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Open University, 1 – 11 Hawley Crescent, Camden, NW1 8NP

Energy Strategy Report

Date: 20 June 2017
Project number: 25299
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Contents

Executive Summary

This report details the proposed energy strategy for the proposed residential development at the Open University on Hawley Crescent.

The ground, first and second floors are B1 Commercial let to the Open University. The third and fourth floors are residential. The proposed development involves the part demolition of existing residential flats at third and fourth floor and construction of new three storey extension at third fourth and fifth to replace and extend existing residential accommodation.

The development is in the London Borough of Camden.

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 renewable strategy.

The development does not have much external space apart from a green roof and terrace amenity space provided on the fourth and fifth floors. The flat roof will be used to provide additional green roof and also to house 9 kWp of PV panels (roughly 28 panels). One Air Source Heat Pump will be provided per apartment to provide heating and hot water, 10 on the fourth floor terrace and 5 in the basement, and a comfort cooling will also be provided sited on the terrace.

The proposed strategy has the potential to provide a 30% improvement over the Building Regulations 2013 minimum target; through passive design measures, energy efficient equipment and renewable technologies.

As the project is a minor development, renewable technologies have been specified to achieve a 22.8% reduction in site wide CO_2 emissions and generate 22.8% of the total energy consumption of the development.

1 Introduction

1.1 Site Analysis

Price & Myers have been commissioned by Castle Haven Row Limited to produce an Energy Strategy Report for the proposed development at the Open University, 1 – 11 Hawley Crescent on behalf of their client.

The existing building is mixed use and is currently 5 storeys with basement car parking. The ground, first and second floors are commercial let to the Open University. The third and fourth floors are residential. The proposed development involves the part demolition of existing residential flats at third and fourth floor and construction of new three storey extension at third fourth and fifth to replace and extend existing residential accommodation. The development is in the London Borough of Camden.

The building has a flat roof, some of which will be used as a green roof for ecological enhancement. The building footprint occupies the majority of the site so there is not much available usable space at ground level.

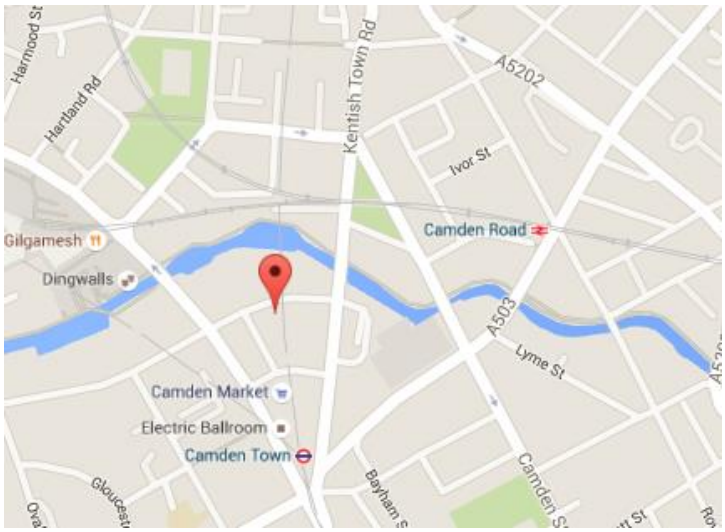


Figure 1 Google Maps extract indicating site location of 1-11 Hawley Crescent

Our assessment has been based on drawings and details provided by Chassay & Last Architects.

1.2 Objectives

This report summarises the work undertaken to support the development of an energy strategy for the 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 most appropriate solution for ensuring a low carbon development.

This report outlines the energy strategy for the development, including passive design, energy and CO2 footprint of the proposed scheme, and renewable energy options.

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

2 Policy

2.1 London Borough of Camden Policies on Energy

Camden Development Policy DP22 – Promoting sustainable design and construction

The Council will promote and measure sustainable design and construction by:

- Expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016;*
- Expecting developments (except new build) of 500 sq m of residential floorspace or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;
- Expecting non-domestic developments of 500sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

CPG3 Sustainability

The Council adopted CPG3 Sustainability on 6 April 2011 following statutory consultation.

- All developments are to be design to reduce carbon dioxide emissions
- Energy strategies are to be designed following the steps set out by the energy hierarchy
- Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies

*NB since the Code for Sustainable Homes has been withdrawn, this policy no longer applies. The London Borough of Camden will expect the development to demonstrate how it will incorporate sustainable design measures in line with the policies above.

2.2 The London Plan Policies on Energy

The London Plan, March 2015, requires compliance with the following policies relating to climate change:

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

As this is not a major development, the remaining London Plan policies are not applicable.

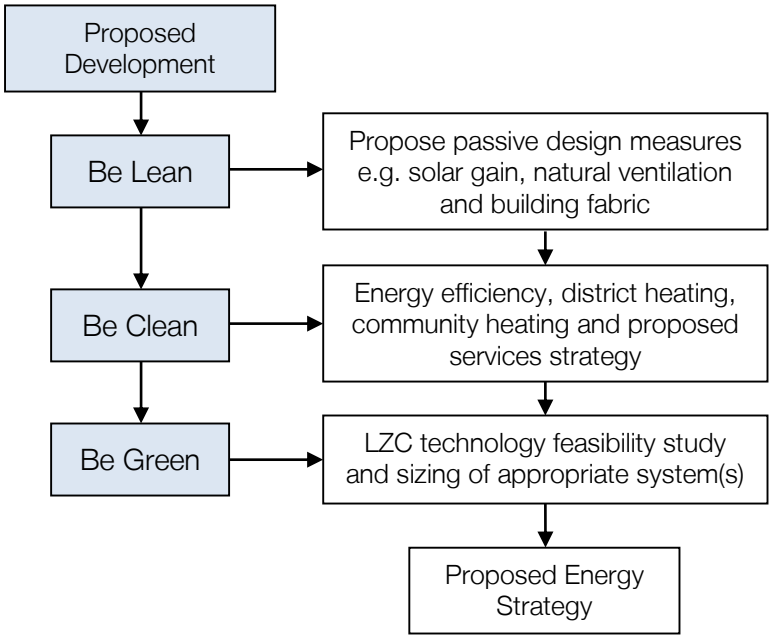
3 Approach

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 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 Deepika Singhal who is an accredited Low Carbon Energy Assessor (LCEA). 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 19% improvement over Building regulations Part L 2013 to meet the London Plan and the London Borough of Camden policy. 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													
	Gas Demand				Electricity Demand							Total Energy (kWh/yr)	Total CO_2 (kg/yr)
Type	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO2 (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)		
Residential	42,224	33,873	76,097	16,437	0	0	0	1,125	4,762	5,887	3,055	81,984	19,492

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 & dynamic thermal modelling using TAS 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 Passive design

Passive design measures have been considered where possible throughout the pre-planning stage to reduce energy demand

As an existing building; the orientation along the north-south axis is fixed. However, thermal elements of the proposed residential development will be specified to meet or exceed Building Regulations minimum standards.

5.2 Solar Gain Control and Daylighting

The development has been designed to balance the use of solar gain to reduce reliance on space heating whilst ensuring that the gains do not result in summer overheating. The U-Values of all glazed elements will meet or exceed Building Regulations standards. Windows will be specified to incorporate low emissivity coating to limit overheating, resulting in an efficient balance between passive solar gain and the thermal losses from each room.

The size and orientation of external windows has been considered carefully to incorporate good levels of daylight and reduce lighting demand. Duel aspect layouts have been maximised to enhance the provision of natural daylight. Table 5.1 provides further information on the parameters that will be met by the glazing installed.

The impact of solar gains has been incorporated into the SAP analysis for compliance with Part L and the risk of solar overheating has been concluded to be medium for the 'worst case scenario' units.

Glazing Parameters	Double glazing – windows and glazed doors
U-value	1.4 W/m^{2}K
Light Transmittance	0.7
Frame factor	0.8

Table 5-1 Proposed glazing parameters for the doors and windows

5.3 Ventilation

A natural ventilation strategy will be available in the form of openable windows in all flats. Cross ventilation has been incorporated where feasible by providing all flats with dual aspect layouts.

Due to the location of the dwelling near to surrounding sources of external noise, a natural ventilation strategy will not always be practicable, as windows will need to remain closed at times in order to preserve the sound insulation performance of the building envelope.

An efficient balanced mechanical ventilation heat recovery will therefore be installed to all flats to provide controlled ventilation. As required to comply with Building Regulations, extract ventilation will be installed to serve all wet rooms.

5.4 Thermal Performance

To further improve the passive design of the development, the thermal envelope will be designed to minimise heat loss by specifying low U-values and minimising thermal bridges where possible. Table 5.2 shows the proposed U-values that will be considered for the development and have been assumed for the energy strategy analysis at this stage. The fabric performance values for air tightness and thermal bridging are also detailed.

Element	U-Value - Proposed
External wall	0.14 W/m^{2}K
Corridor wall	0.25 W/m^{2}K
Flat roof	0.11 W/m^{2}K
Terrace	0.11 W/m^{2}K
Heat loss floor (over unheated spaces)	0.22 W/m^{2}K
Windows / Glazed doors	1.1 W/m^{2}K
External door	1.4 W/m^{2}K
Element	**Measure**
Air Tightness	Pressure testing will be carried out to determine air tightness. This will be an assumed: 4 m^3/m^2/h
Thermal Bridging	Independently assessed, designed to be equivalent to accredited detail figures Details to be calculated at the detailed design stage

Table 5-2 Proposed Be Lean passive design measures

The building utilises a Mechanical Ventilation Heat Recovery (MVHR) system. As such, a low air tightness value must be achieved in order to allow the system to work efficiently. Potential air leakage paths must be minimised during design and construction stages to achieve this, for example gaps around service pipes, windows and floor boards.

In order to further improve the thermal performance of the development; Approved Thermal Bridging values have been used rather than default values. In order to achieve the values required; Accredited Construction Details (ACDs) must be used in the design and construction of all thermal junctions. The ACD checklists should be used by the Designer, Constructor and Building Control Body to demonstrate compliance.

5.5 Improvement Over Part L

Based on the performance of the passive design measures proposed in Section 5, as calculated using SAP, Figure 5-1 demonstrates the percentage improvement over the notional baseline levels in each type of use on the development. Table 5.3 confirms that the development can achieve a 2.04% improvement over Part L before any energy efficiency or low or zero carbon technologies have been considered.

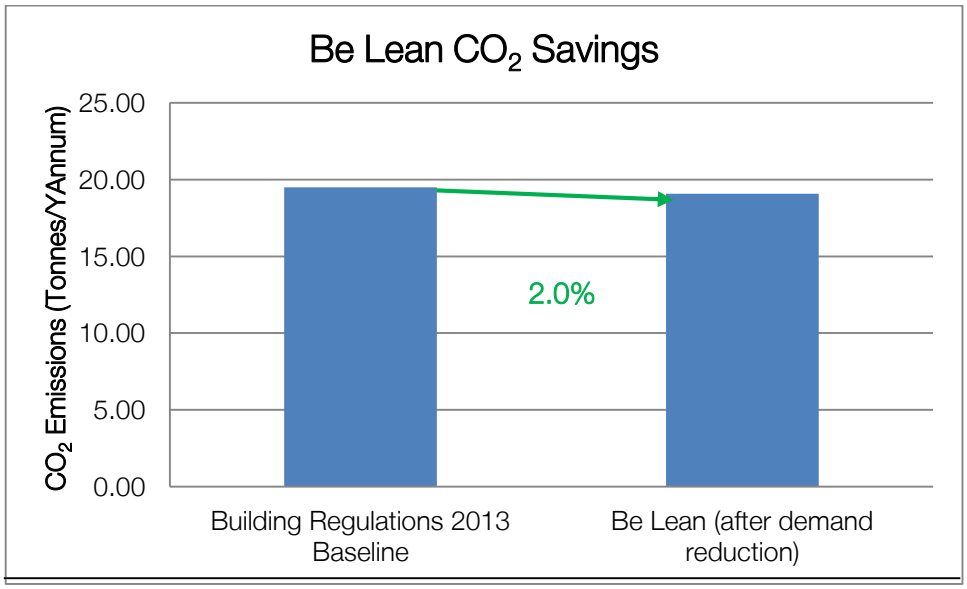


Figure 5-1 Improvement over Building Regulations Part L 2013 with passive design measures

The Be Lean stage has the potential to provide a 2.04% improvement over the Building Regulations 2013 minimum target; through passive design measures, and the energy use for the Be Lean case is broken down (Table 5-3 and Table 5-4).

Be Lean													
Regulated Energy & CO_2													
	Gas Demand				Electricity Demand							Total Energy (kWh/yr)	Total CO_2 (kg/yr)
Type	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO2 (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)		
Residential	38,912	34,684	73,596	15,897	0	0	0	450	5,711	6,161	3,198	79,757	19,094

Table 5-3 Estimated regulated and unregulated energy demand and carbon emissions per energy source

Site Wide	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	19.49		
Be Lean (after demand reduction)	19.09	0.40	2.0%

Table 5-4 % improvement over Part L 2013 at Be Lean Stage

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, a potential heat network is located close to the site. The potential Euston Road heat network has been identified shown in Figure 6-1 below.

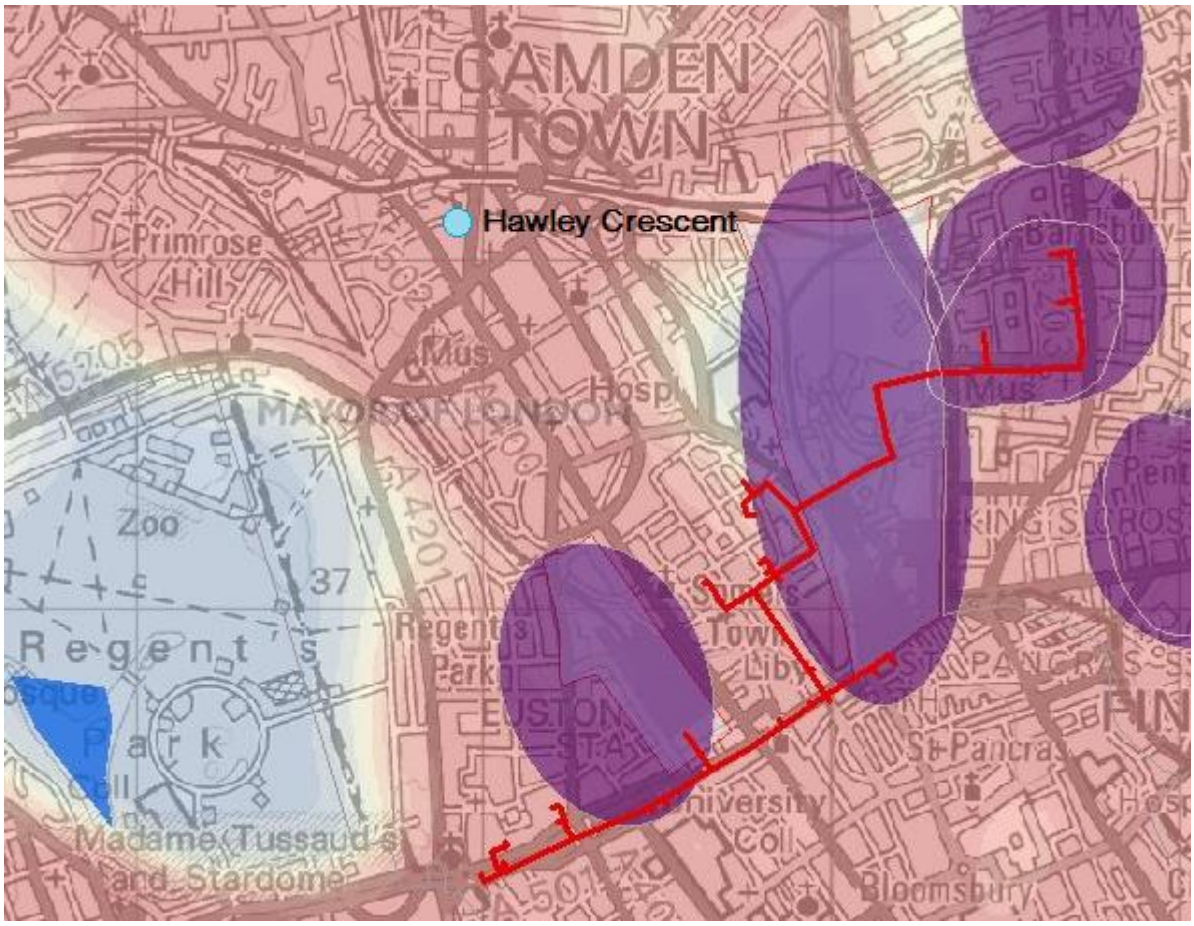


Figure 6-1: London Heat Map

As this network is not yet available, it is not possible to connect at this time. During the detailed design stages of the project, the developer will seek to gain more information on the heat network to ascertain the possibility of connecting in the future.

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 4, energy efficient equipment has been proposed where possible to support the services strategy. All lights will be energy efficient (>45 lumens/watt). Efficient gas boilers have been used to model the Be Lean and Be Clean cases. However, it should be noted that gas will not be used in the development, as noted in the Be Green case.

Table 6-1 shows the proposed services strategy and energy efficiency measures for the development.

Services	Measure
Ventilation	MVHR 90% efficient SFP 0.5 w/l/s
Comfort Cooling	VRF split / multi-split system Modulating control EER 2.5
Lighting	100% low energy lighting

Table 6-1 Proposed energy efficient design measures

6.4 Improvement Over Part L

Based on the performance of the passive design and energy efficient measures proposed in Sections 4 and 5, as calculated using SAP 2012, Figure 6-2 demonstrates the percentage improvement these have over the notional baseline levels for the development before any low or zero carbon technologies have been considered.

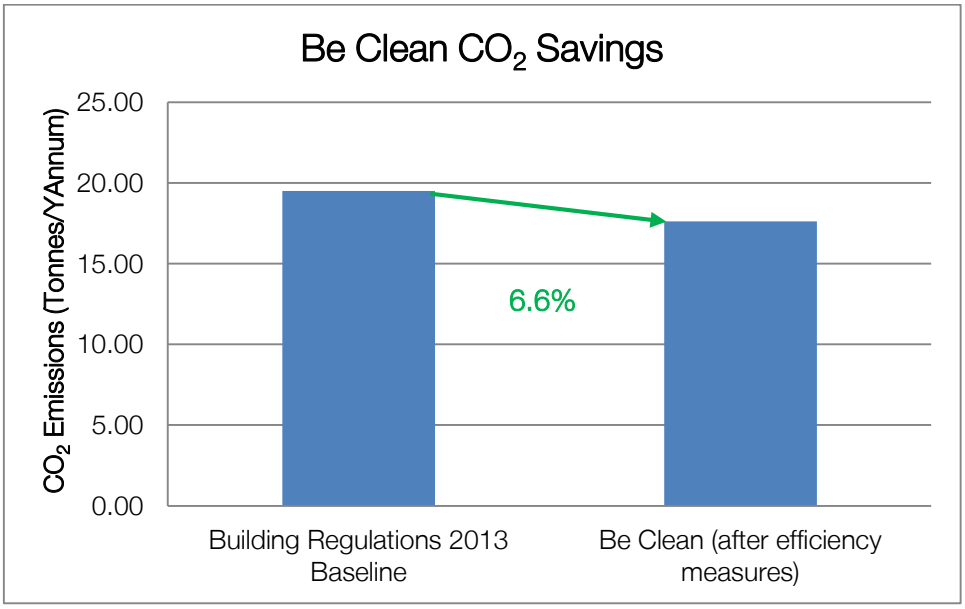


Figure 6-2 Improvement over Building Regulations Part L 2013 before LZCs for residential units

Table 6-1 confirms that the development can achieve 7.59% improvement over Part L 2013 before any on-site renewables have been considered.

Site Wide	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	19.49		
Be Lean (after demand reduction)	19.09	0.40	2.0%
Be Clean (after efficiency measures)	17.82	1.28	6.6%
Total Cumulative Savings		1.67	8.6%

Table 6-1 % improvement over Part L 2013 at Be Clean Stage

The energy use for the Be Clean case is broken down in Table 6-3.

Be Clean													
Regulated Energy & CO_2													
	Gas Demand				Electricity Demand							Total Energy (kWh/yr)	Total CO_2 (kg/yr)
Type	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO2 (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)		
Residential	0	0	0	0	9,081	16,606	1272	2,612	4,759	34,330	17,817	34,330	17,817

Table 6-3 Estimated regulated and unregulated energy demand and carbon emissions per energy source

7 Be Green: 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 south facing 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 periods	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 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 tight 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 and there is a screened location where the units could be located with minimal visual impact; on a screen terrace and in the basement.	✓

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 ASHP combined with solar PV panels, which would most suitably be installed on the roof space. 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 CO2 Emission Savings

The most appropriate LZC technology for the development has been identified as solar PV panels and air source heat pumps to meet the London Borough of Camden's target for on-site renewables.

Table 7-2 shows the proposed system size and the estimated energy and carbon emissions savings for this development. Table 7-3 shows the proposed system size and estimated energy and carbon emissions savings and financial feasibility for this development.

Be Green														
Regulated Energy & CO2														
Type	Gas Demand				Electricity Demand								Total Energy (kWh/yr)	Total CO_2 (kg/yr)
	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)	PV (kWh/yr)	Total (kWh/yr)	Electricity CO_2 (kgCO2/yr)		
Residential	0	0	0	0	9,081	16,606	1272	2,612	4,759	-7,726	26,216	13,606	26,216	13,606

Table 7-2 Estimated regulated and unregulated energy demand and carbon emissions per energy source

	Energy & CO2				Life Cycle Carbon and Cost Analysis
Proposed LZC Technologies	Energy Generated (kWh/yr)	% site energy demand met	CO2 saved by system (kgCO2/yr)	% reduction in site CO2 emissions	25 year CO2 saving (kgCO2)
Total Solar PV = 8.75 kWp 27 High High efficiency, Horizontal South facing	7,511	21.88%	3,898	21.9%	97,455

Table 7-3 Energy, carbon and financial performance of the proposed LZC technologies

7.2 Improvement Over Part L with LZC

Figure 7-1 and Figure 7-2 demonstrate the percentage improvement over the notional baseline levels for the development. Table 7-4 confirms that the development can achieve 20.57% improvement over the Part L 2013 target emissions with on-site renewables.

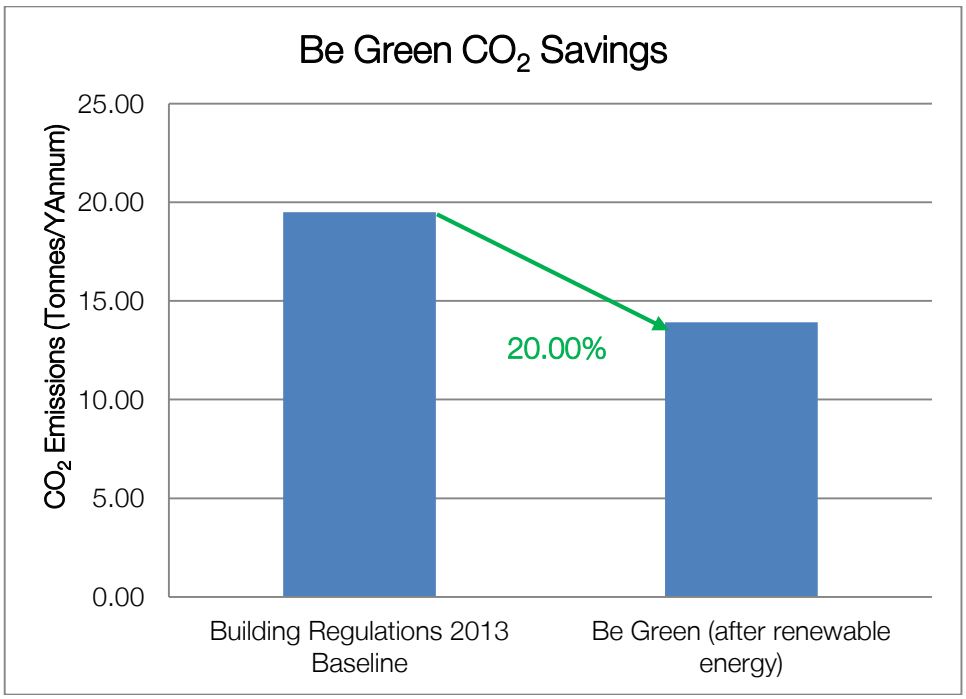


Figure 7-1 Site Wide Improvement over Building Regulations Part L 2013 after LZCs

Site Wide	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	19.49		
Be Lean (after demand reduction)	19.09	0.40	2.0%
Be Clean (after efficiency measures)	17.82	1.28	6.6%
Be Green (after renewable energy)	13.92	3.90	20.0%
Total Cumulative Savings		5.57	28.6%

Table 7-4 Summary of carbon savings through the Energy Hierarchy after LZCs

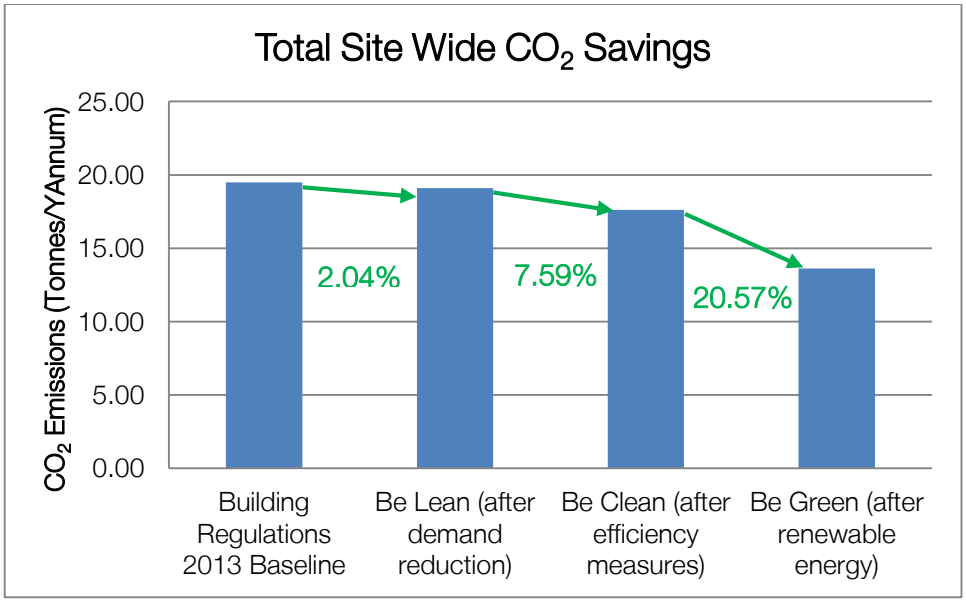


Figure 7-2 Summary of CO2 savings (tonnes CO2/annum) over Building Regulations 2013 baseline

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 30.20% improvement over the Building Regulations Part L 2013 Target Emissions Rate (TER) and an overall 22.8% saving in carbon emissions from renewables.

The design team have made all reasonable endeavours to achieve the minimum requirements of the London Borough of Camden.

Fabric improvements have been prioritised for the development, which will have a longer lasting impact on energy use than renewable technologies with a finite lifetime. The fabric U-Values 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 all available roof space. 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.

Appendix A

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

Energy & Renewable Technology Outputs	
PV energy produced per kWp	768.8 kWh/kWp
PV kWp per m^2 panel	0.2 kWp/m^2
EER of VRF system	2.5
Electricity efficiency	100%
Gas boiler efficiency	90%

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

Appendix B

The following grants may be available with the use of renewable technologies on this development.

Grant	
Feed-in Tariff	By generating your own renewable electricity your energy supplier may pay you money, called a 'Feed-in Tariff' (FIT). Using an MCS certified installer, the system could entitle you to a rate for each unit (kilowatt hour or kWh) of electricity you generate. As well as the FIT, you can sell any excess electricity back to your electricity supplier through an 'Export Tariff'. To qualify, the installation must be less than 5 MW, with the following technologies covered: • Solar photovoltaic (PV) panels • Wind turbines • Water (Hydro) turbines • Anaerobic digestion (biogas energy) • Micro combined heat and power (micro-CHP) https://www.gov.uk/feed-in-tariffs
Renewable Heat Incentive (RHI)	The RHI is a scheme for the non-domestic sector that provides payments to industry, business and public sector organisations that use renewable energy to heat their buildings. Payments are made to the owner of the heat installation over a 20-year period, for the following technologies: • Biomass boilers (including CHP biomass boilers) • Ground source heat pumps (GSHP) • Water source heat pumps • Deep geothermal heat pumps • All solar thermal collectors • Biomethane and biogas There are plans to extend support to the following in 2013: • Air source heat pumps (ASHP) • Biomass direct air heating • Biomass combustion over 200kW There are also plans to launch a domestic RHI scheme in summer 2013. http://www.ofgem.gov.uk/e-serve/RHI/Pages/RHI.aspx
Green Deal	The Green Deal is a Government backed initiative to promote the installation of energy efficiency measures in households in order to reduce energy consumption and bills. There will be no upfront costs, instead consumers will pay through their household energy bills. Consumers can see the Green Deal charge alongside the reductions in energy use which generate savings on their bill. It also means that if they move out (and cease to be the bill payer) the financial obligation remains at the property for the next bill payer: the charge is only paid where/whilst the benefits are enjoyed. https://www.gov.uk/green-deal-energy-saving-measures/how-the-green-deal-works
ECO (Energy Company Obligation)	ECO is a requirement for all large gas and electricity suppliers to fund energy efficiency improvements to dwellings in the UK. Energy suppliers have specific carbon reduction targets to achieve, and therefore must buy ECO 'credits' of CO_2 on a free market, either from installers (and home owners) or from other energy suppliers. Therefore the price of ECO 'credits' is not fixed. The installer (home owner or private renter with owner's permission) can claim back the money for the installation of the improvement measures from the energy suppliers (full payback or partial refund depending on type of

	improvement(s) and value of ECO 'credits'). The scheme can be used to fund a number of domestic energy efficiency improvements. If householders are applying for the Green Deal and are eligible for ECO, they will receive a lower quote from their Green Deal Provider and will benefit from lower repayments. The scheme runs until 31st March 2015, however there are certain Eligibility requirements. See https://www.gov.uk/energy-company-obligation for more information. Energy Companies Obligation - Guidance for suppliers

Appendix C
SAP Calculations

SAP Assumptions

The SAP calculations for the proposed residential development at OU Hawley Crescent have been constructed using the following parameter assumptions;

U-Values

Element	U-Value - Proposed
External wall	0.14 W/m^{2}K
Corridor wall	0.25 W/m^{2}K
Flat roof	0.11 W/m^{2}K
Terrace	0.11 W/m^{2}K
Heat loss floor (over unheated spaces)	0.22 W/m^{2}K
Windows / Glazed doors	1.1 W/m^{2}K
External door	1.4 W/m^{2}K
Element	**Measure**
Air Tightness	Pressure test will be carried out to determine air tightness. This will be an assumed: 4 m^3/m^2/h
Thermal Bridging	Independently assessed, designed to be equivalent to accredited detail figures Details to be calculated at the detailed design stage

Services

Services	Measure
Ventilation	MVHR 90% efficient SFP 0.5 w/l/s Approved installation
Comfort Cooling	VRF split / multi-split system Modulating control
Lighting	100% low energy lighting

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

Design SAP
elmhurst energy

Property Reference	25299 OU Hawley Crescent A1	**Issued on Date**	16/05/2017
Survey Reference	Be Green PT 4 ASHP	**Prop Type Ref**	
Property	1-11 Hawley Crescent, London, NW1 8NP		

SAP Rating	88 B	**DER**	15.95	**TER**	29.46
Environmental	89 B	**% DER<TER**	45.85		
CO_2 Emissions (t/year)	0.76	**DFEE**	51.35	**TFEE**	55.21
General Requirements Compliance	Pass	**% DFEE<TFEE**	6.98		

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

SAP2012 - 9.92 input data (DesignData) -

```
SAP2012 Input Data (Flat)      16/05/2017

FullRefNo:                     Be Green PT 4 ASHP

Regs Region:                   England
SAP Region:                    Thames Valley
Postcode:                      NW1 8NP
DwellingOrientation:           West
Property Type:                 Flat, End-Terrace
Storeys:                       1
Date Built:                    2016
Sheltered Sides:               2
Sunlight Shade:                Average or unknown
Measurements                   Perimeter, Floor Area, Storey Height
     1st Storey:               20.78, 59.85, 2.6
Living Area:                   29.15 m2, fraction: 48.7%
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                8.25, 20.5, 0, Other, Cavity, 0, 0.14, Gross
Corridor wall                  31.62, 33.51, 18, TimberWallTwoLayers, TimberFrame, 0.31, 0.232018561484919, Gross
Party Walls                    Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
Party Wall 1                   53.02, 20, PartyWallDoublePlaster, FilledWithEdge, 0, 0
External Roofs                 Nett Area, Gross Area, Kappa, Construction, Element, UValueFinal
     External Roof 1           41.52, 41.52, 0, Other, 0.11
Party Ceilings                 Area, Kappa, Construction, Element
     Party Ceilings 1          18.33, 0, Other
Heat Loss Floors               Area, Kappa, Construction, Element, Type, ShelterFactor, UValueFinal
     Heat Loss Floor 1         59.85, 0, Other, Exposed Floor - Solid, 0.31, 0.205953941209511
Description                    Data Source, Type, Glazing, Glazing Gap, Argon Filled, Solar Trans, Frame Type, Frame Factor, U Value
     Window                    Manufacturer, Window, Double Low-E Soft 0.1, , , 0.7, , 0.8,
     Door                      Manufacturer, Solid Door, , , , , , ,
Openings                       Opening Type, Location, Orientation, Pitch, Curtain Type, Overhang Ratio, Wide Overhang, Width, Height, Count, Area, Curtain Closed
     North elevation           Window, External Wall 1, North, , None, 0, , 0, 0, 0, 7.32,
     SW elevation              Window, External Wall 1, South West, , None, 0, , 0, 0, 0, 4.93,
     Door                      Solid Door, Corridor wall, West, , , , , 0, 0, 0, 1.89,
Conservatory:                  None
Draught Proofing:              100
Draught Lobby:                 No
Thermal Bridges
     Bridging:                 Calculate Bridges
     Y                         0.056
     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, Table K1 - Approved, Yes, 6.8, 0.5, 0.5, 3.40,
     1.                        External wall, E3 Sill, Table K1 - Approved, Yes, 5.9, 0.04, 0.04, 0.24,
     2.                        External wall, E4 Jamb, Table K1 - Approved, Yes, 12.48, 0.05, 0.05, 0.62,
     3.                        External wall, E7 Party floor between dwellings (in blocks of flats), Table K1 - Approved, Yes, 20.78, 0.07, 0.07, 1.45,
     4.                        External wall, E14 Flat roof, Table K1 - Default, No, 11.33, 0.08, 0.08, 0.91,
     5.                        External wall, E16 Corner (normal), Table K1 - Default, No, 7.8, 0.18, 0.18, 1.40,
     6.                        External wall, E17 Corner (inverted - internal area greater than external area), Table K1 - Default, No, 7.8, 0, 0, 0.00,
     7.                        External wall, E18 Party wall between dwellings, Table K1 - Approved, No, 10.4, 0.06, 0.06, 0.62,
     8.                        Party wall, P3 Party wall - Intermediate floor between dwellings (in blocks of flats), Table K1 - Default, No, 40.8, 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         Yes
     Night Ventilation         Yes
     Air Change Rate           6.00
     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                 1
     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
```

SAP2012 - 9.92 input data (DesignData) -

Intermittent Fans:	0
Passive Vents:	0
Flueless Gas Fires:	0
Cooling System	
Cooled Area	40.00
Data Source	Manufacturer
Type	Split or Multi-Split
Energy Efficiency Ratio	3.6
Control	On/Off
Light Fittings:	10
LEL Fittings:	10
Percentage of LEL Fittings:	100
External Lights Fitted:	Yes
External LELs Fitted:	Yes
Electricity Tariff:	Standard
Main Heating 1	
Description	
Percentage	100
MHS	Electricity PEQ Heat pump air-to-water with flow temperature <= 35°C
SAP Code	214
Boiler Efficiency Type	SAP Table
Efficiency	249.9
Controls by PCDF	0
MHS Controls	CHD Time and temperature zone control
Boiler Interlock	Yes
Ctrl SAP Code	2207
MCS Installation Certificate	Yes
Pumped	Pump in heated space
Heat Pump Age	2013 or later
Heat Emitter	Underfloor
Flow Temperature	<= 35°C
Under Floor Heating	Yes - Pipes in thin screed
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
Immersion Heater Type	Single
Showers in Property	Electric only
Suplementary Immersion	Yes
Hot Water Cylinder	
Cylinder Type	HotWaterCylinder
Cylinder Insulation Type	Foam
Cylinder Volume	150.00
Cylinder Stat	Yes
Pipeworks Insulated	Fully insulated primary pipework
Cylinder in Heated Space	Yes
Separate Time Control	Yes
Flue Gas Heat Recovery System	None
Waste Water Heat Recovery	none
PV Unit	
Type	More Dwellings, One Block
Apportioned Energy	429
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

Mid-floor flat, total floor area 60 m²

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

1a TER and DER
Fuel for main heating:Electricity
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 29.46 kgCO□/m²
Dwelling Carbon Dioxide Emission Rate (DER) 15.95 kgCO□/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)55.2 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)51.4 kWh/m²/yrOK

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2 Fabric U-values

Element	Average	Highest	
External wall	0.21 (max. 0.30)	0.23 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.21 (max. 0.25)	0.21 (max. 0.70)	OK
Roof	0.11 (max. 0.20)	0.11 (max. 0.35)	OK
Openings	1.14 (max. 2.00)	1.40 (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: Heat pump with radiators or underfloor - Electric

SAP2012 - 9.92 input data (DesignData) -

Air-to-water heat pump

Secondary heating system:	None	
5 Cylinder insulation		
Hot water storage	Nominal cylinder loss: 1.43 kWh/day	
Permitted by DBSCG 1.89	OK	
Primary pipework insulated:	Yes	OK
6 Controls		
Space heating controls:	Time and temperature zone control	OK
Hot water controls:	Cylinderstat	OK
	Independent timer for DHW	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):	Slight	OK
Based on:		
Overshading:	Average	
Windows facing North:	7.32 m², No overhang	
Windows facing South West:	4.93 m², No overhang	
Air change rate:	6.00 ach	
Blinds/curtains:	None	
10 Key features		
External wall U-value	0.14 W/m²K	
Party wall U-value	0.00 W/m²K	
Roof U-value	0.11 W/m²K	
Window U-value	1.10 W/m²K	
Photovoltaic array		

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	59.8500 (1b)	x	2.6000 (2b)	=	155.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	59.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	155.6100	(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		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1700	(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	0.2168	0.2125	0.2083	0.1870	0.1828	0.1615	0.1615	0.1573	0.1700	0.1828	0.1913	0.1998	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.3343	0.3300	0.3258	0.3045	0.3003	0.2790	0.2790	0.2748	0.2875	0.3003	0.3088	0.3173	(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	
Window (Uw = 1.10)			12.2500	1.0536	12.9071			(27)
Door			1.8900	1.4000	2.6460			(26)
Heat Loss Floor 1			59.8500	0.2060	12.3263			(28b)
External Wall 1	20.5000	12.2500	8.2500	0.1400	1.1550			(29a)
Corridor wall	33.5100	1.8900	31.6200	0.2320	7.3364			(29a)
External Roof 1	41.5200		41.5200	0.1100	4.5672			(30)
Total net area of external elements Aum(A, m2)			155.3800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	40.9381			(33)
Party Wall 1			53.0200	0.0000	0.0000			(32)
Party Ceilings 1			18.3300					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	8.6490	(36)
Total fabric heat loss (33) + (36) =	49.5871	(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	17.1642	16.9459	16.7277	15.6365	15.4182	14.3270	14.3270	14.1088	14.7635	15.4182	15.8547	16.2912	(38)
Heat transfer coeff	66.7512	66.5330	66.3147	65.2235	65.0053	63.9141	63.9141	63.6958	64.3506	65.0053	65.4418	65.8783	(39)
Average = Sum(39)m / 12 =												65.1690	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1153	1.1117	1.1080	1.0898	1.0861	1.0679	1.0679	1.0643	1.0752	1.0861	1.0934	1.1007	(40)
HLP (average)												1.0889	(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	1.9774 (42)
Average daily hot water use (litres/day)	81.1630 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	89.2793	86.0328	82.7863	79.5398	76.2932	73.0467	73.0467	76.2932	79.5398	82.7863	86.0328	89.2793	(44)
Energy conte	132.3986	115.7967	119.4918	104.1759	99.9592	86.2572	79.9300	91.7208	92.8163	108.1684	118.0743	128.2210	(45)
Energy content (annual)										Total = Sum(45)m =		1277.0102	(45)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Distribution loss (46)m = 0.15 x (45)m

	19.8598	17.3695	17.9238	15.6264	14.9939	12.9386	11.9895	13.7581	13.9224	16.2253	17.7111	19.2332 (46)

Water storage loss:

Store volume 150.0000 (47)

b) If manufacturer declared loss factor is not known :

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.0103 (51)

Volume factor from Table 2a 0.9283 (52)

Temperature factor from Table 2b 0.5400 (53)

Enter (49) or (54) in (55) 0.7736 (55)

Total storage loss

	23.9825	21.6616	23.9825	23.2088	23.9825	23.2088	23.9825	23.9825	23.2088	23.9825	23.2088	23.9825 (56)

If cylinder contains dedicated solar storage

	23.9825	21.6616	23.9825	23.2088	23.9825	23.2088	23.9825	23.9825	23.2088	23.9825	23.2088	23.9825 (57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624 (59)

Total heat required for water heating calculated for each month

	179.6435	158.4695	166.7367	149.8967	147.2041	131.9780	127.1748	138.9657	138.5371	155.4133	163.7951	175.4659 (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

	179.6435	158.4695	166.7367	149.8967	147.2041	131.9780	127.1748	138.9657	138.5371	155.4133	163.7951	175.4659 (64)

Total per year (kWh/year) = Sum(64)m = 1833.2804 (64)

Heat gains from water heating, kWh/month

	81.8184	72.6406	77.5269	71.2151	71.0323	65.2572	64.3726	68.2931	67.4381	73.7619	75.8364	80.4294 (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	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	(66)

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

	15.3846	13.6645	11.1127	8.4130	6.2888	5.3093	5.7369	7.4570	10.0088	12.7085	14.8327	15.8122 (67)

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

	172.5685	174.3592	169.8466	160.2399	148.1132	136.7158	129.1016	127.3109	131.8234	141.4301	153.5569	164.9543 (68)

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

	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870 (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)

	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956 (71)

Water heating gains (Table 5)

	109.9710	108.0962	104.2029	98.9099	95.4736	90.6350	86.5223	91.7918	93.6640	99.1423	105.3283	108.1040 (72)

Total internal gains

	353.5849	351.7807	340.8230	323.2237	305.5364	288.3209	277.0217	282.2205	291.1571	308.9418	329.3787	344.5313 (73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	7.3200	10.6334	0.7000	0.8000	0.7700	30.2068	(74)
Southwest	4.9300	36.7938	0.7000	0.8000	0.7700	70.3952	(79)

Solar gains	100.6020	177.6358	262.1566	360.8448	439.9438	453.2670	430.0724	368.0272	295.5856	201.2412	121.5812	85.4255 (83)
Total gains	454.1869	529.4165	602.9796	684.0685	745.4802	741.5879	707.0940	650.2477	586.7427	510.1829	450.9598	429.9568 (84)

---

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	62.2648	62.4690	62.6746	63.7232	63.9371	65.0287	65.0287	65.2515	64.5876	63.9371	63.5107	63.0899	
alpha	5.1510	5.1646	5.1783	5.2482	5.2625	5.3352	5.3352	5.3501	5.3058	5.2625	5.2340	5.2060	
util living area	0.9942	0.9865	0.9648	0.8935	0.7413	0.5410	0.3960	0.4471	0.7061	0.9327	0.9870	0.9955	(86)
MIT	20.1618	20.2969	20.4971	20.7365	20.8866	20.9397	20.9476	20.9465	20.9133	20.7100	20.3957	20.1418	(87)
Th 2	19.9884	19.9913	19.9943	20.0092	20.0122	20.0271	20.0271	20.0301	20.0211	20.0122	20.0062	20.0002	(88)
util rest of house	0.9923	0.9823	0.9537	0.8631	0.6825	0.4634	0.3094	0.3547	0.6247	0.9060	0.9822	0.9941	(89)
MIT 2	18.8764	19.0741	19.3620	19.6996	19.8816	19.9469	19.9521	19.9547	19.9209	19.6757	19.2306	18.8568	(90)

Living area fraction fLA = Living area / (4) = 0.4871 (91)

MIT	19.5024	19.6697	19.9149	20.2046	20.3711	20.4305	20.4369	20.4378	20.4043	20.1794	19.7981	19.4827	(92)

Temperature adjustment 0.0000

adjusted MIT	19.5024	19.6697	19.9149	20.2046	20.3711	20.4305	20.4369	20.4378	20.4043	20.1794	19.7981	19.4827	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9911	0.9807	0.9527	0.8697	0.7049	0.4961	0.3460	0.3938	0.6580	0.9112	0.9809	0.9931	(94)
Useful gains	450.1671	519.1797	574.4681	594.9348	525.4619	367.8711	244.6704	256.0992	386.1011	464.8833	442.3564	427.0053	(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	1014.7815	982.6718	889.6032	737.3257	563.6653	372.6483	245.2346	257.1898	405.6821	622.7142	830.9852	1006.7964	(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	420.0731	311.4667	234.4605	102.5214	28.4233	0.0000	0.0000	0.0000	0.0000	117.4262	279.8127	431.3646	(98)

Space heating 1925.5485 (98)

Space heating per m2 (98) / (4) = 32.1729 (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	600.7923	472.9641	484.0883	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9627	0.9832	0.9746	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	578.3765	465.0192	471.7712	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	926.1437	884.6250	819.0018	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	250.3924	312.1867	258.3395	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												820.9186	(104)
Cooled fraction											fC = cooled area / (4) =	0.6683	(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	41.8367	52.1615	43.1645	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												137.1627	(107)
Space cooling per m2												2.2918	(108)

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 %)	249.9000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	770.5276	(211)
Cooling System Energy Efficiency Ratio (see Table 10c)	4.5000	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	420.0731	311.4667	234.4605	102.5214	28.4233	0.0000	0.0000	0.0000	0.0000	117.4262	279.8127	431.3646	(98)
Space heating efficiency (main heating system 1)	249.9000	249.9000	249.9000	249.9000	249.9000	0.0000	0.0000	0.0000	0.0000	249.9000	249.9000	249.9000	(210)
Space heating fuel (main heating system)	168.0965	124.6365	93.8217	41.0250	11.3739	0.0000	0.0000	0.0000	0.0000	46.9893	111.9699	172.6149	(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	179.6435	158.4695	166.7367	149.8967	147.2041	131.9780	127.1748	138.9657	138.5371	155.4133	163.7951	175.4659	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	102.5948	90.5023	95.2237	85.6063	84.0686	75.3730	72.6298	79.3636	79.1188	88.7569	93.5438	100.2090	(219)
Water heating fuel used												1046.9905	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	9.2970	11.5915	9.5921	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												30.4806	(221)
Annual totals kWh/year													
Space heating fuel - main system												770.5276	(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)												118.6526	(230a)
central heating pump												30.0000	(230c)
Total electricity for the above, kWh/year												148.6526	(231)
Electricity for lighting (calculated in Appendix L)												271.6969	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
Total delivered energy for all uses												2268.3483	(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	770.5276	0.5190	399.9038	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1046.9905	0.5190	543.3881	(264)
Space and water heating			943.2919	(265)
Space cooling	30.4806	0.5190	15.8194	(266)
Pumps and fans	148.6526	0.5190	77.1507	(267)
Energy for lighting	271.6969	0.5190	141.0107	(268)
Energy saving/generation technologies				
PV Unit	-429.0000	0.5190	-222.6510	(269)
Total CO2, kg/year			954.6218	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			15.9500	(273)

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

DER		15.9500	ZC1
Total Floor Area	TFA	59.8500	
Assumed number of occupants	N	1.9774	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		17.0861	ZC2
CO2 emissions from cooking, equation (L16)		2.7812	ZC3
Total CO2 emissions		35.8174	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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	35.8174 ZC8

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	59.8500 (1b)	x	2.6000 (2b)	=	155.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	59.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	155.6100	(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) =	0.1285	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.3785	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3217	(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	0.4102	0.4022	0.3941	0.3539	0.3459	0.3057	0.3057	0.2976	0.3217	0.3459	0.3620	0.3781	(22b)
Effective ac	0.5841	0.5809	0.5777	0.5626	0.5598	0.5467	0.5467	0.5443	0.5518	0.5598	0.5655	0.5715	(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			1.8900	1.0000	1.8900			(26)
TER Opening Type (Uw = 1.40)			12.2500	1.3258	16.2405			(27)
Heat Loss Floor 1			59.8500	0.1300	7.7805			(28b)
External Wall 1	20.5000	12.2500	8.2500	0.1800	1.4850			(29a)
Corridor wall	33.5100	1.8900	31.6200	0.1800	5.6916			(29a)
External Roof 1	41.5200		41.5200	0.1300	5.3976			(30)
Total net area of external elements Aum(A, m2)			155.3800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		38.4852			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	4.2440	(36)
Total fabric heat loss (33) + (36) =	42.7292	(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	29.9965	29.8287	29.6643	28.8918	28.7473	28.0745	28.0745	27.9499	28.3336	28.7473	29.0397	29.3453	(38)
Heat transfer coeff	72.7258	72.5580	72.3935	71.6210	71.4765	70.8037	70.8037	70.6791	71.0629	71.4765	71.7689	72.0746	(39)
Average = Sum(39)m / 12 =												71.6203	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2151	1.2123	1.2096	1.1967	1.1943	1.1830	1.1830	1.1809	1.1873	1.1943	1.1991	1.2043	(40)
HLP (average)												1.1967	(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	1.9774	(42)
Average daily hot water use (litres/day)	81.1630	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	89.2793	86.0328	82.7863	79.5398	76.2932	73.0467	73.0467	76.2932	79.5398	82.7863	86.0328	89.2793	(44)
Energy conte	132.3986	115.7967	119.4918	104.1759	99.9592	86.2572	79.9300	91.7208	92.8163	108.1684	118.0743	128.2210	(45)
Energy content (annual)										Total = Sum(45)m =		1277.0102	(45)
Distribution loss (46)m = 0.15 x (45)m	19.8598	17.3695	17.9238	15.6264	14.9939	12.9386	11.9895	13.7581	13.9224	16.2253	17.7111	19.2332	(46)

Water storage loss:		
Store volume	150.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):	1.3938	(48)
Temperature factor from Table 2b	0.5400	(49)

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

Enter (49) or (54) in (55)												0.7527	(55)
Total storage loss													
	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder contains dedicated solar storage													
	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month													
	178.9935	157.8824	166.0867	149.2677	146.5541	131.3491	126.5249	138.3157	137.9081	154.7633	163.1661	174.8159	(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													
	178.9935	157.8824	166.0867	149.2677	146.5541	131.3491	126.5249	138.3157	137.9081	154.7633	163.1661	174.8159	(64)
									Total per year (kWh/year) = Sum(64)m =			1825.6276	(64)
Heat gains from water heating, kWh/month													
	81.2985	72.1710	77.0070	70.7119	70.5124	64.7540	63.8526	67.7731	66.9349	73.2419	75.3332	79.9094	(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	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	15.4584	13.7300	11.1660	8.4534	6.3190	5.3348	5.7644	7.4928	10.0568	12.7694	14.9038	15.8880	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	172.5685	174.3592	169.8466	160.2399	148.1132	136.7158	129.1016	127.3109	131.8234	141.4301	153.5569	164.9543	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	(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)													
	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	(71)
Water heating gains (Table 5)													
	109.2721	107.3973	103.5040	98.2110	94.7747	89.9361	85.8234	91.0929	92.9651	98.4434	104.6294	107.4051	(72)
Total internal gains													
	352.9598	351.1473	340.1774	322.5652	304.8677	287.6475	276.3503	281.5574	290.5062	308.3038	328.7509	343.9083	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	7.3200	10.6334	0.6300	0.7000	0.7700	23.7878	(74)
Southwest	4.9300	36.7938	0.6300	0.7000	0.7700	55.4362	(79)

Solar gains	79.2241	139.8882	206.4483	284.1653	346.4557	356.9478	338.6820	289.8214	232.7737	158.4774	95.7452	67.2726	(83)
Total gains	432.1839	491.0355	546.6257	606.7305	651.3234	644.5952	615.0323	571.3788	523.2798	466.7812	424.4961	411.1808	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	57.1496	57.2818	57.4119	58.0311	58.1485	58.7010	58.7010	58.8045	58.4870	58.1485	57.9116	57.6660	
alpha	4.8100	4.8188	4.8275	4.8687	4.8766	4.9134	4.9134	4.9203	4.8991	4.8766	4.8608	4.8444	
util living area													
	0.9955	0.9910	0.9790	0.9397	0.8382	0.6608	0.4975	0.5532	0.8024	0.9589	0.9909	0.9965	(86)
MIT	19.7838	19.9425	20.2012	20.5387	20.8151	20.9576	20.9914	20.9859	20.8902	20.5396	20.1027	19.7552	(87)
Th 2	19.9079	19.9101	19.9123	19.9227	19.9246	19.9336	19.9336	19.9353	19.9301	19.9246	19.9207	19.9166	(88)
util rest of house													
	0.9940	0.9881	0.9717	0.9183	0.7847	0.5675	0.3816	0.4331	0.7215	0.9398	0.9873	0.9953	(89)
MIT 2	18.3055	18.5377	18.9124	19.3933	19.7495	19.9066	19.9306	19.9297	19.8462	19.4052	18.7794	18.2700	(90)
Living area fraction									fLA = Living area / (4) =			0.4871	(91)
MIT	19.0255	19.2219	19.5401	19.9512	20.2685	20.4185	20.4472	20.4441	20.3547	19.9577	19.4239	18.9934	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.0255	19.2219	19.5401	19.9512	20.2685	20.4185	20.4472	20.4441	20.3547	19.9577	19.4239	18.9934	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9924	0.9856	0.9686	0.9190	0.8033	0.6116	0.4384	0.4918	0.7564	0.9405	0.9851	0.9939	(94)
Useful gains	428.8885	483.9558	529.4550	557.5847	523.2235	394.2337	269.6011	281.0264	395.8069	439.0240	418.1840	408.6723	(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													
	1070.9212	1039.1701	944.0200	791.4974	612.4466	411.9707	272.3990	285.8353	444.4762	668.8568	884.4741	1066.2245	(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													
	477.6723	373.1041	308.4363	168.4171	66.3820	0.0000	0.0000	0.0000	0.0000	170.9956	335.7289	489.2188	(98)
Space heating												2389.9551	(98)
Space heating per m2											(98) / (4) =	39.9324	(99)

8c. Space cooling requirement

Not applicable

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												93.5000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												2556.1017	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	477.6723	373.1041	308.4363	168.4171	66.3820	0.0000	0.0000	0.0000	0.0000	170.9956	335.7289	489.2188	(98)
Space heating efficiency (main heating system 1)													
	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)													
	510.8795	399.0418	329.8784	180.1252	70.9968	0.0000	0.0000	0.0000	0.0000	182.8830	359.0684	523.2287	(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													
	178.9935	157.8824	166.0867	149.2677	146.5541	131.3491	126.5249	138.3157	137.9081	154.7633	163.1661	174.8159	(64)
Efficiency of water heater												79.8000	(216)
(217)m	87.3090	87.0302	86.4431	85.1363	82.8539	79.8000	79.8000	79.8000	79.8000	85.0802	86.6980	87.4143	(217)
Fuel for water heating, kWh/month													
	205.0117	181.4110	192.1341	175.3279	176.8827	164.5978	158.5525	173.3280	172.8172	181.9028	188.2005	199.9855	(219)
Water heating fuel used												2170.1516	(219)
Annual totals kWh/year													
Space heating fuel - main system												2556.1017	(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)												272.9997	(232)
Total delivered energy for all uses												5074.2530	(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	2556.1017	0.2160	552.1180	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2170.1516	0.2160	468.7528	(264)
Space and water heating			1020.8707	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	272.9997	0.5190	141.6868	(268)
Total CO2, kg/m2/year			1201.4826	(272)
Emissions per m2 for space and water heating			17.0572	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			2.3674	(272b)
Emissions per m2 for pumps and fans			0.6504	(272c)
Target Carbon Dioxide Emission Rate (TER) = (17.0572 * 1.55) + 2.3674 + 0.6504, rounded to 2 d.p.			29.4600	(273)

CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

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CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	59.8500 (1b)	x	2.6000 (2b)	=	155.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	59.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	155.6100	(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) =	0.1285	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.3285	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2792	(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	0.3560	0.3491	0.3421	0.3072	0.3002	0.2653	0.2653	0.2583	0.2792	0.3002	0.3142	0.3281	(22b)
Effective ac	0.5634	0.5609	0.5585	0.5472	0.5451	0.5352	0.5352	0.5334	0.5390	0.5451	0.5493	0.5538	(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	
Window (Uw = 1.10)			12.2500	1.0536	12.9071			(27)
Door			1.8900	1.4000	2.6460			(26)
Heat Loss Floor 1			59.8500	0.2060	12.3263			(28b)
External Wall 1	20.5000	12.2500	8.2500	0.1400	1.1550			(29a)
Corridor wall	33.5100	1.8900	31.6200	0.2320	7.3364			(29a)
External Roof 1	41.5200		41.5200	0.1100	4.5672			(30)
Total net area of external elements Aum(A, m2)			155.3800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		40.9381			(33)
Party Wall 1			53.0200	0.0000	0.0000			(32)
Party Ceilings 1			18.3300					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	8.6490	(36)
Total fabric heat loss (33) + (36) =	49.5871	(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	28.9304	28.8040	28.6801	28.0983	27.9894	27.4826	27.4826	27.3888	27.6778	27.9894	28.2096	28.4399	(38)
Heat transfer coeff	78.5175	78.3911	78.2672	77.6853	77.5765	77.0697	77.0697	76.9758	77.2649	77.5765	77.7967	78.0269	(39)
Average = Sum(39)m / 12 =												77.6848	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3119	1.3098	1.3077	1.2980	1.2962	1.2877	1.2877	1.2861	1.2910	1.2962	1.2999	1.3037	(40)
HLP (average)												1.2980	(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	1.9774 (42)
Average daily hot water use (litres/day)	81.1630 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	89.2793	86.0328	82.7863	79.5398	76.2932	73.0467	73.0467	76.2932	79.5398	82.7863	86.0328	89.2793	(44)
Energy conte	132.3986	115.7967	119.4918	104.1759	99.9592	86.2572	79.9300	91.7208	92.8163	108.1684	118.0743	128.2210	(45)
Energy content (annual)										Total = Sum(45)m =		1277.0102	(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													

CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

	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													
	28.1347	24.6068	25.3920	22.1374	21.2413	18.3297	16.9851	19.4907	19.7235	22.9858	25.0908	27.2470	(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	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	15.3846	13.6645	11.1127	8.4130	6.2888	5.3093	5.7369	7.4570	10.0088	12.7085	14.8327	15.8122	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	172.5685	174.3592	169.8466	160.2399	148.1132	136.7158	129.1016	127.3109	131.8234	141.4301	153.5569	164.9543	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	(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)													
	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	(71)
Water heating gains (Table 5)													
	37.8155	36.6173	34.1290	30.7463	28.5502	25.4579	22.8295	26.1971	27.3937	30.8949	34.8483	36.6223	(72)
Total internal gains													
	278.4294	277.3018	267.7492	252.0602	235.6131	220.1438	210.3288	213.6259	221.8868	237.6943	255.8987	270.0496	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	7.3200	10.6334	0.7000	0.8000	0.7700	30.2068	(74)
Southwest	4.9300	36.7938	0.7000	0.8000	0.7700	70.3952	(79)

Solar gains	100.6020	177.6358	262.1566	360.8448	439.9438	453.2670	430.0724	368.0272	295.5856	201.2412	121.5812	85.4255	(83)
Total gains	379.0314	454.9376	529.9058	612.9049	675.5568	673.4108	640.4012	581.6531	517.4724	438.9355	377.4799	355.4751	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	52.9341	53.0194	53.1033	53.5011	53.5762	53.9285	53.9285	53.9942	53.7922	53.5762	53.4245	53.2669	
alpha	4.5289	4.5346	4.5402	4.5667	4.5717	4.5952	4.5952	4.5996	4.5861	4.5717	4.5616	4.5511	
util living area													
	0.9974	0.9937	0.9830	0.9456	0.8464	0.6756	0.5157	0.5829	0.8330	0.9708	0.9946	0.9981	(86)
MIT	19.5776	19.7649	20.0634	20.4493	20.7712	20.9414	20.9865	20.9769	20.8438	20.4181	19.9217	19.5406	(87)
Th 2	19.8315	19.8332	19.8348	19.8424	19.8438	19.8505	19.8505	19.8517	19.8479	19.8438	19.8409	19.8379	(88)
util rest of house													
	0.9965	0.9915	0.9768	0.9253	0.7920	0.5764	0.3880	0.4500	0.7531	0.9560	0.9924	0.9974	(89)
MIT 2	18.5484	18.7360	19.0323	19.4100	19.6960	19.8252	19.8473	19.8456	19.7647	19.3891	18.8991	18.5166	(90)
Living area fraction									fLA = Living area / (4) =			0.4871	(91)
MIT	19.0497	19.2371	19.5345	19.9162	20.2197	20.3689	20.4021	20.3966	20.2903	19.8903	19.3972	19.0153	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.0497	19.2371	19.5345	19.9162	20.2197	20.3689	20.4021	20.3966	20.2903	19.8903	19.3972	19.0153	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9957	0.9901	0.9748	0.9268	0.8114	0.6233	0.4507	0.5152	0.7872	0.9568	0.9912	0.9968	(94)
Useful gains	377.4076	450.4247	516.5381	568.0319	548.1635	419.7505	288.5990	299.6768	407.3692	419.9562	374.1753	354.3243	(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													
	1158.1088	1123.9027	1020.1756	855.7967	660.9259	444.6045	293.0300	307.6433	478.2929	720.7101	956.6785	1155.9961	(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													
	580.8417	452.5772	374.7063	207.1907	83.8952	0.0000	0.0000	0.0000	0.0000	223.7609	419.4023	596.4438	(98)
Space heating												2938.8182	(98)
Space heating per m2											(98) / (4) =	49.1031	(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	724.4548	570.3155	585.0162	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8842	0.9342	0.9078	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	640.5641	532.7742	531.0918	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	860.9666	820.9321	753.4072	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	158.6898	214.3895	165.4026	0.0000	0.0000	0.0000	0.0000	(104)

CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

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Space cooling                                                                                                538.4820 (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   39.6725   53.5974   41.3507    0.0000    0.0000    0.0000    0.0000 (107)
Space cooling                                                                                                134.6205 (107)
Space cooling per m2                                                                                           2.2493 (108)
Energy for space heating                                                                                      49.1031 (99)
Energy for space cooling                                                                                       2.2493 (108)
Total                                                                                                         51.3524 (109)
Dwelling Fabric Energy Efficiency (DFEE)                                                                      51.4 (109)


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CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	59.8500 (1b)	x	2.6000 (2b)	=	155.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	59.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	155.6100	(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) =	0.1285	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.3785	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3217	(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	0.4102	0.4022	0.3941	0.3539	0.3459	0.3057	0.3057	0.2976	0.3217	0.3459	0.3620	0.3781	(22b)
Effective ac	0.5841	0.5809	0.5777	0.5626	0.5598	0.5467	0.5467	0.5443	0.5518	0.5598	0.5655	0.5715	(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			1.8900	1.0000	1.8900			(26)
TER Opening Type (Uw = 1.40)			12.2500	1.3258	16.2405			(27)
Heat Loss Floor 1			59.8500	0.1300	7.7805			(28b)
External Wall 1	20.5000	12.2500	8.2500	0.1800	1.4850			(29a)
Corridor wall	33.5100	1.8900	31.6200	0.1800	5.6916			(29a)
External Roof 1	41.5200		41.5200	0.1300	5.3976			(30)
Total net area of external elements Aum(A, m2)			155.3800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		38.4852			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							4.2440	(36)
Total fabric heat loss					(33) + (36) =		42.7292	(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	29.9965	29.8287	29.6643	28.8918	28.7473	28.0745	28.0745	27.9499	28.3336	28.7473	29.0397	29.3453	(38)
Heat transfer coeff	72.7258	72.5580	72.3935	71.6210	71.4765	70.8037	70.8037	70.6791	71.0629	71.4765	71.7689	72.0746	(39)
Average = Sum(39)m / 12 =												71.6203	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2151	1.2123	1.2096	1.1967	1.1943	1.1830	1.1830	1.1809	1.1873	1.1943	1.1991	1.2043	(40)
HLP (average)												1.1967	(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												1.9774	(42)
Average daily hot water use (litres/day)												81.1630	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	89.2793	86.0328	82.7863	79.5398	76.2932	73.0467	73.0467	76.2932	79.5398	82.7863	86.0328	89.2793	(44)
Energy conte	132.3986	115.7967	119.4918	104.1759	99.9592	86.2572	79.9300	91.7208	92.8163	108.1684	118.0743	128.2210	(45)
Energy content (annual)										Total = Sum(45)m =		1277.0102	(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													

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

	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													
	28.1347	24.6068	25.3920	22.1374	21.2413	18.3297	16.9851	19.4907	19.7235	22.9858	25.0908	27.2470	(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	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	98.8695	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	15.4584	13.7300	11.1660	8.4534	6.3190	5.3348	5.7644	7.4928	10.0568	12.7694	14.9038	15.8880	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	172.5685	174.3592	169.8466	160.2399	148.1132	136.7158	129.1016	127.3109	131.8234	141.4301	153.5569	164.9543	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	32.8870	(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)													
	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	(71)
Water heating gains (Table 5)													
	37.8155	36.6173	34.1290	30.7463	28.5502	25.4579	22.8295	26.1971	27.3937	30.8949	34.8483	36.6223	(72)
Total internal gains													
	278.5032	277.3673	267.8025	252.1005	235.6432	220.1692	210.3563	213.6616	221.9348	237.7553	255.9698	270.1254	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	7.3200	10.6334	0.6300	0.7000	0.7700	23.7878	(74)
Southwest	4.9300	36.7938	0.6300	0.7000	0.7700	55.4362	(79)

Solar gains	79.2241	139.8882	206.4483	284.1653	346.4557	356.9478	338.6820	289.8214	232.7737	158.4774	95.7452	67.2726	(83)
Total gains	357.7272	417.2555	474.2508	536.2658	582.0989	577.1170	549.0383	503.4831	454.7084	396.2327	351.7150	337.3980	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	57.1496	57.2818	57.4119	58.0311	58.1485	58.7010	58.7010	58.8045	58.4870	58.1485	57.9116	57.6660	
alpha	4.8100	4.8188	4.8275	4.8687	4.8766	4.9134	4.9134	4.9203	4.8991	4.8766	4.8608	4.8444	
util living area													
	0.9980	0.9955	0.9880	0.9608	0.8799	0.7176	0.5517	0.6170	0.8602	0.9777	0.9959	0.9985	(86)
MIT	19.6702	19.8320	20.0979	20.4533	20.7625	20.9392	20.9865	20.9774	20.8454	20.4459	19.9933	19.6420	(87)
Th 2	19.9079	19.9101	19.9123	19.9227	19.9246	19.9336	19.9336	19.9353	19.9301	19.9246	19.9207	19.9166	(88)
util rest of house													
	0.9973	0.9939	0.9837	0.9456	0.8339	0.6237	0.4260	0.4882	0.7897	0.9663	0.9942	0.9980	(89)
MIT 2	18.7009	18.8638	19.1292	19.4833	19.7651	19.9060	19.9303	19.9289	19.8440	19.4831	19.0335	18.6797	(90)
Living area fraction										fLA = Living area / (4) =		0.4871	(91)
MIT	19.1730	19.3353	19.6010	19.9557	20.2509	20.4092	20.4447	20.4396	20.3318	19.9521	19.5009	19.1484	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.1730	19.3353	19.6010	19.9557	20.2509	20.4092	20.4447	20.4396	20.3318	19.9521	19.5009	19.1484	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9967	0.9928	0.9821	0.9461	0.8494	0.6679	0.4877	0.5515	0.8193	0.9667	0.9933	0.9975	(94)
Useful gains	356.5564	414.2655	465.7470	507.3772	494.4406	385.4469	267.7808	277.6575	372.5525	383.0255	349.3716	336.5609	(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													
	1081.6500	1047.3986	948.4291	791.8233	611.1881	411.3142	272.2210	285.5147	442.8461	668.4520	890.0020	1077.3986	(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													
	539.4697	425.4654	359.1155	204.8012	86.8602	0.0000	0.0000	0.0000	0.0000	212.3573	389.2539	551.1833	(98)
Space heating												2768.5063	(98)
Space heating per m2											(98) / (4) =	46.2574	(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	665.5549	523.9474	537.1613	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8757	0.9308	0.9050	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	582.8230	487.6721	486.1391	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	748.4493	714.1810	662.0872	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	119.2510	168.5226	130.9054	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												418.6790	(104)
Cooled fraction										fC = cooled area / (4) =		1.0000	(105)

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

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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   29.8127   42.1306   32.7264    0.0000    0.0000    0.0000    0.0000 (107)
Space cooling                                                                                                          104.6697 (107)
Space cooling per m2                                                                                                     1.7489 (108)
Energy for space heating                                                                                                46.2574 (99)
Energy for space cooling                                                                                                 1.7489 (108)
Total                                                                                                                   48.0063 (109)
Target Fabric Energy Efficiency (TFEE)                                                                                     55.2 (109)


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CALCULATION OF HEAT DEMAND 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	59.8500 (1b)	x	2.6000 (2b)	=	155.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	59.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	155.6100	(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		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1700	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.3000	4.1000	4.1000	3.8000	3.9000	3.4000	3.5000	3.4000	3.4000	3.7000	3.6000	4.0000	(22)
Wind factor	1.0750	1.0250	1.0250	0.9500	0.9750	0.8500	0.8750	0.8500	0.8500	0.9250	0.9000	1.0000	(22a)
Adj infilt rate	0.1828	0.1743	0.1743	0.1615	0.1658	0.1445	0.1488	0.1445	0.1445	0.1573	0.1530	0.1700	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.3003	0.2918	0.2918	0.2790	0.2833	0.2620	0.2663	0.2620	0.2620	0.2748	0.2705	0.2875	(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	
Window (Uw = 1.10)			12.2500	1.0536	12.9071			(27)
Door			1.8900	1.4000	2.6460			(26)
Heat Loss Floor 1			59.8500	0.2060	12.3263			(28b)
External Wall 1	20.5000	12.2500	8.2500	0.1400	1.1550			(29a)
Corridor wall	33.5100	1.8900	31.6200	0.2320	7.3364			(29a)
External Roof 1	41.5200		41.5200	0.1100	4.5672			(30)
Total net area of external elements Aum(A, m2)			155.3800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	40.9381			(33)
Party Wall 1			53.0200	0.0000	0.0000			(32)
Party Ceilings 1			18.3300					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	8.6490	(36)
Total fabric heat loss (33) + (36) =	49.5871	(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	15.4182	14.9817	14.9817	14.3270	14.5453	13.4540	13.6723	13.4540	13.4540	14.1088	13.8905	14.7635	(38)
Heat transfer coeff	65.0053	64.5688	64.5688	63.9141	64.1323	63.0411	63.2593	63.0411	63.0411	63.6958	63.4776	64.3506	(39)
Average = Sum(39)m / 12 =												63.8413	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0861	1.0788	1.0788	1.0679	1.0716	1.0533	1.0570	1.0533	1.0533	1.0643	1.0606	1.0752	(40)
HLP (average)												1.0667	(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	1.9774 (42)
Average daily hot water use (litres/day)	81.1630 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	89.2793	86.0328	82.7863	79.5398	76.2932	73.0467	73.0467	76.2932	79.5398	82.7863	86.0328	89.2793	(44)
Energy conte	132.3986	115.7967	119.4918	104.1759	99.9592	86.2572	79.9300	91.7208	92.8163	108.1684	118.0743	128.2210	(45)
Energy content (annual)										Total = Sum(45)m =		1277.0102	(45)

CALCULATION OF HEAT DEMAND 09 Jan 2014

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Distribution loss  (46)m = 0.15 x (45)m
              19.8598    17.3695    17.9238    15.6264    14.9939    12.9386    11.9895    13.7581    13.9224    16.2253    17.7111    19.2332 (46)
Water storage loss:
Store volume                                                                                                                          150.0000 (47)
  b) If manufacturer declared loss factor is not known :
  Hot water storage loss factor from Table 2 (kWh/litre/day)                                                                            0.0103 (51)
  Volume factor from Table 2a                                                                                                           0.9283 (52)
  Temperature factor from Table 2b                                                                                                      0.5400 (53)
Enter (49) or (54) in (55)                                                                                                              0.7736 (55)
Total storage loss
              23.9825    21.6616    23.9825    23.2088    23.9825    23.2088    23.9825    23.9825    23.2088    23.9825    23.2088    23.9825 (56)
If cylinder contains dedicated solar storage
              23.9825    21.6616    23.9825    23.2088    23.9825    23.2088    23.9825    23.9825    23.2088    23.9825    23.2088    23.9825 (57)
Primary loss  23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Total heat required for water heating calculated for each month
             179.6435   158.4695   166.7367   149.8967   147.2041   131.9780   127.1748   138.9657   138.5371   155.4133   163.7951   175.4659 (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
             179.6435   158.4695   166.7367   149.8967   147.2041   131.9780   127.1748   138.9657   138.5371   155.4133   163.7951   175.4659 (64)
                                                                                                    Total per year (kWh/year) = Sum(64)m =  1833.2804 (64)
RHI water heating demand                                                                                                                1833 (64)
Heat gains from water heating, kWh/month
              81.8184    72.6406    77.5269    71.2151    71.0323    65.2572    64.3726    68.2931    67.4381    73.7619    75.8364    80.4294 (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         118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
              38.4615    34.1612    27.7817    21.0326    15.7221    13.2732    14.3422    18.6425    25.0220    31.7712    37.0816    39.5305 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
             257.5649   260.2376   253.5024   239.1641   221.0645   204.0534   192.6889   190.0162   196.7514   211.0897   229.1894   246.2004 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
              48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417 (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)
             -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956 (71)
Water heating gains (Table 5)
             109.9710   108.0962   104.2029    98.9099    95.4736    90.6350    86.5223    91.7918    93.6640    99.1423   105.3283   108.1040 (72)
Total internal gains
             497.3869   493.8845   476.8766   450.4961   423.6496   399.3512   384.9430   391.8401   406.8269   433.3928   462.9888   485.2244 (73)
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6. Solar gains

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[Jan]                                    Area          Solar flux              g                FF            Access            Gains
                                         m2            Table 6a       Specific data    Specific data      factor              W
                                                         W/m2          or Table 6b      or Table 6c       Table 6d
-------------------------------------------------------------------------------------------------------------------------------------
North                                   7.3200           11.5683            0.7000           0.8000           0.7700           32.8626 (74)
Southwest                               4.9300           39.0225            0.7000           0.8000           0.7700           74.6591 (79)
-------------------------------------------------------------------------------------------------------------------------------------

Solar gains   107.5218   171.0326   255.0993   365.2187   435.0620   479.0060   453.1853   399.0462   316.8212   212.1159   134.3037    89.5721 (83)
Total gains   604.9087   664.9171   731.9759   815.7148   858.7116   878.3572   838.1283   790.8863   723.6481   645.5087   597.2925   574.7965 (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           63.9371    64.3693    64.3693    65.0287    64.8074    65.9292    65.7018    65.9292    65.9292    65.2515    65.4759    64.5876
alpha          5.2625     5.2913     5.2913     5.3352     5.3205     5.3953     5.3801     5.3953     5.3953     5.3501     5.3651     5.3058
util living area
               0.9708     0.9515     0.8900     0.7452     0.5419     0.3154     0.1811     0.2072     0.4495     0.7719     0.9356     0.9759 (86)

MIT           20.4556    20.5559    20.7323    20.8812    20.9379    20.9492    20.9495    20.9496    20.9466    20.8824    20.6686    20.4357 (87)
Th 2           20.0122    20.0181    20.0181    20.0271    20.0241    20.0391    20.0361    20.0391    20.0391    20.0301    20.0331    20.0211 (88)
util rest of house
               0.9621     0.9378     0.8613     0.6937     0.4747     0.2467     0.1084     0.1307     0.3682     0.7110     0.9149     0.9685 (89)
MIT 2          19.3177    19.4625    19.7001    19.8884    19.9418    19.9652    19.9622    19.9654    19.9640    19.8973    19.6337    19.2973 (90)
Living area fraction                                                                                    fLA = Living area / (4) =       0.4871 (91)
MIT           19.8719    19.9951    20.2028    20.3720    20.4269    20.4445    20.4431    20.4448    20.4426    20.3771    20.1378    19.8517 (92)
Temperature adjustment                                                                                                                  0.0000
adjusted MIT  19.8719    19.9951    20.2028    20.3720    20.4269    20.4445    20.4431    20.4448    20.4426    20.3771    20.1378    19.8517 (93)
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8. Space heating requirement

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                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation    0.9606     0.9375     0.8672     0.7127     0.5028     0.2757     0.1391     0.1630     0.4026     0.7340     0.9174     0.9670 (94)
Useful gains 581.1026   623.3335   634.7905   581.3971   431.7826   242.1915   116.5880   128.8980   291.3521   473.8332   547.9783   555.8134 (95)
Ext temp.      5.6000     6.1000     8.1000    10.6000    13.6000    16.6000    18.6000    18.4000    15.8000    12.3000     8.5000     5.6000 (96)
Heat loss rate W
             927.7502   897.1885   781.4664   624.5658   437.8266   242.3603   116.5905   128.9040   292.6750   514.4769   738.7370   917.1071 (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
             257.9058   184.0306   109.1269    31.0815     4.4967     0.0000     0.0000     0.0000     0.0000    30.2389   137.3462   268.8025 (98)
Space heating                                                                                                                        1023.0292 (98)
```

RHI space heating demand 1023 (98)

CALCULATION OF ENERGY RATINGS 09 Jan 2014

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	59.8500 (1b)	x	2.6000 (2b)	=	155.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	59.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	155.6100	(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		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1700	(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	0.2168	0.2125	0.2083	0.1870	0.1828	0.1615	0.1615	0.1573	0.1700	0.1828	0.1913	0.1998	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.3343	0.3300	0.3258	0.3045	0.3003	0.2790	0.2790	0.2748	0.2875	0.3003	0.3088	0.3173	(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	
Window (Uw = 1.10)			12.2500	1.0536	12.9071			(27)
Door			1.8900	1.4000	2.6460			(26)
Heat Loss Floor 1			59.8500	0.2060	12.3263			(28b)
External Wall 1	20.5000	12.2500	8.2500	0.1400	1.1550			(29a)
Corridor wall	33.5100	1.8900	31.6200	0.2320	7.3364			(29a)
External Roof 1	41.5200		41.5200	0.1100	4.5672			(30)
Total net area of external elements Aum(A, m2)			155.3800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	40.9381			(33)
Party Wall 1			53.0200	0.0000	0.0000			(32)
Party Ceilings 1			18.3300					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	8.6490	(36)
Total fabric heat loss (33) + (36) =	49.5871	(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	17.1642	16.9459	16.7277	15.6365	15.4182	14.3270	14.3270	14.1088	14.7635	15.4182	15.8547	16.2912	(38)
Heat transfer coeff	66.7512	66.5330	66.3147	65.2235	65.0053	63.9141	63.9141	63.6958	64.3506	65.0053	65.4418	65.8783	(39)
Average = Sum(39)m / 12 =												65.1690	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1153	1.1117	1.1080	1.0898	1.0861	1.0679	1.0679	1.0643	1.0752	1.0861	1.0934	1.1007	(40)
HLP (average)												1.0889	(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	1.9774 (42)
Average daily hot water use (litres/day)	81.1630 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	89.2793	86.0328	82.7863	79.5398	76.2932	73.0467	73.0467	76.2932	79.5398	82.7863	86.0328	89.2793	(44)
Energy conte	132.3986	115.7967	119.4918	104.1759	99.9592	86.2572	79.9300	91.7208	92.8163	108.1684	118.0743	128.2210	(45)
Energy content (annual)										Total = Sum(45)m =		1277.0102	(45)

CALCULATION OF ENERGY RATINGS 09 Jan 2014

```
Distribution loss  (46)m = 0.15 x (45)m
              19.8598    17.3695    17.9238    15.6264    14.9939    12.9386    11.9895    13.7581    13.9224    16.2253    17.7111    19.2332 (46)
Water storage loss:
Store volume                                                                                                                          150.0000 (47)
  b) If manufacturer declared loss factor is not known :
  Hot water storage loss factor from Table 2 (kWh/litre/day)                                                                            0.0103 (51)
  Volume factor from Table 2a                                                                                                           0.9283 (52)
  Temperature factor from Table 2b                                                                                                      0.5400 (53)
Enter (49) or (54) in (55)                                                                                                              0.7736 (55)
Total storage loss
              23.9825    21.6616    23.9825    23.2088    23.9825    23.2088    23.9825    23.9825    23.2088    23.9825    23.2088    23.9825 (56)
If cylinder contains dedicated solar storage
              23.9825    21.6616    23.9825    23.2088    23.9825    23.2088    23.9825    23.9825    23.2088    23.9825    23.2088    23.9825 (57)
Primary loss  23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Total heat required for water heating calculated for each month
             179.6435   158.4695   166.7367   149.8967   147.2041   131.9780   127.1748   138.9657   138.5371   155.4133   163.7951   175.4659 (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
             179.6435   158.4695   166.7367   149.8967   147.2041   131.9780   127.1748   138.9657   138.5371   155.4133   163.7951   175.4659 (64)
                                                                                                    Total per year (kWh/year) = Sum(64)m =   1833.2804 (64)
Heat gains from water heating, kWh/month
              81.8184    72.6406    77.5269    71.2151    71.0323    65.2572    64.3726    68.2931    67.4381    73.7619    75.8364    80.4294 (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        118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434   118.6434 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
              38.4615    34.1612    27.7817    21.0326    15.7221    13.2732    14.3422    18.6425    25.0220    31.7712    37.0816    39.5305 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
             257.5649   260.2376   253.5024   239.1641   221.0645   204.0534   192.6889   190.0162   196.7514   211.0897   229.1894   246.2004 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
              48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417    48.8417 (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)
             -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956   -79.0956 (71)
Water heating gains (Table 5)
             109.9710   108.0962   104.2029    98.9099    95.4736    90.6350    86.5223    91.7918    93.6640    99.1423   105.3283   108.1040 (72)
Total internal gains
             497.3869   493.8845   476.8766   450.4961   423.6496   399.3512   384.9430   391.8401   406.8269   433.3928   462.9888   485.2244 (73)
```

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6. Solar gains

```
[Jan]                                    Area          Solar flux              g              FF            Access            Gains
                                          m2           Table 6a      Specific data  Specific data      factor                W
                                                          W/m2        or Table 6b    or Table 6c     Table 6d
-------------------------------------------------------------------------------------------------------------------------------------
North                                   7.3200           10.6334            0.7000          0.8000          0.7700           30.2068 (74)
Southwest                               4.9300           36.7938            0.7000          0.8000          0.7700           70.3952 (79)
-------------------------------------------------------------------------------------------------------------------------------------

Solar gains   100.6020   177.6358   262.1566   360.8448   439.9438   453.2670   430.0724   368.0272   295.5856   201.2412   121.5812    85.4255 (83)
Total gains   597.9889   671.5203   739.0331   811.3409   863.5934   852.6181   815.0154   759.8673   702.4125   634.6339   584.5700   570.6499 (84)
```

---

7. Mean internal temperature (heating season)

```
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                             21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
tau          62.2648    62.4690    62.6746    63.7232    63.9371    65.0287    65.0287    65.2515    64.5876    63.9371    63.5107    63.0899
alpha         5.1510     5.1646     5.1783     5.2482     5.2625     5.3352     5.3352     5.3501     5.3058     5.2625     5.2340     5.2060
util living area
               0.9808     0.9646     0.9263     0.8281     0.6640     0.4748     0.3443     0.3841     0.6105     0.8656     0.9623     0.9843 (86)

MIT           20.3217    20.4456    20.6190    20.8087    20.9114    20.9440    20.9483    20.9479    20.9307    20.7975    20.5353    20.3006 (87)
Th 2          19.9884    19.9913    19.9943    20.0092    20.0122    20.0271    20.0271    20.0301    20.0211    20.0122    20.0062    20.0002 (88)
util rest of house
               0.9753     0.9547     0.9068     0.7890     0.6047     0.4048     0.2686     0.3039     0.5326     0.8246     0.9501     0.9797 (89)
MIT 2         19.1062    19.2843    19.5271    19.7862    19.9050    19.9496    19.9523    19.9553    19.9340    19.7822    19.4265    19.0858 (90)
Living area fraction                                                                                    fLA = Living area / (4) =      0.4871 (91)
MIT           19.6982    19.8499    20.0589    20.2842    20.3952    20.4339    20.4374    20.4387    20.4195    20.2767    19.9666    19.6775 (92)
Temperature adjustment                                                                                                                  0.0000
adjusted MIT  19.6982    19.8499    20.0589    20.2842    20.3952    20.4339    20.4374    20.4387    20.4195    20.2767    19.9666    19.6775 (93)
```

---

8. Space heating requirement

```
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation    0.9734     0.9531     0.9082     0.8005     0.6284     0.4343     0.3006     0.3379     0.5651     0.8366     0.9495     0.9779 (94)
Useful gains 582.0598   640.0442   671.1568   649.5054   542.6576   370.3123   244.9827   256.7329   396.9288   530.9180   555.0707   558.0644 (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
            1027.8506   994.6609   899.1573   742.5166   565.2313   372.8692   245.2657   257.2513   406.6616   629.0371   842.0115  1019.6294 (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
             331.6684   238.3024   169.6324    66.9680    16.7948     0.0000     0.0000     0.0000     0.0000    73.0006   206.5974   343.4044 (98)
Space heating                                                                                                                          1446.3685 (98)
Space heating per m2                                                                                                 (98) / (4) =      24.1666 (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	600.7923	472.9641	484.0883	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9627	0.9832	0.9746	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	578.3765	465.0192	471.7712	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	926.1437	884.6250	819.0018	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	250.3924	312.1867	258.3395	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												820.9186	(104)
Cooled fraction											fC = cooled area / (4) =	0.6683	(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	41.8367	52.1615	43.1645	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												137.1627	(107)
Space cooling per m2												2.2918	(108)

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 %)	249.9000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	578.7789	(211)
Cooling System Energy Efficiency Ratio (see Table 10c)	4.5000	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	331.6684	238.3024	169.6324	66.9680	16.7948	0.0000	0.0000	0.0000	0.0000	73.0006	206.5974	343.4044	(98)
Space heating efficiency (main heating system 1)													
	249.9000	249.9000	249.9000	249.9000	249.9000	0.0000	0.0000	0.0000	0.0000	249.9000	249.9000	249.9000	(210)
Space heating fuel (main heating system)													
	132.7204	95.3591	67.8801	26.7979	6.7206	0.0000	0.0000	0.0000	0.0000	29.2119	82.6720	137.4167	(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													
	179.6435	158.4695	166.7367	149.8967	147.2041	131.9780	127.1748	138.9657	138.5371	155.4133	163.7951	175.4659	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month													
	102.5948	90.5023	95.2237	85.6063	84.0686	75.3730	72.6298	79.3636	79.1188	88.7569	93.5438	100.2090	(219)
Water heating fuel used												1046.9905	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	9.2970	11.5915	9.5921	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												30.4806	(221)
Annual totals kWh/year													
Space heating fuel - main system												578.7789	(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)												118.6526	(230a)
central heating pump												30.0000	(230c)
Total electricity for the above, kWh/year												148.6526	(231)
Electricity for lighting (calculated in Appendix L)												271.6969	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
Total delivered energy for all uses												2076.5996	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	578.7789	13.1900	76.3409	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	1046.9905	13.1900	138.0981	(247)
Space cooling	30.4806	13.1900	4.0204	(248)
Mechanical ventilation fans	118.6526	13.1900	15.6503	(249)
Pumps and fans for heating	30.0000	13.1900	3.9570	(249)
Energy for lighting	271.6969	13.1900	35.8368	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-429.0000	13.1900	-56.5851	(252)
Total energy cost			217.3184	(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] =	0.8705	(257)
SAP value	87.8563	
SAP rating (Section 12)	88	(258)

CALCULATION OF ENERGY RATINGS 09 Jan 2014

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	578.7789	0.5190	300.3862	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1046.9905	0.5190	543.3881	(264)
Space and water heating			843.7743	(265)
Space cooling	30.4806	0.5190	15.8194	(266)
Pumps and fans	148.6526	0.5190	77.1507	(267)
Energy for lighting	271.6969	0.5190	141.0107	(268)
Energy saving/generation technologies				
PV Unit	-429.0000	0.5190	-222.6510	(269)
Total kg/year			855.1042	(272)
CO2 emissions per m2			14.2900	(273)
EI value			89.0716	
EI rating			89	(274)
EI band			B	

Calculation of stars for heating and DHW

Main heating energy efficiency	13.19 × (1 + 0.29 × 0.25) / 2.4990 = 5.661, stars = 3
Main heating environmental impact	0.519 × (1 + 0.29 × 0.25) / 2.4990 = 0.2227, stars = 4
Water heating energy efficiency	13.19 / 1.7510 = 7.533, stars = 2
Water heating environmental impact	0.519 / 1.7510 = 0.2964, stars = 4

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

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	59.8500 (1b)	x	2.6000 (2b)	=	155.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	59.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	155.6100	(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		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1700	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.3000	4.1000	4.1000	3.8000	3.9000	3.4000	3.5000	3.4000	3.4000	3.7000	3.6000	4.0000	(22)
Wind factor	1.0750	1.0250	1.0250	0.9500	0.9750	0.8500	0.8750	0.8500	0.8500	0.9250	0.9000	1.0000	(22a)
Adj infilt rate	0.1828	0.1743	0.1743	0.1615	0.1658	0.1445	0.1488	0.1445	0.1445	0.1573	0.1530	0.1700	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.3003	0.2918	0.2918	0.2790	0.2833	0.2620	0.2663	0.2620	0.2620	0.2748	0.2705	0.2875	(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	
Window (Uw = 1.10)			12.2500	1.0536	12.9071			(27)
Door			1.8900	1.4000	2.6460			(26)
Heat Loss Floor 1			59.8500	0.2060	12.3263			(28b)
External Wall 1	20.5000	12.2500	8.2500	0.1400	1.1550			(29a)
Corridor wall	33.5100	1.8900	31.6200	0.2320	7.3364			(29a)
External Roof 1	41.5200		41.5200	0.1100	4.5672			(30)
Total net area of external elements Aum(A, m2)			155.3800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	40.9381			(33)
Party Wall 1			53.0200	0.0000	0.0000			(32)
Party Ceilings 1			18.3300					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	8.6490	(36)
Total fabric heat loss (33) + (36) =	49.5871	(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	15.4182	14.9817	14.9817	14.3270	14.5453	13.4540	13.6723	13.4540	13.4540	14.1088	13.8905	14.7635	(38)
Heat transfer coeff	65.0053	64.5688	64.5688	63.9141	64.1323	63.0411	63.2593	63.0411	63.0411	63.6958	63.4776	64.3506	(39)
Average = Sum(39)m / 12 =												63.8413	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0861	1.0788	1.0788	1.0679	1.0716	1.0533	1.0570	1.0533	1.0533	1.0643	1.0606	1.0752	(40)
HLP (average)												1.0667	(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	1.9774 (42)
Average daily hot water use (litres/day)	81.1630 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	89.2793	86.0328	82.7863	79.5398	76.2932	73.0467	73.0467	76.2932	79.5398	82.7863	86.0328	89.2793	(44)
Energy conte	132.3986	115.7967	119.4918	104.1759	99.9592	86.2572	79.9300	91.7208	92.8163	108.1684	118.0743	128.2210	(45)
Energy content (annual)										Total = Sum(45)m =		1277.0102	(45)

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

Distribution loss (46)m = 0.15 x (45)m

	19.8598	17.3695	17.9238	15.6264	14.9939	12.9386	11.9895	13.7581	13.9224	16.2253	17.7111	19.2332 (46)

Water storage loss:

Store volume 150.0000 (47)

b) If manufacturer declared loss factor is not known :

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.0103 (51)

Volume factor from Table 2a 0.9283 (52)

Temperature factor from Table 2b 0.5400 (53)

Enter (49) or (54) in (55) 0.7736 (55)

Total storage loss

	23.9825	21.6616	23.9825	23.2088	23.9825	23.2088	23.9825	23.9825	23.2088	23.9825	23.2088	23.9825 (56)

If cylinder contains dedicated solar storage

	23.9825	21.6616	23.9825	23.2088	23.9825	23.2088	23.9825	23.9825	23.2088	23.9825	23.2088	23.9825 (57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624 (59)

Total heat required for water heating calculated for each month

	179.6435	158.4695	166.7367	149.8967	147.2041	131.9780	127.1748	138.9657	138.5371	155.4133	163.7951	175.4659 (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

	179.6435	158.4695	166.7367	149.8967	147.2041	131.9780	127.1748	138.9657	138.5371	155.4133	163.7951	175.4659 (64)

Total per year (kWh/year) = Sum(64)m = 1833.2804 (64)

Heat gains from water heating, kWh/month

	81.8184	72.6406	77.5269	71.2151	71.0323	65.2572	64.3726	68.2931	67.4381	73.7619	75.8364	80.4294 (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	118.6434	118.6434	118.6434	118.6434	118.6434	118.6434	118.6434	118.6434	118.6434	118.6434	118.6434	118.6434	(66)

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

	38.4615	34.1612	27.7817	21.0326	15.7221	13.2732	14.3422	18.6425	25.0220	31.7712	37.0816	39.5305 (67)

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

	257.5649	260.2376	253.5024	239.1641	221.0645	204.0534	192.6889	190.0162	196.7514	211.0897	229.1894	246.2004 (68)

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

	48.8417	48.8417	48.8417	48.8417	48.8417	48.8417	48.8417	48.8417	48.8417	48.8417	48.8417	48.8417 (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)

	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956	-79.0956 (71)

Water heating gains (Table 5)

	109.9710	108.0962	104.2029	98.9099	95.4736	90.6350	86.5223	91.7918	93.6640	99.1423	105.3283	108.1040 (72)

Total internal gains

	497.3869	493.8845	476.8766	450.4961	423.6496	399.3512	384.9430	391.8401	406.8269	433.3928	462.9888	485.2244 (73)

---

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	7.3200	11.5683	0.7000	0.8000	0.7700	32.8626	(74)
Southwest	4.9300	39.0225	0.7000	0.8000	0.7700	74.6591	(79)

Solar gains	107.5218	171.0326	255.0993	365.2187	435.0620	479.0060	453.1853	399.0462	316.8212	212.1159	134.3037	89.5721 (83)
Total gains	604.9087	664.9171	731.9759	815.7148	858.7116	878.3572	838.1283	790.8863	723.6481	645.5087	597.2925	574.7965 (84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	63.9371	64.3693	64.3693	65.0287	64.8074	65.9292	65.7018	65.9292	65.9292	65.2515	65.4759	64.5876	
alpha	5.2625	5.2913	5.2913	5.3352	5.3205	5.3953	5.3801	5.3953	5.3953	5.3501	5.3651	5.3058	
util living area	0.9708	0.9515	0.8900	0.7452	0.5419	0.3154	0.1811	0.2072	0.4495	0.7719	0.9356	0.9759	(86)
MIT	20.4556	20.5559	20.7323	20.8812	20.9379	20.9492	20.9495	20.9496	20.9466	20.8824	20.6686	20.4357	(87)
Th 2	20.0122	20.0181	20.0181	20.0271	20.0241	20.0391	20.0361	20.0391	20.0391	20.0301	20.0331	20.0211	(88)
util rest of house	0.9621	0.9378	0.8613	0.6937	0.4747	0.2467	0.1084	0.1307	0.3682	0.7110	0.9149	0.9685	(89)
MIT 2	19.3177	19.4625	19.7001	19.8884	19.9418	19.9652	19.9622	19.9654	19.9640	19.8973	19.6337	19.2973	(90)
Living area fraction									fLA = Living area / (4) =			0.4871	(91)
MIT	19.8719	19.9951	20.2028	20.3720	20.4269	20.4445	20.4431	20.4448	20.4426	20.3771	20.1378	19.8517	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.8719	19.9951	20.2028	20.3720	20.4269	20.4445	20.4431	20.4448	20.4426	20.3771	20.1378	19.8517	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9606	0.9375	0.8672	0.7127	0.5028	0.2757	0.1391	0.1630	0.4026	0.7340	0.9174	0.9670	(94)
Useful gains	581.1026	623.3335	634.7905	581.3971	431.7826	242.1915	116.5880	128.8980	291.3521	473.8332	547.9783	555.8134	(95)
Ext temp.	5.6000	6.1000	8.1000	10.6000	13.6000	16.6000	18.6000	18.4000	15.8000	12.3000	8.5000	5.6000	(96)
Heat loss rate W	927.7502	897.1885	781.4664	624.5658	437.8266	242.3603	116.5905	128.9040	292.6750	514.4769	738.7370	917.1071	(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	257.9058	184.0306	109.1269	31.0815	4.4967	0.0000	0.0000	0.0000	0.0000	30.2389	137.3462	268.8025	(98)

Space heating 1023.0292 (98)

Space heating per m2 (98) / (4) = 17.0932 (99)

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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.	5.6000	6.1000	8.1000	10.6000	13.6000	16.6000	18.6000	18.4000	15.8000	12.3000	8.5000	5.6000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	466.5041	341.6004	353.0302	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9892	0.9968	0.9950	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	461.4815	340.5119	351.2730	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	956.2283	911.6401	855.2577	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	356.2177	424.9194	374.9646	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												1156.1018	(104)
Cooled fraction											fC = cooled area / (4) =	0.6683	(105)
Intermittency factor (Table 10b)	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	59.5184	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												59.5184	(107)
Space cooling per m2												0.9945	(108)

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 %)	249.9000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	409.3754	(211)
Cooling System Energy Efficiency Ratio (see Table 10c)	4.5000	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	257.9058	184.0306	109.1269	31.0815	4.4967	0.0000	0.0000	0.0000	0.0000	30.2389	137.3462	268.8025	(98)
Space heating efficiency (main heating system 1)	249.9000	249.9000	249.9000	249.9000	249.9000	0.0000	0.0000	0.0000	0.0000	249.9000	249.9000	249.9000	(210)
Space heating fuel (main heating system)	103.2036	73.6417	43.6682	12.4376	1.7994	0.0000	0.0000	0.0000	0.0000	12.1004	54.9605	107.5640	(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	179.6435	158.4695	166.7367	149.8967	147.2041	131.9780	127.1748	138.9657	138.5371	155.4133	163.7951	175.4659	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	102.5948	90.5023	95.2237	85.6063	84.0686	75.3730	72.6298	79.3636	79.1188	88.7569	93.5438	100.2090	(219)
Water heating fuel used												1046.9905	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	13.2263	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												13.2263	(221)
Annual totals kWh/year													
Space heating fuel - main system												409.3754	(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)	118.6526	(230a)
central heating pump	30.0000	(230c)
Total electricity for the above, kWh/year	148.6526	(231)
Electricity for lighting (calculated in Appendix L)	271.6969	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
Total delivered energy for all uses	1889.9418	(238)

10a. Fuel costs - using BEDF prices (410)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	409.3754	15.5400	63.6169	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	1046.9905	15.5400	162.7023	(247)
Space cooling	13.2263	15.5400	2.0554	(248)
Mechanical ventilation fans	118.6526	15.5400	18.4386	(249)
Pumps and fans for heating	30.0000	15.5400	4.6620	(249)
Energy for lighting	271.6969	15.5400	42.2217	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-429.0000	15.5400	-66.6666	(252)
Total energy cost			227.0304	(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	409.3754	0.5190	212.4659	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)

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Water heating (other fuel)	1046.9905	0.5190	543.3881 (264)
Space and water heating			755.8539 (265)
Space cooling	13.2263	0.5190	6.8645 (266)
Pumps and fans	148.6526	0.5190	77.1507 (267)
Energy for lighting	271.6969	0.5190	141.0107 (268)
Energy saving/generation technologies			
PV Unit	-429.0000	0.5190	-222.6510 (269)
Total kg/year			758.2288 (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	409.3754	3.0700	1256.7826 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	1046.9905	3.0700	3214.2609 (264)
Space and water heating			4471.0436 (265)
Space cooling	13.2263	3.0700	40.6048 (266)
Pumps and fans	148.6526	3.0700	456.3636 (267)
Energy for lighting	271.6969	3.0700	834.1096 (268)
Energy saving/generation technologies			
PV Unit	-429.0000	3.0700	-1317.0300 (269)
Primary energy kWh/year			4485.0915 (272)
Primary energy kWh/m2/year			74.9389 (273)

SAP 2012 EPC IMPROVEMENTS

Current energy efficiency rating: B 88
Current environmental impact rating: B 89

(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 88
Potential environmental impact rating: B 89

Fuel prices for cost data on this page from database revision number 410 TEST (03 Apr 2017)
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	£294	£294	£0
Space heating	£87	£87	£0

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

Space cooling	£2	£2	£0
Water heating	£163	£163	£0
Lighting	£42	£42	£0
Generated (PV)	-£67	-£67	£0
Total cost of fuels	£227	£227	£0
Total cost of uses	£227	£227	£0
Delivered energy	32 kWh/m²	32 kWh/m²	0 kWh/m²
Carbon dioxide emissions	0.8 tonnes	0.8 tonnes	0.0 tonnes
CO2 emissions per m²	13 kg/m²	13 kg/m²	0 kg/m²
Primary energy	75 kWh/m²	75 kWh/m²	0 kWh/m²

CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

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

No improvements selected / applicable

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

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

No improvements selected / applicable

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

Overheating Calculation Input Data

Dwelling type	EndTerrace Flat
Number of storeys	1
Cross ventilation possible	Yes
SAP Region	Thames Valley
Front of dwelling faces	West
Overshading	Average or unknown
Thermal mass parameter	250.0
Night ventilation	Yes
Ventilation rate during hot weather (ach)	6.00 (Windows fully open)

Overheating Calculation

Summer ventilation heat loss coefficient	308.11 (P1)
Transmission heat loss coefficient	49.59 (37)
Summer heat loss coefficient	357.69 (P2)

Overhangs

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

Solar shading

Orientation	Z blinds	Solar access	Z overhangs	Z summer
North	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
North	7.3200	81.1852	0.7000	0.8000	0.9000	269.5634
South West	4.9300	119.9223	0.7000	0.8000	0.9000	268.1761
total:						537.7395

	Jun	Jul	Aug	
Solar gains	573	538	469	(P3)
Internal gains	396	382	389	
Total summer gains	970	920	858	(P5)
Summer gain/loss ratio	2.71	2.57	2.40	(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	18.96	20.72	20.45	(P7)
Likelihood of high internal temperature	Not significant	Slight	Not significant	

Assessment of likelihood of high internal temperature: Slight