m	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58	130.58
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
(67)m	42.89	38.09	30.98	23.45	17.53	14.80	15.99	20.79	27.90	35.43	41.35	44.08
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
(68)m	284.59	287.54	280.10	264.26	244.26	225.46	212.91	209.95	217.40	233.24	253.24	272.03
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
(69)m	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23	50.23
Pumps and fans gains (Table 5a)												
(70)m	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Losses e.g. evaporation (negative values) (Table 5)												
(71)m	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05	-87.05
Water heating gains (Table 5)												
(72)m	117.06	115.07	110.94	105.33	101.68	96.55	92.19	97.78	99.76	105.57	112.14	115.08
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
(73)m	548.30	544.47	525.78	496.80	467.23	440.57	424.85	432.28	448.82	478.00	510.48	534.95

6. Solar gains

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

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
Southeast	1.00	x	4.63	x	37.39	x 0.9 x	0.63	x	0.70	=	68.68	(77)
Northwest	1.00	x	5.64	x	11.51	x 0.9 x	0.63	x	0.70	=	25.78	(81)
Southwest	1.00	x	0.67	x	37.39	x 0.9 x	0.63	x	0.70	=	9.97	(79)
Solar gains in watts, calculated for each month $\Sigma(74)m \dots (82)m$												
(83)m	104.43	186.83	269.27	369.54	439.46	460.38	445.51	390.50	310.19	218.51	126.83	88.17 (83)
Total gains - internal and solar (73)m + (83)m												
(84)m	652.72	731.29	795.05	866.34	906.69	900.95	870.36	822.78	759.01	696.51	637.31	623.13 (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, $\eta_{1,m}$ (see Table 9a)													
(86)m	0.91	0.88	0.83	0.76	0.64	0.49	0.35	0.36	0.58	0.77	0.88	0.91	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.03	19.30	19.73	20.18	20.61	20.86	20.96	20.96	20.78	20.29	19.54	19.08	(87)
Temperature during heating periods in the living area from Table 9, Th2(°C)													
(88)m	19.91	19.92	19.92	19.94	19.96	19.96	19.96	19.96	19.95	19.94	19.93	19.92	(88)
Utilisation factor for gains for rest of dwelling $\eta_{2,m}$ (see Table 9a)													
(89)m	0.90	0.87	0.81	0.73	0.59	0.43	0.27	0.28	0.51	0.73	0.86	0.90	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	17.33	17.72	18.32	18.95	19.54	19.84	19.94	19.94	19.75	19.13	18.07	17.41	(90)
Living area fraction								fLA	12.10	÷ (4) =		0.18	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	17.64	18.01	18.58	19.17	19.74	20.02	20.12	20.12	19.94	19.34	18.34	17.71	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	17.49	17.86	18.43	19.02	19.59	19.87	19.97	19.97	19.79	19.19	18.19	17.56	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a												
Utilisation factor for gains, η_m												
(94)m	0.86	0.83	0.78	0.70	0.57	0.42	0.27	0.28	0.50	0.70	0.83	0.87 (94)
Useful gains, $\eta_m G_m$, W = (94)m x (84)m												
(95)m	563.06	606.84	616.21	604.86	517.73	377.75	231.68	230.65	379.47	488.96	527.40	539.77 (95)
Monthly average external temperature from Table 8												
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90 (96)
Heat loss rate for mean internal temperature, Lm, W												
(97)m	1065.70	1041.92	942.21	815.47	612.23	407.62	237.56	237.30	427.73	662.44	895.14	1026.38 (97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m												
(98)m	373.96	292.38	242.55	151.64	70.31	0.00	0.00	0.00	0.00	129.07	264.77	362.04 (98)
Total per year (kWh/year) = $\Sigma(98)1 \dots 12 =$											1886.71	(98)
Space heating requirement in kWh/m ² /year											(98) $\div$ (4)	28.08 (99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)

0.00 (201)

Fraction of space heating from main system(s) 1 - (201)

1.00 (202)

Fraction of main heating from main system 2

0.00 (203)

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 space heating system 1 (%)

93.50 (206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement, kWh/month (as calculated above)													
(98)m	373.96	292.38	242.55	151.64	70.31	0.00	0.00	0.00	0.00	129.07	264.77	362.04	
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)													
(211)m	399.96	312.70	259.41	162.18	75.20	0.00	0.00	0.00	0.00	138.04	283.17	387.20	
Total per year (kWh/year) = $\Sigma(211)1 \dots 12 =$	2017.87												(211)

Water heating:

Output from water heater, kWh/month (calculated above)

(64)m	190.94	168.44	177.24	159.37	156.53	140.36	135.28	147.79	147.32	165.23	174.11	186.50	
$\Sigma(64)1 \dots 12 =$	1949.11												(64)

Efficiency of water heater per month

(217)m	86.58	86.27	85.65	84.68	82.84	79.80	79.80	79.80	79.80	84.16	85.93	86.55	
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Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m

(219)m	220.54	195.24	206.94	188.20	188.96	175.89	169.52	185.20	184.61	196.32	202.62	215.48	
Total per year (kWh/year) = $\Sigma(219)1 \dots 12 =$	2329.52												(219)

Annual Totals Summary:

	kWh/year	kWh/year	
Space heating fuel used, main system 1	2017.87		(211)
Water heating fuel used	2329.52		(219)

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

mechanical ventilation fans - balanced, extract or positive input from outside	74.62	(230a)
warm air heating system fans	0.00	(230b)
central heating pump	130.00	(230c)
oil boiler pump	0.00	(230d)
boiler flue fan	45.00	(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00	(230f)
pump for solar water heating	0.00	(230g)
Total electricity for the above	$\Sigma(230a) \dots (230g)$	249.62 (231)

Electricity for lighting (calculated in Appendix L):

302.96 (232)

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

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	2017.87	x	3.10	x 0.01 =	62.55	(240)
Water heating cost (other fuel)	2329.52	x	3.10	x 0.01 =	72.22	(247)
Pumps, fans and electric keep-hot	249.62	x	11.46	x 0.01 =	28.61	(249)
Energy for lighting	302.96	x	11.46	x 0.01 =	34.72	(250)
Additional standing charges (Table 12)					106.00	(251)
Total energy cost				(240) + (242) + (245) + (254) =	304.10	(255)

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

Energy cost deflator (Table 12)	0.47	(256)
Energy cost factor (ECF)	$[(255) \times (256)] \div [(4) + 45.0] =$	1.27 (257)

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SAP value

82.23

SAP rating

82

(258)

SAP band

B

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO ₂ /year)	
Space heating - main system 1	2017.87	x	0.198	=	399.54	(261)
Water heating	2329.52	x	0.198	=	461.25	(264)
Space and water heating			(261) + (262) + (263) + (264) =		860.78	(265)
Pumps, fans and electric keep-hot	249.62	x	0.517	=	129.05	(267)
Lighting	302.96	x	0.517	=	156.63	(268)
Total carbon dioxide emissions			$\Sigma(261)$	(271) =	1146.47	(272)
Dwelling carbon dioxide emissions rate			(272) ÷ (4) =		17.06	(273)
EI value					86.31	
EI rating (see section 14)					86	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	2017.87	x	1.02	=	2058.23	(261*)
Water heating	2329.52	x	1.02	=	2376.11	(264*)
Space and water heating			(261*) + (262*) + (263*) + (264*) =		4434.34	(265*)
Pumps, fans and electric keep-hot	249.62	x	2.92	=	728.90	(267*)
Lighting	302.96	x	2.92	=	884.65	(268*)
Total primary energy kWh/year			$\Sigma(261^*)$	(271*) =	6047.89	(272*)
Primary energy kWh/m ² /year			(272*) ÷ (4) =		90.00	(273*)