MSUSTAINABILITY

Energy Statement
40 Ham Green, Pill, North Somerset BS20 0HA

For Jerry Evans

4 December 2021

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Client	Jerry Evans
Project	40 Ham Green
Title	Energy Statement
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Prepared by	Laura Meehan

Revision Record		
Issue Number	Date	Revision details
P01	04/12/2021	Preliminary draft for comment

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Executive Summary

This Energy Statement has been prepared by M Sustainability as supporting documentation to the planning application submitted to North Somerset Council regarding the proposed development for application for 1 new house at 40 Ham Green, Pill.

Policy CS2 of the North Somerset Council Planning Policies relates to Sustainable Energy Strategies. This report seeks to outline how the development will address this policy.

It is our opinion that sufficient design works have been carried out at this early stage to demonstrate that the proposal is successfully addressing the requirements above.

The preferred energy strategy of North Somerset County Council is to reduce energy usage first approach. The glazing, walls, floor and roof elements will all significantly improve on Part L required values. However the target of the development is to meet the passivhaus standard and initial calcs have shown that this can be achieved.

This helps to reduce the overall demand and consequently the amount of renewable energy required to meet the 10% in energy use for the development at 40 Ham Green, North Somerset. The most appropriate renewable energy source for the development has been identified as solar photovoltaic panels.

The calculations provided draw on the detailed SAP calculations for the development to give as accurate a guide as possible to the energy usage of the final development.

The development has a roof space that can be utilised for Photovoltaic panels to offset the energy use within the dwelling.

1. Policy Requirements

Purpose of Report

The report has been produced as part of the planning application for proposed development at 40 Ham Green, North Somerset. and will address the energy and carbon reduction objectives required by North Somerset Council.

This document addresses the energy and sustainability objectives required by National and North Somerset planning policy. North Somerset Council have set standards for sustainable design and adaption to climate change. As part of this report, an initial option appraisal that has been carried out for the development, including any centralised heating and hot water generation systems (where feasible), with a focus on local, regional and national policy targets.

This energy assessment follows the guidance set out in the North Somerset Council, Core Strategy (Adopted April 2012). Throughout this report carbon emissions are:

- Regulated: Emissions associated with heating, cooling, hot water, lighting and any other fixed building services equipment (those that are covered under Building Regulations Part L1A); and

Building Regulations Part L

The development will need to meet the standards set by Building Regulations Approved Document Part L1A, Conservation of Fuel and Power in New Dwellings.

These standards include a minimum level for regulated carbon emissions defined by the Target Emission Rate (TER) which relate to a 'Notional Building', automatically generated as part of the Standard Assessment Procedure (SAP). In addition, there are minimum levels of fabric efficiency set by the Target Fabric Energy Efficiency rating (TFEE) under the SAP methodology.

The resulting Dwelling Emission Rate (DER), L1A, must be less than the relevant TER in order to comply. A benchmark Energy Performance Certificate (EPC), rated A (most efficient) through G (least efficient) will also be calculated as part of this assessment via comparison of each building assessed to a 'Reference Building', also automatically generated as part of the SAP toolkits.

2. Local Policies From North Somerset Council, Core Strategy Adopted April 2012

CS2: Delivering sustainable design and construction

New development both residential (including conversions) and non-residential should demonstrate a commitment to sustainable design and construction, increasing energy efficiency through design, and prioritising the use of sustainable low or zero carbon forms of renewable energy generation in order to increase the sustainability of the building stock across North Somerset.The greatest potential for energy saving opportunities is likely to be at larger scale developments particularly at the Weston Villages and Weston town centre. In addition these areas are expected to demonstrate exemplar environmental standards contributing to the objectives of Policy CS1, and adding value to the local economy. When considering proposals for development the council will:

1) Require designs that are energy efficient and designed to reduce their energy demands;

2) Require the use of on-site renewable energy sources or by linking with/contributing to available local off-site renewable energy sources to meet a minimum of 10% of predicted energy use for residential development proposals involving one to nine dwellings, and 15% for 10 or more dwellings; and 10% for non-residential developments over 500m^2 and 15% for 1000m^2 and above;

5) Require the application of best practice in Sustainable Drainage Systems to reduce the impact of additional surface water run-off from new development. Such environmental infrastructure should be integrated into the design of the scheme and into landscaping features, and be easily maintained.

In moving towards zero carbon development, applicants will ensure that sustainable principles are established in the new proposals from the outset. CS2 Checklist suggests the following bullet points:

- Land use ecology
- Siting and orientation
- Passive design
- Thermal mass
- Surface water run-off
- Water use
- Energy use
- Material use
- Waste management

3. CS2 Sustainable Energy

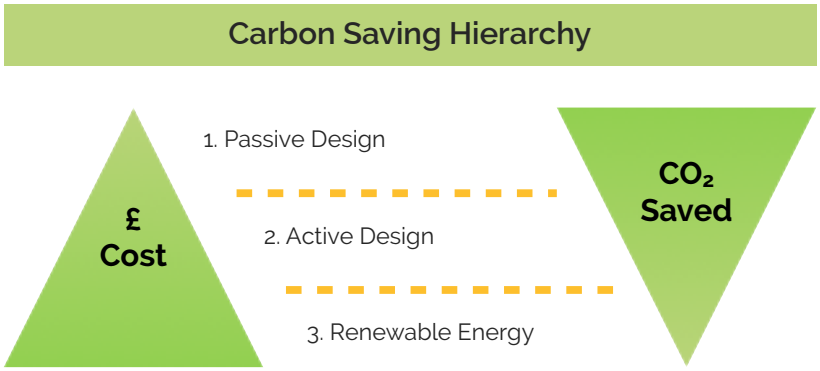
North Somerset Council Planning Policies

CS2 - Sustainable Energy

Provides criteria for assessing new renewable energy schemes, with a presumption in favour of large-scale renewable energy installations. Requires new development to minimise its energy requirements and then incorporate an element of renewable energy to reduce its CO_2 emissions by a further 10%.

Energy Strategy

The development will adopt a hierarchical approach to reducing energy. The first step will be to minimise energy use wherever possible through reduction of demand through passive design to reduce heating and cooling demand.



Following this, the focus will then turn to building services performance choosing highly efficient systems.

This approach will be adopted as it makes sense both in terms of conservation of energy and commercial viability.

Building Fabric Energy Efficiency

The minimum standards new thermal elements for Building Regulations L1A are listed below, the thermal elements proposed will be best practice and are as follows:

Thermal Elements Fabric Parameters for Part L1A		
Element	**Threshold U Value**	**Targeted U Values (New L1A)**
New walls	0.28 W/m²K	0.12 W/m²K
Roof	0.18 W/m²K	0.12 W/m²K
Floors	0.22 W/m²K	0.12 W/m²K
New windows	1.6 W/m²K	1 W/m²K
Roof lights	1.6 W/m²K	1
Air Permeability	N/A	1

To assist with the achievement of compliance with Part L1A of the Building Regulations exemplary levels of building fabric performance will be used. Elements such as walls, floors and roof will all be improved to better than building regulations, aiming for a high level of fabric energy efficiency.

There will be triple glazed windows specified with a U value of 1 W/m²K this is a significantly increased level of thermal efficiency from industry standard.

It is proposed that thermal bridges should be eliminated from the construction to reduce heat loss and increase air tightness, and through careful construction can reduce thermal bridging and increase energy efficiency of the dwelling. For the purposes of this calculation ACDs have been used throughout.

Air tightness will be used to reduce infiltration (i.e. drafts), this will reduce the heat loss and should in turn reduce the heating requirements. There will be a reduction on the air permeability from 10 to 1 m3/(h.m) at 50 Pa. In practice to meet the passivhaus standard this will need to be 0.6, although the measuring process is slightly different to standard air tightness testing.

Mechanical Ventilation with Heat Recovery is proposed and cross ventilation will help to reduce the risk of overheating.

Building Services

Building services are generally installed in buildings to provide comfort conditions or protect life safety. The services that provide comfort conditions are most efficient when they are accurately sized to match the load that they need to provide. Therefore both the efficiency of the items of equipment and their level of control affects overall CO_2 emissions performance.

A full building services strategy will be produced for the development and the final strategy has yet to be detailed. The following items have been used to show that in conjunction with insulating building fabric the building's energy use can be reduced by:

- Low energy lighting such as LEDs throughout
- Optimised and thermostatically controlled heating elements (e.g. radiators, programmers, thermostatic radiator valves)
- Small electric heaters to meet the demand
- Highly efficient hot water tank
- There will be a Microgeneration Certification Scheme Photovoltaic panel system that will provide electricity for the development.

This will mean and reduction in CO_2 emissions and low running and maintenance costs.

As part of this design we have modelled indicative SAP to show their energy demand and CO_2 emissions.

4. Development Demand Summary

The proposed design is based on the Part L1A for New Buildings with enhancements as detailed above.

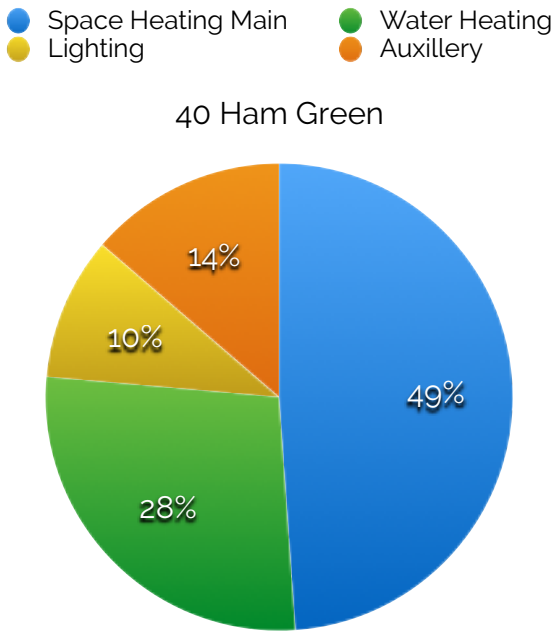
As part of this design we have modelled an indicative SAP to show the energy demand and CO_2 emissions.

Energy demand and CO_2 emissions per sq m floor area for the dwelling

The SAP calculations for the dwelling can be viewed in Appendix A, but are summarised below:

40 Ham Green 195.8 m2		
	Energy (kWh/yr)	Emissions ($kgCO_2$/yr)
Space heating (main)	2875.50	1492.38
Water heating	1618.22	839.85
Auxillery	805.06	417.82
Lights	583.80	302.99
Total	**5882.58**	**3053.04**

Pie Charts to show distribution of kWh



5. Energy Strategy

Design

The strategy will be to ensure that the house is highly insulated to ensure that the heating demand is as low as possible and then efficient building services are proposed to meet that demand.

The hierarchy

The development will adopt a hierarchical approach to reducing energy. The first step will be to minimise energy use wherever possible.

Following this, the focus will then turn to building services performance choosing highly efficient systems. As per North Somerset Councils Practice Note and policy requirements energy efficiency will be targeted first; low or zero carbon technologies can then be considered.

Passivhaus

Passivhaus Planning Package takes into account how your building is performing holistically and in some detail, and although no model can accurately predict how a building will be used, it is backed up by 15 years of real building performance evidence and designed by a physicist to show the balance of energy demand and gain within a building. Although the package has a clear structure this can provide a more flexible environment to try new methods and prove them within the model.

Passivhaus, (unlike some other energy models), is also a rigorous comfort standard, so it's methodology should provide the following

1. **No draughts** - low airtightness mean less uncontrolled air infiltration which will be most obvious on cold windy days and less active on still summers days.
2. **No cold spots -** the low u value of the windows will be a change from standard windows which are significantly cooler than the rest of the room creating a reverse radiator drawing heat away from the body and meaning that spaces away from windows are more thermally comfortable.
3. **No overheating -** Overheating can be caused by inadequate insulation, and unshaded glazed areas facing the summer sun. The PHPP produces a warning if the indoor temperature exceeds 25 degrees for more than 10% of time occupied for the year. This includes internal gains from people and appliances, ideally we would be around 5%.

Comparatively Passivhaus is a physics model of a comfort standard for a building, whereas SAP is used to estimate fuel bills and CO_2 emissions, Passivhaus' minimum standard has significantly lower energy demand and emissions than Building Regulations.

6. Renewable Energy Generation on Site

Of the technologies considered: (PV, Solar Thermal, Air Source Heat Pumps, Wind, District Heating and CHP), only PV was considered an appropriate option for the site. This was due to the nature of the site in terms of planning restrictions, financial investment required and limited potential of renewable energy generation.

CHP

Gas-fired combined heat and power (CHP) schemes in high-density urban areas are the most popular because the costs are viable, the technology is mature and heat networks benefit many users.

CHP systems requires a significant infrastructure, and a substantial heat demand to be viable and therefore has been discounted within development, as the infrastructure is not yet available.

Wind

The first consideration for this technology is local wind speed. The Energy Saving Trust has established the wind speed at 40 Ham Green to be 5 metres per second at 10 metres above ground[1]. Wind speeds of less than 5 metres per second are unlikely to provide a cost effective source of electricity (based on current technologies) and considering the neighbouring buildings and suburban environment it may not be the best placed to provide wind power.

A solution may be to mount the turbine beyond the zone of turbulence which may be 15m or more in the air – there may be planning concerns from both an aesthetic and noise perspective. Turbines also carry high capital costs upwards of £35,000 for a 12 kW turbine, however this would not be feasible in an urban environment.

Solar hot water systems

Solar water heating systems use the energy from the sun to heat water stored in a hot water cylinder inside the building.

Typical cost for 4m^2 of flat plate solar hot water is approximately £2,800 with a payback period of around 6-10 years. This could also benefit from the Renewable Heat Incentive.

There could be a mix of solar thermal and PV in detailed design stage, however as the PV panels are more efficient they are preferred at this stage.

[1] http://www.rensmart.com/Weather/BERR

Biomass heating

Biomass boilers such as Woodchip-fed systems remain very costly and the requirements for siting both the boiler and the fuel source were considered impractical for this development.

There are also some concerns on current availability of suitable fuel within a reasonable distance of the development at 40 Ham Green as well as space concerns in terms of ducting and pipework which would be disruptive.

Therefore use of this technology for the main heating system was considered to be inappropriate for this development.

Heat pumps

Heat pumps take in heat at a certain temperature and release it at a higher temperature, using the same process as a refrigerator. Fluid is circulated through pipes buried in the ground and passes through a heat exchanger in the heat pump that extracts heat from the fluid.

The heat pump raises the temperature of the fluid via the compression cycle to supply hot water to the building as from a normal boiler. Air source heat pumps work in the same way but use the air as the heat source rather than the ground.

Ground-source heat pumps are used to extract heat from the ground to provide space and water heating. The ground pipe system can be horizontal or vertical.

Ground Source heat pumps have a high capital cost and would be very disruptive to install, therefore they are not advised for this site.

Photovoltaic Panels

Photovoltaic Panel systems convert energy from the sun into electricity through semi-conductor cells mounted in collector panels. The panels are connected to an inverter to turn the DC output into AC for use in the building to which they are attached and to be fed back into the grid when not required.

The current Feed in Tariff scheme yields guaranteed payments for 25 years for all electricity generated by the system and payment for electricity exported back to the grid. Typical cost for around 3kWp array is around £5,000 with a payback period of around 12 years.

Photovoltaic arrays provide a quiet and effective renewable energy source with a relatively low aesthetic impact. The major benefit of PV systems is the significant reductions they can achieve in comparison to other technologies, in terms of CO_2 and energy use.

Solar Photovoltaics, chosen strategy

Table 1, Emissions Reductions Incorporating a 4 kWp for the house, Solar PV array East Facing 45 degree tilt in an unshaded location.

The South facing PV array provides a good return on the input producing 2763.58 kWh, it should be noted that the Photovoltaics suggested should be checked with a systems specialist to ensure optimum efficiency. It would likely require between 16 panels.

Based on a 60 cell panel the panel dimensions should be 1.482 meters by 0.992 meter dimension per panel (these are approximate values and may vary from panel to panel.)

This electricity will be supplied directly to the house.

As supporting evidence to this report included is the 40 Ham Green — SAP Worksheet

7. Table 1, Proposed renewables and Emissions Reductions for the House[2]

	Total Energy demand (kWh/yr)	Energy saving (%)	Total Regulated CO_2 emissions (kg CO_2/yr)	Saving achieved on residual CO_2 emissions (%)
Baseline energy demand – "Baseline"	11938	0%	4142.91	0%
Proposed scheme after energy efficiency measures to achieve pass were it required to comply with Part L1A standards – "Residual"	5883	51%	3053.04	26%
Proposed scheme after on-site renewables	3120	47%	1619.04	46.97%
Proposed scheme offset for financial contribution or other allowable solution	N/A	N/A	N/A	N/A

Baseline energy demand (kWh/yr)	11938
Regulated emissions (kg/yr)	4142.91

Energy savings from energy efficiency measures (kWh)	6056
Emission savings from energy efficiency measures	1089.87
Total regulated emissions after energy efficiency measures	3053.04

Generated PV Power (kWh)	2763
Saving on residual emissions from use of renewables (kg/yr)	1434.00

Total renewable capacity (kWpeak from Solar PV)	**4 kWp**
Saving on residual emissions from use of renewables (kg/yr)	**1434.00**
Saving on residual emissions from the use of renewables (%)	**47%**

2 As the development has reached the 20% the financial contribution is not needed. Information on Photovoltaic generation accessed http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php

8. Conclusion

It is our opinion that sufficient design works have been carried out at this early stage to demonstrate that the proposal is successfully addressing those requirements of CS2.

The development has shown considerable improvement on U values using best practice to meet energy efficiency levels within the dwellings. The dwelling has made considerable improvements to the baseline requirements, mainly through fabric improvements. The PV panels can therefore meet nearly 50% of total emissions.

The project includes plans to eliminate thermal bridging through careful detailing and very reduced air tightness and MVHR for air quality, however the dwelling performs exceptionally well under the SAP performance rating.

The roof space provides a good site for the photovoltaic array to perform optimally as it can be south facing and unshaded.

The calculations provided draw on the proposed SAP worksheets for the development to give an outline of the energy usage of the final development.

The table above shows how the development can meet a 10% energy in kWh reduction target for onsite renewables.

Appendix A SAP

elmhurst energy

SAP Report Submission for Building Regulations Compliance

Client: Jerry Evans

Project: 40 , Ham Green
Pill, North Somerset, BS20 0HA

Contact: Laura Meehan
M Sustainability
laura@msustainability.co.uk

Report Issue Date: 03/12/2021

EXCELLENCE IN ENERGY ASSESSMENT

PREDICTED ENERGY ASSESSMENT

Design SAP
elmhurst energy

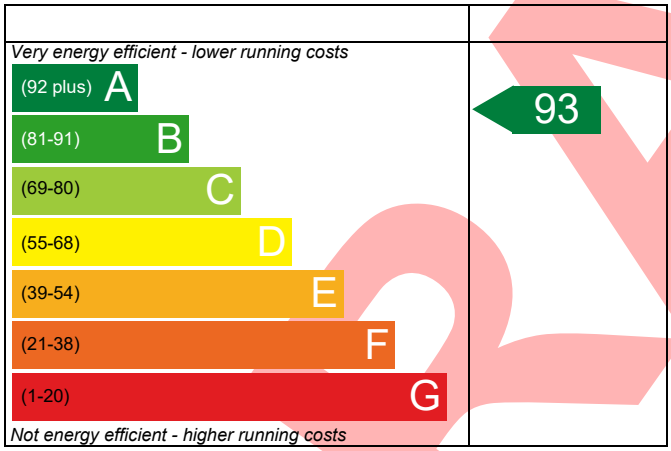
40 , Ham Green,
Pill,
North Somerset,
BS20 0HA

Dwelling type:	House, Detached
Date of assessment:	03/12/2021
Produced by:	M Sustainability
Total floor area:	195.8 m²

This document is a Predicted Energy Assessment for properties marketed when they are incomplete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, this rating will be updated and an official Energy Performance Certificate will be created for the property. This will include more detailed information about the energy performance of the completed property.

The energy performance has been assessed using the Government approved SAP2012 methodology and is rated in terms of the energy use per square meter of floor area; the energy efficiency is based on fuel costs and the environmental impact is based on carbon dioxide (CO_2) emissions.

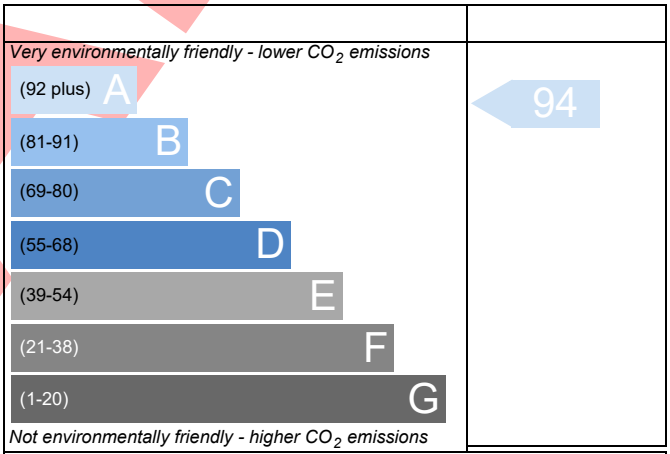
Energy Efficiency Rating



England EU Directive 2002/91/EC

The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

Environmental Impact (CO_2) Rating



England EU Directive 2002/91/EC

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

This report has not been submitted through the Elmhurst Energy members' portal, therefore results are subject to change when the dwelling is completed.

FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Property Reference	000085	**Issued on Date**	03/12/2021
Assessment Reference	001	**Prop Type Ref**	
Property	40 , Ham Green, Pill, North Somerset, BS20 0HA		

SAP Rating	93 A	**DER**	7.78	**TER**	20.85
Environmental	94 A	**% DER<TER**	62.68		
CO_2 Emissions (t/year)	0.66	**DFEE**	31.82	**TFEE**	52.84
General Requirements Compliance	Pass	**% DFEE<TFEE**	39.78		

Assessor Details	Ms. Laura Meehan, M Sustainability, Tel: 07852802823, laura@msustainability.co.uk	**Assessor ID**	Z762-0001
Client	Jerry Evans, Jerry Evans		

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

DWELLING AS DESIGNED

Detached House, total floor area 196 m²

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.

1a TER and DER
Fuel for main heating:Electricity
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 20.85 kgCO□/m²
Dwelling Carbon Dioxide Emission Rate (DER) 7.78 kgCO□/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)52.8 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)31.8 kWh/m²/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.11 (max. 0.30)	0.11 (max. 0.70)	OK
Floor	(no floor)		
Roof	0.11 (max. 0.20)	0.11 (max. 0.35)	OK
Openings	0.90 (max. 2.00)	0.90 (max. 3.30)	OK

2a Thermal bridging
Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability
Air permeability at 50 pascals: 1.00 (design value)
Maximum 10.0 OK

4 Heating efficiency
Main heating system: Room heaters - Electric
Panel, convector or radiant heaters

Secondary heating system: None

5 Cylinder insulation
Hot water storage Measured cylinder loss: 1.20 kWh/day
Permitted by DBSCG 2.86 OK
Primary pipework insulated: No primary pipework

6 Controls
Space heating controls: Programmer and appliance thermostats OK

Hot water controls: Cylinderstat OK

7 Low energy lights
Percentage of fixed lights with low-energy fittings:100%
Minimum 75% OK

8 Mechanical ventilation
Continuous supply and extract system
Specific fan power: 0.90
Maximum 1.5 OK
MVHR efficiency: 88%
Minimum: 70% OK

9 Summertime temperature
Overheating risk (Severn Valley): Not significant OK
Based on:
Overshading: Average
Windows facing North: 4.16 m², No overhang
Windows facing East: 2.84 m², No overhang
Windows facing South: 11.67 m², No overhang
Windows facing West: 24.84 m², No overhang
Air change rate: 4.00 ach
Blinds/curtains: Dark-coloured venetian blind, closed 50% of daylight hours

10 Key features
External wall U-value 0.11 W/m²K
Roof U-value 0.11 W/m²K
Floor U-value 0.00 W/m²K
Window U-value 0.90 W/m²K
Air permeability 1.0 m³/m²h
Photovoltaic array 4.00 kW

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000 (1b)	x	2.4500 (2b)	=	240.1000 (1b) - (3b)	
First floor	97.8000 (1c)	x	2.9000 (2c)	=	283.6200 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							0 * 10 =	0.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Measured/design AP50		1.0000	
Infiltration rate		0.0500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0425	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.0542	0.0531	0.0521	0.0468	0.0457	0.0404	0.0404	0.0393	0.0425	0.0457	0.0478	0.0499	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation:	0.5000	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	61.6000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2462	0.2451	0.2441	0.2388	0.2377	0.2324	0.2324	0.2313	0.2345	0.2377	0.2398	0.2419	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 0.90)			43.5100	0.8687	37.7983			(27)
Heat Loss Floor 1			98.0000	0.0000	0.0000			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1100	17.3008			(29a)
External Roof 1	98.2000		98.2000	0.1100	10.8020			(30)
Total net area of external elements Aum(A, m2)			298.9900					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	65.9011			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	19.7788	(36)
Total fabric heat loss	(33) + (36) = 85.6799	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	42.5480	42.3644	42.1807	41.2626	41.0790	40.1608	40.1608	39.9772	40.5281	41.0790	41.4462	41.8135	(38)
Heat transfer coeff	128.2279	128.0442	127.8606	126.9425	126.7588	125.8407	125.8407	125.6570	126.2079	126.7588	127.1261	127.4933	(39)
Average = Sum(39)m / 12 =												126.8965	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6549	0.6540	0.6530	0.6483	0.6474	0.6427	0.6427	0.6418	0.6446	0.6474	0.6493	0.6511	(40)
HLP (average)												0.6481	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9965 (42)
Average daily hot water use (litres/day)	105.3658 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	25.7820	22.5491	23.2686	20.2862	19.4650	16.7969	15.5648	17.8608	18.0741	21.0636	22.9926	24.9685	(46)
Water storage loss:													

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.6000	(49)
Enter (49) or (54) in (55)												0.7200	(55)
Total storage loss													
	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(56)
If cylinder contains dedicated solar storage													
	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month													
	194.1998	170.4872	177.4442	156.8410	152.0870	133.5790	126.0850	141.3919	142.0940	162.7441	174.8839	188.7764	(62)
WWHRS	-54.2514	-47.7367	-48.7201	-40.0692	-37.1967	-30.6795	-25.9543	-31.4283	-32.3500	-40.0026	-46.3535	-52.4400	eq.(G10)
Total of WWHRS savings												-487.1822	
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
									Solar input (sum of months) = Sum(63)m =			0.0000	(63)
Output from w/h													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(64)
									Total per year (kWh/year) = Sum(64)m =			1433.4314	(64)
Heat gains from water heating, kWh/month													
	75.0060	66.1118	69.4348	62.2476	61.0035	54.5130	52.3579	57.4474	57.3443	64.5470	68.2469	73.2028	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	33.0572	29.3611	23.8781	18.0772	13.5130	11.4082	12.3270	16.0231	21.5061	27.3070	31.8712	33.9760	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	367.0361	370.8447	361.2470	340.8145	315.0221	290.7809	274.5863	270.7776	280.3754	300.8079	326.6003	350.8415	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	(71)
Water heating gains (Table 5)													
	100.8146	98.3806	93.3263	86.4551	81.9940	75.7125	70.3735	77.2143	79.6448	86.7568	94.7874	98.3908	(72)
Total internal gains													
	568.8547	566.5333	546.3982	513.2936	478.4758	445.8485	425.2336	431.9617	449.4731	482.8184	521.2057	551.1550	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.1600	10.6334	0.6800	0.7000	0.7700	14.5917	(74)
East	2.8400	19.6403	0.6800	0.7000	0.7700	18.3995	(76)
South	11.6700	46.7521	0.6800	0.7000	0.7700	179.9749	(78)
West	24.8400	19.6403	0.6800	0.7000	0.7700	160.9308	(80)

Solar gains	373.8968	673.4459	1000.5774	1343.0511	1577.3526	1592.3915	1524.6481	1349.5597	1121.1108	767.3754	454.9361	315.1517	(83)
Total gains	942.7515	1239.9792	1546.9756	1856.3447	2055.8284	2038.2399	1949.8817	1781.5214	1570.5839	1250.1938	976.1417	866.3067	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	106.0395	106.1916	106.3441	107.1133	107.2684	108.0511	108.0511	108.2090	107.7367	107.2684	106.9586	106.6505	
alpha	8.0693	8.0794	8.0896	8.1409	8.1512	8.2034	8.2034	8.2139	8.1824	8.1512	8.1306	8.1100	
util living area													
	0.9993	0.9934	0.9526	0.7903	0.5708	0.3950	0.2840	0.3244	0.5525	0.9128	0.9964	0.9996	(86)
MIT	20.3677	20.5625	20.7994	20.9636	20.9971	20.9999	21.0000	21.0000	20.9983	20.9065	20.5807	20.3268	(87)
Th 2	20.3808	20.3817	20.3825	20.3867	20.3875	20.3917	20.3917	20.3926	20.3900	20.3875	20.3859	20.3842	(88)
util rest of house													
	0.9990	0.9914	0.9408	0.7590	0.5341	0.3575	0.2447	0.2816	0.5045	0.8873	0.9951	0.9995	(89)
MIT 2	19.5159	19.8001	20.1356	20.3486	20.3851	20.3916	20.3917	20.3926	20.3889	20.2859	19.8311	19.4588	(90)
Living area fraction										fLA = Living area / (4) =		0.1190	(91)
MIT	19.6173	19.8909	20.2146	20.4218	20.4579	20.4640	20.4641	20.4648	20.4614	20.3598	19.9203	19.5621	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.6173	19.8909	20.2146	20.4218	20.4579	20.4640	20.4641	20.4648	20.4614	20.3598	19.9203	19.5621	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9986	0.9894	0.9371	0.7608	0.5384	0.3620	0.2494	0.2867	0.5102	0.8860	0.9937	0.9993	(94)
Useful gains	941.4370	1226.8733	1449.7465	1412.3747	1106.7682	737.8195	486.2572	510.7623	801.2400	1107.6615	970.0218	865.6593	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	1964.0989	1919.4935	1753.5581	1462.6080	1110.1439	737.9325	486.2614	510.7751	802.8624	1237.1388	1629.7956	1958.5687	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	760.8605	465.4408	226.0358	36.1680	2.5115	0.0000	0.0000	0.0000	0.0000	96.3311	475.0371	813.1246	(98)
Space heating												2875.5093	(98)
Space heating per m2											(98) / (4) =	14.6860	(99)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8c. Space cooling requirement

Not applicable

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												100.0000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												2875.5093	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	760.8605	465.4408	226.0358	36.1680	2.5115	0.0000	0.0000	0.0000	0.0000	96.3311	475.0371	813.1246	(98)
Space heating efficiency (main heating system 1)													
	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)													
	760.8605	465.4408	226.0358	36.1680	2.5115	0.0000	0.0000	0.0000	0.0000	96.3311	475.0371	813.1246	(211)
Water heating requirement													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(219)
Water heating fuel used												1433.4314	(219)
Annual totals kWh/year													
Space heating fuel - main system												2875.5093	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.2600)													
mechanical ventilation fans (SFP = 1.2600)												805.0624	(230a)
Total electricity for the above, kWh/year												805.0624	(231)
Electricity for lighting (calculated in Appendix L)												583.8010	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 4.00 * 1080 * 0.80) =											-2763.5830	-2763.5830	(233)
Total delivered energy for all uses												2934.2211	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2875.5093	0.5190	1492.3893	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1433.4314	0.5190	743.9509	(264)
Space and water heating			2236.3402	(265)
Pumps and fans	805.0624	0.5190	417.8274	(267)
Energy for lighting	583.8010	0.5190	302.9927	(268)
Energy saving/generation technologies				
PV Unit	-2763.5830	0.5190	-1434.2996	(269)
Total CO2, kg/year			1522.8607	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			7.7800	(273)

16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES

DER		7.7800	ZC1
Total Floor Area	TFA	195.8000	
Assumed number of occupants	N	2.9965	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		11.1082	ZC2
CO2 emissions from cooking, equation (L16)		0.9751	ZC3
Total CO2 emissions		19.8632	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		19.8632	ZC8

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF TARGET EMISSIONS 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000	(1b)	x 2.4500	(2b) =	240.1000	(1b) - (3b)
First floor	97.8000	(1c)	x 2.9000	(2c) =	283.6200	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							4 * 10 =	40.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0764	(8)
Pressure test		Yes	
Measured/design AP50		5.0000	
Infiltration rate		0.3264	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2774	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3537	0.3468	0.3398	0.3052	0.2982	0.2635	0.2635	0.2566	0.2774	0.2982	0.3121	0.3260	(22b)
Effective ac	0.5626	0.5601	0.5577	0.5466	0.5445	0.5347	0.5347	0.5329	0.5385	0.5445	0.5487	0.5531	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.40)			43.5100	1.3258	57.6837			(27)
Heat Loss Floor 1			98.0000	0.1300	12.7400			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1800	28.3104			(29a)
External Roof 1	98.2000		98.2000	0.1300	12.7660			(30)
Total net area of external elements Aum(A, m2)			396.9900					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		111.5001			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	14.1700	(36)
Total fabric heat loss (33) + (36) =	125.6701	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	97.2251	96.8053	96.3938	94.4610	94.0994	92.4159	92.4159	92.1042	93.0644	94.0994	94.8309	95.5958	(38)
Heat transfer coeff	222.8953	222.4754	222.0639	220.1311	219.7695	218.0861	218.0861	217.7743	218.7345	219.7695	220.5010	221.2659	(39)
Average = Sum(39)m / 12 =												220.1294	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1384	1.1362	1.1341	1.1243	1.1224	1.1138	1.1138	1.1122	1.1171	1.1224	1.1262	1.1301	(40)
HLP (average)												1.1243	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9965 (42)
Average daily hot water use (litres/day)	105.3658 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	25.7820	22.5491	23.2686	20.2862	19.4650	16.7969	15.5648	17.8608	18.0741	21.0636	22.9926	24.9685	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1409	(55)

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

```
Total storage loss
          35.3664    31.9439    35.3664    34.2256    35.3664    34.2256    35.3664    35.3664    34.2256    35.3664    34.2256    35.3664 (56)
If cylinder contains dedicated solar storage
          35.3664    31.9439    35.3664    34.2256    35.3664    34.2256    35.3664    35.3664    34.2256    35.3664    34.2256    35.3664 (57)
Primary loss    23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Total heat required for water heating calculated for each month
          230.5086   203.2822   213.7530   191.9786   188.3958   168.7166   162.3939   177.7007   177.2316   199.0530   210.0215   225.0852 (62)
Solar input      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63)
                                                                                                Solar input (sum of months) = Sum(63)m =      0.0000 (63)
Output from w/h
          230.5086   203.2822   213.7530   191.9786   188.3958   168.7166   162.3939   177.7007   177.2316   199.0530   210.0215   225.0852 (64)
                                                                                                  Total per year (kWh/year) = Sum(64)m =   2348.1207 (64)
Heat gains from water heating, kWh/month
          104.0531    92.3478    98.4818    90.3577    90.0506    82.6231    81.4049    86.4945    85.4543    93.5941    96.3570   102.2498 (65)
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5. Internal gains (see Table 5 and 5a)

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Metabolic gains (Table 5), Watts
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m      149.8226   149.8226   149.8226   149.8226   149.8226   149.8226   149.8226   149.8226   149.8226   149.8226   149.8226   149.8226 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
           32.7238    29.0650    23.6373    17.8949    13.3767    11.2931    12.2026    15.8615    21.2892    27.0316    31.5498    33.6333 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
          367.0361   370.8447   361.2470   340.8145   315.0221   290.7809   274.5863   270.7776   280.3754   300.8079   326.6003   350.8415 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
           37.9823    37.9823    37.9823    37.9823    37.9823    37.9823    37.9823    37.9823    37.9823    37.9823    37.9823    37.9823 (69)
Pumps, fans      3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)
         -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581 (71)
Water heating gains (Table 5)
          139.8563   137.4224   132.3681   125.4968   121.0357   114.7543   109.4152   116.2560   118.6865   125.7985   133.8291   137.4325 (72)
Total internal gains
          610.5630   608.2789   588.1991   555.1530   520.3813   487.7751   467.1510   473.8419   491.2979   524.5847   562.9260   592.8541 (73)
```

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6. Solar gains

```
[Jan]                                    Area          Solar flux              g                FF            Access              Gains
                                         m2             Table 6a       Specific data    Specific data      factor                W
                                                           W/m2         or Table 6b      or Table 6c     Table 6d
-------------------------------------------------------------------------------------------------------------------------------------
North                                  4.1600            10.6334            0.6300           0.7000           0.7700           13.5188 (74)
East                                   2.8400            19.6403            0.6300           0.7000           0.7700           17.0466 (76)
South                                 11.6700            46.7521            0.6300           0.7000           0.7700          166.7414 (78)
West                                  24.8400            19.6403            0.6300           0.7000           0.7700          149.0976 (80)
-------------------------------------------------------------------------------------------------------------------------------------

Solar gains    346.4044   623.9278   927.0055  1244.2974  1461.3708  1475.3038  1412.5417  1250.3274  1038.6762   710.9508   421.4849   291.9788 (83)
Total gains    956.9674  1232.2068  1515.2046  1799.4504  1981.7521  1963.0790  1879.6926  1724.1692  1529.9741  1235.5355   984.4109   884.8329 (84)
```

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7. Mean internal temperature (heating season)

```
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                      21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
tau          61.0027    61.1179    61.2311    61.7687    61.8704    62.3480    62.3480    62.4372    62.1631    61.8704    61.6651    61.4520
alpha         5.0668     5.0745     5.0821     5.1179     5.1247     5.1565     5.1565     5.1625     5.1442     5.1247     5.1110     5.0968
util living area
              0.9992     0.9971     0.9884     0.9521     0.8494     0.6707     0.5026     0.5657     0.8315     0.9799     0.9980     0.9995 (86)

MIT          19.6704    19.8684    20.1715    20.5420    20.8261    20.9618    20.9928    20.9873    20.8856    20.4818    19.9967    19.6362 (87)
Th 2         19.9696    19.9713    19.9731    19.9811    19.9826    19.9896    19.9896    19.9909    19.9869    19.9826    19.9795    19.9764 (88)
util rest of house
              0.9990     0.9961     0.9842     0.9345     0.7992     0.5809     0.3913     0.4493     0.7576     0.9696     0.9971     0.9993 (89)
MIT 2        18.1837    18.4743    18.9158    19.4463    19.8156    19.9648    19.9870    19.9857    19.8960    19.3725    18.6683    18.1385 (90)
Living area fraction                                                                                  fLA = Living area / (4) =      0.1190 (91)
MIT          18.3607    18.6402    19.0652    19.5767    19.9359    20.0835    20.1067    20.1049    20.0138    19.5045    18.8264    18.3168 (92)
Temperature adjustment                                                                                                          0.0000
adjusted MIT 18.3607    18.6402    19.0652    19.5767    19.9359    20.0835    20.1067    20.1049    20.0138    19.5045    18.8264    18.3168 (93)
```

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8. Space heating requirement

```
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation   0.9983     0.9940     0.9790     0.9258     0.7966     0.5898     0.4045     0.4630     0.7599     0.9629     0.9955     0.9988 (94)
Useful gains  955.3362  1224.8621  1483.3307  1665.8609  1578.6333  1157.7834   760.3456   798.2378  1162.5560  1189.6454   980.0183   883.8085 (95)
Ext temp.       4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000 (96)
Heat loss rate W
          3134.0538  3056.8519  2790.2800  2350.2713  1809.9962  1195.8663   764.7556   806.8322  1293.5428  1956.9465  2585.6729  3123.5568 (97)
Month fracti    1.0000     1.0000     1.0000     1.0000     1.0000     0.0000     0.0000     0.0000     0.0000     1.0000     1.0000     1.0000 (97a)
Space heating kWh
          1620.9659  1231.0971   972.3703   492.7755   172.1340     0.0000     0.0000     0.0000     0.0000   570.8721  1156.0713  1666.3727 (98)
Space heating                                                                                                                   7882.6588 (98)
Space heating per m2                                                                                                 (98) / (4) =     40.2587 (99)
```

8c. Space cooling requirement

Not applicable

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												93.5000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												8430.6511	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1620.9659	1231.0971	972.3703	492.7755	172.1340	0.0000	0.0000	0.0000	0.0000	570.8721	1156.0713	1666.3727	(98)
Space heating efficiency (main heating system 1)													
	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)													
	1733.6534	1316.6814	1039.9682	527.0326	184.1006	0.0000	0.0000	0.0000	0.0000	610.5584	1236.4399	1782.2168	(211)
Water heating requirement													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	230.5086	203.2822	213.7530	191.9786	188.3958	168.7166	162.3939	177.7007	177.2316	199.0530	210.0215	225.0852	(64)
Efficiency of water heater												79.8000	(216)
(217)m	89.0140	88.8123	88.3648	87.2212	84.5742	79.8000	79.8000	79.8000	79.8000	87.4679	88.6721	89.0786	(217)
Fuel for water heating, kWh/month													
	258.9576	228.8897	241.8984	220.1055	222.7581	211.4243	203.5011	222.6826	222.0947	227.5727	236.8518	252.6815	(219)
Water heating fuel used												2749.4180	(219)
Annual totals kWh/year													
Space heating fuel - main system												8430.6511	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												75.0000	(231)
Electricity for lighting (calculated in Appendix L)												577.9132	(232)
Total delivered energy for all uses												11832.9823	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	8430.6511	0.2160	1821.0206	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2749.4180	0.2160	593.8743	(264)
Space and water heating			2414.8949	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	577.9132	0.5190	299.9370	(268)
Total CO2, kg/m2/year			2753.7569	(272)
Emissions per m2 for space and water heating			12.3335	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			1.5319	(272b)
Emissions per m2 for pumps and fans			0.1988	(272c)
Target Carbon Dioxide Emission Rate (TER) = (12.3335 * 1.55) + 1.5319 + 0.1988, rounded to 2 d.p.			20.8500	(273)

CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000	(1b)	x 2.4500	(2b) =	240.1000	(1b) - (3b)
First floor	97.8000	(1c)	x 2.9000	(2c) =	283.6200	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							4 * 10 =	40.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0764	(8)
Pressure test		Yes	
Measured/design AP50		1.0000	
Infiltration rate		0.1264	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1074	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.1370	0.1343	0.1316	0.1182	0.1155	0.1020	0.1020	0.0994	0.1074	0.1155	0.1208	0.1262	(22b)
Effective ac	0.5094	0.5090	0.5087	0.5070	0.5067	0.5052	0.5052	0.5049	0.5058	0.5067	0.5073	0.5080	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 0.90)			43.5100	0.8687	37.7983			(27)
Heat Loss Floor 1			98.0000	0.0000	0.0000			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1100	17.3008			(29a)
External Roof 1	98.2000		98.2000	0.1100	10.8020			(30)
Total net area of external elements Aum(A, m2)			298.9900					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		65.9011			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							19.7788	(36)
Total fabric heat loss					(33) + (36) =		85.6799	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	88.0348	87.9718	87.9101	87.6203	87.5661	87.3137	87.3137	87.2670	87.4109	87.5661	87.6758	87.7905	(38)
Heat transfer coeff	173.7146	173.6517	173.5900	173.3002	173.2460	172.9936	172.9936	172.9468	173.0908	173.2460	173.3557	173.4703	(39)
Average = Sum(39)m / 12 =												173.2999	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8872	0.8869	0.8866	0.8851	0.8848	0.8835	0.8835	0.8833	0.8840	0.8848	0.8854	0.8860	(40)
HLP (average)												0.8851	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy		2.9965 (42)
Average daily hot water use (litres/day)		105.3658 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)

CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Heat gains from water heating, kWh/month													
	36.5245	31.9445	32.9639	28.7387	27.5755	23.7955	22.0501	25.3028	25.6050	29.8401	32.5728	35.3720	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	33.0572	29.3611	23.8781	18.0772	13.5130	11.4082	12.3270	16.0231	21.5061	27.3070	31.8712	33.9760	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	367.0361	370.8447	361.2470	340.8145	315.0221	290.7809	274.5863	270.7776	280.3754	300.8079	326.6003	350.8415	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	(71)
Water heating gains (Table 5)													
	49.0920	47.5365	44.3063	39.9149	37.0638	33.0494	29.6372	34.0091	35.5625	40.1077	45.2400	47.5430	(72)
Total internal gains													
	517.1321	515.6892	497.3782	466.7534	433.5457	403.1853	384.4973	388.7566	405.3908	436.1693	471.6584	500.3072	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.1600	10.6334	0.6800	0.7000	0.7700	14.5917	(74)
East	2.8400	19.6403	0.6800	0.7000	0.7700	18.3995	(76)
South	11.6700	46.7521	0.6800	0.7000	0.7700	179.9749	(78)
West	24.8400	19.6403	0.6800	0.7000	0.7700	160.9308	(80)

Solar gains	373.8968	673.4459	1000.5774	1343.0511	1577.3526	1592.3915	1524.6481	1349.5597	1121.1108	767.3754	454.9361	315.1517	(83)
Total gains	891.0289	1189.1351	1497.9556	1809.8045	2010.8983	1995.5767	1909.1454	1738.3163	1526.5016	1203.5448	926.5944	815.4589	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	78.2733	78.3017	78.3295	78.4605	78.4851	78.5996	78.5996	78.6208	78.5554	78.4851	78.4354	78.3836	
alpha	6.2182	6.2201	6.2220	6.2307	6.2323	6.2400	6.2400	6.2414	6.2370	6.2323	6.2290	6.2256	
util living area													
	0.9996	0.9972	0.9836	0.9165	0.7511	0.5485	0.3979	0.4558	0.7380	0.9716	0.9984	0.9997	(86)
MIT	19.9872	20.1889	20.4742	20.7791	20.9492	20.9936	20.9993	20.9983	20.9659	20.6813	20.2519	19.9423	(87)
Th 2	20.1784	20.1787	20.1789	20.1802	20.1804	20.1815	20.1815	20.1817	20.1811	20.1804	20.1800	20.1795	(88)
util rest of house													
	0.9994	0.9962	0.9782	0.8926	0.6996	0.4811	0.3243	0.3757	0.6669	0.9589	0.9978	0.9997	(89)
MIT 2	19.2374	19.4388	19.7208	20.0091	20.1490	20.1788	20.1813	20.1813	20.1637	19.9256	19.5032	19.1935	(90)
Living area fraction									fLA = Living area / (4) =			0.1190	(91)
MIT	19.3267	19.5281	19.8105	20.1008	20.2442	20.2758	20.2787	20.2785	20.2592	20.0155	19.5923	19.2826	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.3267	19.5281	19.8105	20.1008	20.2442	20.2758	20.2787	20.2785	20.2592	20.0155	19.5923	19.2826	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9992	0.9952	0.9752	0.8900	0.7038	0.4890	0.3331	0.3853	0.6741	0.9557	0.9971	0.9995	(94)
Useful gains	890.2943	1183.4795	1460.8037	1610.6655	1415.2862	975.8671	635.9393	669.6928	1029.0726	1150.1912	923.9106	815.0633	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	2610.3526	2540.1928	2310.5683	1941.0944	1480.2485	981.8715	636.3866	670.7746	1066.0954	1631.1958	2165.6053	2616.3784	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	1279.7234	911.7114	632.2248	237.9088	48.3319	0.0000	0.0000	0.0000	0.0000	357.8674	894.0202	1340.1785	(98)
Space heating												5701.9664	(98)
Space heating per m2											(98) / (4) =	29.1214	(99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W													
	0.0000	0.0000	0.0000	0.0000	0.0000	1626.1396	1280.1525	1314.3960	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9737	0.9900	0.9823	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1583.3551	1267.3445	1291.1819	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	2472.7122	2368.2454	2171.5241	0.0000	0.0000	0.0000	0.0000	(103)
Month fracti	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	(103a)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	640.3372	819.0703	654.9746	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												2114.3821	(104)

CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

Cooled fraction											fC = cooled area / (4) =	1.0000 (105)
Intermittency factor (Table 10b)												
0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000	0.0000		0.0000 (106)
Space cooling kWh												
0.0000	0.0000	0.0000	0.0000	0.0000	160.0843	204.7676	163.7436	0.0000	0.0000	0.0000		0.0000 (107)
Space cooling												528.5955 (107)
Space cooling per m2												2.6997 (108)
Energy for space heating												29.1214 (99)
Energy for space cooling												2.6997 (108)
Total												31.8211 (109)
Dwelling Fabric Energy Efficiency (DFEE)												31.8 (109)

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000 (1b)	x	2.4500 (2b)	=	240.1000 (1b) - (3b)	
First floor	97.8000 (1c)	x	2.9000 (2c)	=	283.6200 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							4 * 10 =	40.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0764	(8)
Pressure test		Yes	
Measured/design AP50		5.0000	
Infiltration rate		0.3264	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2774	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3537	0.3468	0.3398	0.3052	0.2982	0.2635	0.2635	0.2566	0.2774	0.2982	0.3121	0.3260	(22b)
Effective ac	0.5626	0.5601	0.5577	0.5466	0.5445	0.5347	0.5347	0.5329	0.5385	0.5445	0.5487	0.5531	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.40)			43.5100	1.3258	57.6837			(27)
Heat Loss Floor 1			98.0000	0.1300	12.7400			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1800	28.3104			(29a)
External Roof 1	98.2000		98.2000	0.1300	12.7660			(30)
Total net area of external elements Aum(A, m2)			396.9900					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		111.5001			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	14.1700	(36)
Total fabric heat loss (33) + (36) =	125.6701	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	97.2251	96.8053	96.3938	94.4610	94.0994	92.4159	92.4159	92.1042	93.0644	94.0994	94.8309	95.5958	(38)
Heat transfer coeff	222.8953	222.4754	222.0639	220.1311	219.7695	218.0861	218.0861	217.7743	218.7345	219.7695	220.5010	221.2659	(39)
Average = Sum(39)m / 12 =												220.1294	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1384	1.1362	1.1341	1.1243	1.1224	1.1138	1.1138	1.1122	1.1171	1.1224	1.1262	1.1301	(40)
HLP (average)												1.1243	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9965	(42)
Average daily hot water use (litres/day)	105.3658	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Heat gains from water heating, kWh/month													
	36.5245	31.9445	32.9639	28.7387	27.5755	23.7955	22.0501	25.3028	25.6050	29.8401	32.5728	35.3720	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	149.8226	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	32.7238	29.0650	23.6373	17.8949	13.3767	11.2931	12.2026	15.8615	21.2892	27.0316	31.5498	33.6333	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	367.0361	370.8447	361.2470	340.8145	315.0221	290.7809	274.5863	270.7776	280.3754	300.8079	326.6003	350.8415	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	37.9823	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	(71)
Water heating gains (Table 5)													
	49.0920	47.5365	44.3063	39.9149	37.0638	33.0494	29.6372	34.0091	35.5625	40.1077	45.2400	47.5430	(72)
Total internal gains													
	516.7987	515.3931	497.1373	466.5711	433.4094	403.0702	384.3729	388.5950	405.1739	435.8939	471.3369	499.9646	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.1600	10.6334	0.6300	0.7000	0.7700	13.5188	(74)
East	2.8400	19.6403	0.6300	0.7000	0.7700	17.0466	(76)
South	11.6700	46.7521	0.6300	0.7000	0.7700	166.7414	(78)
West	24.8400	19.6403	0.6300	0.7000	0.7700	149.0976	(80)

Solar gains	346.4044	623.9278	927.0055	1244.2974	1461.3708	1475.3038	1412.5417	1250.3274	1038.6762	710.9508	421.4849	291.9788	(83)
Total gains	863.2031	1139.3209	1424.1429	1710.8685	1894.7802	1878.3741	1796.9146	1638.9224	1443.8501	1146.8447	892.8218	791.9433	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	61.0027	61.1179	61.2311	61.7687	61.8704	62.3480	62.3480	62.4372	62.1631	61.8704	61.6651	61.4520	
alpha	5.0668	5.0745	5.0821	5.1179	5.1247	5.1565	5.1565	5.1625	5.1442	5.1247	5.1110	5.0968	
util living area													
	0.9995	0.9980	0.9911	0.9602	0.8667	0.6939	0.5240	0.5916	0.8552	0.9852	0.9987	0.9997	(86)
MIT	19.6255	19.8244	20.1301	20.5081	20.8064	20.9554	20.9913	20.9844	20.8676	20.4429	19.9530	19.5916	(87)
Th 2	19.9696	19.9713	19.9731	19.9811	19.9826	19.9896	19.9896	19.9909	19.9869	19.9826	19.9795	19.9764	(88)
util rest of house													
	0.9994	0.9972	0.9878	0.9451	0.8195	0.6036	0.4089	0.4716	0.7858	0.9774	0.9981	0.9996	(89)
MIT 2	18.7054	18.9054	19.2106	19.5848	19.8536	19.9695	19.9874	19.9865	19.9130	19.5289	19.0407	18.6770	(90)
Living area fraction									fLA = Living area / (4) =			0.1190	(91)
MIT	18.8149	19.0147	19.3200	19.6947	19.9670	20.0868	20.1069	20.1052	20.0266	19.6377	19.1493	18.7858	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8149	19.0147	19.3200	19.6947	19.9670	20.0868	20.1069	20.1052	20.0266	19.6377	19.1493	18.7858	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9991	0.9963	0.9850	0.9398	0.8187	0.6129	0.4226	0.4858	0.7890	0.9738	0.9975	0.9994	(94)
Useful gains	862.4195	1135.0799	1402.7615	1607.9046	1551.1770	1151.3196	759.4027	796.2087	1139.2480	1116.7573	890.5683	791.4792	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	3235.3075	3140.1801	2846.8549	2376.2405	1816.8314	1196.6005	764.7983	806.9058	1296.3546	1986.2046	2656.8784	3227.3462	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	1765.4287	1347.4273	1074.4055	553.2019	197.6469	0.0000	0.0000	0.0000	0.0000	646.8689	1271.7433	1812.2850	(98)
Space heating												8669.0075	(98)
Space heating per m2											(98) / (4) =	44.2748	(99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W													
	0.0000	0.0000	0.0000	0.0000	0.0000	2050.0089	1613.8368	1655.0848	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8869	0.9403	0.9136	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1818.2163	1517.4329	1512.0369	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	2335.5690	2236.9011	2055.1343	0.0000	0.0000	0.0000	0.0000	(103)
Month fracti	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	(103a)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	372.4939	535.2843	404.0645	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												1311.8427	(104)

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

Cooled fraction											fC = cooled area / (4) =	1.0000 (105)
Intermittency factor (Table 10b)												
	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000	0.0000	0.0000 (106)
Space cooling kWh												
	0.0000	0.0000	0.0000	0.0000	0.0000	93.1235	133.8211	101.0161	0.0000	0.0000	0.0000	0.0000 (107)
Space cooling												327.9607 (107)
Space cooling per m2												1.6750 (108)
Energy for space heating												44.2748 (99)
Energy for space cooling												1.6750 (108)
Total												45.9498 (109)
Target Fabric Energy Efficiency (TFEE)												52.8 (109)

CALCULATION OF HEAT DEMAND 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF HEAT DEMAND 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000 (1b)	x	2.4500 (2b)	=	240.1000 (1b) - (3b)	
First floor	97.8000 (1c)	x	2.9000 (2c)	=	283.6200 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							0 * 10 =	0.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Measured/design AP50		1.0000	
Infiltration rate		0.0500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0425	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	6.0000	5.7000	5.6000	5.0000	5.2000	4.7000	4.8000	4.6000	4.9000	5.4000	5.5000	5.8000	(22)
Wind factor	1.5000	1.4250	1.4000	1.2500	1.3000	1.1750	1.2000	1.1500	1.2250	1.3500	1.3750	1.4500	(22a)
Adj infilt rate	0.0638	0.0606	0.0595	0.0531	0.0553	0.0499	0.0510	0.0489	0.0521	0.0574	0.0584	0.0616	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation:	0.5000	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	61.6000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2558	0.2526	0.2515	0.2451	0.2473	0.2419	0.2430	0.2409	0.2441	0.2494	0.2504	0.2536	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 0.90)			43.5100	0.8687	37.7983			(27)
Heat Loss Floor 1			98.0000	0.0000	0.0000			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1100	17.3008			(29a)
External Roof 1	98.2000		98.2000	0.1100	10.8020			(30)
Total net area of external elements Aum(A, m2)			298.9900					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	65.9011			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	19.7788	(36)
Total fabric heat loss	(33) + (36) = 85.6799	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	44.2007	43.6498	43.4661	42.3644	42.7316	41.8135	41.9971	41.6298	42.1807	43.0989	43.2825	43.8334	(38)
Heat transfer coeff	129.8805	129.3296	129.1460	128.0442	128.4115	127.4933	127.6770	127.3097	127.8606	128.7787	128.9624	129.5133	(39)
Average = Sum(39)m / 12 =												128.5339	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6633	0.6605	0.6596	0.6540	0.6558	0.6511	0.6521	0.6502	0.6530	0.6577	0.6586	0.6615	(40)
HLP (average)												0.6565	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9965 (42)
Average daily hot water use (litres/day)	105.3658 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	25.7820	22.5491	23.2686	20.2862	19.4650	16.7969	15.5648	17.8608	18.0741	21.0636	22.9926	24.9685	(46)

Water storage loss:

CALCULATION OF HEAT DEMAND 09 Jan 2014

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Store volume                                                                                                                300.0000 (47)
a) If  manufacturer declared loss factor is known  (kWh/day):                                                                 1.2000 (48)
  Temperature factor from Table 2b                                                                                            0.6000 (49)
Enter (49) or (54) in (55)                                                                                                    0.7200 (55)
Total storage loss
                22.3200    20.1600    22.3200    21.6000    22.3200    21.6000    22.3200    22.3200    21.6000    22.3200    21.6000    22.3200 (56)
If cylinder contains dedicated solar storage
                22.3200    20.1600    22.3200    21.6000    22.3200    21.6000    22.3200    22.3200    21.6000    22.3200    21.6000    22.3200 (57)
Primary loss     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (59)
Total heat required for water heating calculated for each month
               194.1998   170.4872   177.4442   156.8410   152.0870   133.5790   126.0850   141.3919   142.0940   162.7441   174.8839   188.7764 (62)
Solar input      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63)
                                                                                          Solar input (sum of months) = Sum(63)m =    0.0000 (63)
Output from w/h
               194.1998   170.4872   177.4442   156.8410   152.0870   133.5790   126.0850   141.3919   142.0940   162.7441   174.8839   188.7764 (64)
                                                                                             Total per year (kWh/year) = Sum(64)m = 1920.6137 (64)
RHI water heating demand                                                                                                        1921 (64)
Heat gains from water heating, kWh/month
                75.0060    66.1118    69.4348    62.2476    61.0035    54.5130    52.3579    57.4474    57.3443    64.5470    68.2469    73.2028 (65)


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5. Internal gains (see Table 5 and 5a)
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Metabolic gains (Table 5), Watts
                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m          179.7872   179.7872   179.7872   179.7872   179.7872   179.7872   179.7872   179.7872   179.7872   179.7872   179.7872   179.7872 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
                82.6431    73.4028    59.6952    45.1931    33.7824    28.5205    30.8174    40.0576    53.7653    68.2674    79.6781    84.9400 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
               547.8150   553.4996   539.1746   508.6783   470.1822   434.0014   409.8303   404.1457   418.4707   448.9670   487.4631   523.6440 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                55.9752    55.9752    55.9752    55.9752    55.9752    55.9752    55.9752    55.9752    55.9752    55.9752    55.9752    55.9752 (69)
Pumps, fans      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)
              -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581  -119.8581 (71)
Water heating gains (Table 5)
               100.8146    98.3806    93.3263    86.4551    81.9940    75.7125    70.3735    77.2143    79.6448    86.7568    94.7874    98.3908 (72)
Total internal gains
               847.1769   841.1873   808.1004   756.2307   701.8628   654.1386   626.9255   637.3218   667.7850   719.8954   777.8328   822.8790 (73)


-------------------------------------------------------------------------------------------------
6. Solar gains
-------------------------------------------------------------------------------------------------
[Jan]                                     Area        Solar flux              g              FF            Access                Gains
                                            m2          Table 6a    Specific data   Specific data           factor                   W
                                                            W/m2      or Table 6b     or Table 6c         Table 6d
-------------------------------------------------------------------------------------------------
North                                     4.1600         12.7650          0.6800          0.7000           0.7700              17.5168 (74)
East                                      2.8400         23.8018          0.6800          0.7000           0.7700              22.2981 (76)
South                                    11.6700         54.2217          0.6800          0.7000           0.7700             208.7297 (78)
West                                     24.8400         23.8018          0.6800          0.7000           0.7700             195.0298 (80)
-------------------------------------------------------------------------------------------------

Solar gains    443.5744   698.7284  1042.5699  1472.1030  1642.3517  1816.2677  1670.9123  1501.5265  1253.4137   843.7820   531.7904   361.5142 (83)
Total gains   1290.7513  1539.9157  1850.6702  2228.3338  2344.2145  2470.4064  2297.8378  2138.8483  1921.1987  1563.6774  1309.6232  1184.3932 (84)


-------------------------------------------------------------------------------------------------
7. Mean internal temperature (heating season)
-------------------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                  21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)
                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
tau            104.6902   105.1362   105.2857   106.1916   105.8879   106.6505   106.4971   106.8043   106.3441   105.5859   105.4356   104.9871
alpha            7.9793     8.0091     8.0190     8.0794     8.0592     8.1100     8.0998     8.1203     8.0896     8.0391     8.0290     7.9991
util living area
                 0.9890     0.9643     0.8645     0.6475     0.4651     0.2942     0.2223     0.2202     0.3925     0.7295     0.9564     0.9931 (86)

MIT             20.6192    20.7535    20.9176    20.9911    20.9994    21.0000    21.0000    21.0000    20.9999    20.9836    20.8174    20.5828 (87)
Th 2            20.3733    20.3758    20.3767    20.3817    20.3800    20.3842    20.3834    20.3850    20.3825    20.3783    20.3775    20.3750 (88)
util rest of house
                 0.9858     0.9552     0.8403     0.6145     0.4314     0.2624     0.1880     0.1836     0.3515     0.6860     0.9432     0.9909 (89)
MIT 2           19.8751    20.0663    20.2835    20.3731    20.3795    20.3842    20.3834    20.3850    20.3824    20.3636    20.1587    19.8244 (90)
Living area fraction                                                                                    fLA = Living area / (4) =     0.1190 (91)
MIT             19.9636    20.1481    20.3589    20.4466    20.4533    20.4575    20.4567    20.4582    20.4559    20.4374    20.2371    19.9146 (92)
Temperature adjustment                                                                                                                0.0000
adjusted MIT    19.9636    20.1481    20.3589    20.4466    20.4533    20.4575    20.4567    20.4582    20.4559    20.4374    20.2371    19.9146 (93)


-------------------------------------------------------------------------------------------------
8. Space heating requirement
-------------------------------------------------------------------------------------------------

                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9831     0.9513     0.8395     0.6180     0.4354     0.2662     0.1921     0.1880     0.3564     0.6903     0.9397     0.9888 (94)
Useful gains  1268.9071  1464.9476  1553.7125  1377.2149  1020.5780   657.5318   441.3449   402.0702   684.7065  1079.3725  1230.6817  1171.1729 (95)
Ext temp.        5.6000     5.9000     7.4000     9.6000    12.5000    15.3000    17.0000    17.3000    15.1000    11.9000     8.6000     5.8000 (96)
Heat loss rate W
              1865.5526  1842.7039  1673.5942  1388.8496  1021.2905   657.5423   441.3454   402.0706   684.8112  1099.4328  1500.7424  1828.0328 (97)
Month fracti     1.0000     1.0000     1.0000     1.0000     0.0000     0.0000     0.0000     0.0000     0.0000     1.0000     1.0000     1.0000 (97a)
Space heating kWh
               443.9042   253.8522    89.1920     8.3770     0.5301     0.0000     0.0000     0.0000     0.0000    14.9249   194.4437   488.7038 (98)
Space heating                                                                                                                 1493.9278 (98)
RHI space heating demand                                                                                                           1494 (98)
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1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000 (1b)	x	2.4500 (2b)	=	240.1000 (1b) - (3b)	
First floor	97.8000 (1c)	x	2.9000 (2c)	=	283.6200 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							0 * 10 =	0.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Measured/design AP50		1.0000	
Infiltration rate		0.0500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0425	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.0542	0.0531	0.0521	0.0468	0.0457	0.0404	0.0404	0.0393	0.0425	0.0457	0.0478	0.0499	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation:	0.5000	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	61.6000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2462	0.2451	0.2441	0.2388	0.2377	0.2324	0.2324	0.2313	0.2345	0.2377	0.2398	0.2419	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 0.90)			43.5100	0.8687	37.7983			(27)
Heat Loss Floor 1			98.0000	0.0000	0.0000			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1100	17.3008			(29a)
External Roof 1	98.2000		98.2000	0.1100	10.8020			(30)
Total net area of external elements Aum(A, m2)			298.9900					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	65.9011			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							19.7788	(36)
Total fabric heat loss					(33) + (36) =		85.6799	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	42.5480	42.3644	42.1807	41.2626	41.0790	40.1608	40.1608	39.9772	40.5281	41.0790	41.4462	41.8135	(38)
Heat transfer coeff	128.2279	128.0442	127.8606	126.9425	126.7588	125.8407	125.8407	125.6570	126.2079	126.7588	127.1261	127.4933	(39)
Average = Sum(39)m / 12 =												126.8965	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6549	0.6540	0.6530	0.6483	0.6474	0.6427	0.6427	0.6418	0.6446	0.6474	0.6493	0.6511	(40)
HLP (average)												0.6481	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9965	(42)
Average daily hot water use (litres/day)	105.3658	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	25.7820	22.5491	23.2686	20.2862	19.4650	16.7969	15.5648	17.8608	18.0741	21.0636	22.9926	24.9685	(46)
Water storage loss:													

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Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.6000	(49)
Enter (49) or (54) in (55)												0.7200	(55)
Total storage loss													
	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(56)
If cylinder contains dedicated solar storage													
	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month													
	194.1998	170.4872	177.4442	156.8410	152.0870	133.5790	126.0850	141.3919	142.0940	162.7441	174.8839	188.7764	(62)
WWHRS	-54.2514	-47.7367	-48.7201	-40.0692	-37.1967	-30.6795	-25.9543	-31.4283	-32.3500	-40.0026	-46.3535	-52.4400	eq.(G10)
Total of WWHRS savings												-487.1822	
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
Solar input (sum of months) = Sum(63)m =												0.0000	(63)
Output from w/h													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(64)
Total per year (kWh/year) = Sum(64)m =												1433.4314	(64)
Heat gains from water heating, kWh/month													
	75.0060	66.1118	69.4348	62.2476	61.0035	54.5130	52.3579	57.4474	57.3443	64.5470	68.2469	73.2028	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	82.6431	73.4028	59.6952	45.1931	33.7824	28.5205	30.8174	40.0576	53.7653	68.2674	79.6781	84.9400	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	547.8150	553.4996	539.1746	508.6783	470.1822	434.0014	409.8303	404.1457	418.4707	448.9670	487.4631	523.6440	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	(71)
Water heating gains (Table 5)													
	100.8146	98.3806	93.3263	86.4551	81.9940	75.7125	70.3735	77.2143	79.6448	86.7568	94.7874	98.3908	(72)
Total internal gains													
	847.1769	841.1873	808.1004	756.2307	701.8628	654.1386	626.9255	637.3218	667.7850	719.8954	777.8328	822.8790	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.1600	10.6334	0.6800	0.7000	0.7700	14.5917	(74)
East	2.8400	19.6403	0.6800	0.7000	0.7700	18.3995	(76)
South	11.6700	46.7521	0.6800	0.7000	0.7700	179.9749	(78)
West	24.8400	19.6403	0.6800	0.7000	0.7700	160.9308	(80)

Solar gains	373.8968	673.4459	1000.5774	1343.0511	1577.3526	1592.3915	1524.6481	1349.5597	1121.1108	767.3754	454.9361	315.1517	(83)
Total gains	1221.0737	1514.6333	1808.6778	2099.2819	2279.2154	2246.5301	2151.5736	1986.8815	1788.8958	1487.2708	1232.7689	1138.0307	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	106.0395	106.1916	106.3441	107.1133	107.2684	108.0511	108.0511	108.2090	107.7367	107.2684	106.9586	106.6505	
alpha	8.0693	8.0794	8.0896	8.1409	8.1512	8.2034	8.2034	8.2139	8.1824	8.1512	8.1306	8.1100	
util living area													
	0.9954	0.9766	0.9007	0.7153	0.5161	0.3584	0.2573	0.2909	0.4861	0.8300	0.9832	0.9972	(86)
MIT	20.5118	20.6929	20.8814	20.9819	20.9986	20.9999	21.0000	21.0000	20.9993	20.9557	20.7071	20.4687	(87)
Th 2	20.3808	20.3817	20.3825	20.3867	20.3875	20.3917	20.3917	20.3926	20.3900	20.3875	20.3859	20.3842	(88)
util rest of house													
	0.9940	0.9706	0.8814	0.6833	0.4825	0.3244	0.2218	0.2525	0.4434	0.7952	0.9779	0.9964	(89)
MIT 2	19.7259	19.9861	20.2429	20.3683	20.3864	20.3917	20.3917	20.3926	20.3896	20.3427	20.0121	19.6660	(90)
Living area fraction									fLA = Living area / (4) =			0.1190	(91)
MIT	19.8194	20.0702	20.3189	20.4413	20.4592	20.4641	20.4641	20.4648	20.4622	20.4157	20.0948	19.7615	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.8194	20.0702	20.3189	20.4413	20.4592	20.4641	20.4641	20.4648	20.4622	20.4157	20.0948	19.7615	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9924	0.9670	0.8793	0.6862	0.4864	0.3285	0.2260	0.2571	0.4485	0.7969	0.9748	0.9953	(94)
Useful gains	1211.7976	1464.7210	1590.3678	1440.4886	1108.6864	737.8845	486.2597	510.7704	802.3250	1185.2089	1201.6653	1132.6470	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	1990.0176	1942.4594	1766.8872	1465.0849	1110.3084	737.9381	486.2616	510.7758	802.9554	1244.2218	1651.9796	1983.9867	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	578.9957	321.0402	131.3304	17.7093	1.2068	0.0000	0.0000	0.0000	0.0000	43.9055	324.2263	633.3967	(98)
Space heating												2051.8111	(98)
Space heating per m2											(98) / (4) =	10.4791	(99)

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8c. Space cooling requirement

Not applicable

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												100.0000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												2051.8111	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	578.9957	321.0402	131.3304	17.7093	1.2068	0.0000	0.0000	0.0000	0.0000	43.9055	324.2263	633.3967	(98)
Space heating efficiency (main heating system 1)													
	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)													
	578.9957	321.0402	131.3304	17.7093	1.2068	0.0000	0.0000	0.0000	0.0000	43.9055	324.2263	633.3967	(211)
Water heating requirement													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(219)
Water heating fuel used												1433.4314	(219)
Annual totals kWh/year													
Space heating fuel - main system												2051.8111	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.2600)													
mechanical ventilation fans (SFP = 1.2600)												805.0624	(230a)
Total electricity for the above, kWh/year												805.0624	(231)
Electricity for lighting (calculated in Appendix L)												583.8010	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 4.00 * 1080 * 0.80) =											-2763.5830	-2763.5830	(233)
Total delivered energy for all uses												2110.5228	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	2051.8111	13.1900	270.6339	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	1433.4314	13.1900	189.0696	(247)
Mechanical ventilation fans	805.0624	13.1900	106.1877	(249)
Pumps and fans for heating	0.0000	0.0000	0.0000	(249)
Energy for lighting	583.8010	13.1900	77.0033	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-2763.5830	13.1900	-364.5166	(252)
Total energy cost			278.3780	(255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.4200	(256)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	0.4855	(257)
SAP value		93.2267	
SAP rating (Section 12)		93	(258)
SAP band		A	

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2051.8111	0.5190	1064.8899	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1433.4314	0.5190	743.9509	(264)
Space and water heating			1808.8409	(265)
Pumps and fans	805.0624	0.5190	417.8274	(267)
Energy for lighting	583.8010	0.5190	302.9927	(268)
Energy saving/generation technologies				
PV Unit	-2763.5830	0.5190	-1434.2996	(269)
Total kg/year			1095.3614	(272)
CO2 emissions per m2			5.5900	(273)
EI value			93.9046	
EI rating			94	(274)
EI band			A	

CALCULATION OF ENERGY RATINGS 09 Jan 2014

Calculation of stars for heating and DHW

Main heating energy efficiency	13.19 × (1 + 0.29 × 0.00) / 1.0000 = 13.190, stars = 1
Main heating environmental impact	0.519 × (1 + 0.29 × 0.00) / 1.0000 = 0.5190, stars = 2
Water heating energy efficiency	13.19 / 1.0000 = 13.190, stars = 2
Water heating environmental impact	0.519 / 1.0000 = 0.5190, stars = 3

CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000 (1b)	x	2.4500 (2b)	=	240.1000 (1b) - (3b)	
First floor	97.8000 (1c)	x	2.9000 (2c)	=	283.6200 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							0 * 10 =	0.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Measured/design AP50		1.0000	
Infiltration rate		0.0500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0425	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	6.0000	5.7000	5.6000	5.0000	5.2000	4.7000	4.8000	4.6000	4.9000	5.4000	5.5000	5.8000	(22)
Wind factor	1.5000	1.4250	1.4000	1.2500	1.3000	1.1750	1.2000	1.1500	1.2250	1.3500	1.3750	1.4500	(22a)
Adj infilt rate	0.0638	0.0606	0.0595	0.0531	0.0553	0.0499	0.0510	0.0489	0.0521	0.0574	0.0584	0.0616	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation:	0.5000	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	61.6000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2558	0.2526	0.2515	0.2451	0.2473	0.2419	0.2430	0.2409	0.2441	0.2494	0.2504	0.2536	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 0.90)			43.5100	0.8687	37.7983			(27)
Heat Loss Floor 1			98.0000	0.0000	0.0000			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1100	17.3008			(29a)
External Roof 1	98.2000		98.2000	0.1100	10.8020			(30)
Total net area of external elements Aum(A, m2)			298.9900					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	65.9011			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	19.7788	(36)
Total fabric heat loss	(33) + (36) = 85.6799	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	44.2007	43.6498	43.4661	42.3644	42.7316	41.8135	41.9971	41.6298	42.1807	43.0989	43.2825	43.8334	(38)
Heat transfer coeff	129.8805	129.3296	129.1460	128.0442	128.4115	127.4933	127.6770	127.3097	127.8606	128.7787	128.9624	129.5133	(39)
Average = Sum(39)m / 12 =												128.5339	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6633	0.6605	0.6596	0.6540	0.6558	0.6511	0.6521	0.6502	0.6530	0.6577	0.6586	0.6615	(40)
HLP (average)												0.6565	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9965	(42)
Average daily hot water use (litres/day)	105.3658	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	25.7820	22.5491	23.2686	20.2862	19.4650	16.7969	15.5648	17.8608	18.0741	21.0636	22.9926	24.9685	(46)
Water storage loss:													

CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.6000	(49)
Enter (49) or (54) in (55)												0.7200	(55)
Total storage loss													
	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(56)
If cylinder contains dedicated solar storage													
	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month													
	194.1998	170.4872	177.4442	156.8410	152.0870	133.5790	126.0850	141.3919	142.0940	162.7441	174.8839	188.7764	(62)
WWHRS	-54.2514	-47.7367	-48.7201	-40.0692	-37.1967	-30.6795	-25.9543	-31.4283	-32.3500	-40.0026	-46.3535	-52.4400	eq.(G10)
Total of WWHRS savings												-487.1822	
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
Solar input (sum of months) = Sum(63)m =												0.0000	(63)
Output from w/h													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(64)
Total per year (kWh/year) = Sum(64)m =												1433.4314	(64)
Heat gains from water heating, kWh/month													
	75.0060	66.1118	69.4348	62.2476	61.0035	54.5130	52.3579	57.4474	57.3443	64.5470	68.2469	73.2028	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	82.6431	73.4028	59.6952	45.1931	33.7824	28.5205	30.8174	40.0576	53.7653	68.2674	79.6781	84.9400	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	547.8150	553.4996	539.1746	508.6783	470.1822	434.0014	409.8303	404.1457	418.4707	448.9670	487.4631	523.6440	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	(71)
Water heating gains (Table 5)													
	100.8146	98.3806	93.3263	86.4551	81.9940	75.7125	70.3735	77.2143	79.6448	86.7568	94.7874	98.3908	(72)
Total internal gains													
	847.1769	841.1873	808.1004	756.2307	701.8628	654.1386	626.9255	637.3218	667.7850	719.8954	777.8328	822.8790	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.1600	12.7650	0.6800	0.7000	0.7700	17.5168	(74)
East	2.8400	23.8018	0.6800	0.7000	0.7700	22.2981	(76)
South	11.6700	54.2217	0.6800	0.7000	0.7700	208.7297	(78)
West	24.8400	23.8018	0.6800	0.7000	0.7700	195.0298	(80)

Solar gains	443.5744	698.7284	1042.5699	1472.1030	1642.3517	1816.2677	1670.9123	1501.5265	1253.4137	843.7820	531.7904	361.5142	(83)
Total gains	1290.7513	1539.9157	1850.6702	2228.3338	2344.2145	2470.4064	2297.8378	2138.8483	1921.1987	1563.6774	1309.6232	1184.3932	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	104.6902	105.1362	105.2857	106.1916	105.8879	106.6505	106.4971	106.8043	106.3441	105.5859	105.4356	104.9871	
alpha	7.9793	8.0091	8.0190	8.0794	8.0592	8.1100	8.0998	8.1203	8.0896	8.0391	8.0290	7.9991	
util living area													
	0.9890	0.9643	0.8645	0.6475	0.4651	0.2942	0.2223	0.2202	0.3925	0.7295	0.9564	0.9931	(86)
MIT	20.6192	20.7535	20.9176	20.9911	20.9994	21.0000	21.0000	21.0000	20.9999	20.9836	20.8174	20.5828	(87)
Th 2	20.3733	20.3758	20.3767	20.3817	20.3800	20.3842	20.3834	20.3850	20.3825	20.3783	20.3775	20.3750	(88)
util rest of house													
	0.9858	0.9552	0.8403	0.6145	0.4314	0.2624	0.1880	0.1836	0.3515	0.6860	0.9432	0.9909	(89)
MIT 2	19.8751	20.0663	20.2835	20.3731	20.3795	20.3842	20.3834	20.3850	20.3824	20.3636	20.1587	19.8244	(90)
Living area fraction									fLA = Living area / (4) =			0.1190	(91)
MIT	19.9636	20.1481	20.3589	20.4466	20.4533	20.4575	20.4567	20.4582	20.4559	20.4374	20.2371	19.9146	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.9636	20.1481	20.3589	20.4466	20.4533	20.4575	20.4567	20.4582	20.4559	20.4374	20.2371	19.9146	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9831	0.9513	0.8395	0.6180	0.4354	0.2662	0.1921	0.1880	0.3564	0.6903	0.9397	0.9888	(94)
Useful gains	1268.9071	1464.9476	1553.7125	1377.2149	1020.5780	657.5318	441.3449	402.0702	684.7065	1079.3725	1230.6817	1171.1729	(95)
Ext temp.	5.6000	5.9000	7.4000	9.6000	12.5000	15.3000	17.0000	17.3000	15.1000	11.9000	8.6000	5.8000	(96)
Heat loss rate W													
	1865.5526	1842.7039	1673.5942	1388.8496	1021.2905	657.5423	441.3454	402.0706	684.8112	1099.4328	1500.7424	1828.0328	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	443.9042	253.8522	89.1920	8.3770	0.5301	0.0000	0.0000	0.0000	0.0000	14.9249	194.4437	488.7038	(98)
Space heating												1493.9278	(98)
Space heating per m2											(98) / (4) =	7.6299	(99)

CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

8c. Space cooling requirement

Not applicable

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												100.0000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												1493.9278	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	443.9042	253.8522	89.1920	8.3770	0.5301	0.0000	0.0000	0.0000	0.0000	14.9249	194.4437	488.7038	(98)
Space heating efficiency (main heating system 1)													
	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)													
	443.9042	253.8522	89.1920	8.3770	0.5301	0.0000	0.0000	0.0000	0.0000	14.9249	194.4437	488.7038	(211)
Water heating requirement													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month													
	139.9484	122.7505	128.7240	116.7718	114.8903	102.8995	100.1307	109.9636	109.7440	122.7416	128.5304	136.3364	(219)
Water heating fuel used												1433.4314	(219)
Annual totals kWh/year													
Space heating fuel - main system												1493.9278	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.2600)													
mechanical ventilation fans (SFP = 1.2600)												805.0624	(230a)
Total electricity for the above, kWh/year												805.0624	(231)
Electricity for lighting (calculated in Appendix L)												583.8010	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 4.00 * 1190 * 0.80) =												-3046.7795	(233)
Total delivered energy for all uses												1269.4431	(238)

10a. Fuel costs - using BEDF prices (479)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1493.9278	19.1200	285.6390	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	1433.4314	19.1200	274.0721	(247)
Mechanical ventilation fans	805.0624	19.1200	153.9279	(249)
Pumps and fans for heating	0.0000	0.0000	0.0000	(249)
Energy for lighting	583.8010	19.1200	111.6227	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-3046.7795	19.1200	-582.5442	(252)
Total energy cost			242.7175	(255)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1493.9278	0.5190	775.3485	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1433.4314	0.5190	743.9509	(264)
Space and water heating			1519.2994	(265)
Pumps and fans	805.0624	0.5190	417.8274	(267)
Energy for lighting	583.8010	0.5190	302.9927	(268)
Energy saving/generation technologies				
PV Unit	-3046.7795	0.5190	-1581.2786	(269)
Total kg/year			658.8410	(272)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1493.9278	3.0700	4586.3583	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1433.4314	3.0700	4400.6345	(264)
Space and water heating			8986.9929	(265)
Pumps and fans	805.0624	3.0700	2471.5415	(267)
Energy for lighting	583.8010	3.0700	1792.2690	(268)
Energy saving/generation technologies				

CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

PV Unit	-3046.7795	3.0700	-9353.6130 (269)
Primary energy kWh/year			3897.1904 (272)
Primary energy kWh/m2/year			19.9039 (273)

SAP 2012 EPC IMPROVEMENTS

Current energy efficiency rating: A 93
Current environmental impact rating: A 94

(For testing purposes):

A	Not considered
B	Not considered
C	Not considered
D	Not considered
E Low energy lighting	Already installed
F	Not considered
G	Not considered
H	Not considered
I	Not considered
J	Not considered
K	Not considered
M	Not considered
N Solar water heating	Recommended
O	Not considered
P	Not considered
R	Not considered
S	Not considered
T	Not considered
U Solar photovoltaic panels	Already installed
A2	Not considered
A3	Not considered
T2	Not considered
W	Not considered
X	Not considered
Y	Not considered
J2	Not considered
Q2	Not considered
Z1	Not considered
Z2	Not considered
Z3	Not considered
Z4	Not considered
Z5	Not considered
V2 Wind turbine	Not applicable
L2	Not considered
Q3	Not considered
O3	Not considered

Recommended measures:	SAP change	Cost change	CO2 change
N Solar water heating	+ 2.4	-£ 146	-395 kg (60.0%)

	Typical annual savings		Energy efficiency	Environmental impact
Recommended measures				
Solar water heating	£146	2.02 kg/m²	A 96	A 96
Total Savings	£146	2.02 kg/m²		

Potential energy efficiency rating: A 96
Potential environmental impact rating: A 96

Fuel prices for cost data on this page from database revision number 479 TEST (30 Jun 2021)
Recommendation texts revision number 4.9c (22 Feb 2014)

Typical heating and lighting costs of this home (per year, Severn Valley):

	Current	Potential	Saving
Electricity	£825	£680	£146
Space heating	£440	£442	-£3
Water heating	£274	£126	£148
Lighting	£112	£112	£0
Generated (PV)	-£583	-£583	£0
Total cost of fuels	£242	£97	£146
Total cost of uses	£243	£97	£145
Delivered energy	6 kWh/m²	3 kWh/m²	4 kWh/m²
Carbon dioxide emissions	0.7 tonnes	0.3 tonnes	0.4 tonnes
CO2 emissions per m²	3 kg/m²	1 kg/m²	2 kg/m²
Primary energy	20 kWh/m²	8 kWh/m²	12 kWh/m²

CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000 (1b)	x	2.4500 (2b)	=	240.1000 (1b) - (3b)	
First floor	97.8000 (1c)	x	2.9000 (2c)	=	283.6200 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							0 * 10 =	0.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Measured/design AP50		1.0000	
Infiltration rate		0.0500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0425	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.0542	0.0531	0.0521	0.0468	0.0457	0.0404	0.0404	0.0393	0.0425	0.0457	0.0478	0.0499	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation:	0.5000	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	61.6000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2462	0.2451	0.2441	0.2388	0.2377	0.2324	0.2324	0.2313	0.2345	0.2377	0.2398	0.2419	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 0.90)			43.5100	0.8687	37.7983			(27)
Heat Loss Floor 1			98.0000	0.0000	0.0000			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1100	17.3008			(29a)
External Roof 1	98.2000		98.2000	0.1100	10.8020			(30)
Total net area of external elements Aum(A, m2)			298.9900					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	65.9011			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	19.7788	(36)
Total fabric heat loss	(33) + (36) = 85.6799	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	42.5480	42.3644	42.1807	41.2626	41.0790	40.1608	40.1608	39.9772	40.5281	41.0790	41.4462	41.8135	(38)
Heat transfer coeff	128.2279	128.0442	127.8606	126.9425	126.7588	125.8407	125.8407	125.6570	126.2079	126.7588	127.1261	127.4933	(39)
Average = Sum(39)m / 12 =												126.8965	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6549	0.6540	0.6530	0.6483	0.6474	0.6427	0.6427	0.6418	0.6446	0.6474	0.6493	0.6511	(40)
HLP (average)												0.6481	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9965 (42)
Average daily hot water use (litres/day)	105.3658 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	25.7820	22.5491	23.2686	20.2862	19.4650	16.7969	15.5648	17.8608	18.0741	21.0636	22.9926	24.9685	(46)
Water storage loss:													

CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.6000	(49)
Enter (49) or (54) in (55)												0.7200	(55)
Total storage loss													
	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(56)
If cylinder contains dedicated solar storage													
	16.7400	15.1200	16.7400	16.2000	16.7400	16.2000	16.7400	16.7400	16.2000	16.7400	16.2000	16.7400	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month													
	188.6198	165.4472	171.8642	151.4410	146.5070	128.1790	120.5050	135.8119	136.6940	157.1641	169.4839	183.1964	(62)
WWHRS	-54.2514	-47.7367	-48.7201	-40.0692	-37.1967	-30.6795	-25.9543	-31.4283	-32.3500	-40.0026	-46.3535	-52.4400	eq.(G10)
Total of WWHRS savings												-487.1822	
Aperture area of solar collector												3.0000	(H1)
Zero-loss collector efficiency												0.7000	(H2)
Collector heat loss coefficient												1.8000	(H3)
Collector 2nd order heat loss coefficient												0.0050	(H3a)
Collector effective heat loss coefficient												1.8063	(H3b)
Collector performance ratio												2.5804	(H4)
Annual solar radiation per m2												1079.5246	(H5)
Overshading factor												0.8000	(H6)
Solar energy available												1813.6014	(H7)
Adjustment factor for showers												1.0000	(H7a)
Solar-to-load ratio												1.5493	(H8)
Utilisation factor												0.4756	(H9)
Collector performance factor												0.8793	(H10)
Dedicated solar storage volume												75.0000	(H11)
Effective solar volume												142.5000	(H13)
Daily hot water demand												105.3658	(H14)
Volume ratio Veff/V												1.3524	(H15)
Solar storage volume factor												1.0000	(H16)
Solar input												-758.4108	(H17)
Solar input	-21.9924	-36.6990	-62.5026	-83.7658	-103.4856	-101.7428	-100.3982	-87.7184	-68.7011	-46.9148	-26.0862	-18.4039	(63)
								Solar input (sum of months) = Sum(63)m =				-758.4108	(63)
Output from w/h													
	112.3760	81.0115	60.6414	27.6060	5.8247	0.0000	0.0000	16.6652	35.6429	70.2468	97.0443	112.3525	(64)
								Total per year (kWh/year) = Sum(64)m =				619.4114	(64)
Heat gains from water heating, kWh/month													
	70.5420	62.0798	64.9708	57.9276	56.5395	50.1930	47.8939	52.9834	53.0243	60.0830	63.9269	68.7388	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	82.6431	73.4028	59.6952	45.1931	33.7824	28.5205	30.8174	40.0576	53.7653	68.2674	79.6781	84.9400	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	547.8150	553.4996	539.1746	508.6783	470.1822	434.0014	409.8303	404.1457	418.4707	448.9670	487.4631	523.6440	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	(71)
Water heating gains (Table 5)													
	94.8146	92.3806	87.3263	80.4551	75.9940	69.7125	64.3735	71.2143	73.6448	80.7568	88.7874	92.3908	(72)
Total internal gains													
	841.1769	835.1873	802.1004	750.2307	695.8628	648.1386	620.9255	631.3218	661.7850	713.8954	771.8328	816.8790	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.1600	10.6334	0.6800	0.7000	0.7700	14.5917	(74)
East	2.8400	19.6403	0.6800	0.7000	0.7700	18.3995	(76)
South	11.6700	46.7521	0.6800	0.7000	0.7700	179.9749	(78)
West	24.8400	19.6403	0.6800	0.7000	0.7700	160.9308	(80)

Solar gains	373.8968	673.4459	1000.5774	1343.0511	1577.3526	1592.3915	1524.6481	1349.5597	1121.1108	767.3754	454.9361	315.1517	(83)
Total gains	1215.0737	1508.6333	1802.6778	2093.2819	2273.2154	2240.5301	2145.5736	1980.8815	1782.8958	1481.2708	1226.7689	1132.0307	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	106.0395	106.1916	106.3441	107.1133	107.2684	108.0511	108.0511	108.2090	107.7367	107.2684	106.9586	106.6505	
alpha	8.0693	8.0794	8.0896	8.1409	8.1512	8.2034	8.2034	8.2139	8.1824	8.1512	8.1306	8.1100	
util living area													
	0.9955	0.9771	0.9021	0.7171	0.5174	0.3594	0.2581	0.2918	0.4877	0.8322	0.9837	0.9973	(86)
MIT	20.5088	20.6903	20.8798	20.9815	20.9986	20.9999	21.0000	21.0000	20.9993	20.9548	20.7043	20.4656	(87)
Th 2	20.3808	20.3817	20.3825	20.3867	20.3875	20.3917	20.3917	20.3926	20.3900	20.3875	20.3859	20.3842	(88)
util rest of house													
	0.9942	0.9713	0.8830	0.6850	0.4838	0.3253	0.2224	0.2533	0.4449	0.7976	0.9785	0.9965	(89)
MIT 2	19.7214	19.9824	20.2409	20.3680	20.3863	20.3917	20.3917	20.3926	20.3896	20.3418	20.0082	19.6615	(90)
Living area fraction									fLA = Living area / (4) =			0.1190	(91)
MIT	19.8151	20.0666	20.3170	20.4410	20.4592	20.4641	20.4641	20.4648	20.4622	20.4147	20.0910	19.7572	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.8151	20.0666	20.3170	20.4410	20.4592	20.4641	20.4641	20.4648	20.4622	20.4147	20.0910	19.7572	(93)

CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9926	0.9677	0.8808	0.6879	0.4877	0.3293	0.2266	0.2578	0.4500	0.7992	0.9754	0.9954	(94)
Useful gains	1206.1221	1459.9484	1587.7763	1440.0133	1108.6524	737.8833	486.2596	510.7702	802.3077	1183.8608	1196.6401	1126.8554	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	1989.4715	1941.9981	1766.6448	1465.0434	1110.3055	737.9380	486.2616	510.7758	802.9539	1244.1009	1651.4970	1983.4336	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	582.8119	323.9374	133.0782	18.0217	1.2300	0.0000	0.0000	0.0000	0.0000	44.8187	327.4970	637.2942	(98)
Space heating												2068.6889	(98)
Space heating per m2											(98) / (4) =	10.5653	(99)

8c. Space cooling requirement

Not applicable

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	2068.6889	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	582.8119	323.9374	133.0782	18.0217	1.2300	0.0000	0.0000	0.0000	0.0000	44.8187	327.4970	637.2942	(98)
Space heating efficiency (main heating system 1)													
	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)													
	582.8119	323.9374	133.0782	18.0217	1.2300	0.0000	0.0000	0.0000	0.0000	44.8187	327.4970	637.2942	(211)
Water heating requirement													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	112.3760	81.0115	60.6414	27.6060	5.8247	0.0000	0.0000	16.6652	35.6429	70.2468	97.0443	112.3525	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month													
	112.3760	81.0115	60.6414	27.6060	5.8247	0.0000	0.0000	16.6652	35.6429	70.2468	97.0443	112.3525	(219)
Water heating fuel used												619.4114	(219)
Annual totals kWh/year													
Space heating fuel - main system												2068.6889	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.2600)													
mechanical ventilation fans (SFP = 1.2600)												805.0624	(230a)
pump for solar water heating												50.0000	(230g)
Total electricity for the above, kWh/year												855.0624	(231)
Electricity for lighting (calculated in Appendix L)												583.8010	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 4.00 * 1080 * 0.80) =										-2763.5830		-2763.5830	(233)
Total delivered energy for all uses												1363.3806	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	2068.6889	13.1900	272.8601	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	619.4114	13.1900	81.7004	(247)
Mechanical ventilation fans	805.0624	13.1900	106.1877	(249)
Pumps and fans for heating	0.0000	0.0000	0.0000	(249)
Pump for solar water heating	50.0000	13.1900	6.5950	(249)
Energy for lighting	583.8010	13.1900	77.0033	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-2763.5830	13.1900	-364.5166	(252)
Total energy cost			179.8299	(255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):	0.4200	(256)
Energy cost factor (ECF) [(255) x (256)] / [(4) + 45.0] =	0.3137	(257)
SAP value	95.6245	
SAP rating (Section 12)	96	(258)
SAP band	A	

CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2068.6889	0.5190	1073.6495	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	619.4114	0.5190	321.4745	(264)
Space and water heating			1395.1240	(265)
Pumps and fans	855.0624	0.5190	443.7774	(267)
Energy for lighting	583.8010	0.5190	302.9927	(268)
Energy saving/generation technologies				
PV Unit	-2763.5830	0.5190	-1434.2996	(269)
Total kg/year			707.5945	(272)
CO2 emissions per m2			3.6100	(273)
EI value			96.0624	
EI rating			96	(274)
EI band			A	

CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	98.0000 (1b)	x	2.4500 (2b)	=	240.1000 (1b) - (3b)	
First floor	97.8000 (1c)	x	2.9000 (2c)	=	283.6200 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	195.8000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	523.7200	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							0 * 10 =	0.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Measured/design AP50		1.0000	
Infiltration rate		0.0500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0425	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	6.0000	5.7000	5.6000	5.0000	5.2000	4.7000	4.8000	4.6000	4.9000	5.4000	5.5000	5.8000	(22)
Wind factor	1.5000	1.4250	1.4000	1.2500	1.3000	1.1750	1.2000	1.1500	1.2250	1.3500	1.3750	1.4500	(22a)
Adj infilt rate	0.0638	0.0606	0.0595	0.0531	0.0553	0.0499	0.0510	0.0489	0.0521	0.0574	0.0584	0.0616	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation:	0.5000	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	61.6000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2558	0.2526	0.2515	0.2451	0.2473	0.2419	0.2430	0.2409	0.2441	0.2494	0.2504	0.2536	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 0.90)			43.5100	0.8687	37.7983			(27)
Heat Loss Floor 1			98.0000	0.0000	0.0000			(28a)
External Wall 1	200.7900	43.5100	157.2800	0.1100	17.3008			(29a)
External Roof 1	98.2000		98.2000	0.1100	10.8020			(30)
Total net area of external elements Aum(A, m2)			298.9900					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	65.9011			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	19.7788	(36)
Total fabric heat loss	(33) + (36) = 85.6799	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	44.2007	43.6498	43.4661	42.3644	42.7316	41.8135	41.9971	41.6298	42.1807	43.0989	43.2825	43.8334	(38)
Heat transfer coeff	129.8805	129.3296	129.1460	128.0442	128.4115	127.4933	127.6770	127.3097	127.8606	128.7787	128.9624	129.5133	(39)
Average = Sum(39)m / 12 =												128.5339	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6633	0.6605	0.6596	0.6540	0.6558	0.6511	0.6521	0.6502	0.6530	0.6577	0.6586	0.6615	(40)
HLP (average)												0.6565	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9965	(42)
Average daily hot water use (litres/day)	105.3658	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	115.9023	111.6877	107.4731	103.2584	99.0438	94.8292	94.8292	99.0438	103.2584	107.4731	111.6877	115.9023	(44)
Energy conte	171.8798	150.3272	155.1242	135.2410	129.7670	111.9790	103.7650	119.0719	120.4940	140.4241	153.2839	166.4564	(45)
Energy content (annual)										Total = Sum(45)m =		1657.8137	(45)
Distribution loss (46)m = 0.15 x (45)m	25.7820	22.5491	23.2686	20.2862	19.4650	16.7969	15.5648	17.8608	18.0741	21.0636	22.9926	24.9685	(46)
Water storage loss:													

CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.6000	(49)
Enter (49) or (54) in (55)												0.7200	(55)
Total storage loss													
	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(56)
If cylinder contains dedicated solar storage													
	16.7400	15.1200	16.7400	16.2000	16.7400	16.2000	16.7400	16.7400	16.2000	16.7400	16.2000	16.7400	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month													
	188.6198	165.4472	171.8642	151.4410	146.5070	128.1790	120.5050	135.8119	136.6940	157.1641	169.4839	183.1964	(62)
WWHRS	-54.2514	-47.7367	-48.7201	-40.0692	-37.1967	-30.6795	-25.9543	-31.4283	-32.3500	-40.0026	-46.3535	-52.4400	eq.(G10)
Total of WWHRS savings												-487.1822	
Aperture area of solar collector												3.0000	(H1)
Zero-loss collector efficiency												0.7000	(H2)
Collector heat loss coefficient												1.8000	(H3)
Collector 2nd order heat loss coefficient												0.0050	(H3a)
Collector effective heat loss coefficient												1.8063	(H3b)
Collector performance ratio												2.5804	(H4)
Annual solar radiation per m2												1190.1482	(H5)
Overshading factor												0.8000	(H6)
Solar energy available												1999.4490	(H7)
Adjustment factor for showers												1.0000	(H7a)
Solar-to-load ratio												1.7080	(H8)
Utilisation factor												0.4432	(H9)
Collector performance factor												0.8793	(H10)
Dedicated solar storage volume												75.0000	(H11)
Effective solar volume												142.5000	(H13)
Daily hot water demand												105.3658	(H14)
Volume ratio Veff/V												1.3524	(H15)
Solar storage volume factor												1.0000	(H16)
Solar input												-779.1204	(H17)
Solar input	-24.4670	-35.7111	-61.0458	-85.9400	-100.7163	-108.4028	-102.8102	-91.2971	-71.9613	-48.3760	-28.5973	-19.7955	(63)
								Solar input (sum of months) = Sum(63)m =				-779.1204	(63)
Output from w/h													
	109.9014	81.9995	62.0983	25.4318	8.5940	0.0000	0.0000	13.0865	32.3828	68.7855	94.5331	110.9609	(64)
								Total per year (kWh/year) = Sum(64)m =				607.7738	(64)
Heat gains from water heating, kWh/month													
	70.5420	62.0798	64.9708	57.9276	56.5395	50.1930	47.8939	52.9834	53.0243	60.0830	63.9269	68.7388	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	179.7872	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	82.6431	73.4028	59.6952	45.1931	33.7824	28.5205	30.8174	40.0576	53.7653	68.2674	79.6781	84.9400	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	547.8150	553.4996	539.1746	508.6783	470.1822	434.0014	409.8303	404.1457	418.4707	448.9670	487.4631	523.6440	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	55.9752	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	-119.8581	(71)
Water heating gains (Table 5)													
	94.8146	92.3806	87.3263	80.4551	75.9940	69.7125	64.3735	71.2143	73.6448	80.7568	88.7874	92.3908	(72)
Total internal gains													
	841.1769	835.1873	802.1004	750.2307	695.8628	648.1386	620.9255	631.3218	661.7850	713.8954	771.8328	816.8790	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.1600	12.7650	0.6800	0.7000	0.7700	17.5168	(74)
East	2.8400	23.8018	0.6800	0.7000	0.7700	22.2981	(76)
South	11.6700	54.2217	0.6800	0.7000	0.7700	208.7297	(78)
West	24.8400	23.8018	0.6800	0.7000	0.7700	195.0298	(80)

Solar gains	443.5744	698.7284	1042.5699	1472.1030	1642.3517	1816.2677	1670.9123	1501.5265	1253.4137	843.7820	531.7904	361.5142	(83)
Total gains	1284.7513	1533.9157	1844.6702	2222.3338	2338.2145	2464.4064	2291.8378	2132.8483	1915.1987	1557.6774	1303.6232	1178.3932	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	104.6902	105.1362	105.2857	106.1916	105.8879	106.6505	106.4971	106.8043	106.3441	105.5859	105.4356	104.9871	
alpha	7.9793	8.0091	8.0190	8.0794	8.0592	8.1100	8.0998	8.1203	8.0896	8.0391	8.0290	7.9991	
util living area													
	0.9893	0.9650	0.8661	0.6491	0.4663	0.2949	0.2228	0.2209	0.3938	0.7319	0.9574	0.9933	(86)
MIT	20.6163	20.7511	20.9164	20.9910	20.9993	21.0000	21.0000	21.0000	20.9999	20.9832	20.8151	20.5798	(87)
Th 2	20.3733	20.3758	20.3767	20.3817	20.3800	20.3842	20.3834	20.3850	20.3825	20.3783	20.3775	20.3750	(88)
util rest of house													
	0.9862	0.9561	0.8420	0.6161	0.4325	0.2630	0.1885	0.1841	0.3526	0.6884	0.9445	0.9912	(89)
MIT 2	19.8709	20.0630	20.2821	20.3729	20.3795	20.3842	20.3834	20.3850	20.3824	20.3633	20.1556	19.8201	(90)
Living area fraction									fLA = Living area / (4) =			0.1190	(91)
MIT	19.9596	20.1449	20.3575	20.4465	20.4533	20.4575	20.4567	20.4582	20.4559	20.4370	20.2341	19.9105	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.9596	20.1449	20.3575	20.4465	20.4533	20.4575	20.4567	20.4582	20.4559	20.4370	20.2341	19.9105	(93)

CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9835	0.9522	0.8412	0.6196	0.4365	0.2668	0.1926	0.1885	0.3575	0.6926	0.9410	0.9892	(94)
Useful gains	1263.5804	1460.6444	1551.7775	1376.9894	1020.5633	657.5316	441.3449	402.0702	684.7038	1078.8610	1226.7018	1165.6336	(95)
Ext temp.	5.6000	5.9000	7.4000	9.6000	12.5000	15.3000	17.0000	17.3000	15.1000	11.9000	8.6000	5.8000	(96)
Heat loss rate W	1865.0319	1842.2856	1673.4147	1388.8299	1021.2893	657.5423	441.3454	402.0706	684.8110	1099.3876	1500.3581	1827.4939	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	447.4799	256.4629	90.4980	8.5252	0.5401	0.0000	0.0000	0.0000	0.0000	15.2718	197.0326	492.4241	(98)
Space heating												1508.2346	(98)
Space heating per m2											(98) / (4) =	7.7029	(99)

8c. Space cooling requirement

Not applicable

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	1508.2346	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	447.4799	256.4629	90.4980	8.5252	0.5401	0.0000	0.0000	0.0000	0.0000	15.2718	197.0326	492.4241	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	447.4799	256.4629	90.4980	8.5252	0.5401	0.0000	0.0000	0.0000	0.0000	15.2718	197.0326	492.4241	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	109.9014	81.9995	62.0983	25.4318	8.5940	0.0000	0.0000	13.0865	32.3828	68.7855	94.5331	110.9609	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month	109.9014	81.9995	62.0983	25.4318	8.5940	0.0000	0.0000	13.0865	32.3828	68.7855	94.5331	110.9609	(219)
Water heating fuel used												607.7738	(219)
Annual totals kWh/year													
Space heating fuel - main system												1508.2346	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.2600)													
mechanical ventilation fans (SFP = 1.2600)												805.0624	(230a)
pump for solar water heating												50.0000	(230g)
Total electricity for the above, kWh/year												855.0624	(231)
Electricity for lighting (calculated in Appendix L)												583.8010	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 4.00 * 1190 * 0.80) =										-3046.7795		-3046.7795	(233)
Total delivered energy for all uses												508.0922	(238)

10a. Fuel costs - using BEDF prices (479)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1508.2346	19.1200	288.3744	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	607.7738	19.1200	116.2063	(247)
Mechanical ventilation fans	805.0624	19.1200	153.9279	(249)
Pumps and fans for heating	0.0000	0.0000	0.0000	(249)
Pump for solar water heating	50.0000	19.1200	9.5600	(249)
Energy for lighting	583.8010	19.1200	111.6227	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-3046.7795	19.1200	-582.5442	(252)
Total energy cost			97.1472	(255)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1508.2346	0.5190	782.7737	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	607.7738	0.5190	315.4346	(264)
Space and water heating			1098.2083	(265)
Pumps and fans	855.0624	0.5190	443.7774	(267)

CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

Energy for lighting	583.8010	0.5190	302.9927 (268)
Energy saving/generation technologies			
PV Unit	-3046.7795	0.5190	-1581.2786 (269)
Total kg/year			263.6999 (272)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	1508.2346	3.0700	4630.2801 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	607.7738	3.0700	1865.8655 (264)
Space and water heating			6496.1456 (265)
Pumps and fans	855.0624	3.0700	2625.0415 (267)
Energy for lighting	583.8010	3.0700	1792.2690 (268)
Energy saving/generation technologies			
PV Unit	-3046.7795	3.0700	-9353.6130 (269)
Primary energy kWh/year			1559.8432 (272)
Primary energy kWh/m2/year			7.9665 (273)

SAP 2012 OVERHEATING ASSESSMENT FOR New Build (As Designed) 9.92

Overheating Calculation Input Data

Dwelling type	Detached House
Number of storeys	2
Cross ventilation possible	Yes
SAP Region	Severn Valley
Front of dwelling faces	North
Overshading	Average or unknown
Thermal mass parameter	250.0
Night ventilation	Yes
Ventilation rate during hot weather (ach)	4.00 (Windows half open)

Overheating Calculation

Summer ventilation heat loss coefficient	691.31 (P1)
Transmission heat loss coefficient	85.68 (37)
Summer heat loss coefficient	776.99 (P2)

Overhangs

Orientation	Ratio	Z_overhangs	Overhang type
North	0.000	1.000	None
East	0.000	1.000	None
South	0.000	1.000	None
West	0.000	1.000	None

Solar shading

Orientation	Z blinds	Solar access	Z overhangs	Z summer
North	0.940	0.90	1.000	0.846 (P8)
East	0.940	0.90	1.000	0.846 (P8)
South	1.000	0.90	1.000	0.900 (P8)
West	0.940	0.90	1.000	0.846 (P8)

[Jul]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Shading	Gains W
North	4.1600	82.4373	0.6800	0.7000	0.8460	124.2903
East	2.8400	119.1985	0.6800	0.7000	0.8460	122.6899
South	11.6700	113.6726	0.6800	0.7000	0.9000	511.4683
West	24.8400	119.1985	0.6800	0.7000	0.8460	1073.1049
total:						1831.5534

	Jun	Jul	Aug	
Solar gains	1985	1832	1652	(P3)
Internal gains	654	627	637	
Total summer gains	2639	2458	2289	(P5)
Summer gain/loss ratio	3.40	3.16	2.95	(P6)
Summer external temperature	15.00	16.70	16.70	
Thermal mass temperature increment (TMP = 250.0)	0.25	0.25	0.25	
Threshold temperature	18.65	20.11	19.90	(P7)
Likelihood of high internal temperature	Not significant	Not significant	Not significant	

Assessment of likelihood of high internal temperature: Not significant

BASIC COMPLIANCE REPORT
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Property Reference	000085	**Issued on Date**	03/12/2021
Assessment Reference	001	**Prop Type Ref**	
Property	40 , Ham Green, Pill, North Somerset, BS20 0HA		

SAP Rating	93 A	**DER**	7.78	**TER**	20.85
Environmental	94 A	**% DER<TER**	62.68		
CO_2 Emissions (t/year)	0.66	**DFEE**	31.82	**TFEE**	52.84
General Requirements Compliance	Pass	**% DFEE<TFEE**	39.78		

Assessor Details	Ms. Laura Meehan, M Sustainability, Tel: 07852802823, laura@msustainability.co.uk	**Assessor ID**	Z762-0001
Client	Jerry Evans, Jerry Evans		

SUMARY FOR INPUT DATA FOR New Build (As Designed)

Criterion 1 – Achieving the TER and TFEE rate

1a TER and DER

Fuel for main heating	Electricity		
Fuel factor	1.55 (electricity)		
Target Carbon Dioxide Emission Rate (TER)	20.85	$kgCO_2/m^2$	
Dwelling Carbon Dioxide Emission Rate (DER)	7.78	$kgCO_2/m^2$	Pass
	-13.07 (-62.7%)	$kgCO_2/m^2$	

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	52.84	$kWh/m^2/yr$	
Dwelling Fabric Energy Efficiency (DFEE)	31.82	$kWh/m^2/yr$	
	-21.0 (-39.8%)	$kWh/m^2/yr$	Pass

Criterion 2 – Limits on design flexibility

Limiting Fabric Standards

2 Fabric U-values

Element	Average	Highest	
External wall	0.11 (max. 0.30)	0.11 (max. 0.70)	Pass
Roof	0.11 (max. 0.20)	0.11 (max. 0.35)	Pass
Openings	0.90 (max. 2.00)	0.90 (max. 3.30)	Pass

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

Air permeability at 50 pascals	1.00 (design value)	
Maximum	10.0	Pass

Limiting System Efficiencies

4 Heating efficiency

Main heating system	Room heaters - Electric Panel, convector or radiant heaters	
Secondary heating system	None	

5 Cylinder insulation

Hot water storage	Measured cylinder loss: 1.20 kWh/day Permitted by DBSCG 2.86		Pass
Primary pipework insulated	No primary pipework		

6 Controls

Space heating controls	Programmer and appliance thermostats		Pass
Hot water controls	Cylinderstat		Pass

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100	%	
Minimum	75	%	Pass

8 Mechanical ventilation

Continuous supply and extract system			
Specific fan power	0.90		
Maximum	1.5		Pass
MVHR efficiency	88	%	
Minimum	70	%	Pass

Criterion 3 – Limiting the effects of heat gains in summer

9 Summertime temperature

Overheating risk (Severn Valley)	Not significant	Pass

Based on:

Overshading	Average
Windows facing North	4.16 m², No overhang
Windows facing East	2.84 m², No overhang
Windows facing South	11.67 m², No overhang
Windows facing West	24.84 m², No overhang
Air change rate	4.00 ach
Blinds/curtains	Dark-coloured venetian blind, closed 50% of daylight hours

Criterion 4 – Building performance consistent with DER and DFEE rate

Air permeability and pressure testing

3 Air permeability

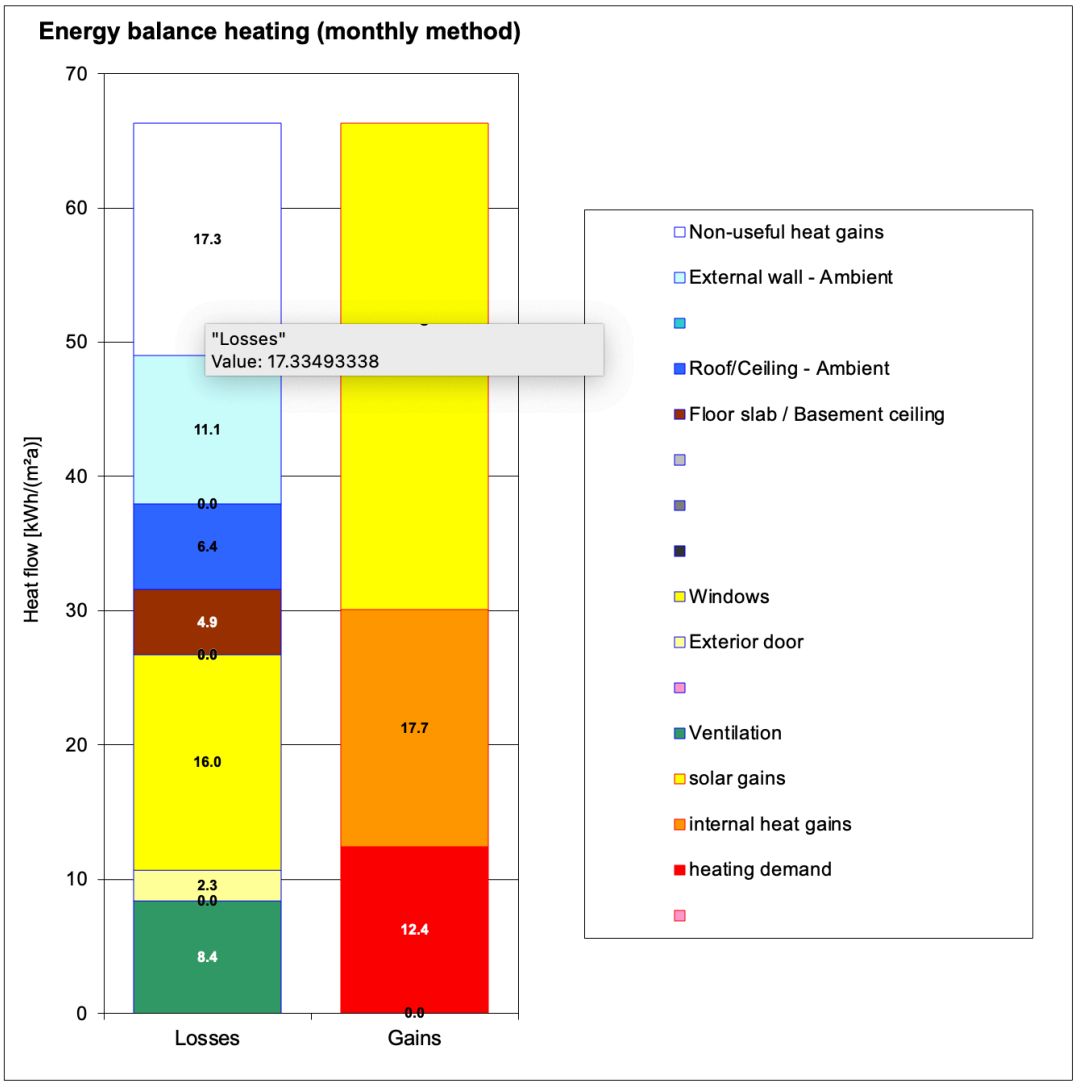
Air permeability at 50 pascals	1.00 (design value)		
Maximum	10.0		Pass

10 Key features

External wall U-value	0.11	W/m²K
Roof U-value	0.11	W/m²K
Floor U-value	0.00	W/m²K
Window U-value	0.90	W/m²K
Air permeability	1.0	m³/m²h
Photovoltaic array	4.00	kW

This report has not been submitted through the Elmhurst Energy members' portal, therefore results are subject to change when the dwelling is completed.

Appendix B Passivhaus



					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	150.8				
Space heating	Heating demand	kWh/(m²a)	12	≤	15	-	yes
	Heating load	W/m²	11	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	8	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	4	≤	135		yes
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	1	≤	-	-	-
	Generation of renewable energy (in relation to pro-jected building footprint area)	kWh/(m²a)	0	≥	-	-	

[2] Empty field: Data missing; '-': No requirement