4 and 6 Manor Road, Teddington

Energy Strategy Report

CIBSE LOW CARBON ENERGY ASSESSORS

Date: 03 May 2016

Project number: 22491

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Contents

Executive Summary

This report details the proposed energy strategy for the 4 – 6 Manor Road scheme, which entails the demolition of two existing houses to be replaced by a block of twelve, new, 2-bedroom flats. The development will also see the addition of three third floor, 2-bedroom flats, on top of an existing block of flats. There will also be the addition of a basement level under the new block of flats for the secure storage of vehicles and bikes, this will be accessible from the current basement under the existing flats or via stairs or the lift. The site is in the London Borough of Richmond Upon Thames.

The proposed development addresses national planning policies on energy; in particular, mitigation of climate change and energy security through energy efficiency enhancements and use of alternative energy technologies. In order to reduce the carbon footprint of the building beyond the requirements of current regulatory and market standards, the development will benefit from the following integrated systems:

- Passive design features (Be Lean)
- Energy efficiency measures (Be Clean)
- Low and zero carbon technologies (Be Green)

The building fabric performance will meet or exceed the Part L 2013 requirements where applicable.

An energy assessment has been carried out based on design information to identify the most appropriate strategy. The development includes the use of high efficiency gas condensing combination boilers and MVHR units for all the flats. Improved detailing for thermal bridges has also been specified and will be calculated at a later stage. The PV system will serve both the new block and the additional 3 flats, it will be located on the proposed new block of flats. The scheme will make best use of the available area to allow for the installation of a 17.04 kWp solar PV system, contributing to a 20% reduction of CO_2 emissions

The proposed strategy provides a 46.14% improvement over the Building Regulations 2013 minimum target; through passive design measures, energy efficient equipment and renewable technologies.

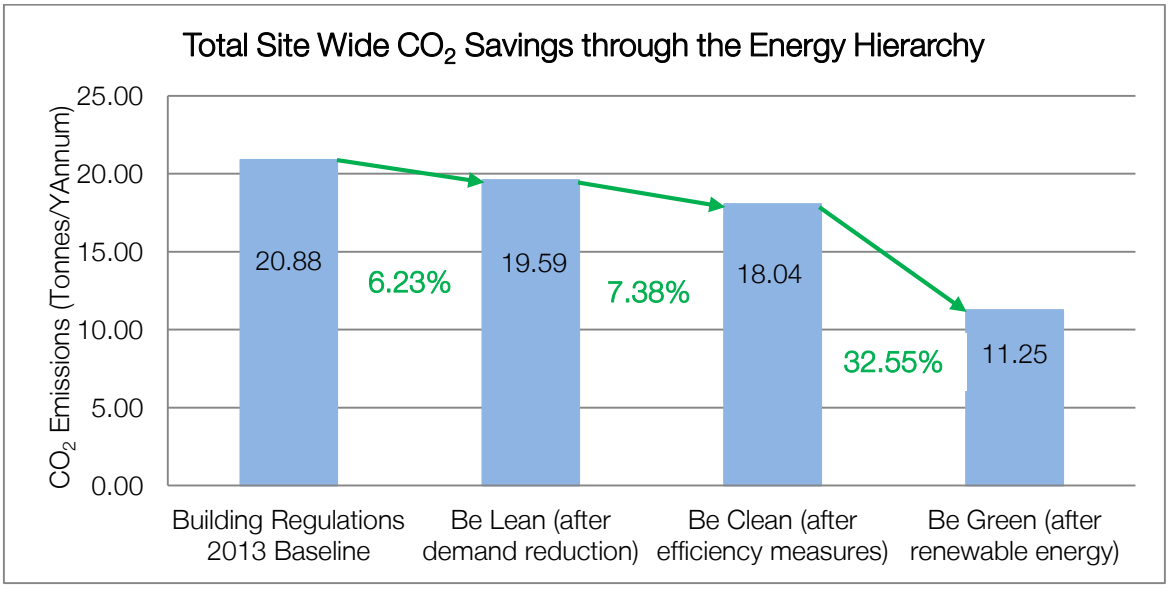


Figure 1 Summary of CO_2 savings from passive design, energy efficient measures and renewable technologies over the Building Regulations 2013 Baseline, through the Energy Hierarchy

The reductions show that the development exceeds the required 35% improvement over the Building Regulations 2013 minimum target, as required by the London Borough of Richmond Upon Thames.

1 Introduction

1.1 Site Analysis

The 4 – 6 Manor Road development is located in the London Borough of Richmond Upon Thames.

The residential development entails the demolition of two existing houses to be replaced by a block of twelve, new 2-bedroom flats. The development will also see the addition of three third floor, 2-bedroom flats, on top of an existing block of flats. Under the new block of flats there will also be a basement level for the storage of cycles and vehicles. This will be accessible via the basement under the existing block of flats as well as via the stairs, or the lift.

Figure 1-1 Google Maps extract indicating site location of Manor Road © Google

The proposals have been designed and specified in accordance with the following relevant planning policies, and will provide a good level of energy efficiency and sustainability for a development of this type and size.

1.2 Objective

This report summarises the work undertaken to support the development of an energy strategy for the 4 – 6 Manor Road scheme. This work has resulted in a strategy that requires design, technical and commercial decisions in order to continue the design development and ultimately select the final solution for ensuring a low carbon development.

This report outlines the energy strategy for the development, including passive design, energy and CO_2 footprint of the proposed scheme, and renewable energy options.

The final proposed strategy would allow the scheme to demonstrate compliance with the guidelines set out by the London Borough of Richmond Upon Thames and the London Plan in demonstrating a positive commitment to sustainability through providing environmental improvements.

2 Policy

2.1 The London Plan Policies on Energy

Policy 5.2: Minimising Carbon Dioxide Emissions

Planning Decisions

Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

1. Be Lean: use less energy
2. Be Clean: supply energy efficiently
3. Be Green: use Renewable energy

The mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emission reductions in buildings:

2013 - 2016: 35% improvement over Part L 2013

Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy. This report contains a detailed energy assessment in line with the requirements of Policy 5.2.

Policy 5.6: Decentralised Energy in Development Proposals

Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

Major development proposals should select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks
2. Site wide CHP network
3. Communal heating and cooling.

Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.

Policy 5.7: Renewable Energy

Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20% through the use of on-site renewable energy generation wherever feasible. Development proposals should seek to utilise renewable energy technologies such as: biomass heating; cooling and electricity; renewable energy from waste; photovoltaics; solar water heating; wind and heat pumps. The Mayor encourages the use of a full range of renewable energy technologies, which should be incorporated wherever site conditions make them feasible and where they contribute to the highest overall and most cost effective carbon dioxide emissions savings for a development proposal.

2.2 London Borough of Richmond Upon Thames Policies on Energy

Policy DM SD 1: Sustainable Construction

New buildings should be flexible to respond to future social, technological and economic needs by conforming to the Borough's Sustainable Construction Checklist SPD.

New homes must achieve a minimum 40% reduction from 2013 to 2016.

Policy DM SD 2: Renewable Energy and Decentralised Energy Networks

Developments of one dwelling unit or more, or 100sqm of non-residential floor space or more will be required to reduce their total CO_2 emissions by following a hierarchy that first requires an efficient design to minimise the amount of energy used, secondly, by using low carbon technologies and finally, where feasible and viable, including a contribution from renewable sources.

The Council encourages developers to achieve a 20% reduction where feasible in total site CO_2 emissions from the use of on-site renewable energy, to improve savings beyond those generated by energy efficiency measures, as set out in Core Strategy Policy CP2.

2.3 Code for Sustainable Homes withdrawn

The Government have announced the official withdrawal of the Code for Sustainable Homes. The Deregulation Bill has been given Royal Assent. In the Ministerial Statement, the following was confirmed:

The government's policy is that planning permissions should not be granted requiring, or subject to conditions requiring, compliance with any technical housing standards other than for those areas where authorities have existing policies on access, internal space, or water efficiency.

This statement therefore addresses key sustainability criteria in relation to local and regional policy, in place of a Code for Sustainable Homes pre-assessment.

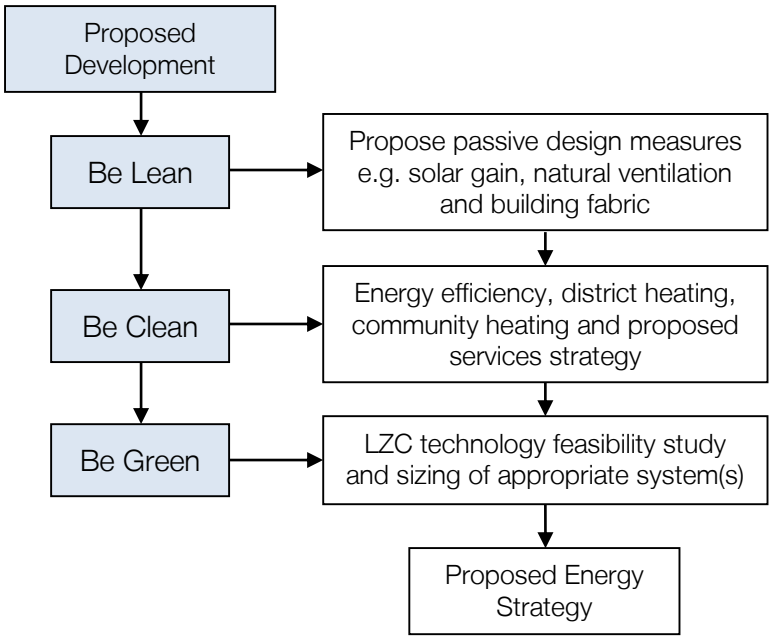
3 Approach

The approach to achieving the planning policy energy objectives has been to consider strategies and technologies to achieve a low energy and carbon footprint for the scheme.

The development will adopt the following energy hierarchy:

- Use less energy through passive design measures (Be Lean)
- Supply and consume energy efficiently (Be Clean)
- Utilise renewable energy sources to reduce carbon emissions (Be Green)

This energy strategy examines the energy performance of the proposed 4-6 Manor Road Teddington development based on the following methodology:



The performance of the development in terms of energy consumption and carbon emissions is calculated at each stage of the assessment, ensuring that both regulated and unregulated energy is considered when determining the performance of the proposed energy strategy.

3.1 Accredited Energy Assessor

This report has been checked and reviewed by Jessica James who is an On Construction Domestic Energy Assessor (OCDEA). The energy consumption and carbon emission figures within this report have been calculated using the approved Standard Assessment Procedure for the Energy Rating of Dwellings (SAP), current SAP 2012 version.

4 Energy Targets

The target for the project is a 35% improvement over Building Regulations Part L 2013 baseline following the aforementioned hierarchy. Table 4-1 details the energy broken down by fuel types and fuel use categories for the site taking into account the regulated and unregulated energy. These are the target energy and carbon calculations before any passive design and energy efficient measures.

Building Regulations Target Emission Rate Breakdown															
Regulated Energy & CO_2															
Type	Gas Demand				Electricity Demand							Total Energy (kWh/yr)	Total CO_2 (kg/yr)	Unregulated Energy & CO_2	
	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO_2 (kg/yr)	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Cooling (kWh/yr)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	Total (kWh/yr)	Electricity CO_2 ($kgCO_2$/yr)			Energy (kWh/yr)	CO_2 (kg/yr)
Residential	48,266	34,211	82,477	17,815	0	0	0	1,125	4,793	5,918	3,072	**88,395**	**20,887**	30,860	16,016

Table 4-1 Estimated regulated and unregulated energy demand and carbon emissions per energy source

The energy consumption calculations for this and all subsequent stages of the assessment include regulated energy (space and water heating, lighting, pumps and fans) derived from outputs of the SAP calculations for the site and unregulated energy (household appliances and equipment) based on the BRE methodology.

5 Be Lean: Passive Design

As part of the Be Lean approach, passive design measures have been considered throughout the pre-planning stage to reduce energy demand.

5.1 Solar Gain Control and Daylighting

Windows and natural daylight have been provided to ensure appropriate daylighting levels throughout the development and reduce the lighting demand. The size and orientation of external windows has been considered carefully to balance daylight with excessive solar gains. Windows are specified to incorporate low emissivity coatings to limit overheating while ensuring adequate daylight. In addition, roof lights have been included for natural daylighting within the flats.

The impact of solar gains has been incorporated into the SAP analysis for compliance with Part L and using a natural ventilation strategy the risk of solar overheating has been concluded to be not significant for the development.

5.2 Building Fabric Efficiency

To further improve the passive design of the development, the thermal fabric has been specified to meet or exceed current Building Regulations targets. Table 5-1 shows the proposed U-values that will be considered for the development and have been assumed for the energy strategy analysis at this stage.

Element	Measure
External Wall	0.13W/m^2K
Shelter Wall	0.13W/m^2K
Cavity Walls	0.00 W/m^2K (Filled cavity with sealed edges)
Roof	0.12W/m^2K
Floor	0.11W/m^2K
Doors	1.2W/m^2K
Windows	1.2W/m^2K
Rooflights	1.2W/m^2K
French Doors	1.2 W/m^2K
Air Tightness	4 $m^3/m^2/h$
Thermal Bridging	Independently assessed, designed to be equivalent to accredited details figures Details to be calculated at the detailed design stage

Table 5-1 Proposed Be Lean passive design measures

5.3 Improvement Over Part L

Based on the performance of the passive design measures proposed in Sections 5, as calculated using SAP, Figure 5-1 demonstrates the percentage improvement over the notional baseline levels in each type of development. It confirms that the development can achieve a 6.23% improvement over Part L 2013 before energy efficiency or low or zero carbon technologies have been considered.

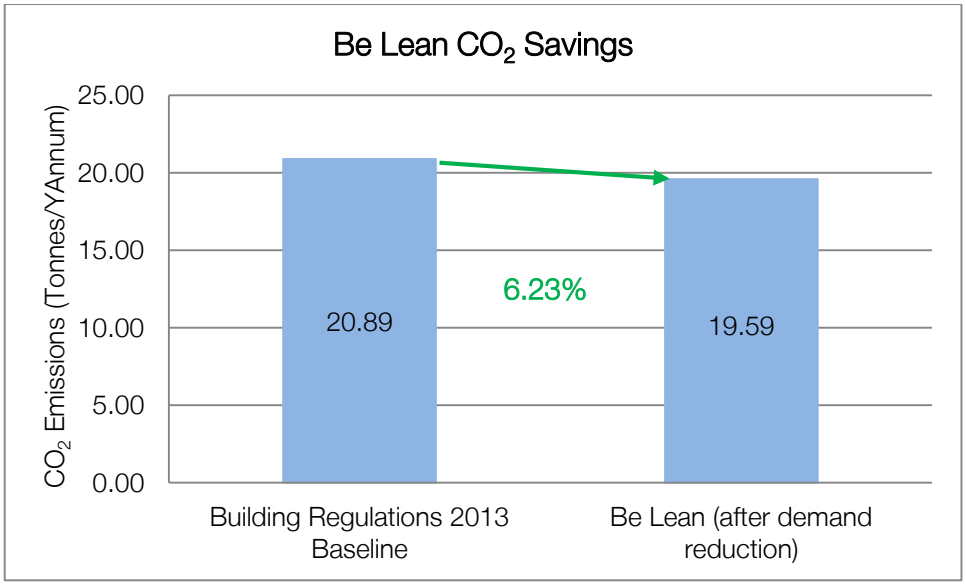


Figure 5-1 Improvement over Building Regulations Part L 2013 with passive design measures

The Be Lean stage has the potential to provide a 6.23% improvement over the Target Fabric Energy Efficiency; through passive design measures. The energy use for the Be Lean case is broken down (Table 5-2).

Be Lean															
Regulated Energy & CO_2															
	Gas Demand				Electricity Demand							Total Energy (kWh/yr)	Total CO_2 (kg/yr)	Unregulated Energy & CO_2	
Type	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO_2 (kg/yr)	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Cooling (kWh/yr)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	Total (kWh/yr)	Electricity CO_2 ($kgCO_2$/yr)			Energy (kWh/yr)	CO_2 (kg/yr)
Residential	44,126	33,953	78,079	16,865	0	0	0	450	4,794	5,244	2,721	**83,323**	**19,586**	30,860	16,016

Table 5-2 Estimated regulated and unregulated energy demand and carbon emissions per energy source

Table 5-3 below indicates the site wide carbon savings compared to the Base Case through the energy hierarchy.

Site Wide	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	20.89		
Be Lean (after demand reduction)	19.59	1.30	6.23%

Table 5-3 Site wide carbon savings (tonnes CO_2/annum)

6 Be Clean: Energy Efficiency

As part of the Be Clean approach, the use of heat networks, community heating and cooling and energy efficient equipment has been considered for this development.

6.1 District Energy Systems

District energy systems produce steam, hot water or chilled water at a central energy centre. The steam or water is distributed in pre-insulated pipework to individual buildings for space heating, domestic hot water and air conditioning. As a result, individual buildings served by a district energy system don't required their own boilers or chillers.

According to the London Heat Map Study, there are currently no heat networks in Figure 6-1 below.

Figure 6-1 London Heat Map

Due to the size and location of the development it would not be viable to connect to a district heating system.

6.2 Community Heating

Community heating involves distributing space and water heating services throughout the development served from a central plant, making use of higher efficiencies available from larger systems.

As this development is relatively small, the installation of a community energy system would not be cost effective. A CHP system would not be viable for such small development due to low peak demand. The potential savings associated with a communal gas heating system would not be significant enough to justify the additional cost. Fabric improvements would have a greater impact and are therefore more cost effective for this development.

6.3 Services Strategy

In addition to the passive design measures identified in Section 5, energy efficient equipment has been proposed where possible to support the services strategy. Table 6-1 shows the proposed services strategy and energy efficiency measures for the development.

Services	Measure
Space Heating	Gas Condensing Combi Boiler 90% efficient Space heating from radiators
Heating Controls	Time and temperature zone control
Hot Water Heating	Gas Condensing Combi Boiler 90% efficient Boiler Interlock Delayed Start Stat
Ventilation	MVHR 90% efficient SFP 0.5 W/L/S
Comfort Cooling	None
Lighting	100% low energy lighting
Lighting control	PIR/Daylight/timer controls fitted to lighting in communal and external areas

Table 6-1 Proposed energy efficient design measures

6.4 Improvement Over Part L 2013

Based on the performance of the passive design and energy efficient measures proposed in Sections 5 and 6, as calculated using SAP 2012, Figure 6-2 demonstrates the percentage improvement to the fabric energy efficiency that these have made over the notional baseline levels for the development.

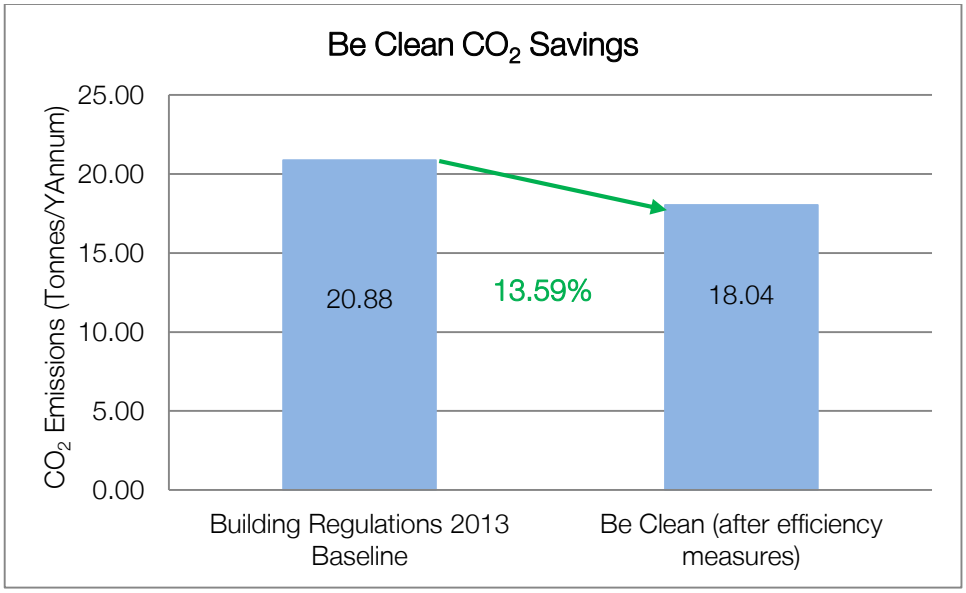


Figure 6-2 Improvement over Building Regulations Part L 2013 with passive design and energy efficient measures

The energy use for the Be Clean case is broken down in Table 6-2.

Be Clean															
Regulated Energy & CO_2															
Type	Gas Demand				Electricity Demand							Total Energy (kWh/ yr)	Total CO_2 (kg/ yr)	Unregulated Energy & CO_2	
	Space Heating (kWh/ yr)	Hot Water (kWh/ yr)	Total (kWh/ yr)	Gas CO_2 (kg/yr)	Space Heating (kWh/ yr)	Hot Water (kWh/ yr)	Cooling (kWh/yr)	Pumps & Fans (kWh/ yr)	Lighting (kWh/yr)	Total (kWh/ yr)	Electricity CO_2 (kgCO_2/ yr)			Energy (kWh/ yr)	CO_2 (kg/yr)
Residential	31,258	34,216	65,474	14,142	0	0	0	2,725	4,794	7,519	3,902	**72,993**	**18,045**	30,860	16,016

Table 6-2 Estimated regulated and unregulated energy demand and carbon emissions per energy source

Table 6-3 below indicates the site wide carbon savings compared to the Base Case through the energy hierarchy.

Site Wide	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	20.88		
Be Lean (after demand reduction)	19.59	1.30	6.21%
Be Clean (after efficiency measures)	18.04	1.54	7.38%
Total Cumulative Savings		**2.84**	**13.59%**

Table 6-3 Site wide carbon savings (tonnes CO_2/annum)

7 Low and Zero Carbon (LZC) Technologies Feasibility Study

The final level of the energy hierarchy is to Be Green, therefore the following table discusses the options for on-site low and zero carbon technologies and their feasibility on this development to contribute to meeting the relevant London Plan and Borough's sustainability targets.

LZC Technologies	Description	Advantages	Disadvantages	Feasibility	
Solar Thermal Collectors	Solar thermal collectors can be used to provide hot water using the irradiation from the sun They can generally provide approx. 50% of the hot water demand	No noise issues associated with Solar thermal collectors No additional land use from the installation of solar thermal collectors Low maintenance and easy to manage Favourable payback periods	The hot water cylinder will need to be larger than a traditional cylinder Needs unobstructed space on roof Low efficiencies Often not compatible with other LZC technologies Saves less carbon when offsetting gas systems	There is a flat roof where solar thermal panels can be installed. However, solar PV is favoured due to greater potential carbon savings.	✗
Solar Photovoltaic Panels (PV)	Solar PV panels provide noiseless, low-maintenance, carbon free electricity	Can have significant impact on carbon emissions by offsetting grid electricity (which has a high carbon footprint) Low maintenance, No noise issues No additional land use from the installation of PV panels Bolt on technology that does not need significant amounts of auxiliary equipment Favourable payback period	Needs unobstructed space on roof Low efficiencies per unit area of PV Often used to supplement landlord's electricity so savings not always transferred to individual properties	There is a large flat roof on the new block of flats which Solar PV panels could be installed to contribute to the electricity demand of the building	✓

CHP (Combined Heat & Power)	CHP systems use an engine driven alternator to generate electricity while using the waste heat from the engine, jacket and exhaust to provide heating and hot water Economic viability relies on at least 4,000 hours running time per annum	Mature technology High CO_2 savings	Cost of the system is relatively high for small schemes Only appropriate for large development with high heat loads	Communal CHP is not viable for such a small development Micro CHP would be technically feasible but is unlikely to save enough carbon to meet the targets with incorporating multiple technologies	✗
Biomass Heating	Solid, liquid or gaseous fuels derived from plant material can provide boiler heat for space and water heating	Potential to reduce large component of the total CO_2 A biomass boiler would supplement a standard gas heating system so some of the cost may be offset through money saved on using smaller traditional boilers	Regular maintenance is required Reliability of fuel access/supply can be a problem The noise generated by a biomass boiler is similar to that of a gas boiler. It is advisable not to locate next to particularly sensitive areas such as bedrooms A plant room and fuel store will be required which may take additional land from the proposed development or surroundings Biomass is often not a favoured technology in new development due to the potential local impacts of NO_x emissions and delivery vehicles for the fuel	This is a small site in an urban area and so there is insufficient space for a biomass boiler system Biomass is not considered feasible for this development due to issues with fuel storage, access for delivery vehicles and local NO_x emissions	✗

Wind Turbines	Vertical and horizontal axis wind turbines enable electricity to be generated using the power within the wind	Low noise Bolt on technology that does not need significant amounts of auxiliary equipment	Not suitable for urban environments due to low wind conditions and obstructions High visual impact Noise impact (45-65dB at 3m) High capital cost and only achieve good paybacks in locations with strong wind profiles Requires foundations or vibration supports for building installations (generally not recommended)	This development is in an urban environment and so a wind turbine will not generate much energy	✗
Ground Source Heat Pumps (GSHP)	Utilising horizontal loops or vertical boreholes, GSHP make use of the grounds almost constant temperature to provide heating and/or cooling using a heat exchanger connected to a space/water heating delivery system	Low maintenance and easy to manage High COP (ratio of energy output per energy input) Optimum efficiency with underfloor heating systems As heat pumps would replace standard heating systems, some of the cost may offset through savings on a traditional boiler	The heat pump has a noise level around 35-60dB so some attenuation may be required and it should be sensibly located Relatively high capital cost Requires electricity to run the pump, therefore limited carbon savings in some cases For communal systems a plant room is required which may take additional land from the proposed development/surroundings	GSHP are not a feasible technology for the site since there is a no external space available for installation of boreholes	✗

Air Source Heat Pumps (ASHP)	Air Source Heat Pumps extract latent energy from the external air in a manner similar to ground source heat pumps	ASHP systems are generally cheaper than GSHP as there is no requirement for long lengths of buried piping or boreholes Low maintenance and easy to manage Optimum efficiency with underfloor heating systems As heat pumps would replace standard heating systems, some of the cost may offset through savings on a traditional boiler	The ASHP unit has a noise level around 50-60dB so some attenuation may be required and it should be sensibly located The potential noise from the external unit may mean there is local opposition to their installation Requires electricity to run the pump, therefore limited carbon savings in some cases For communal systems a plant room is required which may take additional land from the proposed development/surroundings	The use of ASHP is technically feasible for the development but is discounted due to noise issues and locating the unsightly units	✗

Table 7-1 Feasibility of LZC technologies for the development

Having reviewed potential LZC technologies for the development it has been identified that the most appropriate system would be solar PV panels, which would most suitably be installed on the flat roof space of the new block of flats. The chosen system should be accurately sized during the detailed design stages and MCS (Microgeneration Certification Scheme) approved equipment and installers used.

7.1 Summary of CO_2 Emission Savings

The most appropriate LZC technology for the development has been identified as solar PV panels and to meet the London Plan and Borough's target for on-site renewables. This provides 12.61% of total site energy and reduces carbon emissions by 20%.

Table 7-2 shows the proposed system size and the estimated energy and carbon emissions savings and financial feasibility for this development.

	Energy & CO_2				
Proposed LZC Technologies	Energy Generated (kWh/yr)	% site energy demand met	CO_2 saved by system ($kgCO_2$/yr)	% reduction in site CO_2 emissions	25 year CO_2 saving ($kgCO_2$)
Total Solar PV = 17.04 kWp 53 no.s High Efficiency horizontal, S facing (Based on Sunpower E20-327W PV Panels)	13,100	12.61%	6,799	20.0%	169,977

Table 7-2 Energy, carbon and financial performance of the proposed LZC technologies

7.2 Improvement Over Part L 2013 with LZC

Figure 7-1 demonstrates the percentage improvement over the notional baseline levels for the development incorporating the community heating system. Based on the feasibility study of LZC technologies in Section 7 above, Figure 7-1 confirms that the development can achieve 46.14% improvement over Part L 2013 after on-site renewables.

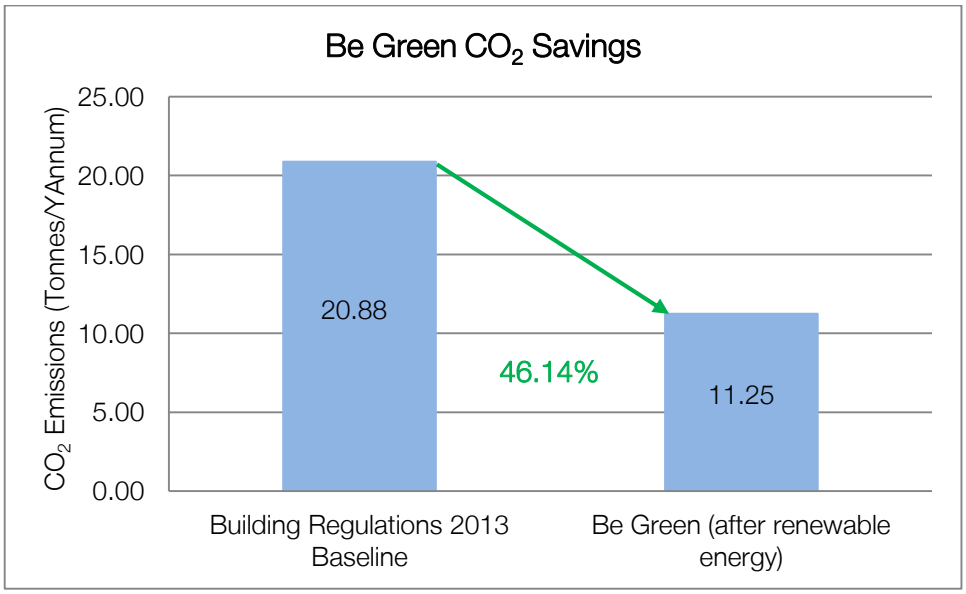


Figure 7-1 Improvement over Building Regulations Part L 2013 after LZCs for Manor Road

The energy use for the Be Green case is broken down (Table 7-3).

Be Green																
Regulated Energy & CO_2																
Type	Gas Demand				Electricity Demand								Total Energy (kWh/yr)	Total CO_2 (kg/yr)	Unregulated Energy & CO_2	
	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO_2 (kg/yr)	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	Cooling (kWh/yr)	PV (kWh/yr)	Total (kWh/yr)	Electricity CO_2 ($kgCO_2$/yr)			Energy (kWh/yr)	CO_2 (kg/yr)
Residential	31,258	34,216	65,474	14,142	0	0	0	2,725	4,794	-13,100	-5,581	-2,897	**72,993**	**11,246**	30,860	16,016

Table 7-3 Estimated regulated and unregulated energy demand and carbon emissions per energy source

Table 7-4 below indicates the site wide carbon savings compared to the Base Case through the energy hierarchy.

Site Wide	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	20.88		
Be Lean (after demand reduction)	19.59	1.30	6.21%
Be Clean (after efficiency measures)	18.04	1.54	7.38%
Be Green (after renewable energy)	11.25	6.80	32.55%
Total Cumulative Savings		**9.63**	**46.14%**

Table 7-4 Site wide carbon savings (tonnes CO_2/annum)

8 Conclusion

Following the Be Lean, Be Clean and Be Green energy hierarchy, passive design measures, energy efficient equipment and LZC technologies have been shown to provide a 46.14% improvement over the Building Regulations Part L 2013 Target Emissions Rate (TER) and an overall 20% saving in carbon emissions from renewables.

The design team have made all reasonable endeavours to achieve the minimum requirements of the London Plan and the London Borough of Richmond Upon Thames. The development achieves an improvement over Part L in excess of 35% in line with the London Plan. The saving from renewables meets the required 20% target. The fabric U-Values have been specified to exceed Building Regulations. Efficiencies for building services are all particularly high and represent the best that is available on the market. The PV system specified occupies the majority of the available roof space on the new block of flats. The strategy therefore represents the best possible savings that could be achieved for this development.

The figures within this report are based on preliminary analysis only and further detailed studies will be required at the detailed design stage before specifying any of the proposed systems.

9 Appendix A

The following table shows the energy assumptions used for the energy and CO_2 calculations within this report. Calculations for residential areas are based on Standard Assessment Procedure (SAP) results with an inclusion for unregulated energy appliance use not covered by SAP (based on BRE methodology).

The appliances figure is based on the BRE calculation formula for appliances and cooking, taken from the Code for Sustainable Homes in Ene 7 table 1.4, as below.

$kgCO_2$/year from appliances and cooking. See Ene 1:

$$99.9 \times (TFA \times N)^{0.4714} - (3.267 \times TFA) + (32.23 \times N) + 72.6$$

Where:

TFA = Total Floor Area

N = Number of Occupants

For TFA < $43m^2$; N = 1.46

For TFA ≥ $43m^2$; N = $2.844 \times (1 - \exp(-0.000391 \times TFA^2))$

Residential		
Energy Demands		**Source**
Use Type	**Demand (kWh/m^2)**	SAP Calculations
Space Heating	28.81	
DHW	31.54	
Fans/Pumps/Controls	2.51	
Lighting	4.42	
Appliances	34.98	BRE Methodology

Table A Energy Demands from the Manor Road development

10 Appendix B

The following tables show figures used in the energy and CO_2 calculations to estimate energy produced and CO_2 savings from LZC technologies. These figures can be used to validate the results.

CO_2 Intensity Values	
Gas Intensity	0.216 $kgCO_2/kWh$
Electricity Intensity	0.519 $kgCO_2/kWh$

Table B-1 Energy intensity values

Energy & Renewable Technology Outputs	
PV energy produced per kWp	768.78 kWh/kWp
PV kWp per m^2 panel	0.20 kWp/m^2
Electricity efficiency	100%
Gas boiler efficiency	90%

Table B-2 Renewable technology energy outputs

Fuel Prices (as of March 2016)	
Natural Gas	4.18 p/kWh
Electricity (Grid)	13.86 p/kWh

Table B-3 Natural Gas and Electricity fuel prices

11 Appendix C

SAP Calculations

Sample Report Ltd
1 Sample Street
Sampletown

Full SAP Calculation Printout

Property Reference: 22491 - Flat 11
Survey Reference: Be Lean
Property: 4 and 6 Manor Road, TW11 8BG

Issued on Date: 12.Jan.2016
Prop Type Ref:

SAP Rating:	85 B	**CO2 Emissions (t/year):**	0.97	**DER:**	15.53 Pass	**TER:**	16.89	**Percentage DER<TER:**	8.03 %
Environmental:	88 B	**General Requirements Compliance:**	Pass	**DFEE:**	35.11 Pass	**TFEE:**	44.20	**Percentage DFEE<TFEE:**	20.56 %

CfSH Results **Version:** **ENE1 Credits:** N/A **ENE2 Credits:** N/A **ENE7 Credits:** N/A **CfSH Level:** N/A

Surveyor: admin Admin, Tel: 4, Fax: s@l.f Surveyor ID: Admin
Address:
Client:

Software Version: Elmhurst Energy Systems SAP2012 Calculator (Design System) version 3.05r04
SAP version: SAP 2012, Regs Region: England (Part L1A 2013), Calculation Type: New Build (As Designed)

CALCULATION DETAILS for survey reference no 'Be Lean'
SAP2012 - 9.92 input data (DesignData) -


```
SAP2012 Input Data (Flat)     03/05/2016

FullRefNo:                    Be Lean

Regs Region:                  England
SAP Region:                   Thames Valley
Postcode:                     TW11 8BG
DwellingOrientation:          North West
Property Type:                Flat, Mid-Terrace
Storeys:                      1
Date Built:                   2015
Sheltered Sides:              3
Sunlight Shade:               Average or unknown
Measurements                  Perimeter, Floor Area, Storey Height
    1st Storey:              27.84, 75.82, 2.5
Living Area:                  18.31 m2, fraction: 24.1%
Thermal Mass:                 Simple calculation
Thermal Mass Simple:          Medium
Thermal MassValue:            250
External Walls                Nett Area, Gross Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
External Wall 1               22.96, 42.48, 0, Other, Cavity, 0, 0.13, Gross
Shelter Wall                  25.27, 27.13, 0, Other, Cavity, 0, 0.13, Gross
Party Walls                   Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
Party Wall 1                  29.38, 0, Other, FilledWithEdge, 0, 0
External Roofs                Nett Area, Gross Area, Kappa, Construction, Element, UValueFinal
Party Ceilings                Area, Kappa, Construction, Element
    Party Ceilings 1         75.82, 80, Concrete floor slab, carpeted
Heat Loss Floors              Area, Kappa, Construction, Element, Type, ShelterFactor, UValueFinal
    Heat Loss Floor 1        75.82, 0, Other, Exposed Floor - Solid, 0.13, 0.108449176772158
Description                   Data Source, Type, Glazing, Glazing Gap, Argon Filled, Solar Trans, Frame Type, Frame Factor, U Value
    Flat Door                Manufacturer, Solid Door, , , , , , ,
    Windows                  Manufacturer, Window, Double Low-E Soft 0.1, , , 0.63, , 0.7,
    French Doors             Manufacturer, Window, Double Low-E Soft 0.1, , , 0.63, , 0.7,
Openings                      Opening Type, Location, Orientation, Pitch, Curtain Type, Overhang Ratio, Wide Overhang, Width, Height, Count, Area, Curtain Closed
    Flat Door                Solid Door, Shelter Wall, North West, , , , , 0, 0, 0, 1.86,
    SE F Windows             Window, External Wall 1, South East, , None, 0, , 0, 0, 0, 14.48,
    SE F F Door              Window, External Wall 1, South East, , None, 0, , 0, 0, 0, 2.34,
    SW F Windows             Window, External Wall 1, South West, , None, 0, , 0, 0, 0, 2.70,
Conservatory:                 None
Draught Proofing:             100
Draught Lobby:                No
Thermal Bridges
    Bridging:                Calculate Bridges
    Y                        0.077
    List of Bridges          Junction with, Bridge Type, Source Type, Imported, Length, Psi, Adjusted, Result, Reference
    0.                       External wall, E1 Steel lintel with perforated steel base plate, , No, 0, 0, 0, 0.00,
    1.                       External wall, E2 Other lintels (including other steel lintels), Table K1 - Approved, Yes, 11.95, 0.3, 0.3, 3.59,
    2.                       External wall, E3 Sill, Table K1 - Approved, Yes, 11.04, 0.04, 0.04, 0.44,
    3.                       External wall, E4 Jamb, Table K1 - Approved, Yes, 43.24, 0.05, 0.05, 2.16,
    4.                       External wall, E5 Ground floor (normal), Table K1 - Approved, Yes, 27.84, 0.16, 0.16, 4.45,
    5.                       External wall, E19 Ground floor (inverted), , No, 0, 0, 0, 0.00,
    6.                       External wall, E20 Exposed floor (normal), , No, 0, 0, 0, 0.00,
    7.                       External wall, E21 Exposed floor (inverted), , No, 0, 0, 0, 0.00,
    8.                       External wall, E22 Basement floor, , No, 0, 0, 0, 0.00,
    9.                       External wall, E6 Intermediate floor within a dwelling, , No, 0, 0, 0, 0.00,
    10.                      External wall, E7 Party floor between dwellings (in blocks of flats), , No, 0, 0, 0, 0.00,
    11.                      External wall, E8 Balcony within a dwelling, wall insulation continuous, Table K1 - Approved, No, 4.74, 0, 0, 0.00,
    12.                      External wall, E9 Balcony between dwellings, wall insulation continuous, , No, 0, 0, 0, 0.00,
    13.                      External wall, E23 Balcony within or between dwellings, balcony support penetrates wall insulation , , No, 0, 0, 0, 0.00,
    14.                      External wall, E10 Eaves (insulation at ceiling level), , No, 0, 0, 0, 0.00,
    15.                      External wall, E24 Eaves (insulation at ceiling level - inverted), , No, 0, 0, 0, 0.00,
    16.                      External wall, E11 Eaves (insulation at rafter level), , No, 0, 0, 0, 0.00,
    17.                      External wall, E12 Gable (insulation at ceiling level), , No, 0, 0, 0, 0.00,
    18.                      External wall, E13 Gable (insulation at rafter level), , No, 0, 0, 0, 0.00,
    19.                      External wall, E14 Flat roof, , No, 0, 0, 0, 0.00,
    20.                      External wall, E15 Flat roof with parapet, , No, 0, 0, 0, 0.00,
    21.                      External wall, E16 Corner (normal), Table K1 - Approved, No, 2.5, 0.09, 0.09, 0.23,
    22.                      External wall, E17 Corner (inverted - internal area greater than external area), Table K1 - Approved, No, 2.5, -0.09, -0.09, -0.23,
    23.                      External wall, E18 Party wall between dwellings, Table K1 - Approved, Yes, 10, 0.06, 0.06, 0.60,
    24.                      External wall, E25 Staggered party wall between dwellings, , No, 0, 0, 0, 0.00,
    25.                      Party wall, P1 Party wall - Ground floor, , No, 0, 0, 0, 0.00,
    26.                      Party wall, P6 Party wall - Ground floor (inverted), , No, 0, 0, 0, 0.00,
    27.                      Party wall, P2 Party wall - Intermediate floor within a dwelling, , No, 0, 0, 0, 0.00,
    28.                      Party wall, P3 Party wall - Intermediate floor between dwellings (in blocks of flats), , No, 0, 0, 0, 0.00,
    29.                      Party wall, P7 Party Wall - Exposed floor (normal), , No, 0, 0, 0, 0.00,
    30.                      Party wall, P8 Party Wall - Exposed floor (inverted), , No, 0, 0, 0, 0.00,
    31.                      Party wall, P4 Party wall - Roof (insulation at ceiling level), , No, 0, 0, 0, 0.00,
    32.                      Party wall, P5 Party wall - Roof (insulation at rafter level), , No, 0, 0, 0, 0.00,
    33.                      External roof, R1 Head of roof window, , No, 0, 0, 0, 0.00,
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    34.                     External roof, R2 Sill of roof window, , No, 0, 0, 0, 0.00,
    35.                     External roof, R3 Jamb of roof window, , No, 0, 0, 0, 0.00,
    36.                     External roof, R4 Ridge (vaulted ceiling), , No, 0, 0, 0, 0.00,
    37.                     External roof, R5 Ridge (inverted), , No, 0, 0, 0, 0.00,
    38.                     External roof, R6 Flat ceiling, , No, 0, 0, 0, 0.00,
    39.                     External roof, R7 Flat ceiling (inverted), , No, 0, 0, 0, 0.00,
    40.                     External roof, R8 Roof to wall (rafter), , No, 0, 0, 0, 0.00,
    41.                     External roof, R9 Roof to wall (flat ceiling), , No, 0, 0, 0, 0.00,
Pressure Test:               True
Designed q50:                4
AsBuilt q50:                 15
Property Tested:             False
Mechanical Ventilation       None
Chimneys MHS:                0
Chimneys SHS:                0
Chimneys Other:              0
Chimneys Total:              0
Open Flues MHS:              0
Open Flues SHS:              0
Open Flues Other:            0
Open Flues Total:            0
Intermittent Fans:           2
Passive Vents:               0
Flueless Gas Fires:          0
Cooling System               None
Light Fittings:              8
LEL Fittings:                8
Percentage of LEL Fittings:  100
External Lights Fitted:      Yes
External LELs Fitted:        Yes
Electricity Tariff:          Standard
Main Heating 1
    Description
    Percentage               100
    MHS                      Mains gas BGW Post 98 Combi condens. with auto ign.
    SAP Code                 104
    Boiler Efficiency Type   Sedbuk 2009
    Efficiency               90
    Model Name               tbc
    Manufacturer             tbc
    Controls by PCDF         0
    MHS Controls             CBI Time and temperature zone control
    Boiler Interlock         Yes
    Compensator              0
    Delayed Start Stat       Yes
    Ctrl SAP Code            2110
    Burner Control           OnOff
    Flue Type                None or Unknown
    Fan Assisted Flue        No
    Pumped                   Pump in heated space
    Heat Pump Age            2013 or later
    Heat Emitter             Radiators
    Flow Temperature         Normal (> 45°C)
    Combi boiler type        Standard Combi
    Combi keep hot type      None
Main Heating 2               None
Heating Systems Interaction  Each system heats separate parts of dwelling
Smoke Control Area           Unknown
Community Heating            None
Secondary Heating            None
Water Heating
    Type                     MainHeating1
    WHS                      HWP From main heating 1
    Low Water Usage          Yes
    SAP Code                 901
    Showers in Property      Non-electric only
    Hot Water Cylinder       None
Flue Gas Heat Recovery System None
Waste Water Heat Recovery    none
PV Unit                      None
Wind Turbine                 None
Terrain Type:                Urban
Small Scale Hydro            None
Special Features             None


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

DWELLING AS DESIGNED

Ground-floor flat, total floor area 76 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:Mains gas
Fuel factor:1.00 (mains gas)
Target Carbon Dioxide Emission Rate (TER) 16.89 kg/m²
Dwelling Carbon Dioxide Emission Rate (DER) 15.53 kg/m²OK
-------------------------------------------------------------------------------------------------
1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)44.2 kWh/m²
Dwelling Fabric Energy Efficiency (DFEE)35.1 kWh/m²OK
-------------------------------------------------------------------------------------------------
2 Fabric U-values
Element         Average                 Highest
External wall   0.13 (max. 0.30)        0.13 (max. 0.70)          OK
Party wall      0.00 (max. 0.20)         -                        OK
Floor           0.11 (max. 0.25)        0.11 (max. 0.70)          OK
Roof            (no roof)
Openings        1.20 (max. 2.00)        1.20 (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:         4.00 (design value)
Maximum                                 10.0                                            OK
```

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4 Heating efficiency
Main heating system: Boiler system with radiators or underfloor - Mains gas
Data from manufacturer
tbc tbc
Combi boiler
Efficiency: 90.0% SEDBUK2009
Minimum: 88.0% OK

Secondary heating system: None

---

5 Cylinder insulation
Hot water storage: No cylinder

---

6 Controls
Space heating controls: Time and temperature zone control OK

Hot water controls: No cylinder

Boiler interlock: Yes OK

---

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

---

8 Mechanical ventilation
Not applicable

---

9 Summertime temperature
Overheating risk (Thames Valley): Medium OK
Based on:
Overshading: Average
Windows facing South East: 16.82 m^2, No overhang
Windows facing South West: 2.70 m^2, No overhang
Air change rate: 4.00 ach
Blinds/curtains: None

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10 Key features
External wall U-value: 0.13 W/m^2K
External wall U-value: 0.13 W/m^2K
Party wall U-value: 0.00 W/m^2K
Exposed floor U-value: 0.11 W/m^2K

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							2 * 10 =	20.0000	(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) =	20.0000 / (5) =	0.1055	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.3055	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2368	(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	0.3019	0.2960	0.2900	0.2604	0.2545	0.2249	0.2249	0.2190	0.2368	0.2545	0.2664	0.2782	(22b)
Effective ac	0.5456	0.5438	0.5421	0.5339	0.5324	0.5253	0.5253	0.5240	0.5280	0.5324	0.5355	0.5387	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		11.2430 (36)
Total fabric heat loss	(33) + (36) =	50.3187 (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	34.1261	34.0154	33.9069	33.3973	33.3020	32.8582	32.8582	32.7760	33.0291	33.3020	33.4948	33.6965	(38)
Heat transfer coeff	84.4447	84.3340	84.2255	83.7160	83.6206	83.1768	83.1768	83.0946	83.3478	83.6206	83.8135	84.0151	(39)
Average = Sum(39)m / 12 =												83.7155	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1138	1.1123	1.1109	1.1041	1.1029	1.0970	1.0970	1.0959	1.0993	1.1029	1.1054	1.1081	(40)
HLP (average)												1.1041	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)
Total heat required for water heating calculated for each month	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202	(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

198.7885 173.6469 180.6683 160.2437 155.1442 136.6423 130.9137 145.9381 147.5499 168.0149 179.3526 194.1202 (64)
Total per year (kWh/year) = Sum(64)m = 1971.0232 (64)

Heat gains from water heating, kWh/month
61.9029 54.0870 56.1830 49.6649 48.0013 42.1126 40.0972 44.9403 45.4442 51.9758 55.7234 60.3507 (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	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
18.7648 16.6667 13.5543 10.2614 7.6706 6.4758 6.9973 9.0954 12.2078 15.5006 18.0915 19.2863 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
210.4835 212.6677 207.1636 195.4462 180.6551 166.7536 157.4665 155.2823 160.7864 172.5037 187.2949 201.1964 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
34.8938 34.8938 34.8938 34.8938 34.8938 34.8938 34.8938 34.8938 34.8938 34.8938 34.8938 34.8938 (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)
-95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 (71)
Water heating gains (Table 5)
83.2028 80.4866 75.5148 68.9790 64.5178 58.4897 53.8940 60.4036 63.1169 69.8599 77.3936 81.1165 (72)
Total internal gains
374.1326 371.5025 357.9142 336.3682 314.5251 293.4007 280.0394 286.4629 297.7926 319.5458 344.4615 363.2808 (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	
Southeast	14.4800	36.7938	0.6300	0.7000	0.7700	162.8229	(77)
Southwest	2.7000	36.7938	0.6300	0.7000	0.7700	30.3606	(79)
Southeast	2.3400	36.7938	0.6300	0.7000	0.7700	26.3125	(77)

Solar gains	219.4960	373.8829	511.5629	633.8513	709.9663	704.8322	679.5334	622.7482	553.9145	413.2203	262.9057	187.8429	(83)
Total gains	593.6287	745.3854	869.4772	970.2195	1024.4913	998.2328	959.5728	909.2111	851.7071	732.7661	607.3672	551.1236	(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, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	62.3518	62.4336	62.5140	62.8945	62.9662	63.3022	63.3022	63.3648	63.1724	62.9662	62.8214	62.6706	
alpha	5.1568	5.1622	5.1676	5.1930	5.1977	5.2201	5.2201	5.2243	5.2115	5.1977	5.1881	5.1780	
util living area	0.9933	0.9791	0.9432	0.8560	0.7058	0.5237	0.3799	0.4178	0.6442	0.9012	0.9834	0.9953	(86)
MIT	19.9768	20.2167	20.4996	20.7721	20.9318	20.9881	20.9981	20.9970	20.9670	20.7385	20.2910	19.9229	(87)
Th 2	19.9896	19.9908	19.9920	19.9975	19.9985	20.0033	20.0033	20.0041	20.0014	19.9985	19.9964	19.9942	(88)
util rest of house	0.9911	0.9728	0.9271	0.8198	0.6457	0.4464	0.2946	0.3287	0.5631	0.8665	0.9773	0.9938	(89)
MIT 2	18.6445	18.9906	19.3885	19.7530	19.9391	19.9962	20.0026	20.0030	19.9789	19.7222	19.1051	18.5696	(90)
Living area fraction										fLA = Living area / (4) =		0.2415	(91)
MIT	18.9663	19.2867	19.6568	19.9991	20.1788	20.2357	20.2430	20.2431	20.2175	19.9677	19.3915	18.8964	(92)
Temperature adjustment												-0.1500	
adjusted MIT	18.8163	19.1367	19.5068	19.8491	20.0288	20.0857	20.0930	20.0931	20.0675	19.8177	19.2415	18.7464	(93)

---

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9876	0.9658	0.9177	0.8138	0.6476	0.4529	0.3024	0.3367	0.5687	0.8591	0.9711	0.9910	(94)
Useful gains	586.2661	719.9098	797.9204	789.5514	663.4428	452.0925	290.1438	306.1752	484.3763	629.5125	589.8172	546.1904	(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	1225.8209	1200.6369	1095.5078	916.6130	696.4608	456.2851	290.5403	306.8739	497.3790	770.7872	1017.6223	1222.1209	(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	475.8288	323.0487	221.4050	91.4843	24.5654	0.0000	0.0000	0.0000	0.0000	105.1084	308.0197	502.8923	(98)
Space heating												2052.3525	(98)
Space heating per m2											(98) / (4) =	27.0687	(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 %) 90.8000 (206)
Efficiency of secondary/supplementary heating system, % 0.0000 (208)
Space heating requirement 2260.3002 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	475.8288	323.0487	221.4050	91.4843	24.5654	0.0000	0.0000	0.0000	0.0000	105.1084	308.0197	502.8923	(98)
Space heating efficiency (main heating system 1)	90.8000	90.8000	90.8000	90.8000	90.8000	0.0000	0.0000	0.0000	0.0000	90.8000	90.8000	90.8000	(210)
Space heating fuel (main heating system)	524.0405	355.7805	243.8381	100.7537	27.0544	0.0000	0.0000	0.0000	0.0000	115.7582	339.2287	553.8462	(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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
Efficiency of water heater												81.5000 (216)
(217)m	87.8462	87.3166	86.3713	84.6510	82.6573	81.5000	81.5000	81.5000	81.5000	84.8442	87.1407	88.0032 (217)
Fuel for water heating, kWh/month												
	226.2915	198.8703	209.1762	189.2993	187.6957	167.6593	160.6304	179.0652	181.0428	198.0275	205.8195	220.5830 (219)
Water heating fuel used												2324.1606 (219)
Annual totals kWh/year												
Space heating fuel - main system												2260.3002 (211)
Space heating fuel - secondary												0.0000 (215)
Electricity for pumps and fans:												
central heating pump												30.0000 (230c)
Total electricity for the above, kWh/year												30.0000 (231)
Electricity for lighting (calculated in Appendix L)												331.3915 (232)
Total delivered energy for all uses												4945.8522 (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	2260.3002	0.2160	488.2248	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2324.1606	0.2160	502.0187	(264)
Space and water heating			990.2435	(265)
Pumps and fans	30.0000	0.5190	15.5700	(267)
Energy for lighting	331.3915	0.5190	171.9922	(268)
Total CO2, kg/year			1177.8057	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			15.5300	(273)

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

DER		15.5300	ZC1
Total Floor Area	TFA	75.8200	
Assumed number of occupants	N	2.3788	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		16.4506	ZC2
CO2 emissions from cooking, equation (L16)		2.3225	ZC3
Total CO2 emissions		34.3030	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		34.3030	ZC8

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							3 * 10 =	30.0000	(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) =	30.0000 / (5) =	0.1583	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.4083	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3164	(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	0.4034	0.3955	0.3876	0.3480	0.3401	0.3006	0.3006	0.2927	0.3164	0.3401	0.3560	0.3718	(22b)
Effective ac	0.5814	0.5782	0.5751	0.5606	0.5578	0.5452	0.5452	0.5428	0.5501	0.5578	0.5634	0.5691	(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 Opaque door			1.8600	1.0000	1.8600			(26)
TER Opening Type (Uw = 1.40)			17.0900	1.3258	22.6572			(27)
Heat Loss Floor 1			75.8200	0.1300	9.8566			(28b)
External Wall 1	42.4800	17.0900	25.3900	0.1800	4.5702			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1800	4.5486			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	43.4926			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		8.3659 (36)
Total fabric heat loss	(33) + (36) =	51.8585 (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	36.3658	36.1682	35.9744	35.0645	34.8942	34.1016	34.1016	33.9548	34.4069	34.8942	35.2386	35.5987	(38)
Heat transfer coeff	88.2243	88.0267	87.8329	86.9229	86.7527	85.9601	85.9601	85.8133	86.2654	86.7527	87.0971	87.4572	(39)
Average = Sum(39)m / 12 =												86.9221	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1636	1.1610	1.1584	1.1464	1.1442	1.1337	1.1337	1.1318	1.1378	1.1442	1.1487	1.1535	(40)
HLP (average)												1.1464	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)
Total heat required for water heating calculated for each month	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202	(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	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202	(64)
								Total per year (kWh/year) = Sum(64)m =				1971.0232	(64)

Heat gains from water heating, kWh/month

	61.9029	54.0870	56.1830	49.6649	48.0013	42.1126	40.0972	44.9403	45.4442	51.9758	55.7234	60.3507 (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	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	18.7618	16.6640	13.5521	10.2598	7.6693	6.4748	6.9962	9.0940	12.2059	15.4982	18.0887	19.2832	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	210.4835	212.6677	207.1636	195.4462	180.6551	166.7536	157.4665	155.2823	160.7864	172.5037	187.2949	201.1964	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	(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)													
	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)
Water heating gains (Table 5)													
	83.2028	80.4866	75.5148	68.9790	64.5178	58.4897	53.8940	60.4036	63.1169	69.8599	77.3936	81.1165	(72)
Total internal gains													
	374.1296	371.4998	357.9121	336.3666	314.5238	293.3996	280.0383	286.4614	297.7907	319.5433	344.4587	363.2777	(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	
Southeast	14.7300	36.7938	0.6300	0.7000	0.7700	165.6340	(77)
Southwest	2.3600	36.7938	0.6300	0.7000	0.7700	26.5374	(79)

Solar gains	192.1715	327.3391	447.8796	554.9446	621.5842	617.0892	594.9399	545.2237	484.9589	361.7795	230.1771	164.4587	(83)
Total gains	566.3011	698.8389	805.7917	891.3112	936.1080	910.4889	874.9782	831.6852	782.7496	681.3228	574.6358	527.7364	(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, ni1,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	59.6806	59.8146	59.9465	60.5741	60.6930	61.2526	61.2526	61.3573	61.0358	60.6930	60.4529	60.2040	
alpha	4.9787	4.9876	4.9964	5.0383	5.0462	5.0835	5.0835	5.0905	5.0691	5.0462	5.0302	5.0136	
util living area													
	0.9947	0.9849	0.9601	0.8952	0.7670	0.5849	0.4288	0.4690	0.7043	0.9273	0.9875	0.9962	(86)
MIT	19.8755	20.0989	20.3817	20.6853	20.8899	20.9781	20.9962	20.9941	20.9455	20.6647	20.2031	19.8320	(87)
Th 2	19.9492	19.9513	19.9534	19.9631	19.9649	19.9734	19.9734	19.9749	19.9701	19.9649	19.9612	19.9574	(88)
util rest of house													
	0.9930	0.9801	0.9478	0.8644	0.7076	0.4992	0.3306	0.3674	0.6199	0.8986	0.9827	0.9950	(89)
MIT 2	18.4683	18.7926	19.1963	19.6160	19.8658	19.9600	19.9721	19.9727	19.9316	19.6014	18.9533	18.4108	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	18.8081	19.1081	19.4826	19.8742	20.1131	20.2059	20.2194	20.2194	20.1765	19.8581	19.2551	18.7540	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8081	19.1081	19.4826	19.8742	20.1131	20.2059	20.2194	20.2194	20.1765	19.8581	19.2551	18.7540	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9903	0.9750	0.9409	0.8614	0.7168	0.5192	0.3544	0.3920	0.6379	0.8951	0.9783	0.9929	(94)
Useful gains	560.8127	681.3873	758.1490	767.7437	670.9834	472.7586	310.0774	326.0144	499.3228	609.8217	562.1708	523.9777	(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													
	1279.9712	1250.6883	1140.2988	953.9111	729.8588	481.8813	311.1248	327.7555	524.1888	803.1693	1058.6739	1272.8544	(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													
	535.0539	382.5702	284.3194	134.0405	43.8033	0.0000	0.0000	0.0000	0.0000	143.8506	357.4822	557.1642	(98)
Space heating												2438.2844	(98)
Space heating per m2											(98) / (4) =	32.1589	(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 %)												93.4000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												2610.5829	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	535.0539	382.5702	284.3194	134.0405	43.8033	0.0000	0.0000	0.0000	0.0000	143.8506	357.4822	557.1642	(98)
Space heating efficiency (main heating system 1)													
	93.4000	93.4000	93.4000	93.4000	93.4000	0.0000	0.0000	0.0000	0.0000	93.4000	93.4000	93.4000	(210)
Space heating fuel (main heating system)													
	572.8629	409.6041	304.4105	143.5123	46.8986	0.0000	0.0000	0.0000	0.0000	154.0156	382.7433	596.5356	(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													

	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
Efficiency of water heater												80.3000 (216)
(217)m	87.4214	86.9844	86.1880	84.6055	82.3251	80.3000	80.3000	80.3000	80.3000	84.6631	86.7544	87.5546 (217)
Fuel for water heating, kWh/month												
	227.3911	199.6299	209.6213	189.4011	188.4530	170.1648	163.0308	181.7411	183.7483	198.4513	206.7360	221.7134 (219)
Water heating fuel used												2340.0820 (219)
Annual totals kWh/year												
Space heating fuel - main system												2610.5829 (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)												331.3386 (232)
Total delivered energy for all uses												5357.0035 (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	2610.5829	0.2160	563.8859	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2340.0820	0.2160	505.4577	(264)
Space and water heating			1069.3436	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	331.3386	0.5190	171.9647	(268)
Total CO2, kg/m2/year			1280.2334	(272)
Emissions per m2 for space and water heating			14.1037	(272a)
Fuel factor (mains gas)			1.0000	
Emissions per m2 for lighting			2.2681	(272b)
Emissions per m2 for pumps and fans			0.5134	(272c)
Target Carbon Dioxide Emission Rate (TER) = (14.1037 * 1.00) + 2.2681 + 0.5134, rounded to 2 d.p.			16.8900	(273)

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							3 * 10 =	30.0000	(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) =	30.0000 / (5) =	0.1583	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.3583	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2777	(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	0.3540	0.3471	0.3401	0.3054	0.2985	0.2638	0.2638	0.2568	0.2777	0.2985	0.3124	0.3262	(22b)
Effective ac	0.5627	0.5602	0.5578	0.5466	0.5445	0.5348	0.5348	0.5330	0.5385	0.5445	0.5488	0.5532	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		11.2430 (36)
Total fabric heat loss	(33) + (36) =	50.3187 (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	35.1954	35.0432	34.8940	34.1933	34.0622	33.4518	33.4518	33.3388	33.6869	34.0622	34.3274	34.6047	(38)
Heat transfer coeff	85.5141	85.3619	85.2127	84.5119	84.3808	83.7705	83.7705	83.6575	84.0056	84.3808	84.6461	84.9234	(39)
Average = Sum(39)m / 12 =												84.5113	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1279	1.1258	1.1239	1.1146	1.1129	1.1049	1.1049	1.1034	1.1080	1.1129	1.1164	1.1201	(40)
HLP (average)												1.1146	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(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)
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	31.4392	27.4969	28.3744	24.7375	23.7362	20.4825	18.9801	21.7799	22.0400	25.6855	28.0377	30.4472	(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	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	(66)

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

	18.7648	16.6667	13.5543	10.2614	7.6706	6.4758	6.9973	9.0954	12.2078	15.5006	18.0915	19.2863	(67)

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

	210.4835	212.6677	207.1636	195.4462	180.6551	166.7536	157.4665	155.2823	160.7864	172.5037	187.2949	201.1964	(68)

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

	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	(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)

	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)

Water heating gains (Table 5)

	42.2570	40.9180	38.1376	34.3576	31.9035	28.4479	25.5108	29.2741	30.6111	34.5235	38.9413	40.9236	(72)

Total internal gains

	330.1868	328.9339	317.5370	298.7468	278.9107	260.3589	248.6562	252.3333	262.2869	281.2095	303.0092	320.0879	(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
Southeast	14.4800	36.7938	0.6300	0.7000	0.7700	162.8229 (77)
Southwest	2.7000	36.7938	0.6300	0.7000	0.7700	30.3606 (79)
Southeast	2.3400	36.7938	0.6300	0.7000	0.7700	26.3125 (77)

Solar gains	219.4960	373.8829	511.5629	633.8513	709.9663	704.8322	679.5334	622.7482	553.9145	413.2203	262.9057	187.8429	(83)
Total gains	549.6828	702.8169	829.1000	932.5981	988.8770	965.1910	928.1896	875.0816	816.2013	694.4298	565.9149	507.9307	(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	61.5720	61.6818	61.7898	62.3022	62.3990	62.8536	62.8536	62.9385	62.6777	62.3990	62.2035	62.0003	
alpha	5.1048	5.1121	5.1193	5.1535	5.1599	5.1902	5.1902	5.1959	5.1785	5.1599	5.1469	5.1334	
util living area													
	0.9953	0.9839	0.9533	0.8735	0.7281	0.5435	0.3951	0.4363	0.6704	0.9183	0.9879	0.9968	(86)
MIT	19.9043	20.1505	20.4459	20.7407	20.9193	20.9855	20.9977	20.9962	20.9595	20.7009	20.2304	19.8537	(87)
Th 2	19.9781	19.9798	19.9814	19.9889	19.9903	19.9969	19.9969	19.9981	19.9943	19.9903	19.9875	19.9845	(88)
util rest of house													
	0.9937	0.9789	0.9393	0.8395	0.6681	0.4635	0.3061	0.3431	0.5879	0.8875	0.9833	0.9957	(89)
MIT 2	18.9901	19.2342	19.5209	19.7966	19.9418	19.9910	19.9963	19.9971	19.9752	19.7708	19.3214	18.9449	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	19.2109	19.4555	19.7443	20.0246	20.1778	20.2311	20.2382	20.2384	20.2129	19.9954	19.5409	19.1643	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2109	19.4555	19.7443	20.0246	20.1778	20.2311	20.2382	20.2384	20.2129	19.9954	19.5409	19.1643	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9922	0.9757	0.9355	0.8409	0.6798	0.4826	0.3277	0.3657	0.6067	0.8877	0.9806	0.9946	(94)
Useful gains	545.3946	685.7070	775.6199	784.1795	672.2807	465.7840	304.1373	319.9965	495.1877	616.4537	554.9638	505.1686	(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													
	1275.0898	1242.4836	1128.5808	940.1639	715.3667	471.7235	304.7700	321.1101	513.5170	792.7905	1053.0751	1270.8223	(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													
	542.8932	374.1538	262.6029	112.3088	32.0560	0.0000	0.0000	0.0000	0.0000	131.1946	358.6401	569.6463	(98)
Space heating												2383.4957	(98)
Space heating per m2											(98) / (4) =	31.4362	(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	787.4428	619.9018	635.7969	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9604	0.9824	0.9757	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	756.2851	608.9615	620.3413	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1216.5800	1171.5154	1110.8916	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	331.4124	418.5401	364.9694	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												1114.9219	(104)
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	82.8531	104.6350	91.2424	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												278.7305	(107)
Space cooling per m2												3.6762	(108)
Energy for space heating												31.4362	(99)
Energy for space cooling												3.6762	(108)
Total												35.1125	(109)
Dwelling Fabric Energy Efficiency (DFEE)												35.1	(109)

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 75.8200						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							3 * 10 =	30.0000	(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) =	30.0000 / (5) =	0.1583	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.4083	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3164	(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	0.4034	0.3955	0.3876	0.3480	0.3401	0.3006	0.3006	0.2927	0.3164	0.3401	0.3560	0.3718	(22b)
Effective ac	0.5814	0.5782	0.5751	0.5606	0.5578	0.5452	0.5452	0.5428	0.5501	0.5578	0.5634	0.5691	(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 Opaque door			1.8600	1.0000	1.8600			(26)
TER Opening Type (Uw = 1.40)			17.0900	1.3258	22.6572			(27)
Heat Loss Floor 1			75.8200	0.1300	9.8566			(28b)
External Wall 1	42.4800	17.0900	25.3900	0.1800	4.5702			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1800	4.5486			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		43.4926			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		8.3659 (36)
Total fabric heat loss	(33) + (36) =	51.8585 (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	36.3658	36.1682	35.9744	35.0645	34.8942	34.1016	34.1016	33.9548	34.4069	34.8942	35.2386	35.5987	(38)
Heat transfer coeff	88.2243	88.0267	87.8329	86.9229	86.7527	85.9601	85.9601	85.8133	86.2654	86.7527	87.0971	87.4572	(39)
Average = Sum(39)m / 12 =												86.9221	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1636	1.1610	1.1584	1.1464	1.1442	1.1337	1.1337	1.1318	1.1378	1.1442	1.1487	1.1535	(40)
HLP (average)												1.1464	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(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)
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	31.4392	27.4969	28.3744	24.7375	23.7362	20.4825	18.9801	21.7799	22.0400	25.6855	28.0377	30.4472	(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	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	(66)

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

	18.7618	16.6640	13.5521	10.2598	7.6693	6.4748	6.9962	9.0940	12.2059	15.4982	18.0887	19.2832	(67)

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

	210.4835	212.6677	207.1636	195.4462	180.6551	166.7536	157.4665	155.2823	160.7864	172.5037	187.2949	201.1964	(68)

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

	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	(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)

	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)

Water heating gains (Table 5)

	42.2570	40.9180	38.1376	34.3576	31.9035	28.4479	25.5108	29.2741	30.6111	34.5235	38.9413	40.9236	(72)
Total internal gains													
	330.1838	328.9313	317.5349	298.7452	278.9095	260.3578	248.6551	252.3319	262.2849	281.2070	303.0064	320.0848	(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	
Southeast	14.7300	36.7938	0.6300	0.7000	0.7700	165.6340	(77)
Southwest	2.3600	36.7938	0.6300	0.7000	0.7700	26.5374	(79)

Solar gains	192.1715	327.3391	447.8796	554.9446	621.5842	617.0892	594.9399	545.2237	484.9589	361.7795	230.1771	164.4587	(83)
Total gains	522.3552	656.2704	765.4145	853.6898	900.4937	877.4471	843.5950	797.5556	747.2439	642.9865	533.1835	484.5435	(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, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	59.6806	59.8146	59.9465	60.5741	60.6930	61.2526	61.2526	61.3573	61.0358	60.6930	60.4529	60.2040	
alpha	4.9787	4.9876	4.9964	5.0383	5.0462	5.0835	5.0835	5.0905	5.0691	5.0462	5.0302	5.0136	
util living area													
	0.9963	0.9883	0.9671	0.9081	0.7856	0.6038	0.4441	0.4879	0.7282	0.9403	0.9909	0.9974	(86)
MIT	19.8226	20.0498	20.3404	20.6573	20.8768	20.9748	20.9956	20.9930	20.9366	20.6309	20.1546	19.7795	(87)
Th 2	19.9492	19.9513	19.9534	19.9631	19.9649	19.9734	19.9734	19.9749	19.9701	19.9649	19.9612	19.9574	(88)
util rest of house													
	0.9951	0.9846	0.9566	0.8798	0.7275	0.5167	0.3427	0.3828	0.6441	0.9154	0.9873	0.9966	(89)
MIT 2	18.8855	19.1122	19.3975	19.7021	19.8882	19.9627	19.9723	19.9731	19.9390	19.6873	19.2256	18.8492	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	19.1118	19.3387	19.6252	19.9328	20.1269	20.2071	20.2194	20.2194	20.1799	19.9152	19.4500	19.0739	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.1118	19.3387	19.6252	19.9328	20.1269	20.2071	20.2194	20.2194	20.1799	19.9152	19.4500	19.0739	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9937	0.9818	0.9525	0.8789	0.7374	0.5372	0.3673	0.4083	0.6625	0.9139	0.9850	0.9955	(94)
Useful gains	519.0785	644.2961	729.0597	750.3010	663.9978	471.3792	309.8917	325.6599	495.0592	587.6312	525.1895	482.3866	(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													
	1306.7629	1270.9885	1152.8233	959.0035	731.0592	481.9907	311.1275	327.7571	524.4849	808.1181	1075.6460	1300.8262	(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													
	586.0373	421.1373	315.2801	150.2658	49.8937	0.0000	0.0000	0.0000	0.0000	164.0422	396.3287	608.9191	(98)
Space heating												2691.9042	(98)
Space heating per m2											(98) / (4) =	35.5039	(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	808.0251	636.1049	652.1814	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9375	0.9702	0.9604	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	757.4836	617.1381	626.3763	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1114.0207	1072.6370	1020.2749	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	256.7067	338.8912	293.0605	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												888.6585	(104)
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	64.1767	84.7228	73.2651	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												222.1646	(107)
Space cooling per m2												2.9302	(108)
Energy for space heating												35.5039	(99)
Energy for space cooling												2.9302	(108)
Total												38.4340	(109)
Target Fabric Energy Efficiency (TFEE)												44.2	(109)

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							2 * 10 =	20.0000	(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) =	20.0000 / (5) =	0.1055	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.3055	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2368	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	3.7000	3.5000	3.5000	3.3000	3.3000	3.0000	3.2000	3.0000	2.9000	3.1000	3.1000	3.4000	(22)
Wind factor	0.9250	0.8750	0.8750	0.8250	0.8250	0.7500	0.8000	0.7500	0.7250	0.7750	0.7750	0.8500	(22a)
Adj infilt rate	0.2190	0.2072	0.2072	0.1953	0.1953	0.1776	0.1894	0.1776	0.1717	0.1835	0.1835	0.2013	(22b)
Effective ac	0.5240	0.5215	0.5215	0.5191	0.5191	0.5158	0.5179	0.5158	0.5147	0.5168	0.5168	0.5203	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	11.2430 (36)
Total fabric heat loss (33) + (36) =	50.3187 (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	32.7760	32.6182	32.6182	32.4691	32.4691	32.2620	32.3979	32.2620	32.1974	32.3289	32.3289	32.5426	(38)
Heat transfer coeff	83.0946	82.9368	82.9368	82.7878	82.7878	82.5807	82.7166	82.5807	82.5160	82.6475	82.6475	82.8612	(39)
Average = Sum(39)m / 12 =												82.7578	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0959	1.0939	1.0939	1.0919	1.0919	1.0892	1.0910	1.0892	1.0883	1.0900	1.0900	1.0929	(40)
HLP (average)												1.0915	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)
Total heat required for water heating calculated for each month	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202	(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

198.7885 173.6469 180.6683 160.2437 155.1442 136.6423 130.9137 145.9381 147.5499 168.0149 179.3526 194.1202 (64)
Total per year (kWh/year) = Sum(64)m = 1971.0232 (64)
RHI water heating demand 1971 (64)
Heat gains from water heating, kWh/month
61.9029 54.0870 56.1830 49.6649 48.0013 42.1126 40.0972 44.9403 45.4442 51.9758 55.7234 60.3507 (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	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
46.9119 41.6667 33.8857 25.6536 19.1764 16.1895 17.4933 22.7385 30.5196 38.7516 45.2288 48.2157 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
314.1545 317.4144 309.1995 291.7108 269.6345 248.8860 235.0246 231.7647 239.9796 257.4683 279.5446 300.2931 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 (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)
-95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 (71)
Water heating gains (Table 5)
83.2028 80.4866 75.5148 68.9790 64.5178 58.4897 53.8940 60.4036 63.1169 69.8599 77.3936 81.1165 (72)
Total internal gains
546.4960 541.7945 520.8267 488.5702 455.5555 425.7920 408.6388 417.1335 435.8429 468.3065 504.3938 531.8522 (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	
Southeast	14.4800	41.6087	0.6300	0.7000	0.7700	184.1300	(77)
Southwest	2.7000	41.6087	0.6300	0.7000	0.7700	34.3336	(79)
Southeast	2.3400	41.6087	0.6300	0.7000	0.7700	29.7558	(77)

Solar gains	248.2195	361.5583	498.6489	640.5534	703.4492	746.1949	717.4950	661.6596	581.8065	440.5543	287.1578	203.6348	(83)
Total gains	794.7155	903.3528	1019.4756	1129.1236	1159.0047	1171.9869	1126.1338	1078.7931	1017.6494	908.8608	791.5516	735.4870	(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	63.3648	63.4854	63.4854	63.5997	63.5997	63.7592	63.6545	63.7592	63.8092	63.7076	63.7076	63.5433	
alpha	5.2243	5.2324	5.2324	5.2400	5.2400	5.2506	5.2436	5.2506	5.2539	5.2472	5.2472	5.2362	
util living area	0.9677	0.9406	0.8679	0.7189	0.5261	0.3166	0.1836	0.2066	0.4346	0.7400	0.9306	0.9762	(86)
MIT	20.3508	20.5065	20.7372	20.9176	20.9860	20.9992	21.0000	20.9999	20.9959	20.9211	20.6184	20.2911	(87)
Th 2	20.0041	20.0058	20.0058	20.0075	20.0075	20.0097	20.0082	20.0097	20.0104	20.0090	20.0090	20.0067	(88)
util rest of house	0.9582	0.9246	0.8366	0.6670	0.4603	0.2472	0.1108	0.1309	0.3566	0.6781	0.9088	0.9689	(89)
MIT 2	19.1911	19.4077	19.7136	19.9300	19.9978	20.0094	20.0082	20.0097	20.0085	19.9405	19.5686	19.1094	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	19.4712	19.6730	19.9608	20.1685	20.2365	20.2485	20.2477	20.2488	20.2469	20.1773	19.8221	19.3948	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.3212	19.5230	19.8108	20.0185	20.0865	20.0985	20.0977	20.0988	20.0969	20.0273	19.6721	19.2448	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9499	0.9153	0.8297	0.6676	0.4656	0.2534	0.1174	0.1377	0.3635	0.6794	0.8999	0.9616	(94)
Useful gains	754.9351	826.8272	845.8274	753.8365	539.6745	296.9984	132.1565	148.5443	369.8887	617.4584	712.2913	707.2516	(95)
Ext temp.	5.5000	6.0000	7.8000	10.4000	13.5000	16.5000	18.5000	18.3000	15.6000	12.1000	8.4000	5.5000	(96)
Heat loss rate W	1148.4661	1121.5570	996.1367	796.2946	545.2790	297.1633	132.1580	148.5482	371.0671	655.1731	931.6116	1138.9088	(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	292.7871	198.0584	111.8302	30.5698	4.1698	0.0000	0.0000	0.0000	0.0000	28.0598	157.9106	321.1529	(98)

Space heating 1144.5386 (98)
RHI space heating demand 1145 (98)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							2 * 10 =	20.0000	(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) =	20.0000 / (5) =	0.1055	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.3055	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2368	(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	0.3019	0.2960	0.2900	0.2604	0.2545	0.2249	0.2249	0.2190	0.2368	0.2545	0.2664	0.2782	(22b)
Effective ac	0.5456	0.5438	0.5421	0.5339	0.5324	0.5253	0.5253	0.5240	0.5280	0.5324	0.5355	0.5387	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	11.2430	(36)
Total fabric heat loss (33) + (36) =	50.3187	(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	34.1261	34.0154	33.9069	33.3973	33.3020	32.8582	32.8582	32.7760	33.0291	33.3020	33.4948	33.6965	(38)
Heat transfer coeff	84.4447	84.3340	84.2255	83.7160	83.6206	83.1768	83.1768	83.0946	83.3478	83.6206	83.8135	84.0151	(39)
Average = Sum(39)m / 12 =												83.7155	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1138	1.1123	1.1109	1.1041	1.1029	1.0970	1.0970	1.0959	1.0993	1.1029	1.1054	1.1081	(40)
HLP (average)												1.1041	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)
Total heat required for water heating calculated for each month	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202	(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

	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
									Total per year (kWh/year) = Sum(64)m =			1971.0232 (64)

Heat gains from water heating, kWh/month

	61.9029	54.0870	56.1830	49.6649	48.0013	42.1126	40.0972	44.9403	45.4442	51.9758	55.7234	60.3507 (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	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	(66)

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

	46.9119	41.6667	33.8857	25.6536	19.1764	16.1895	17.4933	22.7385	30.5196	38.7516	45.2288	48.2157 (67)

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

	314.1545	317.4144	309.1995	291.7108	269.6345	248.8860	235.0246	231.7647	239.9796	257.4683	279.5446	300.2931 (68)

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

	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514 (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)

	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508 (71)

Water heating gains (Table 5)

	83.2028	80.4866	75.5148	68.9790	64.5178	58.4897	53.8940	60.4036	63.1169	69.8599	77.3936	81.1165 (72)

Total internal gains

	546.4960	541.7945	520.8267	488.5702	455.5555	425.7920	408.6388	417.1335	435.8429	468.3065	504.3938	531.8522 (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	
Southeast	14.4800	36.7938	0.6300	0.7000	0.7700	162.8229	(77)
Southwest	2.7000	36.7938	0.6300	0.7000	0.7700	30.3606	(79)
Southeast	2.3400	36.7938	0.6300	0.7000	0.7700	26.3125	(77)

Solar gains	219.4960	373.8829	511.5629	633.8513	709.9663	704.8322	679.5334	622.7482	553.9145	413.2203	262.9057	187.8429 (83)
Total gains	765.9920	915.6774	1032.3896	1122.4215	1165.5218	1130.6242	1088.1722	1039.8818	989.7574	881.5268	767.2994	719.6950 (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, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	62.3518	62.4336	62.5140	62.8945	62.9662	63.3022	63.3022	63.3648	63.1724	62.9662	62.8214	62.6706	
alpha	5.1568	5.1622	5.1676	5.1930	5.1977	5.2201	5.2201	5.2243	5.2115	5.1977	5.1881	5.1780	
util living area	0.9799	0.9533	0.8994	0.7926	0.6377	0.4659	0.3356	0.3663	0.5662	0.8329	0.9577	0.9848	(86)
MIT	20.1775	20.3952	20.6348	20.8460	20.9570	20.9930	20.9990	20.9984	20.9816	20.8308	20.4628	20.1229	(87)
Th 2	19.9896	19.9908	19.9920	19.9975	19.9985	20.0033	20.0033	20.0041	20.0014	19.9985	19.9964	19.9942	(88)
util rest of house	0.9741	0.9410	0.8752	0.7503	0.5784	0.3956	0.2600	0.2877	0.4903	0.7870	0.9443	0.9803	(89)
MIT 2	18.9327	19.2399	19.5666	19.8385	19.9623	19.9992	20.0029	20.0036	19.9894	19.8298	19.3446	18.8581	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	19.2333	19.5189	19.8246	20.0818	20.2025	20.2392	20.2435	20.2438	20.2290	20.0715	19.6147	19.1636	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.0833	19.3689	19.6746	19.9318	20.0525	20.0892	20.0935	20.0938	20.0790	19.9215	19.4647	19.0136	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9673	0.9317	0.8665	0.7473	0.5818	0.4017	0.2668	0.2948	0.4964	0.7830	0.9353	0.9744	(94)
Useful gains	740.9059	853.1028	894.5818	838.7689	678.0444	454.1735	290.3585	306.5662	491.3141	690.2448	717.6912	701.2671	(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	1248.3705	1220.2221	1109.6372	923.5368	698.4453	456.5762	290.5748	306.9350	498.3377	779.4721	1036.3250	1244.5628	(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	377.5536	246.7041	160.0012	61.0329	15.1783	0.0000	0.0000	0.0000	0.0000	66.3851	229.4163	404.2120	(98)
Space heating												1560.4836	(98)
Space heating per m2											(98) / (4) =	20.5814	(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 %)	90.8000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	1718.5942	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	377.5536	246.7041	160.0012	61.0329	15.1783	0.0000	0.0000	0.0000	0.0000	66.3851	229.4163	404.2120	(98)
Space heating efficiency (main heating system 1)	90.8000	90.8000	90.8000	90.8000	90.8000	0.0000	0.0000	0.0000	0.0000	90.8000	90.8000	90.8000	(210)
Space heating fuel (main heating system)													
	415.8080	271.7006	176.2128	67.2168	16.7162	0.0000	0.0000	0.0000	0.0000	73.1113	252.6612	445.1674	(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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
Efficiency of water heater												81.5000 (216)
(217)m	87.3616	86.7125	85.6187	83.8693	82.2507	81.5000	81.5000	81.5000	81.5000	83.9347	86.4706	87.5585 (217)
Fuel for water heating, kWh/month												
	227.5467	200.2559	211.0151	191.0635	188.6234	167.6593	160.6304	179.0652	181.0428	200.1733	207.4145	221.7035 (219)
Water heating fuel used												2336.1936 (219)
Annual totals kWh/year												
Space heating fuel - main system												1718.5942 (211)
Space heating fuel - secondary												0.0000 (215)
Electricity for pumps and fans:												
central heating pump												30.0000 (230c)
Total electricity for the above, kWh/year												30.0000 (231)
Electricity for lighting (calculated in Appendix L)												331.3915 (232)
Total delivered energy for all uses												4416.1792 (238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	1718.5942	3.4800	59.8071 (240)
Space heating - secondary	0.0000	0.0000	0.0000 (242)
Water heating (other fuel)	2336.1936	3.4800	81.2995 (247)
Pumps and fans for heating	30.0000	13.1900	3.9570 (249)
Energy for lighting	331.3915	13.1900	43.7105 (250)
Additional standing charges			120.0000 (251)
Total energy cost			308.7741 (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] =	1.0734 (257)
SAP value		85.0264
SAP rating (Section 12)		85 (258)
SAP band		B

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	1718.5942	0.2160	371.2164 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	2336.1936	0.2160	504.6178 (264)
Space and water heating			875.8342 (265)
Pumps and fans	30.0000	0.5190	15.5700 (267)
Energy for lighting	331.3915	0.5190	171.9922 (268)
Total kg/year			1063.3963 (272)
CO2 emissions per m2			14.0300 (273)
EI value			88.2060
EI rating			88 (274)
EI band			B

Calculation of stars for heating and DHW

Main heating energy efficiency	3.48 × (1 + 0.29 × 0.00) / 0.9080 = 3.833, stars = 4
Main heating environmental impact	0.216 × (1 + 0.29 × 0.00) / 0.9080 = 0.2379, stars = 4
Water heating energy efficiency	3.48 / 0.8415 = 4.136, stars = 4
Water heating environmental impact	0.216 / 0.8415 = 0.2567, stars = 4

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							2 * 10 =	20.0000	(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) =	20.0000 / (5) =	0.1055	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.3055	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2368	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	3.7000	3.5000	3.5000	3.3000	3.3000	3.0000	3.2000	3.0000	2.9000	3.1000	3.1000	3.4000	(22)
Wind factor	0.9250	0.8750	0.8750	0.8250	0.8250	0.7500	0.8000	0.7500	0.7250	0.7750	0.7750	0.8500	(22a)
Adj infilt rate	0.2190	0.2072	0.2072	0.1953	0.1953	0.1776	0.1894	0.1776	0.1717	0.1835	0.1835	0.2013	(22b)
Effective ac	0.5240	0.5215	0.5215	0.5191	0.5191	0.5158	0.5179	0.5158	0.5147	0.5168	0.5168	0.5203	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		11.2430 (36)
Total fabric heat loss	(33) + (36) =	50.3187 (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	32.7760	32.6182	32.6182	32.4691	32.4691	32.2620	32.3979	32.2620	32.1974	32.3289	32.3289	32.5426	(38)
Heat transfer coeff	83.0946	82.9368	82.9368	82.7878	82.7878	82.5807	82.7166	82.5807	82.5160	82.6475	82.6475	82.8612	(39)
Average = Sum(39)m / 12 =												82.7578	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0959	1.0939	1.0939	1.0919	1.0919	1.0892	1.0910	1.0892	1.0883	1.0900	1.0900	1.0929	(40)
HLP (average)												1.0915	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)
Total heat required for water heating calculated for each month	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202	(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

198.7885 173.6469 180.6683 160.2437 155.1442 136.6423 130.9137 145.9381 147.5499 168.0149 179.3526 194.1202 (64)
Total per year (kWh/year) = Sum(64)m = 1971.0232 (64)

Heat gains from water heating, kWh/month
61.9029 54.0870 56.1830 49.6649 48.0013 42.1126 40.0972 44.9403 45.4442 51.9758 55.7234 60.3507 (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	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
46.9119 41.6667 33.8857 25.6536 19.1764 16.1895 17.4933 22.7385 30.5196 38.7516 45.2288 48.2157 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
314.1545 317.4144 309.1995 291.7108 269.6345 248.8860 235.0246 231.7647 239.9796 257.4683 279.5446 300.2931 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 51.6514 (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)
-95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 -95.1508 (71)
Water heating gains (Table 5)
83.2028 80.4866 75.5148 68.9790 64.5178 58.4897 53.8940 60.4036 63.1169 69.8599 77.3936 81.1165 (72)
Total internal gains
546.4960 541.7945 520.8267 488.5702 455.5555 425.7920 408.6388 417.1335 435.8429 468.3065 504.3938 531.8522 (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	
Southeast	14.4800	41.6087	0.6300	0.7000	0.7700	184.1300	(77)
Southwest	2.7000	41.6087	0.6300	0.7000	0.7700	34.3336	(79)
Southeast	2.3400	41.6087	0.6300	0.7000	0.7700	29.7558	(77)

Solar gains	248.2195	361.5583	498.6489	640.5534	703.4492	746.1949	717.4950	661.6596	581.8065	440.5543	287.1578	203.6348	(83)
Total gains	794.7155	903.3528	1019.4756	1129.1236	1159.0047	1171.9869	1126.1338	1078.7931	1017.6494	908.8608	791.5516	735.4870	(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	63.3648	63.4854	63.4854	63.5997	63.5997	63.7592	63.6545	63.7592	63.8092	63.7076	63.7076	63.5433	
alpha	5.2243	5.2324	5.2324	5.2400	5.2400	5.2506	5.2436	5.2506	5.2539	5.2472	5.2472	5.2362	
util living area	0.9677	0.9406	0.8679	0.7189	0.5261	0.3166	0.1836	0.2066	0.4346	0.7400	0.9306	0.9762	(86)
MIT	20.3508	20.5065	20.7372	20.9176	20.9860	20.9992	21.0000	20.9999	20.9959	20.9211	20.6184	20.2911	(87)
Th 2	20.0041	20.0058	20.0058	20.0075	20.0075	20.0097	20.0082	20.0097	20.0104	20.0090	20.0090	20.0067	(88)
util rest of house	0.9582	0.9246	0.8366	0.6670	0.4603	0.2472	0.1108	0.1309	0.3566	0.6781	0.9088	0.9689	(89)
MIT 2	19.1911	19.4077	19.7136	19.9300	19.9978	20.0094	20.0082	20.0097	20.0085	19.9405	19.5686	19.1094	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	19.4712	19.6730	19.9608	20.1685	20.2365	20.2485	20.2477	20.2488	20.2469	20.1773	19.8221	19.3948	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.3212	19.5230	19.8108	20.0185	20.0865	20.0985	20.0977	20.0988	20.0969	20.0273	19.6721	19.2448	(93)

---

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9499	0.9153	0.8297	0.6676	0.4656	0.2534	0.1174	0.1377	0.3635	0.6794	0.8999	0.9616	(94)
Useful gains	754.9351	826.8272	845.8274	753.8365	539.6745	296.9984	132.1565	148.5443	369.8887	617.4584	712.2913	707.2516	(95)
Ext temp.	5.5000	6.0000	7.8000	10.4000	13.5000	16.5000	18.5000	18.3000	15.6000	12.1000	8.4000	5.5000	(96)
Heat loss rate W	1148.4661	1121.5570	996.1367	796.2946	545.2790	297.1633	132.1580	148.5482	371.0671	655.1731	931.6116	1138.9088	(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	292.7871	198.0584	111.8302	30.5698	4.1698	0.0000	0.0000	0.0000	0.0000	28.0598	157.9106	321.1529	(98)
Space heating												1144.5386	(98)
Space heating per m2											(98) / (4) =	15.0955	(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 %) 90.8000 (206)
Efficiency of secondary/supplementary heating system, % 0.0000 (208)
Space heating requirement 1260.5051 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	292.7871	198.0584	111.8302	30.5698	4.1698	0.0000	0.0000	0.0000	0.0000	28.0598	157.9106	321.1529	(98)
Space heating efficiency (main heating system 1)	90.8000	90.8000	90.8000	90.8000	90.8000	0.0000	0.0000	0.0000	0.0000	90.8000	90.8000	90.8000	(210)
Space heating fuel (main heating system)	322.4528	218.1260	123.1610	33.6672	4.5923	0.0000	0.0000	0.0000	0.0000	30.9029	173.9104	353.6926	(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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
Efficiency of water heater												81.5000 (216)
(217)m	86.7948	86.2046	84.8215	82.8596	81.7191	81.5000	81.5000	81.5000	81.5000	82.7124	85.6053	87.0575 (217)
Fuel for water heating, kWh/month												
	229.0326	201.4357	212.9982	193.3917	189.8506	167.6593	160.6304	179.0652	181.0428	203.1316	209.5112	222.9793 (219)
Water heating fuel used												2350.7286 (219)
Annual totals kWh/year												
Space heating fuel - main system												1260.5051 (211)
Space heating fuel - secondary												0.0000 (215)
Electricity for pumps and fans:												
central heating pump												30.0000 (230c)
Total electricity for the above, kWh/year												30.0000 (231)
Electricity for lighting (calculated in Appendix L)												331.3915 (232)
Total delivered energy for all uses												3972.6251 (238)

10a. Fuel costs - using BEDF prices (391)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	1260.5051	4.3200	54.4538 (240)
Space heating - secondary	0.0000	0.0000	0.0000 (242)
Water heating (other fuel)	2350.7286	4.3200	101.5515 (247)
Pumps and fans for heating	30.0000	15.3200	4.5960 (249)
Energy for lighting	331.3915	15.3200	50.7692 (250)
Additional standing charges			95.0000 (251)
Total energy cost			306.3705 (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	1260.5051	0.2160	272.2691 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	2350.7286	0.2160	507.7574 (264)
Space and water heating			780.0265 (265)
Pumps and fans	30.0000	0.5190	15.5700 (267)
Energy for lighting	331.3915	0.5190	171.9922 (268)
Total kg/year			967.5886 (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	1260.5051	1.2200	1537.8162 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	2350.7286	1.2200	2867.8889 (264)
Space and water heating			4405.7051 (265)
Pumps and fans	30.0000	3.0700	92.1000 (267)
Energy for lighting	331.3915	3.0700	1017.3718 (268)
Primary energy kWh/year			5515.1769 (272)
Primary energy kWh/m2/year			72.7404 (273)

SAP 2012 EPC IMPROVEMENTS

Current energy efficiency rating: B 85
Current environmental impact rating: B 88

(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	Not applicable
O	Not considered
P	Not considered
R	Not considered
S	Not considered
T	Not considered
U Solar photovoltaic panels	Not applicable
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
(none)			

Recommended measures	Typical annual savings	Energy efficiency	Environmental impact
(none)			
Total Savings	£0	0.00 kg/m²	

Potential energy efficiency rating: B 85
Potential environmental impact rating: B 88

Fuel prices for cost data on this page from database revision number 391 TEST (01 Apr 2016)
Recommendation texts revision number 4.9c (22 Feb 2014)

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

	Current	Potential	Saving
Electricity	£55	£55	£0
Mains gas	£251	£251	£0
Space heating	£154	£154	£0
Water heating	£102	£102	£0
Lighting	£51	£51	£0
Total cost of fuels	£306	£306	£0
Total cost of uses	£307	£307	£0
Delivered energy	52 kWh/m²	52 kWh/m²	0 kWh/m²
Carbon dioxide emissions	1.0 tonnes	1.0 tonnes	0.0 tonnes
CO2 emissions per m²	13 kg/m²	13 kg/m²	0 kg/m²
Primary energy	73 kWh/m²	73 kWh/m²	0 kWh/m²

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

No improvements selected / applicable

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

No improvements selected / applicable

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

Overheating Calculation Input Data

Dwelling type	MidTerrace Flat
Number of storeys	1
Cross ventilation possible	No
SAP Region	Thames Valley
Front of dwelling faces	North West
Overshading	Average or unknown
Thermal mass parameter	250.0
Night ventilation	Yes
Ventilation rate during hot weather (ach)	4.00 (Windows fully open)

Overheating Calculation

Summer ventilation heat loss coefficient	250.21 (P1)
Transmission heat loss coefficient	50.32 (37)
Summer heat loss coefficient	300.52 (P2)

Overhangs

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

Solar shading

Orientation	Z blinds	Solar access	Z overhangs	Z summer
South East	1.000	0.90	1.000	0.900 (P8)
South West	1.000	0.90	1.000	0.900 (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
South East	14.4800	119.9223	0.6300	0.7000	0.9000	620.2864
South West	2.7000	119.9223	0.6300	0.7000	0.9000	115.6611
South East	2.3400	119.9223	0.6300	0.7000	0.9000	100.2397
total:						836.1873

	Jun	Jul	Aug	
Solar gains	878	836	780	(P3)
Internal gains	423	406	414	
Total summer gains	1301	1242	1194	(P5)
Summer gain/loss ratio	4.33	4.13	3.97	(P6)
Summer external temperature	16.00	17.90	17.80	
Thermal mass temperature increment (TMP = 250.0)	0.25	0.25	0.25	
Threshold temperature	20.58	22.28	22.02	(P7)
Likelihood of high internal temperature	Slight	Medium	Medium	

Assessment of likelihood of high internal temperature: Medium

Sample Report Ltd
1 Sample Street
Sampletown

Full SAP Calculation Printout

Property Reference: 22491 - Flat 11
Survey Reference: Be Green
Property: 4 and 6 Manor Road, TW11 8BG

Issued on Date: 21.Jan.2016
Prop Type Ref:

SAP Rating:	91 B	**CO2 Emissions (t/year):**	0.43	**DER:**	8.03 Pass	**TER:**	16.89	**Percentage DER<TER:**	52.44 %
Environmental:	94 A	**General Requirements Compliance:**	Pass	**DFEE:**	35.11 Pass	**TFEE:**	44.20	**Percentage DFEE<TFEE:**	20.56 %

CfSH Results **Version:** **ENE1 Credits:** N/A **ENE2 Credits:** N/A **ENE7 Credits:** N/A **CfSH Level:** N/A

Surveyor: admin Admin, Tel: 4, Fax: s@l.f Surveyor ID: Admin
Address:
Client:

Software Version: Elmhurst Energy Systems SAP2012 Calculator (Design System) version 3.05r04
SAP version: SAP 2012, Regs Region: England (Part L1A 2013), Calculation Type: New Build (As Designed)

CALCULATION DETAILS for survey reference no 'Be Green'
SAP2012 - 9.92 input data (DesignData) -

SAP2012 Input Data (Flat)	03/05/2016
FullRefNo:	Be Green
Regs Region:	England
SAP Region:	Thames Valley
Postcode:	TW11 8BG
DwellingOrientation:	North West
Property Type:	Flat, Mid-Terrace
Storeys:	1
Date Built:	2015
Sheltered Sides:	3
Sunlight Shade:	Average or unknown
Measurements	Perimeter, Floor Area, Storey Height
1st Storey:	27.84, 75.82, 2.5
Living Area:	18.31 m2, fraction: 24.1%
Thermal Mass:	Simple calculation
Thermal Mass Simple:	Medium
Thermal MassValue:	250
External Walls	Nett Area, Gross Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
External Wall 1	22.96, 42.48, 0, Other, Cavity, 0, 0.13, Gross
Shelter Wall	25.27, 27.13, 0, Other, Cavity, 0, 0.13, Gross
Party Walls	Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
Party Wall 1	29.38, 0, Other, FilledWithEdge, 0, 0
External Roofs	Nett Area, Gross Area, Kappa, Construction, Element, UValueFinal
Party Ceilings	Area, Kappa, Construction, Element
Party Ceilings 1	75.82, 80, Concrete floor slab, carpeted
Heat Loss Floors	Area, Kappa, Construction, Element, Type, ShelterFactor, UValueFinal
Heat Loss Floor 1	75.82, 0, Other, Exposed Floor - Solid, 0.13, 0.108449176772158
Description	Data Source, Type, Glazing, Glazing Gap, Argon Filled, Solar Trans, Frame Type, Frame Factor, U Value
Flat Door	Manufacturer, Solid Door, , , , , , ,
Windows	Manufacturer, Window, Double Low-E Soft 0.1, , , 0.63, , 0.7,
French Doors	Manufacturer, Window, Double Low-E Soft 0.1, , , 0.63, , 0.7,
Openings	Opening Type, Location, Orientation, Pitch, Curtain Type, Overhang Ratio, Wide Overhang, Width, Height, Count, Area, Curtain Closed
Flat Door	Solid Door, Shelter Wall, North West, , , , , 0, 0, 0, 1.86,
SE F Windows	Window, External Wall 1, South East, , None, 0, , 0, 0, 0, 14.48,
SE F F Door	Window, External Wall 1, South East, , None, 0, , 0, 0, 0, 2.34,
SW F Windows	Window, External Wall 1, South West, , None, 0, , 0, 0, 0, 2.70,
Conservatory:	None
Draught Proofing:	100
Draught Lobby:	No
Thermal Bridges	
Bridging:	Calculate Bridges
Y	0.077
List of Bridges	Junction with, Bridge Type, Source Type, Imported, Length, Psi, Adjusted, Result, Reference
0.	External wall, E1 Steel lintel with perforated steel base plate, , No, 0, 0, 0, 0.00,
1.	External wall, E2 Other lintels (including other steel lintels), Table K1 - Approved, Yes, 11.95, 0.3, 0.3, 3.59,
2.	External wall, E3 Sill, Table K1 - Approved, Yes, 11.04, 0.04, 0.04, 0.44,
3.	External wall, E4 Jamb, Table K1 - Approved, Yes, 43.24, 0.05, 0.05, 2.16,
4.	External wall, E5 Ground floor (normal), Table K1 - Approved, Yes, 27.84, 0.16, 0.16, 4.45,
5.	External wall, E19 Ground floor (inverted), , No, 0, 0, 0, 0.00,
6.	External wall, E20 Exposed floor (normal), , No, 0, 0, 0, 0.00,
7.	External wall, E21 Exposed floor (inverted), , No, 0, 0, 0, 0.00,
8.	External wall, E22 Basement floor, , No, 0, 0, 0, 0.00,
9.	External wall, E6 Intermediate floor within a dwelling, , No, 0, 0, 0, 0.00,
10.	External wall, E7 Party floor between dwellings (in blocks of flats), , No, 0, 0, 0, 0.00,
11.	External wall, E8 Balcony within a dwelling, wall insulation continuous, Table K1 - Approved, No, 4.74, 0, 0, 0.00,
12.	External wall, E9 Balcony between dwellings, wall insulation continuous, , No, 0, 0, 0, 0.00,
13.	External wall, E23 Balcony within or between dwellings, balcony support penetrates wall insulation , , No, 0, 0, 0, 0.00,
14.	External wall, E10 Eaves (insulation at ceiling level), , No, 0, 0, 0, 0.00,
15.	External wall, E24 Eaves (insulation at ceiling level - inverted), , No, 0, 0, 0, 0.00,
16.	External wall, E11 Eaves (insulation at rafter level), , No, 0, 0, 0, 0.00,
17.	External wall, E12 Gable (insulation at ceiling level), , No, 0, 0, 0, 0.00,
18.	External wall, E13 Gable (insulation at rafter level), , No, 0, 0, 0, 0.00,
19.	External wall, E14 Flat roof, , No, 0, 0, 0, 0.00,
20.	External wall, E15 Flat roof with parapet, , No, 0, 0, 0, 0.00,
21.	External wall, E16 Corner (normal), Table K1 - Approved, No, 2.5, 0.09, 0.09, 0.23,
22.	External wall, E17 Corner (inverted - internal area greater than external area), Table K1 - Approved, No, 2.5, -0.09, -0.09, -0.23,
23.	External wall, E18 Party wall between dwellings, Table K1 - Approved, Yes, 10, 0.06, 0.06, 0.60,
24.	External wall, E25 Staggered party wall between dwellings, , No, 0, 0, 0, 0.00,
25.	Party wall, P1 Party wall - Ground floor, , No, 0, 0, 0, 0.00,
26.	Party wall, P6 Party wall - Ground floor (inverted), , No, 0, 0, 0, 0.00,
27.	Party wall, P2 Party wall - Intermediate floor within a dwelling, , No, 0, 0, 0, 0.00,
28.	Party wall, P3 Party wall - Intermediate floor between dwellings (in blocks of flats), , No, 0, 0, 0, 0.00,
29.	Party wall, P7 Party Wall - Exposed floor (normal), , No, 0, 0, 0, 0.00,
30.	Party wall, P8 Party Wall - Exposed floor (inverted), , No, 0, 0, 0, 0.00,
31.	Party wall, P4 Party wall - Roof (insulation at ceiling level), , No, 0, 0, 0, 0.00,
32.	Party wall, P5 Party wall - Roof (insulation at rafter level), , No, 0, 0, 0, 0.00,
33.	External roof, R1 Head of roof window, , No, 0, 0, 0, 0.00,

34.	External roof, R2 Sill of roof window, , No, 0, 0, 0, 0.00,
35.	External roof, R3 Jamb of roof window, , No, 0, 0, 0, 0.00,
36.	External roof, R4 Ridge (vaulted ceiling), , No, 0, 0, 0, 0.00,
37.	External roof, R5 Ridge (inverted), , No, 0, 0, 0, 0.00,
38.	External roof, R6 Flat ceiling, , No, 0, 0, 0, 0.00,
39.	External roof, R7 Flat ceiling (inverted), , No, 0, 0, 0, 0.00,
40.	External roof, R8 Roof to wall (rafter), , No, 0, 0, 0, 0.00,
41.	External roof, R9 Roof to wall (flat ceiling), , No, 0, 0, 0, 0.00,
Pressure Test:	True
Designed q50:	4
AsBuilt q50:	15
Property Tested:	False
Mechanical Ventilation	
MV System Present	Yes
Windows In Hot Weather	Windows fully open
Cross Ventilation	No
Night Ventilation	Yes
Air Change Rate	4.00
Approved Installation	Yes
DataType	Data Sheet
Type	Balanced mechanical ventilation with heat recovery
HR Duct Insulated	Yes
ManufacturerSFP	0.5
DuctType	Rigid
HR Efficiency	90
Wet Rooms	2
Brand Model	tbc
Chimneys MHS:	0
Chimneys SHS:	0
Chimneys Other:	0
Chimneys Total:	0
Open Flues MHS:	0
Open Flues SHS:	0
Open Flues Other:	0
Open Flues Total:	0
Intermittent Fans:	0
Passive Vents:	0
Flueless Gas Fires:	0
Cooling System	None
Light Fittings:	8
LEL Fittings:	8
Percentage of LEL Fittings:	100
External Lights Fitted:	Yes
External LELs Fitted:	Yes
Electricity Tariff:	Standard
Main Heating 1	
Description	
Percentage	100
MHS	Mains gas BGW Post 98 Combi condens. with auto ign.
SAP Code	104
Boiler Efficiency Type	Sedbuk 2009
Efficiency	90
Model Name	tbc
Manufacturer	tbc
Controls by PCDF	0
MHS Controls	CBI Time and temperature zone control
Boiler Interlock	Yes
Compensator	0
Delayed Start Stat	Yes
Ctrl SAP Code	2110
Burner Control	OnOff
Flue Type	None or Unknown
Fan Assisted Flue	No
Pumped	Pump in heated space
Heat Pump Age	2013 or later
Heat Emitter	Radiators
Flow Temperature	Normal (> 45°C)
Combi boiler type	Standard Combi
Combi keep hot type	None
Main Heating 2	None
Heating Systems Interaction	Each system heats separate parts of dwelling
Smoke Control Area	Unknown
Community Heating	None
Secondary Heating	None
Water Heating	
Type	MainHeating1
WHS	HWP From main heating 1
Low Water Usage	Yes
SAP Code	901
Showers in Property	Non-electric only
Hot Water Cylinder	None
Flue Gas Heat Recovery System	None
Waste Water Heat Recovery	none
PV Unit	
Type	More Dwellings, One Block
Apportioned Energy	916
Wind Turbine	None
Terrain Type:	Urban
Small Scale Hydro	None
Special Features	None

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

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DWELLING AS DESIGNED

Ground-floor flat, total floor area 76 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:Mains gas
Fuel factor:1.00 (mains gas)
Target Carbon Dioxide Emission Rate (TER) 16.89 kg/m²
Dwelling Carbon Dioxide Emission Rate (DER) 8.03 kg/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)44.2 kWh/m²

Dwelling Fabric Energy Efficiency (DFEE)35.1 kWh/m²OK

---

2 Fabric U-values

Element	Average	Highest	
External wall	0.13 (max. 0.30)	0.13 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.11 (max. 0.25)	0.11 (max. 0.70)	OK
Roof	(no roof)		
Openings	1.20 (max. 2.00)	1.20 (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: 4.00 (design value)
Maximum 10.0 OK

---

4 Heating efficiency
Main heating system: Boiler system with radiators or underfloor - Mains gas
Data from manufacturer
tbc tbc
Combi boiler
Efficiency: 90.0% SEDBUK2009
Minimum: 88.0% OK

Secondary heating system: None

---

5 Cylinder insulation
Hot water storage: No cylinder

---

6 Controls
Space heating controls: Time and temperature zone control OK

Hot water controls: No cylinder

Boiler interlock: Yes 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: 0.50
Maximum 1.5 OK
MVHR efficiency: 90%
Minimum: 70% OK

---

9 Summertime temperature
Overheating risk (Thames Valley): Medium OK
Based on:
Overshading: Average
Windows facing South East: 16.82 m², No overhang
Windows facing South West: 2.70 m², No overhang
Air change rate: 4.00 ach
Blinds/curtains: None

---

10 Key features
External wall U-value 0.13 W/m²K
External wall U-value 0.13 W/m²K
Party wall U-value 0.00 W/m²K
Exposed floor U-value 0.11 W/m²K
Photovoltaic array

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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 q50		4.0000	
Infiltration rate		0.2000	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1550	(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	0.1976	0.1938	0.1899	0.1705	0.1666	0.1473	0.1473	0.1434	0.1550	0.1666	0.1744	0.1821	(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) = 76.5000 (23c)

Effective ac	0.3151	0.3113	0.3074	0.2880	0.2841	0.2648	0.2648	0.2609	0.2725	0.2841	0.2919	0.2996	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 11.2430 (36)
Total fabric heat loss (33) + (36) = 50.3187 (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	19.7115	19.4692	19.2268	18.0148	17.7724	16.5605	16.5605	16.3181	17.0453	17.7724	18.2572	18.7420	(38)
Heat transfer coeff	70.0302	69.7878	69.5454	68.3335	68.0911	66.8792	66.8792	66.6368	67.3639	68.0911	68.5759	69.0607	(39)

Average = Sum(39)m / 12 = 68.2729 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9236	0.9204	0.9172	0.9013	0.8981	0.8821	0.8821	0.8789	0.8885	0.8981	0.9045	0.9109	(40)
HLP (average)												0.9005	(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 2.3788 (42)
Average daily hot water use (litres/day) 90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)

Total heat required for water heating calculated for each month

	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
								Total per year (kWh/year) = Sum(64)m =				1971.0232 (64)
Heat gains from water heating, kWh/month												
	61.9029	54.0870	56.1830	49.6649	48.0013	42.1126	40.0972	44.9403	45.4442	51.9758	55.7234	60.3507 (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	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	18.7648	16.6667	13.5543	10.2614	7.6706	6.4758	6.9973	9.0954	12.2078	15.5006	18.0915	19.2863	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	210.4835	212.6677	207.1636	195.4462	180.6551	166.7536	157.4665	155.2823	160.7864	172.5037	187.2949	201.1964	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	(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)													
	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)
Water heating gains (Table 5)													
	83.2028	80.4866	75.5148	68.9790	64.5178	58.4897	53.8940	60.4036	63.1169	69.8599	77.3936	81.1165	(72)
Total internal gains													
	374.1326	371.5025	357.9142	336.3682	314.5251	293.4007	280.0394	286.4629	297.7926	319.5458	344.4615	363.2808	(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	
Southeast	14.4800	36.7938	0.6300	0.7000	0.7700	162.8229	(77)
Southwest	2.7000	36.7938	0.6300	0.7000	0.7700	30.3606	(79)
Southeast	2.3400	36.7938	0.6300	0.7000	0.7700	26.3125	(77)

Solar gains	219.4960	373.8829	511.5629	633.8513	709.9663	704.8322	679.5334	622.7482	553.9145	413.2203	262.9057	187.8429	(83)
Total gains	593.6287	745.3854	869.4772	970.2195	1024.4913	998.2328	959.5728	909.2111	851.7071	732.7661	607.3672	551.1236	(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, ni1,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	75.1858	75.4469	75.7099	77.0527	77.3270	78.7282	78.7282	79.0146	78.1617	77.3270	76.7803	76.2414	
alpha	6.0124	6.0298	6.0473	6.1368	6.1551	6.2485	6.2485	6.2676	6.2108	6.1551	6.1187	6.0828	
util living area													
	0.9916	0.9700	0.9133	0.7829	0.6055	0.4275	0.3065	0.3369	0.5399	0.8451	0.9760	0.9943	(86)
MIT	20.2495	20.4822	20.7228	20.9127	20.9832	20.9984	20.9998	20.9997	20.9935	20.8846	20.5327	20.2071	(87)
Th 2	20.1475	20.1502	20.1529	20.1664	20.1691	20.1828	20.1828	20.1855	20.1773	20.1691	20.1637	20.1583	(88)
util rest of house													
	0.9891	0.9619	0.8930	0.7445	0.5556	0.3735	0.2497	0.2774	0.4780	0.8051	0.9681	0.9926	(89)
MIT 2	19.1584	19.4926	19.8249	20.0760	20.1550	20.1818	20.1827	20.1854	20.1730	20.0519	19.5791	19.1054	(90)
Living area fraction										fLA = Living area / (4) =		0.2415	(91)
MIT	19.4219	19.7316	20.0418	20.2781	20.3550	20.3790	20.3800	20.3820	20.3712	20.2530	19.8094	19.3715	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.2719	19.5816	19.8918	20.1281	20.2050	20.2290	20.2300	20.2320	20.2212	20.1030	19.6594	19.2215	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9855	0.9552	0.8858	0.7426	0.5578	0.3766	0.2530	0.2808	0.4814	0.8015	0.9621	0.9899	(94)
Useful gains	585.0465	711.9906	770.2039	720.4769	571.4670	375.9333	242.7398	255.2901	409.9819	587.3469	584.3220	545.5488	(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													
	1048.4878	1024.5950	931.3355	767.2530	579.1138	376.4631	242.7736	255.3542	412.3454	647.0707	861.2692	1037.3924	(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													
	344.8003	210.0701	119.8819	33.6788	5.6892	0.0000	0.0000	0.0000	0.0000	44.4344	199.4020	365.9317	(98)
Space heating												1323.8884	(98)
Space heating per m2											(98) / (4) =	17.4609	(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 %)												90.8000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												1458.0269	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	344.8003	210.0701	119.8819	33.6788	5.6892	0.0000	0.0000	0.0000	0.0000	44.4344	199.4020	365.9317	(98)
Space heating efficiency (main heating system 1)													

	90.8000	90.8000	90.8000	90.8000	90.8000	0.0000	0.0000	0.0000	0.0000	90.8000	90.8000	90.8000 (210)
Space heating fuel (main heating system)												
	379.7360	231.3548	132.0285	37.0912	6.2656	0.0000	0.0000	0.0000	0.0000	48.9366	219.6057	403.0084 (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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
Efficiency of water heater												81.5000 (216)
(217)m	87.1627	86.3414	84.9714	82.9760	81.7964	81.5000	81.5000	81.5000	81.5000	83.2841	86.1451	87.3453 (217)
Fuel for water heating, kWh/month												
	228.0659	201.1166	212.6224	193.1206	189.6712	167.6593	160.6304	179.0652	181.0428	201.7371	208.1982	222.2445 (219)
Water heating fuel used												2345.1741 (219)
Annual totals kWh/year												
Space heating fuel - main system												1458.0269 (211)
Space heating fuel - secondary												0.0000 (215)
Electricity for pumps and fans:												
(BalancedWithHeatRecovery, DataSheet: in-use factor = 1.2500, SFP = 0.6250)												
mechanical ventilation fans (SFP = 0.6250)												144.5319 (230a)
central heating pump												30.0000 (230c)
Total electricity for the above, kWh/year												174.5319 (231)
Electricity for lighting (calculated in Appendix L)												331.3915 (232)
Energy saving/generation technologies (Appendices M ,N and Q)												
Total delivered energy for all uses												4309.1244 (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	1458.0269	0.2160	314.9338	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2345.1741	0.2160	506.5576	(264)
Space and water heating			821.4914	(265)
Pumps and fans	174.5319	0.5190	90.5820	(267)
Energy for lighting	331.3915	0.5190	171.9922	(268)
Energy saving/generation technologies				
PV Unit	-916.0000	0.5190	-475.4040	(269)
Total CO2, kg/year			608.6616	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			8.0300	(273)

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

DER		8.0300	ZC1
Total Floor Area	TFA	75.8200	
Assumed number of occupants	N	2.3788	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		16.4506	ZC2
CO2 emissions from cooking, equation (L16)		2.3225	ZC3
Total CO2 emissions		26.8030	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		26.8030	ZC8

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							3 * 10	=	30.0000	(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) =	30.0000 / (5) =	0.1583	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.4083	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3164	(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	0.4034	0.3955	0.3876	0.3480	0.3401	0.3006	0.3006	0.2927	0.3164	0.3401	0.3560	0.3718	(22b)
Effective ac	0.5814	0.5782	0.5751	0.5606	0.5578	0.5452	0.5452	0.5428	0.5501	0.5578	0.5634	0.5691	(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 Opaque door			1.8600	1.0000	1.8600			(26)
TER Opening Type (Uw = 1.40)			17.0900	1.3258	22.6572			(27)
Heat Loss Floor 1			75.8200	0.1300	9.8566			(28b)
External Wall 1	42.4800	17.0900	25.3900	0.1800	4.5702			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1800	4.5486			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	43.4926			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		8.3659 (36)
Total fabric heat loss	(33) + (36) =	51.8585 (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	36.3658	36.1682	35.9744	35.0645	34.8942	34.1016	34.1016	33.9548	34.4069	34.8942	35.2386	35.5987	(38)
Heat transfer coeff	88.2243	88.0267	87.8329	86.9229	86.7527	85.9601	85.9601	85.8133	86.2654	86.7527	87.0971	87.4572	(39)
Average = Sum(39)m / 12 =												86.9221	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1636	1.1610	1.1584	1.1464	1.1442	1.1337	1.1337	1.1318	1.1378	1.1442	1.1487	1.1535	(40)
HLP (average)												1.1464	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)
Total heat required for water heating calculated for each month	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202	(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	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202	(64)
								Total per year (kWh/year) = Sum(64)m =				1971.0232	(64)

Heat gains from water heating, kWh/month

61.9029 54.0870 56.1830 49.6649 48.0013 42.1126 40.0972 44.9403 45.4442 51.9758 55.7234 60.3507 (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	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	(66)

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

	18.7618	16.6640	13.5521	10.2598	7.6693	6.4748	6.9962	9.0940	12.2059	15.4982	18.0887	19.2832	(67)

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

	210.4835	212.6677	207.1636	195.4462	180.6551	166.7536	157.4665	155.2823	160.7864	172.5037	187.2949	201.1964	(68)

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

	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	(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)

	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)

Water heating gains (Table 5)

	83.2028	80.4866	75.5148	68.9790	64.5178	58.4897	53.8940	60.4036	63.1169	69.8599	77.3936	81.1165	(72)

Total internal gains

	374.1296	371.4998	357.9121	336.3666	314.5238	293.3996	280.0383	286.4614	297.7907	319.5433	344.4587	363.2777	(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	
Southeast	14.7300	36.7938	0.6300	0.7000	0.7700	165.6340	(77)
Southwest	2.3600	36.7938	0.6300	0.7000	0.7700	26.5374	(79)

Solar gains	192.1715	327.3391	447.8796	554.9446	621.5842	617.0892	594.9399	545.2237	484.9589	361.7795	230.1771	164.4587	(83)
Total gains	566.3011	698.8389	805.7917	891.3112	936.1080	910.4889	874.9782	831.6852	782.7496	681.3228	574.6358	527.7364	(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	59.6806	59.8146	59.9465	60.5741	60.6930	61.2526	61.2526	61.3573	61.0358	60.6930	60.4529	60.2040	
alpha	4.9787	4.9876	4.9964	5.0383	5.0462	5.0835	5.0835	5.0905	5.0691	5.0462	5.0302	5.0136	
util living area													
	0.9947	0.9849	0.9601	0.8952	0.7670	0.5849	0.4288	0.4690	0.7043	0.9273	0.9875	0.9962	(86)
MIT	19.8755	20.0989	20.3817	20.6853	20.8899	20.9781	20.9962	20.9941	20.9455	20.6647	20.2031	19.8320	(87)
Th 2	19.9492	19.9513	19.9534	19.9631	19.9649	19.9734	19.9734	19.9749	19.9701	19.9649	19.9612	19.9574	(88)
util rest of house													
	0.9930	0.9801	0.9478	0.8644	0.7076	0.4992	0.3306	0.3674	0.6199	0.8986	0.9827	0.9950	(89)
MIT 2	18.4683	18.7926	19.1963	19.6160	19.8658	19.9600	19.9721	19.9727	19.9316	19.6014	18.9533	18.4108	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	18.8081	19.1081	19.4826	19.8742	20.1131	20.2059	20.2194	20.2194	20.1765	19.8581	19.2551	18.7540	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8081	19.1081	19.4826	19.8742	20.1131	20.2059	20.2194	20.2194	20.1765	19.8581	19.2551	18.7540	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9903	0.9750	0.9409	0.8614	0.7168	0.5192	0.3544	0.3920	0.6379	0.8951	0.9783	0.9929	(94)
Useful gains	560.8127	681.3873	758.1490	767.7437	670.9834	472.7586	310.0774	326.0144	499.3228	609.8217	562.1708	523.9777	(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													
	1279.9712	1250.6883	1140.2988	953.9111	729.8588	481.8813	311.1248	327.7555	524.1888	803.1693	1058.6739	1272.8544	(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													
	535.0539	382.5702	284.3194	134.0405	43.8033	0.0000	0.0000	0.0000	0.0000	143.8506	357.4822	557.1642	(98)
Space heating												2438.2844	(98)
Space heating per m2											(98) / (4) =	32.1589	(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 %) 93.4000 (206)
Efficiency of secondary/supplementary heating system, % 0.0000 (208)
Space heating requirement 2610.5829 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	535.0539	382.5702	284.3194	134.0405	43.8033	0.0000	0.0000	0.0000	0.0000	143.8506	357.4822	557.1642	(98)
Space heating efficiency (main heating system 1)													
	93.4000	93.4000	93.4000	93.4000	93.4000	0.0000	0.0000	0.0000	0.0000	93.4000	93.4000	93.4000	(210)
Space heating fuel (main heating system)													
	572.8629	409.6041	304.4105	143.5123	46.8986	0.0000	0.0000	0.0000	0.0000	154.0156	382.7433	596.5356	(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

	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
Efficiency of water heater												80.3000 (216)
(217)m	87.4214	86.9844	86.1880	84.6055	82.3251	80.3000	80.3000	80.3000	80.3000	84.6631	86.7544	87.5546 (217)
Fuel for water heating, kWh/month												
	227.3911	199.6299	209.6213	189.4011	188.4530	170.1648	163.0308	181.7411	183.7483	198.4513	206.7360	221.7134 (219)
Water heating fuel used												2340.0820 (219)
Annual totals kWh/year												
Space heating fuel - main system												2610.5829 (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)												331.3386 (232)
Total delivered energy for all uses												5357.0035 (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	2610.5829	0.2160	563.8859	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2340.0820	0.2160	505.4577	(264)
Space and water heating			1069.3436	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	331.3386	0.5190	171.9647	(268)
Total CO2, kg/m2/year			1280.2334	(272)
Emissions per m2 for space and water heating			14.1037	(272a)
Fuel factor (mains gas)			1.0000	
Emissions per m2 for lighting			2.2681	(272b)
Emissions per m2 for pumps and fans			0.5134	(272c)
Target Carbon Dioxide Emission Rate (TER) = (14.1037 * 1.00) + 2.2681 + 0.5134, rounded to 2 d.p.			16.8900	(273)

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							3 * 10 =	30.0000	(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) =	30.0000 / (5) =	0.1583	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.3583	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2777	(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	0.3540	0.3471	0.3401	0.3054	0.2985	0.2638	0.2638	0.2568	0.2777	0.2985	0.3124	0.3262	(22b)
Effective ac	0.5627	0.5602	0.5578	0.5466	0.5445	0.5348	0.5348	0.5330	0.5385	0.5445	0.5488	0.5532	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	11.2430	(36)
Total fabric heat loss (33) + (36) =	50.3187	(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	35.1954	35.0432	34.8940	34.1933	34.0622	33.4518	33.4518	33.3388	33.6869	34.0622	34.3274	34.6047	(38)
Heat transfer coeff	85.5141	85.3619	85.2127	84.5119	84.3808	83.7705	83.7705	83.6575	84.0056	84.3808	84.6461	84.9234	(39)
Average = Sum(39)m / 12 =												84.5113	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1279	1.1258	1.1239	1.1146	1.1129	1.1049	1.1049	1.1034	1.1080	1.1129	1.1164	1.1201	(40)
HLP (average)												1.1146	(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	2.3788 (42)
Average daily hot water use (litres/day)	90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(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)
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	31.4392	27.4969	28.3744	24.7375	23.7362	20.4825	18.9801	21.7799	22.0400	25.6855	28.0377	30.4472	(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	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	(66)

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

	18.7648	16.6667	13.5543	10.2614	7.6706	6.4758	6.9973	9.0954	12.2078	15.5006	18.0915	19.2863	(67)

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

	210.4835	212.6677	207.1636	195.4462	180.6551	166.7536	157.4665	155.2823	160.7864	172.5037	187.2949	201.1964	(68)

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

	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	(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)

	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)

Water heating gains (Table 5)

	42.2570	40.9180	38.1376	34.3576	31.9035	28.4479	25.5108	29.2741	30.6111	34.5235	38.9413	40.9236	(72)

Total internal gains

	330.1868	328.9339	317.5370	298.7468	278.9107	260.3589	248.6562	252.3333	262.2869	281.2095	303.0092	320.0879	(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	
Southeast	14.4800	36.7938	0.6300	0.7000	0.7700	162.8229	(77)
Southwest	2.7000	36.7938	0.6300	0.7000	0.7700	30.3606	(79)
Southeast	2.3400	36.7938	0.6300	0.7000	0.7700	26.3125	(77)

Solar gains	219.4960	373.8829	511.5629	633.8513	709.9663	704.8322	679.5334	622.7482	553.9145	413.2203	262.9057	187.8429	(83)
Total gains	549.6828	702.8169	829.1000	932.5981	988.8770	965.1910	928.1896	875.0816	816.2013	694.4298	565.9149	507.9307	(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	61.5720	61.6818	61.7898	62.3022	62.3990	62.8536	62.8536	62.9385	62.6777	62.3990	62.2035	62.0003	
alpha	5.1048	5.1121	5.1193	5.1535	5.1599	5.1902	5.1902	5.1959	5.1785	5.1599	5.1469	5.1334	
util living area													
	0.9953	0.9839	0.9533	0.8735	0.7281	0.5435	0.3951	0.4363	0.6704	0.9183	0.9879	0.9968	(86)
MIT	19.9043	20.1505	20.4459	20.7407	20.9193	20.9855	20.9977	20.9962	20.9595	20.7009	20.2304	19.8537	(87)
Th 2	19.9781	19.9798	19.9814	19.9889	19.9903	19.9969	19.9969	19.9981	19.9943	19.9903	19.9875	19.9845	(88)
util rest of house													
	0.9937	0.9789	0.9393	0.8395	0.6681	0.4635	0.3061	0.3431	0.5879	0.8875	0.9833	0.9957	(89)
MIT 2	18.9901	19.2342	19.5209	19.7966	19.9418	19.9910	19.9963	19.9971	19.9752	19.7708	19.3214	18.9449	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	19.2109	19.4555	19.7443	20.0246	20.1778	20.2311	20.2382	20.2384	20.2129	19.9954	19.5409	19.1643	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2109	19.4555	19.7443	20.0246	20.1778	20.2311	20.2382	20.2384	20.2129	19.9954	19.5409	19.1643	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9922	0.9757	0.9355	0.8409	0.6798	0.4826	0.3277	0.3657	0.6067	0.8877	0.9806	0.9946	(94)
Useful gains	545.3946	685.7070	775.6199	784.1795	672.2807	465.7840	304.1373	319.9965	495.1877	616.4537	554.9638	505.1686	(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													
	1275.0898	1242.4836	1128.5808	940.1639	715.3667	471.7235	304.7700	321.1101	513.5170	792.7905	1053.0751	1270.8223	(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													
	542.8932	374.1538	262.6029	112.3088	32.0560	0.0000	0.0000	0.0000	0.0000	131.1946	358.6401	569.6463	(98)
Space heating												2383.4957	(98)
Space heating per m2											(98) / (4) =	31.4362	(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	787.4428	619.9018	635.7969	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9604	0.9824	0.9757	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	756.2851	608.9615	620.3413	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1216.5800	1171.5154	1110.8916	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	331.4124	418.5401	364.9694	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												1114.9219	(104)
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	82.8531	104.6350	91.2424	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												278.7305	(107)
Space cooling per m2												3.6762	(108)
Energy for space heating												31.4362	(99)
Energy for space cooling												3.6762	(108)
Total												35.1125	(109)
Dwelling Fabric Energy Efficiency (DFEE)												35.1	(109)

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 75.8200						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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							3 * 10 =	30.0000	(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) =	30.0000 / (5) =	0.1583	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.4083	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3164	(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	0.4034	0.3955	0.3876	0.3480	0.3401	0.3006	0.3006	0.2927	0.3164	0.3401	0.3560	0.3718	(22b)
Effective ac	0.5814	0.5782	0.5751	0.5606	0.5578	0.5452	0.5452	0.5428	0.5501	0.5578	0.5634	0.5691	(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 Opaque door			1.8600	1.0000	1.8600			(26)
TER Opening Type (Uw = 1.40)			17.0900	1.3258	22.6572			(27)
Heat Loss Floor 1			75.8200	0.1300	9.8566			(28b)
External Wall 1	42.4800	17.0900	25.3900	0.1800	4.5702			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1800	4.5486			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		43.4926			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							8.3659	(36)
Total fabric heat loss					(33) + (36) =		51.8585	(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	36.3658	36.1682	35.9744	35.0645	34.8942	34.1016	34.1016	33.9548	34.4069	34.8942	35.2386	35.5987	(38)
Heat transfer coeff	88.2243	88.0267	87.8329	86.9229	86.7527	85.9601	85.9601	85.8133	86.2654	86.7527	87.0971	87.4572	(39)
Average = Sum(39)m / 12 =												86.9221	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1636	1.1610	1.1584	1.1464	1.1442	1.1337	1.1337	1.1318	1.1378	1.1442	1.1487	1.1535	(40)
HLP (average)												1.1464	(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	2.3788	(42)
Average daily hot water use (litres/day)	90.6958	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(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)
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	31.4392	27.4969	28.3744	24.7375	23.7362	20.4825	18.9801	21.7799	22.0400	25.6855	28.0377	30.4472	(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	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	118.9385	(66)

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

	18.7618	16.6640	13.5521	10.2598	7.6693	6.4748	6.9962	9.0940	12.2059	15.4982	18.0887	19.2832	(67)

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

	210.4835	212.6677	207.1636	195.4462	180.6551	166.7536	157.4665	155.2823	160.7864	172.5037	187.2949	201.1964	(68)

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

	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	34.8938	(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)

	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)

Water heating gains (Table 5)

	42.2570	40.9180	38.1376	34.3576	31.9035	28.4479	25.5108	29.2741	30.6111	34.5235	38.9413	40.9236	(72)

Total internal gains

	330.1838	328.9313	317.5349	298.7452	278.9095	260.3578	248.6551	252.3319	262.2849	281.2070	303.0064	320.0848	(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	
Southeast	14.7300	36.7938	0.6300	0.7000	0.7700	165.6340	(77)
Southwest	2.3600	36.7938	0.6300	0.7000	0.7700	26.5374	(79)

Solar gains	192.1715	327.3391	447.8796	554.9446	621.5842	617.0892	594.9399	545.2237	484.9589	361.7795	230.1771	164.4587	(83)
Total gains	522.3552	656.2704	765.4145	853.6898	900.4937	877.4471	843.5950	797.5556	747.2439	642.9865	533.1835	484.5435	(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, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	59.6806	59.8146	59.9465	60.5741	60.6930	61.2526	61.2526	61.3573	61.0358	60.6930	60.4529	60.2040	
alpha	4.9787	4.9876	4.9964	5.0383	5.0462	5.0835	5.0835	5.0905	5.0691	5.0462	5.0302	5.0136	
util living area	0.9963	0.9883	0.9671	0.9081	0.7856	0.6038	0.4441	0.4879	0.7282	0.9403	0.9909	0.9974	(86)
MIT	19.8226	20.0498	20.3404	20.6573	20.8768	20.9748	20.9956	20.9930	20.9366	20.6309	20.1546	19.7795	(87)
Th 2	19.9492	19.9513	19.9534	19.9631	19.9649	19.9734	19.9734	19.9749	19.9701	19.9649	19.9612	19.9574	(88)
util rest of house	0.9951	0.9846	0.9566	0.8798	0.7275	0.5167	0.3427	0.3828	0.6441	0.9154	0.9873	0.9966	(89)
MIT 2	18.8855	19.1122	19.3975	19.7021	19.8882	19.9627	19.9723	19.9731	19.9390	19.6873	19.2256	18.8492	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	19.1118	19.3387	19.6252	19.9328	20.1269	20.2071	20.2194	20.2194	20.1799	19.9152	19.4500	19.0739	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.1118	19.3387	19.6252	19.9328	20.1269	20.2071	20.2194	20.2194	20.1799	19.9152	19.4500	19.0739	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9937	0.9818	0.9525	0.8789	0.7374	0.5372	0.3673	0.4083	0.6625	0.9139	0.9850	0.9955	(94)
Useful gains	519.0785	644.2961	729.0597	750.3010	663.9978	471.3792	309.8917	325.6599	495.0592	587.6312	525.1895	482.3866	(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	1306.7629	1270.9885	1152.8233	959.0035	731.0592	481.9907	311.1275	327.7571	524.4849	808.1181	1075.6460	1300.8262	(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	586.0373	421.1373	315.2801	150.2658	49.8937	0.0000	0.0000	0.0000	0.0000	164.0422	396.3287	608.9191	(98)
Space heating												2691.9042	(98)
Space heating per m2											(98) / (4) =	35.5039	(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	808.0251	636.1049	652.1814	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9375	0.9702	0.9604	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	757.4836	617.1381	626.3763	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1114.0207	1072.6370	1020.2749	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	256.7067	338.8912	293.0605	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												888.6585	(104)
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	64.1767	84.7228	73.2651	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												222.1646	(107)
Space cooling per m2												2.9302	(108)
Energy for space heating												35.5039	(99)
Energy for space cooling												2.9302	(108)
Total												38.4340	(109)
Target Fabric Energy Efficiency (TFEE)												44.2	(109)

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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 q50		4.0000	
Infiltration rate		0.2000	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1550	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	3.7000	3.5000	3.5000	3.3000	3.3000	3.0000	3.2000	3.0000	2.9000	3.1000	3.1000	3.4000	(22)
Wind factor	0.9250	0.8750	0.8750	0.8250	0.8250	0.7500	0.8000	0.7500	0.7250	0.7750	0.7750	0.8500	(22a)
Adj infilt rate	0.1434	0.1356	0.1356	0.1279	0.1279	0.1163	0.1240	0.1163	0.1124	0.1201	0.1201	0.1318	(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) = 76.5000 (23c)

Effective ac	0.2609	0.2531	0.2531	0.2454	0.2454	0.2338	0.2415	0.2338	0.2299	0.2376	0.2376	0.2493	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 11.2430 (36)
Total fabric heat loss (33) + (36) = 50.3187 (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	16.3181	15.8333	15.8333	15.3486	15.3486	14.6214	15.1062	14.6214	14.3790	14.8638	14.8638	15.5910	(38)
Heat transfer coeff	66.6368	66.1520	66.1520	65.6672	65.6672	64.9401	65.4248	64.9401	64.6977	65.1825	65.1825	65.9096	(39)

Average = Sum(39)m / 12 = 65.5460 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8789	0.8725	0.8725	0.8661	0.8661	0.8565	0.8629	0.8565	0.8533	0.8597	0.8597	0.8693	(40)
HLP (average)												0.8645	(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 2.3788 (42)
Average daily hot water use (litres/day) 90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)

Total heat required for water heating calculated for each month

	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
								Total per year (kWh/year) = Sum(64)m =				1971.0232 (64)
RHI water heating demand												1971 (64)
Heat gains from water heating, kWh/month												
	61.9029	54.0870	56.1830	49.6649	48.0013	42.1126	40.0972	44.9403	45.4442	51.9758	55.7234	60.3507 (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	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	46.9119	41.6667	33.8857	25.6536	19.1764	16.1895	17.4933	22.7385	30.5196	38.7516	45.2288	48.2157	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	314.1545	317.4144	309.1995	291.7108	269.6345	248.8860	235.0246	231.7647	239.9796	257.4683	279.5446	300.2931	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	(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)													
	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)
Water heating gains (Table 5)													
	83.2028	80.4866	75.5148	68.9790	64.5178	58.4897	53.8940	60.4036	63.1169	69.8599	77.3936	81.1165	(72)
Total internal gains													
	546.4960	541.7945	520.8267	488.5702	455.5555	425.7920	408.6388	417.1335	435.8429	468.3065	504.3938	531.8522	(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
Southeast	14.4800	41.6087	0.6300	0.7000	0.7700	184.1300 (77)
Southwest	2.7000	41.6087	0.6300	0.7000	0.7700	34.3336 (79)
Southeast	2.3400	41.6087	0.6300	0.7000	0.7700	29.7558 (77)

Solar gains	248.2195	361.5583	498.6489	640.5534	703.4492	746.1949	717.4950	661.6596	581.8065	440.5543	287.1578	203.6348 (83)
Total gains	794.7155	903.3528	1019.4756	1129.1236	1159.0047	1171.9869	1126.1338	1078.7931	1017.6494	908.8608	791.5516	735.4870 (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, ni1,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	79.0146	79.5936	79.5936	80.1812	80.1812	81.0790	80.4783	81.0790	81.3828	80.7775	80.7775	79.8863	
alpha	6.2676	6.3062	6.3062	6.3454	6.3454	6.4053	6.3652	6.4053	6.4255	6.3852	6.3852	6.3258	
util living area													
	0.9476	0.9001	0.7882	0.6052	0.4239	0.2493	0.1452	0.1625	0.3431	0.6247	0.8800	0.9615	(86)
MIT	20.6354	20.7663	20.9091	20.9833	20.9984	21.0000	21.0000	21.0000	20.9997	20.9838	20.8369	20.5895	(87)
Th 2	20.1855	20.1909	20.1909	20.1964	20.1964	20.2046	20.1992	20.2046	20.2074	20.2019	20.2019	20.1937	(88)
util rest of house													
	0.9346	0.8791	0.7541	0.5627	0.3789	0.2053	0.0987	0.1147	0.2928	0.5733	0.8519	0.9513	(89)
MIT 2	19.7354	19.9147	20.0936	20.1813	20.1953	20.2046	20.1992	20.2046	20.2072	20.1884	20.0201	19.6798	(90)
Living area fraction									fLA = Living area / (4) =			0.2415	(91)
MIT	19.9527	20.1203	20.2906	20.3750	20.3892	20.3967	20.3926	20.3967	20.3986	20.3805	20.2173	19.8995	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.8027	19.9703	20.1406	20.2250	20.2392	20.2467	20.2426	20.2467	20.2486	20.2305	20.0673	19.7495	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9274	0.8728	0.7518	0.5643	0.3813	0.2076	0.1012	0.1172	0.2955	0.5752	0.8467	0.9446	(94)
Useful gains	737.0425	788.4108	766.4504	637.1130	441.9386	243.3019	114.0061	126.4191	300.6693	522.7759	670.1996	694.7090	(95)
Ext temp.	5.5000	6.0000	7.8000	10.4000	13.5000	16.5000	18.5000	18.3000	15.6000	12.1000	8.4000	5.5000	(96)
Heat loss rate W													
	953.0889	924.1662	816.3523	645.1776	442.5471	243.3101	114.0061	126.4192	300.7534	529.9656	760.5049	939.1788	(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													
	160.7385	91.2277	37.1270	5.8065	0.4527	0.0000	0.0000	0.0000	0.0000	5.3491	65.0198	181.8855	(98)
Space heating												547.6069	(98)
RHI space heating demand												548	(98)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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 q50		4.0000	
Infiltration rate		0.2000	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1550	(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	0.1976	0.1938	0.1899	0.1705	0.1666	0.1473	0.1473	0.1434	0.1550	0.1666	0.1744	0.1821	(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) = 76.5000 (23c)

Effective ac	0.3151	0.3113	0.3074	0.2880	0.2841	0.2648	0.2648	0.2609	0.2725	0.2841	0.2919	0.2996	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 11.2430 (36)
Total fabric heat loss (33) + (36) = 50.3187 (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	19.7115	19.4692	19.2268	18.0148	17.7724	16.5605	16.5605	16.3181	17.0453	17.7724	18.2572	18.7420	(38)
Heat transfer coeff	70.0302	69.7878	69.5454	68.3335	68.0911	66.8792	66.8792	66.6368	67.3639	68.0911	68.5759	69.0607	(39)

Average = Sum(39)m / 12 = 68.2729 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9236	0.9204	0.9172	0.9013	0.8981	0.8821	0.8821	0.8789	0.8885	0.8981	0.9045	0.9109	(40)
HLP (average)												0.9005	(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 2.3788 (42)
Average daily hot water use (litres/day) 90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)
Energy content (annual)										Total = Sum(45)m =		1426.9977	(45)
Distribution loss (46)m = 0.15 x (45)m	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)

Total heat required for water heating calculated for each month

	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
								Total per year (kWh/year) = Sum(64)m =				1971.0232 (64)
Heat gains from water heating, kWh/month												
	61.9029	54.0870	56.1830	49.6649	48.0013	42.1126	40.0972	44.9403	45.4442	51.9758	55.7234	60.3507 (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	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	46.9119	41.6667	33.8857	25.6536	19.1764	16.1895	17.4933	22.7385	30.5196	38.7516	45.2288	48.2157	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	314.1545	317.4144	309.1995	291.7108	269.6345	248.8860	235.0246	231.7647	239.9796	257.4683	279.5446	300.2931	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	(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)													
	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)
Water heating gains (Table 5)													
	83.2028	80.4866	75.5148	68.9790	64.5178	58.4897	53.8940	60.4036	63.1169	69.8599	77.3936	81.1165	(72)
Total internal gains													
	546.4960	541.7945	520.8267	488.5702	455.5555	425.7920	408.6388	417.1335	435.8429	468.3065	504.3938	531.8522	(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	
Southeast	14.4800	36.7938	0.6300	0.7000	0.7700	162.8229	(77)
Southwest	2.7000	36.7938	0.6300	0.7000	0.7700	30.3606	(79)
Southeast	2.3400	36.7938	0.6300	0.7000	0.7700	26.3125	(77)

Solar gains	219.4960	373.8829	511.5629	633.8513	709.9663	704.8322	679.5334	622.7482	553.9145	413.2203	262.9057	187.8429	(83)
Total gains	765.9920	915.6774	1032.3896	1122.4215	1165.5218	1130.6242	1088.1722	1039.8818	989.7574	881.5268	767.2994	719.6950	(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, ni1,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	75.1858	75.4469	75.7099	77.0527	77.3270	78.7282	78.7282	79.0146	78.1617	77.3270	76.7803	76.2414	
alpha	6.0124	6.0298	6.0473	6.1368	6.1551	6.2485	6.2485	6.2676	6.2108	6.1551	6.1187	6.0828	
util living area													
	0.9714	0.9294	0.8478	0.7031	0.5374	0.3780	0.2704	0.2947	0.4673	0.7515	0.9343	0.9785	(86)
MIT	20.4504	20.6476	20.8278	20.9512	20.9911	20.9992	20.9999	20.9999	20.9971	20.9406	20.6935	20.4094	(87)
Th 2	20.1475	20.1502	20.1529	20.1664	20.1691	20.1828	20.1828	20.1855	20.1773	20.1691	20.1637	20.1583	(88)
util rest of house													
	0.9640	0.9136	0.8198	0.6630	0.4915	0.3300	0.2202	0.2426	0.4126	0.7052	0.9167	0.9727	(89)
MIT 2	19.4447	19.7190	19.9575	20.1177	20.1618	20.1823	20.1827	20.1854	20.1754	20.1123	19.7982	19.3957	(90)
Living area fraction										fLA = Living area / (4) =		0.2415	(91)
MIT	19.6876	19.9433	20.1677	20.3190	20.3621	20.3796	20.3801	20.3821	20.3738	20.3124	20.0144	19.6405	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.5376	19.7933	20.0177	20.1690	20.2121	20.2296	20.2301	20.2321	20.2238	20.1624	19.8644	19.4905	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9574	0.9060	0.8150	0.6632	0.4939	0.3328	0.2231	0.2455	0.4157	0.7048	0.9094	0.9669	(94)
Useful gains	733.3491	829.5925	841.3571	744.3616	575.6163	376.2402	242.7606	255.3309	411.4745	621.3391	697.7872	695.8648	(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													
	1067.0898	1039.3682	940.0910	770.0478	579.5969	376.5008	242.7766	255.3599	412.5252	651.1115	875.3331	1055.9705	(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													
	248.3031	140.9693	73.4580	18.4941	2.9616	0.0000	0.0000	0.0000	0.0000	22.1507	127.8331	267.9186	(98)
Space heating												902.0884	(98)
Space heating per m2											(98) / (4) =	11.8978	(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 %)												90.8000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												993.4894	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	248.3031	140.9693	73.4580	18.4941	2.9616	0.0000	0.0000	0.0000	0.0000	22.1507	127.8331	267.9186	(98)
Space heating efficiency (main heating system 1)													

	90.8000	90.8000	90.8000	90.8000	90.8000	0.0000	0.0000	0.0000	0.0000	90.8000	90.8000	90.8000 (210)
Space heating fuel (main heating system)												
	273.4616	155.2525	80.9009	20.3679	3.2617	0.0000	0.0000	0.0000	0.0000	24.3950	140.7853	295.0645 (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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
Efficiency of water heater												81.5000 (216)
(217)m	86.4156	85.4201	83.9865	82.3730	81.6567	81.5000	81.5000	81.5000	81.5000	82.4841	85.1284	86.6460 (217)
Fuel for water heating, kWh/month												
	230.0378	203.2856	215.1158	194.5343	189.9957	167.6593	160.6304	179.0652	181.0428	203.6938	210.6849	224.0382 (219)
Water heating fuel used												2359.7837 (219)
Annual totals kWh/year												
Space heating fuel - main system												993.4894 (211)
Space heating fuel - secondary												0.0000 (215)

Electricity for pumps and fans:	
(BalancedWithHeatRecovery, DataSheet: in-use factor = 1.2500, SFP = 0.6250)	
mechanical ventilation fans (SFP = 0.6250)	144.5319 (230a)
central heating pump	30.0000 (230c)
Total electricity for the above, kWh/year	174.5319 (231)
Electricity for lighting (calculated in Appendix L)	331.3915 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
Total delivered energy for all uses	3859.1964 (238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	993.4894	3.4800	34.5734	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	2359.7837	3.4800	82.1205	(247)
Mechanical ventilation fans	144.5319	13.1900	19.0638	(249)
Pumps and fans for heating	30.0000	13.1900	3.9570	(249)
Energy for lighting	331.3915	13.1900	43.7105	(250)
Additional standing charges			120.0000	(251)
Energy saving/generation technologies				
PV Unit	-916.0000	13.1900	-120.8204	(252)
Total energy cost			182.6048	(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] =	0.6348 (257)
SAP value		91.1448
SAP rating (Section 12)		91 (258)
SAP band		B

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	993.4894	0.2160	214.5937	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2359.7837	0.2160	509.7133	(264)
Space and water heating			724.3070	(265)
Pumps and fans	174.5319	0.5190	90.5820	(267)
Energy for lighting	331.3915	0.5190	171.9922	(268)
Energy saving/generation technologies				
PV Unit	-916.0000	0.5190	-475.4040	(269)
Total kg/year			511.4772	(272)
CO2 emissions per m2			6.7500	(273)
EI value			94.3273	
EI rating			94	(274)
EI band			A	

Calculation of stars for heating and DHW

Main heating energy efficiency	3.48 × (1 + 0.29 × 0.00) / 0.9080 = 3.833, stars = 4
Main heating environmental impact	0.216 × (1 + 0.29 × 0.00) / 0.9080 = 0.2379, stars = 4
Water heating energy efficiency	3.48 / 0.8334 = 4.176, stars = 4
Water heating environmental impact	0.216 / 0.8334 = 0.2592, stars = 4

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	75.8200 (1b)	x	2.5000 (2b)	=	189.5500 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	75.8200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	189.5500	(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 q50		4.0000	
Infiltration rate		0.2000	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1550	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	3.7000	3.5000	3.5000	3.3000	3.3000	3.0000	3.2000	3.0000	2.9000	3.1000	3.1000	3.4000	(22)
Wind factor	0.9250	0.8750	0.8750	0.8250	0.8250	0.7500	0.8000	0.7500	0.7250	0.7750	0.7750	0.8500	(22a)
Adj infilt rate	0.1434	0.1356	0.1356	0.1279	0.1279	0.1163	0.1240	0.1163	0.1124	0.1201	0.1201	0.1318	(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) = 76.5000 (23c)

Effective ac	0.2609	0.2531	0.2531	0.2454	0.2454	0.2338	0.2415	0.2338	0.2299	0.2376	0.2376	0.2493	(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	
Flat Door			1.8600	1.2000	2.2320			(26)
Windows (Uw = 1.20)			17.1800	1.1450	19.6718			(27)
French Doors (Uw = 1.20)			2.3400	1.1450	2.6794			(27)
Heat Loss Floor 1			75.8200	0.1084	8.2226			(28b)
External Wall 1	42.4800	19.5200	22.9600	0.1300	2.9848			(29a)
Shelter Wall	27.1300	1.8600	25.2700	0.1300	3.2851			(29a)
Total net area of external elements Aum(A, m2)			145.4300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	39.0757			(33)
Party Wall 1			29.3800	0.0000	0.0000			(32)
Party Ceilings 1			75.8200					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 11.2430 (36)
Total fabric heat loss (33) + (36) = 50.3187 (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	16.3181	15.8333	15.8333	15.3486	15.3486	14.6214	15.1062	14.6214	14.3790	14.8638	14.8638	15.5910	(38)
Heat transfer coeff	66.6368	66.1520	66.1520	65.6672	65.6672	64.9401	65.4248	64.9401	64.6977	65.1825	65.1825	65.9096	(39)

Average = Sum(39)m / 12 = 65.5460 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8789	0.8725	0.8725	0.8661	0.8661	0.8565	0.8629	0.8565	0.8533	0.8597	0.8597	0.8693	(40)

HLP (average) 0.8645 (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 2.3788 (42)
Average daily hot water use (litres/day) 90.6958 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	99.7654	96.1375	92.5097	88.8819	85.2540	81.6262	81.6262	85.2540	88.8819	92.5097	96.1375	99.7654	(44)
Energy conte	147.9491	129.3973	133.5264	116.4115	111.6996	96.3883	89.3179	102.4936	103.7177	120.8730	131.9423	143.2808	(45)

Energy content (annual) Total = Sum(45)m = 1426.9977 (45)

Distribution loss (46)m = 0.15 x (45)m													
	22.1924	19.4096	20.0290	17.4617	16.7549	14.4582	13.3977	15.3740	15.5577	18.1310	19.7914	21.4921	(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)
Combi loss	50.8393	44.2496	47.1419	43.8321	43.4445	40.2540	41.5958	43.4445	43.8321	47.1419	47.4103	50.8393	(61)

Total heat required for water heating calculated for each month

	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (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												
	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
								Total per year (kWh/year) = Sum(64)m =				1971.0232 (64)
Heat gains from water heating, kWh/month												
	61.9029	54.0870	56.1830	49.6649	48.0013	42.1126	40.0972	44.9403	45.4442	51.9758	55.7234	60.3507 (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	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	142.7262	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	46.9119	41.6667	33.8857	25.6536	19.1764	16.1895	17.4933	22.7385	30.5196	38.7516	45.2288	48.2157	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	314.1545	317.4144	309.1995	291.7108	269.6345	248.8860	235.0246	231.7647	239.9796	257.4683	279.5446	300.2931	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	51.6514	(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)													
	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	-95.1508	(71)
Water heating gains (Table 5)													
	83.2028	80.4866	75.5148	68.9790	64.5178	58.4897	53.8940	60.4036	63.1169	69.8599	77.3936	81.1165	(72)
Total internal gains													
	546.4960	541.7945	520.8267	488.5702	455.5555	425.7920	408.6388	417.1335	435.8429	468.3065	504.3938	531.8522	(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	
Southeast	14.4800	41.6087	0.6300	0.7000	0.7700	184.1300	(77)
Southwest	2.7000	41.6087	0.6300	0.7000	0.7700	34.3336	(79)
Southeast	2.3400	41.6087	0.6300	0.7000	0.7700	29.7558	(77)

Solar gains	248.2195	361.5583	498.6489	640.5534	703.4492	746.1949	717.4950	661.6596	581.8065	440.5543	287.1578	203.6348	(83)
Total gains	794.7155	903.3528	1019.4756	1129.1236	1159.0047	1171.9869	1126.1338	1078.7931	1017.6494	908.8608	791.5516	735.4870	(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, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	79.0146	79.5936	79.5936	80.1812	80.1812	81.0790	80.4783	81.0790	81.3828	80.7775	80.7775	79.8863	
alpha	6.2676	6.3062	6.3062	6.3454	6.3454	6.4053	6.3652	6.4053	6.4255	6.3852	6.3852	6.3258	
util living area													
	0.9476	0.9001	0.7882	0.6052	0.4239	0.2493	0.1452	0.1625	0.3431	0.6247	0.8800	0.9615	(86)
MIT	20.6354	20.7663	20.9091	20.9833	20.9984	21.0000	21.0000	21.0000	20.9997	20.9838	20.8369	20.5895	(87)
Th 2	20.1855	20.1909	20.1909	20.1964	20.1964	20.2046	20.1992	20.2046	20.2074	20.2019	20.2019	20.1937	(88)
util rest of house													
	0.9346	0.8791	0.7541	0.5627	0.3789	0.2053	0.0987	0.1147	0.2928	0.5733	0.8519	0.9513	(89)
MIT 2	19.7354	19.9147	20.0936	20.1813	20.1953	20.2046	20.1992	20.2046	20.2072	20.1884	20.0201	19.6798	(90)
Living area fraction										fLA = Living area / (4) =		0.2415	(91)
MIT	19.9527	20.1203	20.2906	20.3750	20.3892	20.3967	20.3926	20.3967	20.3986	20.3805	20.2173	19.8995	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.8027	19.9703	20.1406	20.2250	20.2392	20.2467	20.2426	20.2467	20.2486	20.2305	20.0673	19.7495	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9274	0.8728	0.7518	0.5643	0.3813	0.2076	0.1012	0.1172	0.2955	0.5752	0.8467	0.9446	(94)
Useful gains	737.0425	788.4108	766.4504	637.1130	441.9386	243.3019	114.0061	126.4191	300.6693	522.7759	670.1996	694.7090	(95)
Ext temp.	5.5000	6.0000	7.8000	10.4000	13.5000	16.5000	18.5000	18.3000	15.6000	12.1000	8.4000	5.5000	(96)
Heat loss rate W													
	953.0889	924.1662	816.3523	645.1776	442.5471	243.3101	114.0061	126.4192	300.7534	529.9656	760.5049	939.1788	(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													
	160.7385	91.2277	37.1270	5.8065	0.4527	0.0000	0.0000	0.0000	0.0000	5.3491	65.0198	181.8855	(98)
Space heating												547.6069	(98)
Space heating per m2											(98) / (4) =	7.2225	(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 %)	90.8000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	603.0913	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	160.7385	91.2277	37.1270	5.8065	0.4527	0.0000	0.0000	0.0000	0.0000	5.3491	65.0198	181.8855	(98)
Space heating efficiency (main heating system 1)													

	90.8000	90.8000	90.8000	90.8000	90.8000	0.0000	0.0000	0.0000	0.0000	90.8000	90.8000	90.8000 (210)
Space heating fuel (main heating system)												
	177.0248	100.4710	40.8888	6.3948	0.4986	0.0000	0.0000	0.0000	0.0000	5.8911	71.6078	200.3144 (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

	198.7885	173.6469	180.6683	160.2437	155.1442	136.6423	130.9137	145.9381	147.5499	168.0149	179.3526	194.1202 (64)
Efficiency of water heater												81.5000 (216)
(217)m	85.4111	84.4802	82.9483	81.7929	81.5243	81.5000	81.5000	81.5000	81.5000	81.7584	83.7832	85.7484 (217)
Fuel for water heating, kWh/month												
	232.7431	205.5475	217.8084	195.9138	190.3042	167.6593	160.6304	179.0652	181.0428	205.5018	214.0675	226.3834 (219)
Water heating fuel used												2376.6673 (219)
Annual totals kWh/year												
Space heating fuel - main system												603.0913 (211)
Space heating fuel - secondary												0.0000 (215)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, DataSheet: in-use factor = 1.2500, SFP = 0.6250)

mechanical ventilation fans (SFP = 0.6250)	144.5319 (230a)
central heating pump	30.0000 (230c)
Total electricity for the above, kWh/year	174.5319 (231)
Electricity for lighting (calculated in Appendix L)	331.3915 (232)

Energy saving/generation technologies (Appendices M ,N and Q)

Total delivered energy for all uses	3485.6820 (238)

10a. Fuel costs - using BEDF prices (391)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	603.0913	4.3200	26.0535 (240)
Space heating - secondary	0.0000	0.0000	0.0000 (242)
Water heating (other fuel)	2376.6673	4.3200	102.6720 (247)
Mechanical ventilation fans	144.5319	15.3200	22.1423 (249)
Pumps and fans for heating	30.0000	15.3200	4.5960 (249)
Energy for lighting	331.3915	15.3200	50.7692 (250)
Additional standing charges			95.0000 (251)
Energy saving/generation technologies			
PV Unit	-916.0000	15.3200	-140.3312 (252)
Total energy cost			160.9018 (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	603.0913	0.2160	130.2677 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	2376.6673	0.2160	513.3601 (264)
Space and water heating			643.6279 (265)
Pumps and fans	174.5319	0.5190	90.5820 (267)
Energy for lighting	331.3915	0.5190	171.9922 (268)
Energy saving/generation technologies			
PV Unit	-916.0000	0.5190	-475.4040 (269)
Total kg/year			430.7981 (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	603.0913	1.2200	735.7714 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	2376.6673	1.2200	2899.5341 (264)
Space and water heating			3635.3055 (265)
Pumps and fans	174.5319	3.0700	535.8129 (267)
Energy for lighting	331.3915	3.0700	1017.3718 (268)
Energy saving/generation technologies			
PV Unit	-916.0000	3.0700	-2812.1200 (269)
Primary energy kWh/year			2376.3702 (272)
Primary energy kWh/m2/year			31.3423 (273)

SAP 2012 EPC IMPROVEMENTS

Current energy efficiency rating:	B 91
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	Not applicable
O		Not considered
P		Not considered
R		Not considered
S		Not considered
T		Not considered
U	Solar photovoltaic panels	Not applicable
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
(none)			

Recommended measures	Typical annual savings	Energy efficiency	Environmental impact
(none)			
Total Savings	£0	0.00 kg/m²	

Potential energy efficiency rating: B 91
Potential environmental impact rating: A 94

Fuel prices for cost data on this page from database revision number 391 TEST (01 Apr 2016)
Recommendation texts revision number 4.9c (22 Feb 2014)

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

	Current	Potential	Saving
Electricity	£78	£78	£0
Mains gas	£224	£224	£0
Space heating	£148	£148	£0
Water heating	£103	£103	£0
Lighting	£51	£51	£0
Generated (PV)	-£140	-£140	£0
Total cost of fuels	£162	£162	£0
Total cost of uses	£162	£162	£0
Delivered energy	46 kWh/m²	46 kWh/m²	0 kWh/m²
Carbon dioxide emissions	0.4 tonnes	0.4 tonnes	0.0 tonnes
CO2 emissions per m²	6 kg/m²	6 kg/m²	0 kg/m²
Primary energy	31 kWh/m²	31 kWh/m²	0 kWh/m²

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

No improvements selected / applicable

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

No improvements selected / applicable

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

Overheating Calculation Input Data

Dwelling type	MidTerrace Flat
Number of storeys	1
Cross ventilation possible	No
SAP Region	Thames Valley
Front of dwelling faces	North West
Overshading	Average or unknown
Thermal mass parameter	250.0
Night ventilation	Yes
Ventilation rate during hot weather (ach)	4.00 (Windows fully open)

Overheating Calculation

Summer ventilation heat loss coefficient	250.21 (P1)
Transmission heat loss coefficient	50.32 (37)
Summer heat loss coefficient	300.52 (P2)

Overhangs

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

Solar shading

Orientation	Z blinds	Solar access	Z overhangs	Z summer
South East	1.000	0.90	1.000	0.900 (P8)
South West	1.000	0.90	1.000	0.900 (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
South East	14.4800	119.9223	0.6300	0.7000	0.9000	620.2864
South West	2.7000	119.9223	0.6300	0.7000	0.9000	115.6611
South East	2.3400	119.9223	0.6300	0.7000	0.9000	100.2397
total:						836.1873

	Jun	Jul	Aug	
Solar gains	878	836	780	(P3)
Internal gains	423	406	414	
Total summer gains	1301	1242	1194	(P5)
Summer gain/loss ratio	4.33	4.13	3.97	(P6)
Summer external temperature	16.00	17.90	17.80	
Thermal mass temperature increment (TMP = 250.0)	0.25	0.25	0.25	
Threshold temperature	20.58	22.28	22.02	(P7)
Likelihood of high internal temperature	Slight	Medium	Medium	
Assessment of likelihood of high internal temperature:	Medium			