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11 Rosslyn Hill, Camden

Energy Strategy Report

CIBSE LOW CARBON ENERGY ASSESSORS

Date: 27 March 2015

Project number: 23602

Prepared by: Tom Lodge

Reviewed by: Lucy Smallwood

Contents

Executive Summary

This report details the proposed energy strategy for the proposed residential development at 11 Rosslyn Hill, which entails the demolition of an existing building and the construction of a new build 2 storey cottage. The cottage also includes a basement swimming pool, sauna and gym facilities in the London Borough of Camden. The development is within the grounds of a listed building which is also being extended. However the extension of the existing building is under 500m^2. As such this is not being assessed.

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 proposed strategy has the potential to provide a 43% improvement over the Building Regulations 2013 minimum target; through passive design measures, energy efficient equipment and renewable technologies. Renewable technologies have been specified to achieve a 22.3% reduction in site wide CO_2 emissions. The development will be constructed to have a high fabric energy efficiency as well as including the use of MVHR. Solar Slate and Air Source Heat Pump will be used to provide the 22.3% reduction in site CO_2 emissions. The ASHP will provide a challenge to locate and screen within the curtilage of the site of the Grade II listed building.

Based on the proposed energy strategy, 4.6 credits can also be achieved in Ene 1 of the Code for Sustainable Homes assessment, with a further 4.7 credits in Ene 2, helping to achieve a Code Level 4 on the scheme. Further details can be found in the Price & Myers Code for Sustainable Homes Pre-assessment report.

1 Introduction

1.1 Site Analysis

The 11 Rosslyn Hill development is located in the London Borough of Camden.

The residential development will comprise the demolition of an existing building to be replaced by a new two storey 2 bed guest house. The development includes a basement with swimming pool, gym and sauna facilities. Both bedrooms have en-suite bathrooms.

The building has a steep pitched roof and occupies a comparatively small area of the total site, with the rest of the site being occupied by the main Grade II listed house and gardens. The existing building is also being extended but this is not being assessed as it is under 500m^2. Due to the listed status of the main house, there is no opportunity to site renewable technologies on or near to the existing building.

1.2 Objective

This report summarises the work undertaken to support the development of an energy strategy for the 11 Rosslyn Hill scheme. This work has resulted in a strategy that requires design, technical and commercial decisions in order to continue the design development and ultimately select the final solution for ensuring a low carbon development.

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

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

2 Policy

2.1 London Borough of Camden Policies on Energy

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 Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016;
- Expecting developments (except new build) of 500 sq m of residential floor space or above or 5 or more dwellings to achieve "very good" in BREEAM for Domestic Refurbishment assessments prior to 2013 and encouraging "excellent" from 2013;

Policy CPG3 Sustainability

Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies.

All residential new build should achieve a Code for Sustainable Homes level 4 with 50% of the unweighted Energy, Water and Materials credits.

Residential refurbishments of 500sqm floorspace or more to achieve a BREEAM for Domestic Refurbishment Very Good

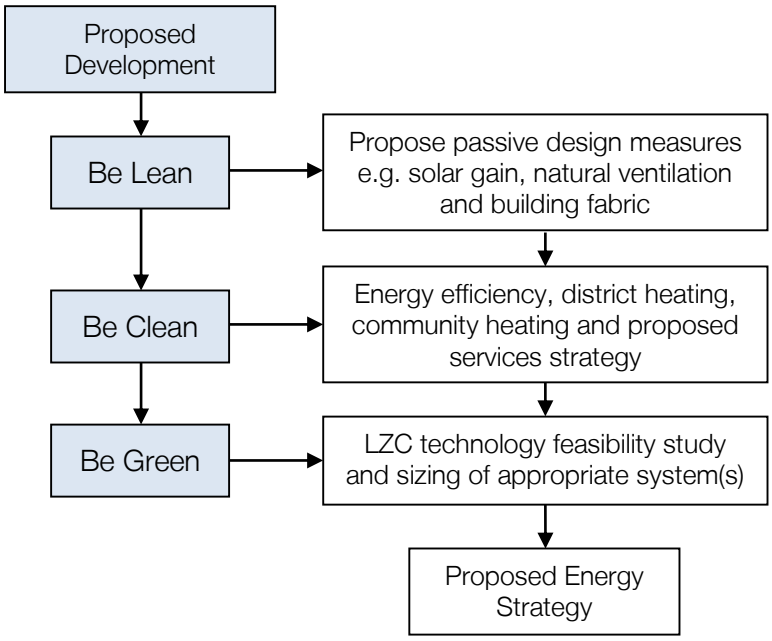
3 Approach

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 11 Rosslyn Hill 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 Lucy Smallwood who is an On Construction Domestic Energy Assessor (OCDEA). The energy consumption and carbon emission figures within this report have been calculated using the approved Standard Assessment Procedure for the Energy Rating of Dwellings (SAP), current SAP 2012 version.

4 Passive Design

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

4.1 Solar Gain Control and Daylighting

Where possible, windows and natural daylight have been provided to ensure appropriate daylighting levels throughout the development and reduce the lighting demand. The size and orientation of external windows has been considered carefully to balance daylight with excessive solar gains. Windows are specified to incorporate low emissivity coatings to limit overheating while ensuring adequate daylight. The impact of solar gains has been incorporated into the SAP analysis for compliance with Part L and using a natural ventilation strategy the risk of solar overheating has been concluded to be not significant for the development.

4.2 Natural Ventilation

Natural ventilation is also possible in the form of openable windows. An efficient Mechanical Ventilation Heat Recovery system will be installed to provide controlled ventilation for the cottage. Air conditioning will also be installed to serve the bedrooms as well as the study. Air Handling Units will be provided separately for the swimming pool.

4.3 Building Fabric Efficiency

To further improve the passive design of the development, the thermal fabric has been specified to meet or exceed current Building Regulations targets. Table 4-1 shows the proposed U-values that will be considered for the development and have been assumed for the energy strategy analysis at this stage.

Element	Measure
External Walls	0.11 W/m^{2}K
Roof	0.11 W/m^{2}K
Basement Floor	0.11 W/m^{2}K
Windows	1.2 W/m^{2}K
Rooflights	1.2 W/m^{2}K
External Doors	1.2 W/m^{2}K
Basement Doors	1 W/m^{2}K
Air Tightness	4 m^3/m^2/h
Thermal Bridging	Y value = 0.093 (To be calculated at detailed design)

Table 4-1 Proposed Be Lean passive design measures

5 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.

5.1 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, London Borough of Camden heat network has been identified shown in Figure 5-1 below.

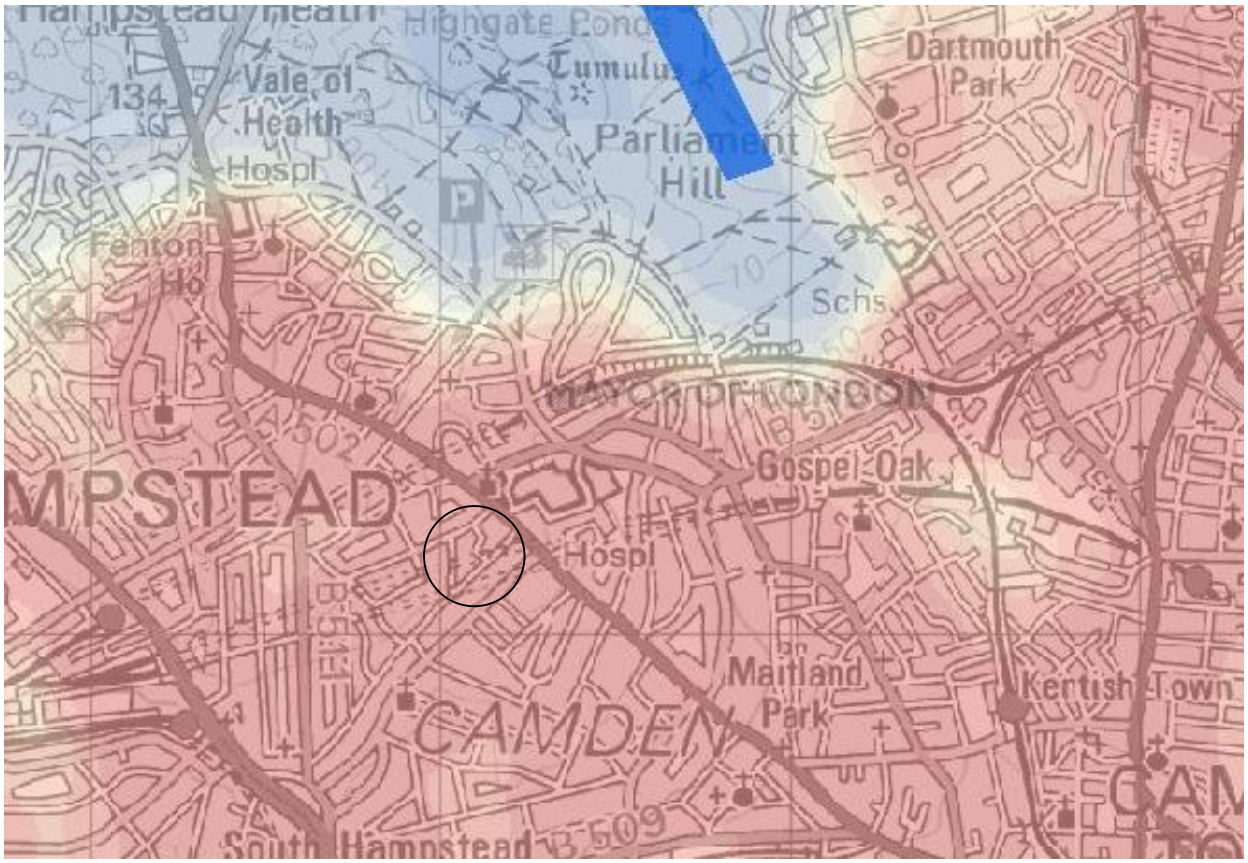


Figure 5-1: London Heat Map (black circle indicates location of development)

The connection to a district heating system will be considered at the detailed design stage and further investigation into the provision of appropriate ducts and risers will be carried out to make this possible should such an energy supply become available.

5.2 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.

5.3 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. Table 5-1 shows the proposed services strategy and energy efficiency measures for the development.

Services	Measure
Space Heating	Air Source Heat Pump 90% efficient COP: 4
Heating Controls	Time and temperature zone control
Hot Water Heating	Air Source Heat Pump 90% efficient COP: 4 Underfloor heating
Ventilation	MVHR 90% efficient SFP 0.66 w/l/s Rigid Ductwork
Comfort Cooling	Air Conditioning for the bedrooms and study Energy rating A Controls On/Off
Lighting	100% low energy lighting
Lighting control	PIR/Daylight/timer controls fitted to lighting in external areas

Table 5-1 Proposed energy efficient design measures

5.4 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 5-2 demonstrates the percentage improvement these have over the notional baseline levels for the development before any low or zero carbon technologies have been considered.

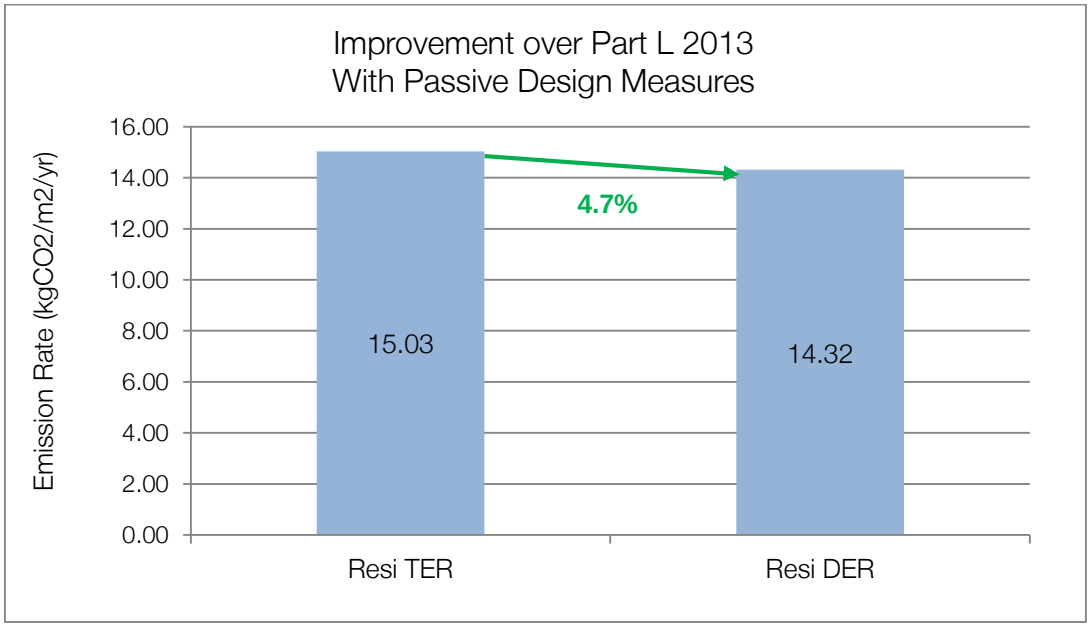


Figure 5-2 Improvement over Building Regulations Part L 2013 before LZCs

6 Estimated Energy Use and Carbon Footprint

Calculations have been carried out to determine the estimated energy demand and carbon footprint of the proposed development, taking into account the passive design and energy efficiency measures identified in Sections 4 and 5. This will form a base case for the development using gas as the baseline fuel.

The energy consumption includes regulated energy (space and water heating, lighting, pumps and fans) derived from outputs of the SAP calculations for the site and unregulated energy (household appliances and equipment) based on the BRE methodology. Full details of assumptions are included in Appendix A and Table 6-1 details the energy demand for the site taking into account the regulated and unregulated energy.

Energy & CO_2												
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)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	Cooling (kWh/yr)	Appliances (kWh/yr)	Total (kWh/yr)	Electricity CO_2 (kgCO2/yr)		
House	2,616	1,721	4,338	937	677	852	187.28	3,701	5,230	2,714	9,568	3,651

Table 6-1: Estimated regulated and unregulated energy demand and carbon emissions per energy source

7 Low and Zero Carbon (LZC) Technologies Feasibility Study

The final level of the energy hierarchy is to Be Green, therefore the following table discusses the options for on-site low and zero carbon technologies and their feasibility on this development to contribute to meeting the London Borough of Camden'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	Due to the steep pitch and small available area of the roof it is deemed that Solar Thermal Collectors are not viable for this development.	✗
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	PV Panels are technically viable for the project. These can be used even with a steep pitch roof. They would help maximise the energy output of the small amount of south facing roof space.	✓

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	Due to the development being within the grounds of a listed building, it is not deemed appropriate for a biomass boiler system. There would also be 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 to provide heating to the assessed development. This will require careful consideration in order to minimise the visual impact on the existing Grade II listed building and site.	✓

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 a combination of Solar Slate (PV) Panels and ASHP. Work has been done with an M&E consultant who has deemed that the use of Solar Slate panels would be the most appropriate system to help meet the 20% CO_2 reduction required. The ASHP will require a considered strategy to ensure that it is screened and attenuated to ensure limited impact to the main house. The chosen system should be accurately sized during the detailed design stages and MCS (Microgeneration Certification Scheme) approved equipment and installers used.

8 Summary of CO2 Emission Savings

8.1 Summary of CO_2 Emissions Savings

The most appropriate LZC technology for the development has been identified as a combination of PV Solar Slates and ASHP to achieve the London Borough of Camden's target for on-site renewables.

Table 8-1 shows the proposed system size and the estimated energy and carbon emissions savings and financial feasibility for this development.

	Energy & CO_2				Life Cycle Carbon and Cost Analysis
Proposed LZC Technologies	Energy Generated (kWh/yr)	% site energy demand met	CO_2 saved by system (kgCO2/yr)	% reduction in site CO_2 emissions	25 year CO_2 saving ($kgCO_2$)
Air Source Heat Pump (ASHP) Gas Fired Boiler = 90% efficient ASHP COP = 4	3,513	36.7%	387	10.6%	9,684
Total Solar Slate PV = 0.975kWp 45 deg, South facing Approx Area of Panels = 7.8m^2	964.275	8.59%	547.7	11.7%	13,692.5
Total	4,477.275	45.29%	934.4	22.3%	23,376.5

Table 8-1 Energy and carbon performance of the proposed LZC technologies

8.2 Estimated Energy Demand and Carbon Emissions

The proposed LZC technologies can deliver a significant amount of electricity demand reduction. Following the strategy discussed above, Table 8.2 summarises the energy demand for the site taking into account the regulated energy.

Energy & CO_2														
Type	Gas Demand				Electricity Demand						LZC Strategy		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)	Pumps & Fans (kWh /yr)	Lighting (kWh /yr)	Cooling (kWh /yr)	Appliances (kWh /yr)	Total (kWh /yr)	Electricity CO_2 ($kgCO_2$ /yr)	Energy Offset by LZCs (kWh /yr)	CO2 saved by LZCs ($kgCO_2$ /yr)		
House	2,616	1,721	4,338	937	677	852	187.28	3,701	5,230	2,714	4,477.275	934.4	5,090	2,717

Table 8-2 Estimated energy demand and carbon emissions per source

The graphs below show the site wide saving from renewable technologies, as well as the improvement over Part L 2013.

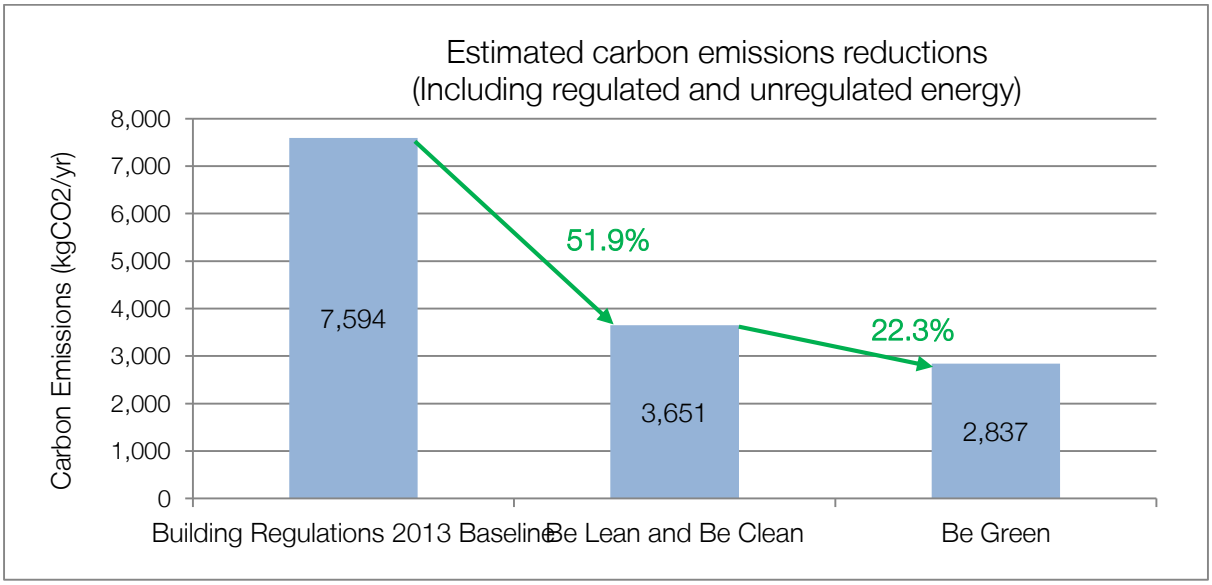


Figure 8-1: Estimated carbon emissions reductions for the site

Site Wide	kgCO2/yr	%
Building Regulations 2013 Baseline	7,594	
Be Lean and Be Clean	3,651	51.9%
Be Green	2,837	22.3%
Be Green Improvement over Baseline		62.64%

Table 8-3 Emissions reduction through the energy hierarchy

Table 8.3 shows the improvement through the energy hierarchy of 11 Rosslyn Hill. Overall a 62.64% reduction in carbon emissions are feasible through inclusion of low material U-Values, efficient services as well as the inclusion of Solar Slate PV's and ASHP's. Based on the feasibility study of LZC technologies in Sections 7 and 8 above, Figure 8-2 demonstrates the percentage improvements over Part L 2013 after incorporating appropriate technologies for each space.

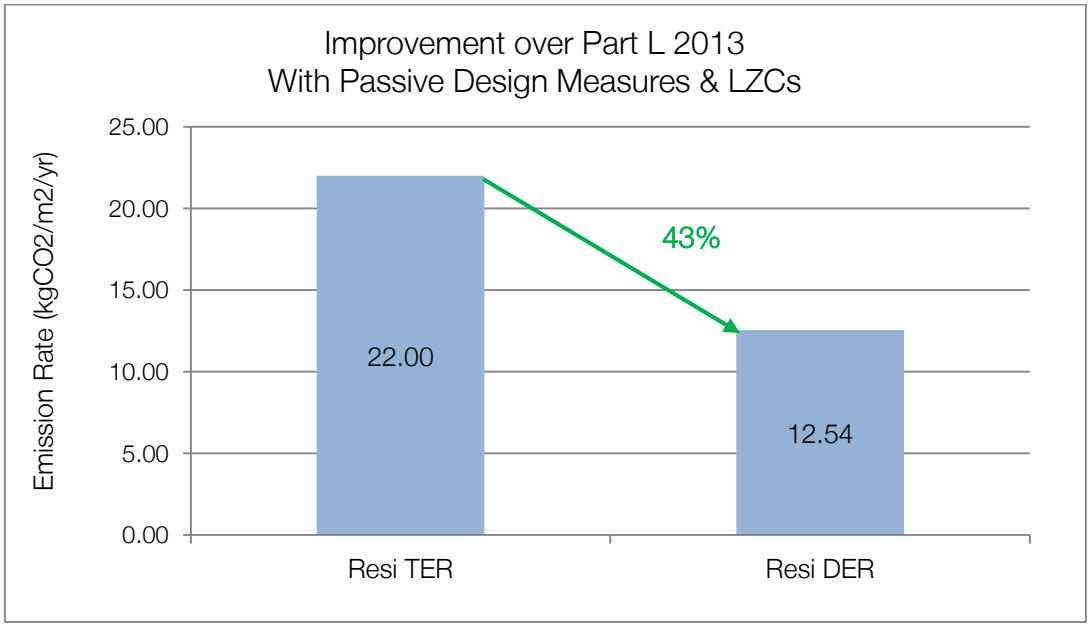


Figure 8-2 Improvement over Building Regulations Part L 2013 after LZCs

8.3 Code for Sustainable Homes

Code for Sustainable Homes (CSH) has set out Energy and CO_2 criteria for the development and the numbers of credits are available under Ene1: Dwelling Emission Rate and Ene2: Fabric Energy Efficiency. These credits are dependent upon the SAP calculation.

Based on the SAP results, the development can achieve 4.6 credits under Ene 1, and 4.7 credits under Ene 2.

9 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 43% improvement over the Building Regulations Part L 2013 Target Emissions Rate (TER) and a 22.3% 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. The development achieves an improvement over Part L in excess of 35%. The saving from renewables is calculated at 22.3%, an improvement over the Planning Policy of 20%. Fabric improvements have also 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 are extremely low and far exceed current Building Regulations. Energy efficiency has been maximised throughout the M&E strategy and in the reduction of unregulated energy uses. 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.

10 Appendix A

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

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

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

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

Where:
TFA = Total Floor Area
N = Number of Occupants

For TFA < $43m^2$; N = 1.46
For TFA ≥ $43m^2$; N = $2.844 \times (1 - \exp(-0.000391 \times TFA^2))$

Residential		
Energy Demands		**Source**
Use Type	**Demand (kWh/m^2)**	SAP Calculations
Space Heating	10.15	
DHW	6.68	
Fans/Pumps/Controls	2.62	
Lighting	3.30	
Appliances	14.36	BRE Methodology

11 Appendix B

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

CO_2 Intensity Values	
Gas Intensity	0.216 kgCO_2/kWh
Electricity Intensity	0.519 kgCO_2/kWh
Grid Displaced Electricity Intensity	0.529 kgCO_2/kWh

Table B-1: Energy intensity values

Energy & Renewable Technology Outputs	
PV energy produced per kWp	0.975 kWh/kWp
PV kWp per m^2 panel	0.039kWp/m^2
COP of ASHP	4
Electricity efficiency	100%
Gas boiler efficiency	90%

Table B-2: Renewable technology energy outputs

Fuel Prices (as of Dec 2013)	
Natural Gas	4.37 p/kWh
Electricity (Grid)	13.7 p/kWh

Table B-3: Natural Gas and Electricity fuel prices

12 Appendix C

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 have a total installed capacity (TIC) of 5 MW or less, 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 both the domestic and non-domestic sector. It provides payments to those that use renewable energy to heat their buildings. In the domestic sector the scheme is open to homeowners, private landlords, social landlords and self-builders. In the non-domestic sector it is open to industry, business and public sector organisations. 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) • Air to Water Heat Pumps (AWHP) • Water Source Heat Pumps • Deep Geothermal Heat Pumps • All solar thermal collectors • Biomethane Injection and Biogas • Energy from Waste (EfW) Domestic RHI • Biomass only boilers and biomass pellet stoves • Air Source Heat Pumps (ASHP) • Ground and Water Source Heat Pumps • Solar thermal panels (flat plate or evacuated tube for hot water only) https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi https://www.ofgem.gov.uk/environmental-programmes/domestic-renewable-heat-incentive https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi

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 has been extended until 31st March 2017, however there are certain Eligibility requirements. See https://www.gov.uk/energy-company-obligation for more information. Energy Companies Obligation - Guidance for suppliers

Table C: A selection of available grants as of 23rd September 2014

13 Appendix D

SAP Assumptions, Solar Slates Product Sheet and SAP Calculations

U-Values

Element	Measure
External Walls	0.11 W/m^{2}K
Roof	0.11 W/m^{2}K
Basement Floor	0.11 W/m^{2}K
Windows	1.2 W/m^{2}K
Rooflights	1.2 W/m^{2}K
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Thermal Bridging	Y value = 0.093 (To be calculated at detailed design)

Services

Services	Measure
Space Heating	Air Source Heat Pump 90% efficient COP: 4
Heating Controls	Time and temperature zone control
Hot Water Heating	Air Source Heat Pump 90% efficient COP: 4 Underfloor heating
Ventilation	MVHR 90% efficient SFP 0.66 w/l/s Rigid Ductwork
Comfort Cooling	Air Conditioning for the bedrooms and study Energy rating A Controls On/Off
Lighting	100% low energy lighting
Lighting control	PIR/Daylight/timer controls fitted to lighting in external areas

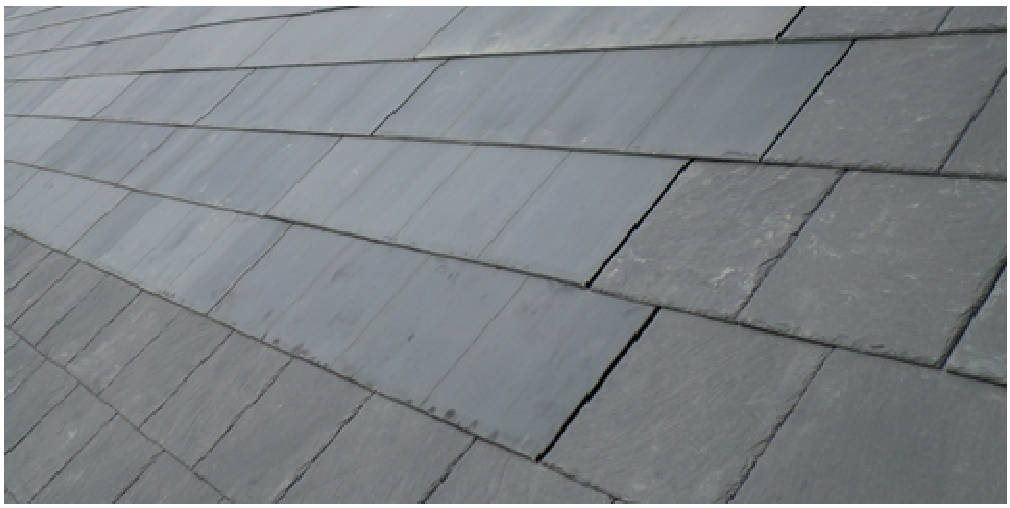
Issue Version	Date	By	Checked	Approved
1.0	16th June 2014	MJA	LS	MJA

SOLAR SLATE – Multi

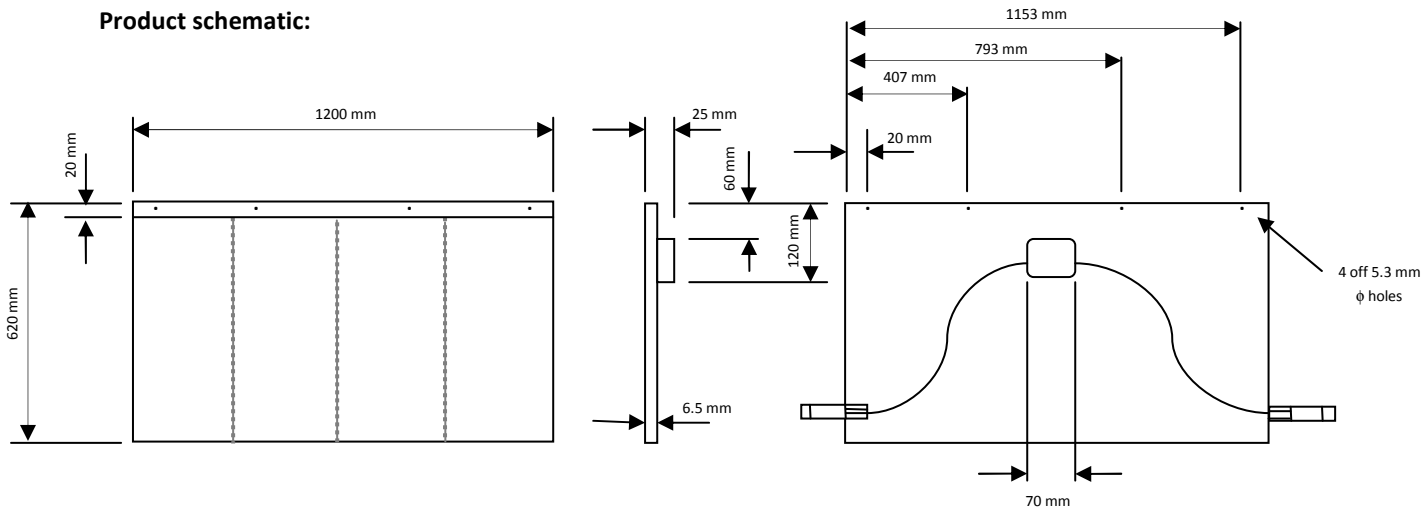
The Solar Slate 'Multi' is a photovoltaic unit that visually emulates a row of four standard 24" x 12" (610 mm x 305 mm) 'Duchess' roofing slates. The product has a very good colour match to traditional Welsh 'blue' slate grades[1], and is installed utilising four stainless steel screws through preprepared holes along the top edge of the unit with two screwed penny washers overlapping the unit's sides, on a 260 mm batten gauge.

The product is designed to be linked togther in a series of 'strings' to feed DC electrical power into a set of inverters for either on-site consumption or export.

Product: **Solar Slate 'Multi' product installed in a slate roof**



Product schematic:



[1] Roofing slate is a natural product that varies in appearance according to both origin and weather exposure, so exact colour matching is impossible to guarantee, however please contact Solar Slate Limited for recommended materials to achieve the best colour alignment.

Product specifications:

Mechanical	Nominal Dimensions (L x W x T)	620 mm x 1200 mm x 6.5 mm
	Connectors	Multi-contact connectors Type MC4 with 1.0 m fly leads
	Junction box	Solar Slate custom designed Antaya junction box
	Slate weight (individual product)	10.5 Kg
	Slate product packaging	Standard palletised carton containing 25 slates Carton dimensions 1250 mm (L) x 800 mm (W) x 800 mm (H) plus Euro pallet Packed weight 285 Kg (including pallet)
	Roof mounting method	Using stainless steel slate roofing screws and penny washers: - 4 off M5 x 25 mm A2 pan head wood screws - 2 off M3.5 x 40 mm A2 counter sunk wood screws - 4 off M5 x 20 A2 penny washer - 2 off M5 x 30 A2 penny washer Batten gauge 260 mm
	Minimum roof angle (When applied In accordance with BS5534:2003 this is determined by the matching 'Duchess' size natural slates headlap)	27.5^{O} In 'Moderate' exposure areas < than 56.5 litre/m^2 per spell 35^{O} In 'Severe' exposure areas > 56.5 litre/m^2 per spell
Electrical	Nominal output at STC ($P_{max.}$ MPP)	39 Wp. (+/- 10%)
	Short Circuit Current - I_{SC}	5.12 A
	Open Circuit Voltage - V_{OC}	10.15 V
	Current at MPP	4.94 A
	Voltage at MPP	8.24 V
	Temperature coefficicent of power	0.0461 % / ^{o}C
	Temperature coefficient of Voltage - V_{OC}	-0.3324 % / ^{o}C
	Maximum permissible system voltage - V_{MAX}	600 V (Maximum string length is 59 Multi Solar Slates)

Note: Under normal conditions, a photovoltaic unit is likely to experience conditions that produce more current and /or voltage than reported at standard test conditions. Accordingly the values of I_{SC} and V_{OC} specified for this product should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor ratings, fuse sizes and size of controls connected to the PV output.

Product certifications:

Design Qualification and Type Approval testing to:- IEC 61215:2005 / EN 61215:2005
EN 61730:2007 +A1 2012

Flammability combined testing and classification to BS476-3:2004, ENV1187:2002-Test 4, BS 13501-5:2005

Weather Resistance Test MCS012 (FprEN 15601[2] Test method)

Resistance to Wind Uplift test MCS012 (EN14437:2004 Test method)

European Community Design Registration 001321301-0001

APPROVED PRODUCT MCS BABT Certificate Number BABT 8504 R1- Product category 8504-02 Multi 24/12 panels

UK patent No. 2456160

Warranty: The Solar Slate Multi has a 10 year product and power performance warranty.
Power peformance warranted as a minimum of 80% of initial estimated output after 10 years

Contacts: Solar Slate Ltd, 2430 The Quadrant, Aztec West, Almondsbury, Bristol BS32 4AQ

T: 01454 627 841 E: info@solarslate-ltd.com W: www.solarslate-ltd.com

Sample Report Ltd
1 Sample Street
Sampletown

Full SAP Calculation Printout

Property Reference: 23602
Survey Reference: Base
Property: Camden, London, NW3 5UL

Issued on Date: 04.Mar.2015
Prop Type Ref:

SAP Rating:	86 B	**CO2 Emissions (t/year):**	2.99	**DER:**	14.32 Pass	**TER:**	15.03	**Percentage DER<TER:**	4.69 %
Environmental:	85 B	**General Requirements Compliance:**	Pass	**DFEE:**	51.91 Pass	**TFEE:**	58.12	**Percentage DFEE<TFEE:**	10.69 %

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

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

Software Version: Elmhurst Energy Systems SAP2012 Calculator (Design System) version 2.02r19
SAP version: SAP 2012, Regs Region: England (Part L1A 2013), Calculation Type: New Dwelling As Designed

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


```
SAP2012 Input Data (House)     26/03/2015

FullRefNo:                     Base

Regs Region:                   England
SAP Region:                    Thames Valley
Postcode:                      NW3 5UL
DwellingOrientation:           North West
Property Type:                 House, Detached
Storeys:                       4
Date Built:                    2015
Sheltered Sides:               2
Sunlight Shade:                Average or unknown
Measurements                   Perimeter, Floor Area, Storey Height
    Basement:                 16.34, 16.32, 2.45
    1st Storey:               47.38, 112.42, 2.65
    2nd Storey:               32.92, 70.54, 2.5
    3rd Storey:               27.86, 58.57, 2.7
Living Area:                   21.95 m2, fraction: 8.5%
Thermal Mass:                  Simple calculation
Thermal Mass Simple:           Medium
Thermal MassValue:             250
External Walls                 Nett Area, Gross Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
Basement Wall 1 (Plant)        40.03, 40.03, 0, Other, Solid, 0.28, 0.106713232440823, Gross
Basement Wall (SP)             111.8, 111.8, 0, Other, Solid, 0.28, 0.106713232440823, Gross
Timber Clad Walling            145.13, 157.22, 0, Other, TimberFrame, 0, 0.11, Gross
Shelter Wall                   8.09, 13.75, 0, Other, Solid, 0.28, 0.106713232440823, Gross
External Roofs                 Nett Area, Gross Area, Kappa, Construction, Element, UValueFinal
    External Roof 1           101.96, 104.68, 0, Other, 0.11
    External Flat Roof        8.7, 10.41, 0, Other, 0.11
    Pool Basement Flat Roof   63.3, 63.3, 0, Other, 0.106713232440823
Heat Loss Floors               Area, Kappa, Construction, Element, Type, UValueFinal, ShelterFactor
    Heat Loss Floor 1         112.42, 110, Slab on ground, screed over insulation, Basement Floor, 0.28, 0.106713232440823
Description                    Data Source, Type, Glazing, Glazing Gap, Argon Filled, Solar Trans, Frame Type, Frame Factor, U Value
    Doors                     Manufacturer, Half Glazed Door, Double Low-E Soft 0.1, , , 0.63, , 0.7,
    Windows                   Manufacturer, Window, Double Low-E Soft 0.1, , , 0.63, , 0.7,
    Rooflight                 Manufacturer, Roof Window, Double Low-E Soft 0.1, , , 0.63, , 0.7,
    Shelter Wall Doors        Manufacturer, Door to Corridor, , , , , , ,
Openings                       Opening Type, Location, Orientation, Pitch, Curtain Type, Overhang Ratio, Wide Overhang, Width, Height, Count, Area, Curtain Closed
    Rooflight                 Roof Window, External Roof 1, West, 45, None, , , 0, 0, 0, 0.68,
    Rooflight                 Roof Window, External Roof 1, South West, 45, None, , , 0, 0, 0, 0.68,
    Rooflight                 Roof Window, External Roof 1, South, 45, None, , , 0, 0, 0, 0.68,
    Front Door                Half Glazed Door, Timber Clad Walling, North West, , , , , 0, 0, 0, 2.89,
    Rooflight                 Roof Window, External Roof 1, East, 45, None, , , 0, 0, 0, 0.68,
    Flat Rooflight            Roof Window, External Flat Roof, East, 0, None, , , 0, 0, 0, 1.71,
    S Face Window             Window, Timber Clad Walling, South, , None, 0, , 0, 0, 0, 2.40,
    SW Facing Windows         Window, Timber Clad Walling, South West, , None, 0, , 0, 0, 0, 2.82,
    W Facing Window           Window, Timber Clad Walling, West, , None, 0, , 0, 0, 0, 1.60,
    N Facing Windows          Window, Timber Clad Walling, North, , None, 0, , 0, 0, 0, 2.38,
    Basement Doors            Door to Corridor, Shelter Wall, South West, , , , , 0, 0, 0, 2.14,
    Basement Double Door      Door to Corridor, Shelter Wall, South West, , , , , 0, 0, 0, 3.52,
Conservatory:                  None
Draught Proofing:              100
Draught Lobby:                 No
Thermal Bridges
    Bridging:                 Calculate Bridges
    Y                         0.093
    List of Bridges           Junction with, Bridge Type, Source Type, Imported, Length, Psi, Adjusted, Result, Reference
    0.                        External wall, E1 Steel lintel with perforated steel base plate, , No, 0, 0, 0, 0.00,
    1.                        External wall, E2 Other lintels (including other steel lintels), Table K1 - Default, Yes, 9.33, 1, 1, 9.33,
    2.                        External wall, E3 Sill, Table K1 - Default, Yes, 5.75, 0.08, 0.08, 0.46,
    3.                        External wall, E4 Jamb, Table K1 - Default, Yes, 30.34, 0.1, 0.1, 3.03,
    4.                        External wall, E5 Ground floor (normal), Table K1 - Default, No, 63.72, 0.32, 0.32, 20.39,
    5.                        External wall, E19 Ground floor (inverted), , No, 0, 0, 0, 0.00,
    6.                        External wall, E20 Exposed floor (normal), , No, 0, 0, 0, 0.00,
    7.                        External wall, E21 Exposed floor (inverted), , No, 0, 0, 0, 0.00,
    8.                        External wall, E22 Basement floor, , No, 0, 0, 0, 0.00,
    9.                        External wall, E6 Intermediate floor within a dwelling, Table K1 - Default, Yes, 108.16, 0.14, 0.14, 15.14,
    10.                       External wall, E7 Party floor between dwellings (in blocks of flats), , No, 0, 0, 0, 0.00,
    11.                       External wall, E8 Balcony within a dwelling, wall insulation continuous, , No, 0, 0, 0, 0.00,
    12.                       External wall, E9 Balcony between dwellings, wall insulation continuous, , No, 0, 0, 0, 0.00,
    13.                       External wall, E23 Balcony within or between dwellings, balcony support penetrates wall insulation , , No, 0, 0, 0, 0.00,
    14.                       External wall, E10 Eaves (insulation at ceiling level), , No, 0, 0, 0, 0.00,
    15.                       External wall, E24 Eaves (insulation at ceiling level - inverted), , No, 0, 0, 0, 0.00,
    16.                       External wall, E11 Eaves (insulation at rafter level), Table K1 - Default, No, 30.88, 0.08, 0.08, 2.47,
    17.                       External wall, E12 Gable (insulation at ceiling level), , No, 0, 0, 0, 0.00,
    18.                       External wall, E13 Gable (insulation at rafter level), , No, 0, 0, 0, 0.00,
    19.                       External wall, E14 Flat roof, , No, 0, 0, 0, 0.00,
    20.                       External wall, E15 Flat roof with parapet, , No, 0, 0, 0, 0.00,
```

21.	External wall, E16 Corner (normal), Table K1 - Default, No, 27.52, 0.18, 0.18, 4.95,
22.	External wall, E17 Corner (inverted - internal area greater than external area), , No, 0, 0, 0, 0.00,
23.	External wall, E18 Party wall between dwellings, , No, 0, 0, 0, 0.00,
24.	External wall, E25 Staggered party wall between dwellings, , No, 0, 0, 0, 0.00,
25.	Party wall, P1 Party wall - Ground floor, , No, 0, 0, 0, 0.00,
26.	Party wall, P6 Party wall - Ground floor (inverted), , No, 0, 0, 0, 0.00,
27.	Party wall, P2 Party wall - Intermediate floor within a dwelling, , No, 0, 0, 0, 0.00,
28.	Party wall, P3 Party wall - Intermediate floor between dwellings (in blocks of flats), , No, 0, 0, 0, 0.00,
29.	Party wall, P7 Party Wall - Exposed floor (normal), , No, 0, 0, 0, 0.00,
30.	Party wall, P8 Party Wall - Exposed floor (inverted), , No, 0, 0, 0, 0.00,
31.	Party wall, P4 Party wall - Roof (insulation at ceiling level), , No, 0, 0, 0, 0.00,
32.	Party wall, P5 Party wall - Roof (insulation at rafter level), , No, 0, 0, 0, 0.00,
33.	External roof, R1 Head of roof window, Table K1 - Default, Yes, 4.43, 0.08, 0.08, 0.35,
34.	External roof, R2 Sill of roof window, Table K1 - Default, Yes, 4.43, 0.06, 0.06, 0.27,
35.	External roof, R3 Jamb of roof window, Table K1 - Default, Yes, 9.72, 0.08, 0.08, 0.78,
36.	External roof, R4 Ridge (vaulted ceiling), , No, 0, 0, 0, 0.00,
37.	External roof, R5 Ridge (inverted), , No, 0, 0, 0, 0.00,
38.	External roof, R6 Flat ceiling, , No, 0, 0, 0, 0.00,
39.	External roof, R7 Flat ceiling (inverted), , No, 0, 0, 0, 0.00,
40.	External roof, R8 Roof to wall (rafter), , No, 0, 0, 0, 0.00,
41.	External roof, R9 Roof to wall (flat ceiling), , No, 0, 0, 0, 0.00,
Pressure Test:	True
Designed q50:	4
AsBuilt q50:	15
Property Tested:	False
Mechanical Ventilation	
MV System Present	Yes
Windows In Hot Weather	Windows half open
Cross Ventilation	No
Night Ventilation	Yes
Air Change Rate	2.50
Approved Installation	Yes
DataType	Database
Type	Balanced mechanical ventilation with heat recovery
Database Ref Number	500366
Configuration	4
HR Duct Insulated	Yes
ManufacturerSFP	0.66
DuctType	Rigid
HR Efficiency	90
Wet Rooms	4
Chimneys MHS:	0
Chimneys SHS:	0
Chimneys Other:	0
Chimneys Total:	0
Open Flues MHS:	0
Open Flues SHS:	0
Open Flues Other:	0
Open Flues Total:	0
Intermittent Fans:	0
Passive Vents:	0
Flueless Gas Fires:	0
Cooling System	None
Light Fittings:	18
LEL Fittings:	18
Percentage of LEL Fittings:	100
External Lights Fitted:	Yes
External LELs Fitted:	Yes
Electricity Tariff:	Standard
Main Heating 1	
Description	
Percentage	100
Sedbuk ID	17117
Fuel Type	Mains gas
MHS	Mains gas BGW Post 98 Combi condens. with auto ign.
SAP Code	104
Boiler Efficiency Type	Split Efficiences
Efficiency Winter	90.7
Efficiency Summer	91.2
Controls by PCDF	0
MHS Controls	CBI Time and temperature zone control
Boiler Interlock	Yes
Compensator	0
Delayed Start Stat	No
Ctrl SAP Code	2110
Flue Type	Balanced
Fan Assisted Flue	Yes
Pumped	Pump in heated space
Heat Pump Age	2013 or later
Heat Emitter	Radiators
Flow Temperature	Normal (> 45°C)
Combi boiler type	Standard Combi
Combi keep hot type	Gas/Oil, time clock
Main Heating 2	None
Heating Systems Interaction	Each system heats separate parts of dwelling
Smoke Control Area	Unknown
Community Heating	None
Secondary Heating	None
Water Heating	
Type	MainHeating1
WHS	HWP From main heating 1
Low Water Usage	Yes
SAP Code	901
Showers in Property	Non-electric only
Hot Water Cylinder	None
Flue Gas Heat Recovery System	None
Waste Water Heat Recovery	none
PV Unit	None
Wind Turbine	None
Terrain Type:	Urban
Small Scale Hydro	None
Special Features	None

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

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DWELLING AS DESIGNED

Detached House, total floor area 258 m²

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

1a TER and DER
Fuel for main heating:Mains gas
Fuel factor:1.00 (mains gas)
Target Carbon Dioxide Emission Rate (TER) 15.03 kg/m²
Dwelling Carbon Dioxide Emission Rate (DER) 14.32 kg/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)58.1 kWh/m²
Dwelling Fabric Energy Efficiency (DFEE)51.9 kWh/m²OK

---

2 Fabric U-values

Element	Average	Highest	
External wall	0.11 (max. 0.30)	0.11 (max. 0.70)	OK
Floor	0.11 (max. 0.25)	0.11 (max. 0.70)	OK
Roof	0.11 (max. 0.20)	0.11 (max. 0.35)	OK
Openings	1.15 (max. 2.00)	1.20 (max. 3.30)	OK

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

---

3 Air permeability
Air permeability at 50 pascals: 4.00 (design value)
Maximum 10.0 OK

---

4 Heating efficiency
Main heating system: Boiler system with radiators or underfloor - Mains gas
Data from database
Worcester Greenstar 25 Si Compact
Combi boiler
Efficiency: 89.8% SEDBUK2009
Minimum: 88.0% OK

Secondary heating system: None

---

5 Cylinder insulation
Hot water storage: No cylinder

---

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

Hot water controls: No cylinder

Boiler interlock: Yes OK

---

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

---

8 Mechanical ventilation
Continuous supply and extract system
Specific fan power: 0.66
Maximum 1.5 OK
MVHR efficiency: 90%
Minimum: 70% OK

---

9 Summertime temperature
Overheating risk (Thames Valley): Not significant OK
Based on:
Overshading: Average
Windows facing North: 2.38 m², No overhang
Windows facing South: 2.40 m², No overhang
Windows facing South West: 2.82 m², No overhang
Windows facing West: 1.60 m², No overhang
Air change rate: 2.50 ach
Blinds/curtains: None

---

10 Key features
External wall U-value 0.11 W/m²K
External wall U-value 0.11 W/m²K
External wall U-value 0.11 W/m²K
External wall U-value 0.11 W/m²K
Roof U-value 0.11 W/m²K
Roof U-value 0.11 W/m²K
Roof U-value 0.11 W/m²K
Floor U-value 0.11 W/m²K
Door U-value 1.00 W/m²K

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)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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)

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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.0000	5.6600			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		88.6890			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 145.8676 (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	74.1659	73.2228	72.2798	67.5647	66.6217	61.9066	61.9066	60.9636	63.7926	66.6217	68.5077	70.3938	(38)
Heat transfer coeff	220.0335	219.0904	218.1474	213.4323	212.4893	207.7742	207.7742	206.8312	209.6602	212.4893	214.3753	216.2614	(39)
Average = Sum(39)m / 12 =												213.1966	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8533	0.8497	0.8460	0.8277	0.8241	0.8058	0.8058	0.8021	0.8131	0.8241	0.8314	0.8387	(40)
HLP (average)												0.8268	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)											Total = Sum(45)m =	1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Total storage loss
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (56)
If cylinder contains dedicated solar storage
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (57)
Combi loss 40.2939 36.3954 40.2883 38.9763 40.2685 38.9472 40.2302 40.2544 38.9575 40.2702 38.9859 40.2877 (61)
Total heat required for water heating calculated for each month
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (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
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (64)
Total per year (kWh/year) = Sum(64)m = 2162.1186 (64)
Heat gains from water heating, kWh/month
68.2629 59.9917 62.5889 55.5295 53.9993 47.6470 45.1869 50.3750 50.5323 57.6077 61.6403 66.4252 (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	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
48.2413 42.8475 34.8459 26.3806 19.7198 16.6483 17.9891 23.3829 31.3844 39.8497 46.5105 49.5820 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
423.1616 427.5527 416.4873 392.9303 363.1939 335.2458 316.5748 312.1837 323.2491 346.8061 376.5425 404.4906 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
91.7511 89.2733 84.1249 77.1243 72.5797 66.1763 60.7351 67.7084 70.1837 77.4297 85.6115 89.2812 (72)
Total internal gains
635.3110 631.8305 607.6150 568.5922 527.6504 490.2275 467.4560 475.4320 496.9743 536.2426 580.8215 615.5108 (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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	773.7696	882.6999	985.3553	1085.5951	1145.0268	1118.2722	1066.7864	998.6967	923.3512	823.3291	749.5302	732.0762	(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	81.3797	81.7299	82.0833	83.8966	84.2690	86.1813	86.1813	86.5742	85.4060	84.2690	83.5276	82.7991	
alpha	6.4253	6.4487	6.4722	6.5931	6.6179	6.7454	6.7454	6.7716	6.6937	6.6179	6.5685	6.5199	
util living area													
	1.0000	0.9999	0.9996	0.9981	0.9885	0.9331	0.7949	0.8492	0.9815	0.9991	0.9999	1.0000	(86)
MIT	19.8831	19.9810	20.1602	20.4200	20.6731	20.8887	20.9743	20.9598	20.7903	20.4628	20.1376	19.8798	(87)
Th 2	20.2073	20.2105	20.2136	20.2294	20.2325	20.2483	20.2483	20.2515	20.2420	20.2325	20.2262	20.2199	(88)
util rest of house													
	1.0000	0.9999	0.9995	0.9972	0.9819	0.8909	0.6885	0.7554	0.9669	0.9986	0.9999	1.0000	(89)
MIT 2	18.6698	18.8156	19.0804	19.4725	19.8419	20.1474	20.2349	20.2275	20.0175	19.5380	19.0570	18.6746	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	18.7731	18.9148	19.1723	19.5531	19.9126	20.2105	20.2978	20.2898	20.0833	19.6167	19.1490	18.7772	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7731	18.9148	19.1723	19.5531	19.9126	20.2105	20.2978	20.2898	20.0833	19.6167	19.1490	18.7772	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9999	0.9998	0.9992	0.9960	0.9780	0.8883	0.6963	0.7611	0.9625	0.9979	0.9998	0.9999	(94)
Useful gains	773.7035	882.4970	984.5559	1081.2447	1119.7929	993.3056	742.8197	760.0668	888.7427	821.5719	749.3729	732.0350	(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													
	3184.5667	3070.5023	2764.4244	2273.7247	1745.0936	1165.7205	768.3168	804.5366	1254.4629	1915.9512	2583.0101	3152.4922	(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													
	1793.6822	1470.3395	1324.2221	858.5856	465.2237	0.0000	0.0000	0.0000	0.0000	814.2182	1320.2188	1800.8202	(98)
Space heating												9847.3104	(98)
Space heating per m2											(98) / (4) =	38.1901	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	90.7000 (206)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)
Space heating requirement	10857.0125 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1793.6822	1470.3395	1324.2221	858.5856	465.2237	0.0000	0.0000	0.0000	0.0000	814.2182	1320.2188	1800.8202	(98)
Space heating efficiency (main heating system 1)													
	90.7000	90.7000	90.7000	90.7000	90.7000	0.0000	0.0000	0.0000	0.0000	90.7000	90.7000	90.7000	(210)
Space heating fuel (main heating system)													
	1977.5989	1621.1020	1460.0024	946.6214	512.9258	0.0000	0.0000	0.0000	0.0000	897.7048	1455.5885	1985.4688	(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													
	215.2996	189.4565	198.2336	176.6769	172.3954	152.9627	145.8823	161.4918	161.6429	183.2482	195.0575	209.7713	(64)
Efficiency of water heater												91.2000	(216)
(217)m	90.7533	90.7568	90.7648	90.7849	90.8346	91.2000	91.2000	91.2000	91.2000	90.7914	90.7641	90.7519	(217)
Fuel for water heating, kWh/month													
	237.2360	208.7519	218.4037	194.6103	189.7904	167.7223	159.9587	177.0743	177.2400	201.8342	214.9061	231.1481	(219)
Water heating fuel used												2378.6758	(219)
Annual totals kWh/year													
Space heating fuel - main system												10857.0125	(211)
Space heating fuel - secondary												0.0000	(215)

Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)	
mechanical ventilation fans (SFP = 0.8250)	676.7565 (230a)
central heating pump	30.0000 (230c)
main heating flue fan	45.0000 (230e)
Total electricity for the above, kWh/year	751.7565 (231)
Electricity for lighting (calculated in Appendix L)	851.9556 (232)
Total delivered energy for all uses	14839.4005 (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	10857.0125	0.2160	2345.1147	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2378.6758	0.2160	513.7940	(264)
Space and water heating			2858.9087	(265)
Pumps and fans	751.7565	0.5190	390.1616	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Total CO2, kg/year			3691.2353	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			14.3200	(273)

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

DER		14.3200	ZC1
Total Floor Area	TFA	257.8500	
Assumed number of occupants	N	3.0771	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		9.7249	ZC2
CO2 emissions from cooking, equation (L16)		0.7479	ZC3
Total CO2 emissions		24.7928	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		24.7928	ZC8

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(5)

2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0595	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.3095	(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) =	0.2631	(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	0.3354	0.3288	0.3223	0.2894	0.2828	0.2499	0.2499	0.2433	0.2631	0.2828	0.2959	0.3091	(22b)
Effective ac	0.5562	0.5541	0.5519	0.5419	0.5400	0.5312	0.5312	0.5296	0.5346	0.5400	0.5438	0.5478	(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			5.6600	1.0000	5.6600			(26)
TER Semi-glazed door			2.8900	1.2000	3.4680			(26a)
TER Opening Type (Uw = 1.40)			9.2000	1.3258	12.1970			(27)
TER Room Window (Uw = 1.70)			4.4300	1.5918	7.0515			(27a)
Heat Loss Floor 1			112.4200	0.1300	14.6146			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1714	6.8597			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1714	19.1584			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1800	26.1234			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1714	1.3863			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1300	13.2548			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1300	1.1310			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1300	8.2290			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		119.1337			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		17.5760 (36)
Total fabric heat loss	(33) + (36) =	136.7097 (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	123.4248	122.9401	122.4651	120.2337	119.8163	117.8728	117.8728	117.5129	118.6214	119.8163	120.6608	121.5438	(38)
Heat transfer coeff	260.1345	259.6498	259.1748	256.9434	256.5259	254.5825	254.5825	254.2226	255.3311	256.5259	257.3705	258.2534	(39)
Average = Sum(39)m / 12 =												256.9414	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0089	1.0070	1.0051	0.9965	0.9949	0.9873	0.9873	0.9859	0.9902	0.9949	0.9981	1.0016	(40)
HLP (average)												0.9965	(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		3.0771 (42)
Average daily hot water use (litres/day)		107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage													

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (57)
Combi loss	50.9589	46.0274	50.9589	49.3151	50.9589	47.6156	49.2027	50.9589	49.3151	50.9589	49.3151	50.9589 (61)
Total heat required for water heating calculated for each month												
	225.9646	199.0885	208.9042	187.0156	183.0858	161.6311	154.8549	172.1963	172.0004	193.9368	205.3866	220.4425 (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												
	225.9646	199.0885	208.9042	187.0156	183.0858	161.6311	154.8549	172.1963	172.0004	193.9368	205.3866	220.4425 (64)
								Total per year (kWh/year) = Sum(64)m =				2284.5072 (64)
Heat gains from water heating, kWh/month												
	70.9291	62.3997	65.2565	58.1142	56.6719	49.8140	47.4300	53.0511	53.1216	60.2799	64.2226	69.0930 (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	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	48.2413	42.8475	34.8459	26.3806	19.7198	16.6483	17.9891	23.3829	31.3844	39.8497	46.5105	49.5820	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	423.1616	427.5527	416.4873	392.9303	363.1939	335.2458	316.5748	312.1837	323.2491	346.8061	376.5425	404.4906	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	(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)													
	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	(71)
Water heating gains (Table 5)													
	95.3348	92.8566	87.7104	80.7142	76.1720	69.1862	63.7500	71.3053	73.7801	81.0213	89.1980	92.8670	(72)
Total internal gains													
	638.8947	635.4138	611.2006	572.1821	531.2427	493.2373	470.4709	479.0289	500.5706	539.8342	584.4081	619.0966	(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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	777.3532	886.2832	988.9408	1089.1850	1148.6190	1121.2820	1069.8014	1002.2937	926.9476	826.9208	753.1167	735.6620	(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	68.8346	68.9631	69.0895	69.6895	69.8029	70.3357	70.3357	70.4353	70.1295	69.8029	69.5738	69.3360	
alpha	5.5890	5.5975	5.6060	5.6460	5.6535	5.6890	5.6890	5.6957	5.6753	5.6535	5.6383	5.6224	
util living area													
	0.9999	0.9999	0.9996	0.9983	0.9916	0.9595	0.8693	0.9078	0.9874	0.9991	0.9999	1.0000	(86)
MIT	19.6665	19.7681	19.9639	20.2424	20.5327	20.7922	20.9286	20.9026	20.6824	20.3097	19.9420	19.6512	(87)
Th 2	20.0760	20.0775	20.0791	20.0863	20.0876	20.0939	20.0939	20.0951	20.0915	20.0876	20.0849	20.0820	(88)
util rest of house													
	0.9999	0.9998	0.9994	0.9974	0.9864	0.9270	0.7623	0.8217	0.9762	0.9985	0.9998	0.9999	(89)
MIT 2	18.2545	18.4044	18.6923	19.1051	19.5284	19.8964	20.0532	20.0314	19.7481	19.2048	18.6645	18.2365	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	18.3747	18.5204	18.8005	19.2019	19.6139	19.9727	20.1278	20.1056	19.8277	19.2989	18.7732	18.3569	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.3747	18.5204	18.8005	19.2019	19.6139	19.9727	20.1278	20.1056	19.8277	19.2989	18.7732	18.3569	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9999	0.9997	0.9990	0.9961	0.9822	0.9209	0.7673	0.8231	0.9711	0.9977	0.9997	0.9999	(94)
Useful gains	777.2472	885.9960	987.9763	1084.9125	1128.2281	1032.5542	820.8549	824.9429	900.1506	825.0171	752.8857	735.5905	(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													
	3661.3213	3536.5451	3187.9860	2647.0005	2030.1173	1367.7840	898.1048	942.0420	1462.4492	2231.4811	3004.3475	3656.0788	(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													
	2145.7511	1781.1690	1636.8072	1124.7033	671.0055	0.0000	0.0000	0.0000	0.0000	1046.4093	1621.0525	2172.8433	(98)
Space heating												12199.7412	(98)
Space heating per m2											(98) / (4) =	47.3133	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)

Fraction of space heat from main system(s) 1.0000 (202)

Efficiency of main space heating system 1 (in %)													93.4000 (206)
Efficiency of secondary/supplementary heating system, %													0.0000 (208)
Space heating requirement													13061.8215 (211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	2145.7511	1781.1690	1636.8072	1124.7033	671.0055	0.0000	0.0000	0.0000	0.0000	1046.4093	1621.0525	2172.8433	(98)
Space heating efficiency (main heating system 1)													
	93.4000	93.4000	93.4000	93.4000	93.4000	0.0000	0.0000	0.0000	0.0000	93.4000	93.4000	93.4000	(210)
Space heating fuel (main heating system)													
	2297.3781	1907.0332	1752.4703	1204.1791	718.4213	0.0000	0.0000	0.0000	0.0000	1120.3525	1735.6023	2326.3847	(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													
	225.9646	199.0885	208.9042	187.0156	183.0858	161.6311	154.8549	172.1963	172.0004	193.9368	205.3866	220.4425	(64)
Efficiency of water heater													80.3000 (216)
(217)m	89.3295	89.2711	89.1311	88.8075	88.0266	80.3000	80.3000	80.3000	80.3000	88.6565	89.1392	89.3647	(217)
Fuel for water heating, kWh/month													
	252.9562	223.0155	234.3785	210.5855	207.9892	201.2840	192.8454	214.4412	214.1972	218.7509	230.4111	246.6775	(219)
Water heating fuel used													2647.5322 (219)
Annual totals kWh/year													
Space heating fuel - main system													13061.8215 (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)													851.9556 (232)
Total delivered energy for all uses													16636.3093 (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	13061.8215	0.2160	2821.3534	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2647.5322	0.2160	571.8670	(264)
Space and water heating			3393.2204	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Total CO2, kg/m2/year			3874.3104	(272)
Emissions per m2 for space and water heating			13.1597	(272a)
Fuel factor (mains gas)			1.0000	
Emissions per m2 for lighting			1.7148	(272b)
Emissions per m2 for pumps and fans			0.1510	(272c)
Target Carbon Dioxide Emission Rate (TER) = (13.1597 * 1.00) + 1.7148 + 0.1510, rounded to 2 d.p.			15.0300	(273)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(5)

2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0595	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.2595	(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) =	0.2206	(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	0.2812	0.2757	0.2702	0.2426	0.2371	0.2095	0.2095	0.2040	0.2206	0.2371	0.2481	0.2592	(22b)
Effective ac	0.5395	0.5380	0.5365	0.5294	0.5281	0.5220	0.5220	0.5208	0.5243	0.5281	0.5308	0.5336	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.0000	5.6600			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		88.6890			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							57.1786	(36)
Total fabric heat loss					(33) + (36) =		145.8676	(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	119.7178	119.3770	119.0431	117.4745	117.1810	115.8148	115.8148	115.5618	116.3410	117.1810	117.7747	118.3954	(38)
Heat transfer coeff	265.5854	265.2446	264.9107	263.3421	263.0486	261.6824	261.6824	261.4294	262.2086	263.0486	263.6423	264.2630	(39)
Average = Sum(39)m / 12 =												263.3407	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0300	1.0287	1.0274	1.0213	1.0202	1.0149	1.0149	1.0139	1.0169	1.0202	1.0225	1.0249	(40)
HLP (average)												1.0213	(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		3.0771 (42)
Average daily hot water use (litres/day)		107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage													

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (59)

Heat gains from water heating, kWh/month

	37.1887	32.5255	33.5634	29.2614	28.0770	24.2283	22.4511	25.7629	26.0706	30.3828	33.1652	36.0153 (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	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	(66)

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

	48.2413	42.8475	34.8459	26.3806	19.7198	16.6483	17.9891	23.3829	31.3844	39.8497	46.5105	49.5820 (67)

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

	423.1616	427.5527	416.4873	392.9303	363.1939	335.2458	316.5748	312.1837	323.2491	346.8061	376.5425	404.4906 (68)

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

	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857 (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)

	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854 (71)

Water heating gains (Table 5)

	49.9848	48.4010	45.1121	40.6408	37.7379	33.6504	30.1762	34.6276	36.2092	40.8371	46.0628	48.4076 (72)

Total internal gains

	590.5447	587.9581	565.6022	529.1087	489.8086	454.7015	433.8971	439.3512	459.9998	496.6500	538.2729	571.6372 (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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654 (83)
Total gains	729.0032	838.8276	943.3425	1046.1116	1107.1849	1082.7462	1033.2276	962.6160	886.3767	783.7365	706.9815	688.2026 (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	67.4218	67.5084	67.5935	67.9962	68.0720	68.4274	68.4274	68.4936	68.2901	68.0720	67.9187	67.7592	
alpha	5.4948	5.5006	5.5062	5.5331	5.5381	5.5618	5.5618	5.5662	5.5527	5.5381	5.5279	5.5173	
util living area													
	1.0000	0.9999	0.9997	0.9986	0.9932	0.9669	0.8895	0.9247	0.9902	0.9993	0.9999	1.0000	(86)
MIT	19.6199	19.7218	19.9203	20.2012	20.4976	20.7655	20.9132	20.8833	20.6523	20.2716	19.8971	19.6018	(87)
Th 2	20.0584	20.0595	20.0606	20.0656	20.0666	20.0710	20.0710	20.0718	20.0693	20.0666	20.0647	20.0627	(88)
util rest of house													
	0.9999	0.9999	0.9995	0.9979	0.9888	0.9386	0.7881	0.8465	0.9811	0.9989	0.9999	1.0000	(89)
MIT 2	18.7714	18.8742	19.0735	19.3583	19.6540	19.9159	20.0359	20.0176	19.8096	19.4297	19.0537	18.7567	(90)
Living area fraction										fLA = Living area / (4) =		0.0851	(91)
MIT	18.8437	18.9464	19.1456	19.4300	19.7258	19.9882	20.1106	20.0913	19.8814	19.5013	19.1255	18.8287	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8437	18.9464	19.1456	19.4300	19.7258	19.9882	20.1106	20.0913	19.8814	19.5013	19.1255	18.8287	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9999	0.9998	0.9993	0.9972	0.9865	0.9351	0.7937	0.8488	0.9783	0.9984	0.9998	0.9999	(94)
Useful gains	728.9412	838.6493	942.7105	1043.1462	1092.2054	1012.4754	820.0895	817.0290	867.1030	782.5200	706.8443	688.1612	(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

	3862.5806	3725.7313	3349.9588	2773.0030	2111.1711	1409.9968	918.6528	965.0153	1515.9230	2341.4810	3170.4294	3865.8169	(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

	2331.4277	1940.1191	1790.9927	1245.4969	758.1105	0.0000	0.0000	0.0000	0.0000	1159.8670	1773.7813	2364.1759	(98)
Space heating												13363.9711	(98)
Space heating per m2											(98) / (4) =	51.8285	(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	2459.8145	1936.4497	1986.8634	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.5480	0.6509	0.6078	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1347.9055	1260.3950	1207.7072	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1372.0258	1313.2808	1243.6480	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	17.3666	39.3470	26.7400	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												83.4536	(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	4.3417	9.8367	6.6850	0.0000	0.0000	0.0000	0.0000 (107)
Space cooling												20.8634 (107)
Space cooling per m2												0.0809 (108)
Energy for space heating												51.8285 (99)
Energy for space cooling												0.0809 (108)
Total												51.9094 (109)
Dwelling Fabric Energy Efficiency (DFEE)												51.9 (109)

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CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500				(4)	
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860 (5)	

2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0595	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.3095	(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) =	0.2631	(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	0.3354	0.3288	0.3223	0.2894	0.2828	0.2499	0.2499	0.2433	0.2631	0.2828	0.2959	0.3091	(22b)
Effective ac	0.5562	0.5541	0.5519	0.5419	0.5400	0.5312	0.5312	0.5296	0.5346	0.5400	0.5438	0.5478	(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			5.6600	1.0000	5.6600			(26)
TER Semi-glazed door			2.8900	1.2000	3.4680			(26a)
TER Opening Type (Uw = 1.40)			9.2000	1.3258	12.1970			(27)
TER Room Window (Uw = 1.70)			4.4300	1.5918	7.0515			(27a)
Heat Loss Floor 1			112.4200	0.1300	14.6146			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1714	6.8597			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1714	19.1584			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1800	26.1234			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1714	1.3863			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1300	13.2548			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1300	1.1310			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1300	8.2290			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		119.1337			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		17.5760 (36)
Total fabric heat loss	(33) + (36) =	136.7097 (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	123.4248	122.9401	122.4651	120.2337	119.8163	117.8728	117.8728	117.5129	118.6214	119.8163	120.6608	121.5438	(38)
Heat transfer coeff	260.1345	259.6498	259.1748	256.9434	256.5259	254.5825	254.5825	254.2226	255.3311	256.5259	257.3705	258.2534	(39)
Average = Sum(39)m / 12 =												256.9414	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0089	1.0070	1.0051	0.9965	0.9949	0.9873	0.9873	0.9859	0.9902	0.9949	0.9981	1.0016	(40)
HLP (average)												0.9965	(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		3.0771 (42)
Average daily hot water use (litres/day)		107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage													

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (59)

Heat gains from water heating, kWh/month

	37.1887	32.5255	33.5634	29.2614	28.0770	24.2283	22.4511	25.7629	26.0706	30.3828	33.1652	36.0153 (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	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	(66)

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

	48.2413	42.8475	34.8459	26.3806	19.7198	16.6483	17.9891	23.3829	31.3844	39.8497	46.5105	49.5820 (67)

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

	423.1616	427.5527	416.4873	392.9303	363.1939	335.2458	316.5748	312.1837	323.2491	346.8061	376.5425	404.4906 (68)

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

	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857 (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)

	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854 (71)

Water heating gains (Table 5)

	49.9848	48.4010	45.1121	40.6408	37.7379	33.6504	30.1762	34.6276	36.2092	40.8371	46.0628	48.4076 (72)

Total internal gains

	590.5447	587.9581	565.6022	529.1087	489.8086	454.7015	433.8971	439.3512	459.9998	496.6500	538.2729	571.6372 (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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654 (83)
Total gains	729.0032	838.8276	943.3425	1046.1116	1107.1849	1082.7462	1033.2276	962.6160	886.3767	783.7365	706.9815	688.2026 (84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	68.8346	68.9631	69.0895	69.6895	69.8029	70.3357	70.3357	70.4353	70.1295	69.8029	69.5738	69.3360	
alpha	5.5890	5.5975	5.6060	5.6460	5.6535	5.6890	5.6890	5.6957	5.6753	5.6535	5.6383	5.6224	
util living area													
	1.0000	0.9999	0.9997	0.9986	0.9930	0.9649	0.8826	0.9199	0.9898	0.9993	0.9999	1.0000	(86)
MIT	19.6485	19.7503	19.9469	20.2265	20.5179	20.7806	20.9218	20.8934	20.6682	20.2936	19.9247	19.6335	(87)
Th 2	20.0760	20.0775	20.0791	20.0863	20.0876	20.0939	20.0939	20.0951	20.0915	20.0876	20.0849	20.0820	(88)
util rest of house													
	0.9999	0.9999	0.9995	0.9979	0.9885	0.9358	0.7802	0.8401	0.9805	0.9989	0.9999	1.0000	(89)
MIT 2	18.8143	18.9174	19.1152	19.4004	19.6914	19.9492	20.0626	20.0460	19.8436	19.4688	19.0978	18.8042	(90)
Living area fraction										fLA = Living area / (4) =		0.0851	(91)
MIT	18.8853	18.9883	19.1860	19.4707	19.7617	20.0200	20.1358	20.1181	19.9138	19.5390	19.1682	18.8748	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8853	18.9883	19.1860	19.4707	19.7617	20.0200	20.1358	20.1181	19.9138	19.5390	19.1682	18.8748	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9999	0.9998	0.9993	0.9972	0.9862	0.9325	0.7862	0.8428	0.9777	0.9985	0.9998	0.9999	(94)
Useful gains	728.9449	838.6576	942.7286	1043.1630	1091.9040	1009.6161	812.3077	811.2833	866.6086	782.5427	706.8517	688.1642	(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													
	3794.1399	3658.0310	3287.8949	2716.0836	2068.0420	1379.8371	900.1403	945.2331	1484.4464	2293.0895	3106.0045	3789.8214	(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													
	2280.5051	1894.6190	1744.8038	1204.5028	726.2466	0.0000	0.0000	0.0000	0.0000	1123.8468	1727.3900	2307.6330	(98)
Space heating												13009.5470	(98)
Space heating per m2											(98) / (4) =	50.4539	(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	2393.0757	1883.9107	1932.0920	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.5627	0.6673	0.6240	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1346.6947	1257.1914	1205.6175	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1372.0258	1313.2808	1243.6480	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	18.2384	41.7305	28.2947	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												88.2636	(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	4.5596	10.4326	7.0737	0.0000	0.0000	0.0000	0.0000 (107)
Space cooling												22.0659 (107)
Space cooling per m2												0.0856 (108)
Energy for space heating												50.4539 (99)
Energy for space cooling												0.0856 (108)
Total												50.5395 (109)
Target Fabric Energy Efficiency (TFEE)												58.1 (109)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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	4.6000	4.5000	4.4000	4.1000	4.1000	3.7000	3.8000	3.7000	3.7000	4.0000	3.9000	4.3000	(22)
Wind factor	1.1500	1.1250	1.1000	1.0250	1.0250	0.9250	0.9500	0.9250	0.9250	1.0000	0.9750	1.0750	(22a)
Adj infilt rate	0.1955	0.1913	0.1870	0.1743	0.1743	0.1573	0.1615	0.1573	0.1573	0.1700	0.1658	0.1828	(22b)

Balanced mechanical ventilation with heat recovery
If mechanical ventilation: 0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 76.5000 (23c)

Effective ac	0.3130	0.3088	0.3045	0.2918	0.2918	0.2748	0.2790	0.2748	0.2748	0.2875	0.2833	0.3003	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.0000	5.6600			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		88.6890			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 145.8676 (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	69.4507	68.5077	67.5647	64.7356	64.7356	60.9636	61.9066	60.9636	60.9636	63.7926	62.8496	66.6217	(38)
Heat transfer coeff	215.3183	214.3753	213.4323	210.6032	210.6032	206.8312	207.7742	206.8312	206.8312	209.6602	208.7172	212.4893	(39)
Average = Sum(39)m / 12 =												210.2889	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8351	0.8314	0.8277	0.8168	0.8168	0.8021	0.8058	0.8021	0.8021	0.8131	0.8095	0.8241	(40)
HLP (average)												0.8155	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)											Total = Sum(45)m =	1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Total storage loss

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)

If cylinder contains dedicated solar storage

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Combi loss 40.2939	36.3954	40.2883	38.9763	40.2685	38.9472	40.2302	40.2544	38.9575	40.2702	38.9859	40.2877	(61)

Total heat required for water heating calculated for each month

215.2996	189.4565	198.2336	176.6769	172.3954	152.9627	145.8823	161.4918	161.6429	183.2482	195.0575	209.7713	(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

215.2996	189.4565	198.2336	176.6769	172.3954	152.9627	145.8823	161.4918	161.6429	183.2482	195.0575	209.7713	(64)

Total per year (kWh/year) = Sum(64)m = 2162.1186 (64)

RHI water heating demand 2162 (64)

Heat gains from water heating, kWh/month

68.2629	59.9917	62.5889	55.5295	53.9993	47.6470	45.1869	50.3750	50.5323	57.6077	61.6403	66.4252	(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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

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

120.6031	107.1186	87.1147	65.9515	49.2995	41.6207	44.9726	58.4571	78.4610	99.6243	116.2763	123.9551	(67)

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

631.5844	638.1383	621.6228	586.4631	542.0804	500.3669	472.4997	465.9459	482.4614	517.6210	562.0038	603.7173	(68)

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

56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	(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)

-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	(71)

Water heating gains (Table 5)

91.7511	89.2733	84.1249	77.1243	72.5797	66.1763	60.7351	67.7084	70.1837	77.4297	85.6115	89.2812	(72)

Total internal gains

965.0214	955.6129	913.9450	850.6216	785.0423	729.2466	699.2901	713.1940	752.1888	815.7577	884.9742	938.0362	(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	2.3800	11.5821	0.6300	0.7000	0.7700	8.4243	(74)
South	2.4000	49.2853	0.6300	0.7000	0.7700	36.1494	(78)
Southwest	2.8200	39.1209	0.6300	0.7000	0.7700	33.7155	(79)
West	1.6000	21.5869	0.6300	0.7000	0.7700	10.5556	(80)
East	2.3900	28.6477	0.6300	0.7000	1.0000	27.4140	(82)
South	0.6800	50.5332	0.6300	0.7000	1.0000	13.6385	(82)
Southwest	0.6800	43.2691	0.6300	0.7000	1.0000	11.6780	(82)
West	0.6800	28.6477	0.6300	0.7000	1.0000	7.7318	(82)

Solar gains 149.3071	243.2089	368.4293	521.8214	607.3414	659.9368	628.0447	561.7797	457.0744	304.2265	187.9424	123.3636	(83)
Total gains 1114.3285	1198.8218	1282.3743	1372.4430	1392.3837	1389.1834	1327.3348	1274.9738	1209.2632	1119.9842	1072.9165	1061.3998	(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	83.1617	83.5276	83.8966	85.0236	85.0236	86.5742	86.1813	86.5742	86.5742	85.4060	85.7919	84.2690	
alpha	6.5441	6.5685	6.5931	6.6682	6.6682	6.7716	6.7454	6.7716	6.7716	6.6937	6.7195	6.6179	
util living area													
	0.9995	0.9991	0.9971	0.9861	0.9258	0.6798	0.4219	0.4689	0.8432	0.9881	0.9987	0.9997	(86)
MIT	20.1159	20.1949	20.3964	20.6428	20.8710	20.9892	20.9996	20.9992	20.9541	20.6891	20.3787	20.1108	(87)
Th 2	20.2231	20.2262	20.2294	20.2388	20.2388	20.2515	20.2483	20.2515	20.2515	20.2420	20.2451	20.2325	(88)
util rest of house													
	0.9994	0.9988	0.9959	0.9796	0.8896	0.5815	0.3049	0.3488	0.7660	0.9812	0.9981	0.9995	(89)
MIT 2	19.0227	19.1408	19.4376	19.8016	20.1124	20.2461	20.2483	20.2513	20.2193	19.8725	19.4244	19.0226	(90)
Living area fraction										fLA = Living area / (4) =		0.0851	(91)
MIT	19.1157	19.2305	19.5192	19.8732	20.1770	20.3094	20.3122	20.3150	20.2819	19.9420	19.5056	19.1153	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.1157	19.2305	19.5192	19.8732	20.1770	20.3094	20.3122	20.3150	20.2819	19.9420	19.5056	19.1153	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9990	0.9982	0.9943	0.9754	0.8861	0.5895	0.3149	0.3591	0.7696	0.9773	0.9973	0.9993	(94)
Useful gains	1113.2468	1196.6978	1275.0469	1338.6542	1233.7411	818.9190	417.9695	457.8473	930.6263	1094.5732	1069.9774	1060.6266	(95)
Ext temp.	5.2000	5.7000	7.7000	10.2000	13.3000	16.3000	18.3000	18.1000	15.5000	11.9000	8.2000	5.2000	(96)
Heat loss rate W													
	2996.3116	2900.6048	2522.6028	2037.2166	1448.3104	829.2636	418.0878	458.1342	989.0419	1686.0958	2359.6767	2956.8458	(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													
	1401.0002	1145.0255	928.1816	502.9650	159.6395	0.0000	0.0000	0.0000	0.0000	440.0929	928.5835	1410.7871	(98)

Space heating 6916.2753 (98)

RHI space heating demand 6916 (98)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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)

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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.0000	5.6600			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		88.6890			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 145.8676 (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	74.1659	73.2228	72.2798	67.5647	66.6217	61.9066	61.9066	60.9636	63.7926	66.6217	68.5077	70.3938	(38)
Heat transfer coeff	220.0335	219.0904	218.1474	213.4323	212.4893	207.7742	207.7742	206.8312	209.6602	212.4893	214.3753	216.2614	(39)

Average = Sum(39)m / 12 = 213.1966 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8533	0.8497	0.8460	0.8277	0.8241	0.8058	0.8058	0.8021	0.8131	0.8241	0.8314	0.8387	(40)
HLP (average)												0.8268	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)

Energy content (annual) Total = Sum(45)m = 1687.9629 (45)

Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Total storage loss
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (56)
If cylinder contains dedicated solar storage
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (57)
Combi loss 40.2939 36.3954 40.2883 38.9763 40.2685 38.9472 40.2302 40.2544 38.9575 40.2702 38.9859 40.2877 (61)
Total heat required for water heating calculated for each month
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (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
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (64)
Total per year (kWh/year) = Sum(64)m = 2162.1186 (64)
Heat gains from water heating, kWh/month
68.2629 59.9917 62.5889 55.5295 53.9993 47.6470 45.1869 50.3750 50.5323 57.6077 61.6403 66.4252 (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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
120.6031 107.1186 87.1147 65.9515 49.2995 41.6207 44.9726 58.4571 78.4610 99.6243 116.2763 123.9551 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
631.5844 638.1383 621.6228 586.4631 542.0804 500.3669 472.4997 465.9459 482.4614 517.6210 562.0038 603.7173 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
91.7511 89.2733 84.1249 77.1243 72.5797 66.1763 60.7351 67.7084 70.1837 77.4297 85.6115 89.2812 (72)
Total internal gains
965.0214 955.6129 913.9450 850.6216 785.0423 729.2466 699.2901 713.1940 752.1888 815.7577 884.9742 938.0362 (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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	1103.4799	1206.4824	1291.6852	1367.6244	1402.4187	1357.2913	1298.6206	1236.4588	1178.5657	1102.8443	1053.6828	1054.6016	(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	81.3797	81.7299	82.0833	83.8966	84.2690	86.1813	86.1813	86.5742	85.4060	84.2690	83.5276	82.7991	
alpha	6.4253	6.4487	6.4722	6.5931	6.6179	6.7454	6.7454	6.7716	6.6937	6.6179	6.5685	6.5199	
util living area	0.9997	0.9993	0.9982	0.9928	0.9676	0.8618	0.6831	0.7349	0.9408	0.9949	0.9993	0.9998	(86)
MIT	20.0099	20.1055	20.2775	20.5261	20.7603	20.9378	20.9895	20.9834	20.8689	20.5692	20.2549	20.0043	(87)
Th 2	20.2073	20.2105	20.2136	20.2294	20.2325	20.2483	20.2483	20.2515	20.2420	20.2325	20.2262	20.2199	(88)
util rest of house	0.9996	0.9991	0.9975	0.9897	0.9518	0.7997	0.5772	0.6322	0.9052	0.9922	0.9990	0.9997	(89)
MIT 2	18.8555	18.9978	19.2518	19.6261	19.9613	20.1982	20.2435	20.2430	20.1164	19.6923	19.2287	18.8569	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	18.9538	19.0920	19.3391	19.7027	20.0293	20.2611	20.3070	20.3060	20.1805	19.7669	19.3161	18.9545	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.9538	19.0920	19.3391	19.7027	20.0293	20.2611	20.3070	20.3060	20.1805	19.7669	19.3161	18.9545	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9993	0.9986	0.9964	0.9867	0.9464	0.8009	0.5859	0.6402	0.9015	0.9898	0.9985	0.9995	(94)
Useful gains	1102.7405	1204.8331	1287.0247	1349.5022	1327.2324	1087.0937	760.8094	791.5989	1062.5242	1091.6081	1052.0890	1054.0839	(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	3224.3243	3109.3424	2800.8245	2305.6453	1769.8856	1176.2351	770.2159	807.8840	1274.8365	1947.8781	2618.8291	3190.8383	(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	1578.4583	1279.8302	1126.2670	688.4230	329.3340	0.0000	0.0000	0.0000	0.0000	637.0649	1128.0529	1589.7452	(98)
Space heating												8357.1756	(98)
Space heating per m2											(98) / (4) =	32.4110	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	90.7000 (206)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)
Space heating requirement	9214.0855 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1578.4583	1279.8302	1126.2670	688.4230	329.3340	0.0000	0.0000	0.0000	0.0000	637.0649	1128.0529	1589.7452	(98)
Space heating efficiency (main heating system 1)													
	90.7000	90.7000	90.7000	90.7000	90.7000	0.0000	0.0000	0.0000	0.0000	90.7000	90.7000	90.7000	(210)
Space heating fuel (main heating system)													
	1740.3068	1411.0587	1241.7498	759.0110	363.1025	0.0000	0.0000	0.0000	0.0000	702.3868	1243.7187	1752.7511	(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													
	215.2996	189.4565	198.2336	176.6769	172.3954	152.9627	145.8823	161.4918	161.6429	183.2482	195.0575	209.7713	(64)
Efficiency of water heater												91.2000	(216)
(217)m	90.7597	90.7642	90.7745	90.8017	90.8712	91.2000	91.2000	91.2000	91.2000	90.8112	90.7734	90.7580	(217)
Fuel for water heating, kWh/month													
	237.2193	208.7349	218.3803	194.5745	189.7141	167.7223	159.9587	177.0743	177.2400	201.7902	214.8840	231.1326	(219)
Water heating fuel used												2378.4251	(219)
Annual totals kWh/year													
Space heating fuel - main system												9214.0855	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)													
mechanical ventilation fans (SFP = 0.8250)												676.7565	(230a)
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												751.7565	(231)
Electricity for lighting (calculated in Appendix L)												851.9556	(232)
Total delivered energy for all uses												13196.2228	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	9214.0855	3.4800	320.6502	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	2378.4251	3.4800	82.7692	(247)
Mechanical ventilation fans	676.7565	13.1900	89.2642	(249)
Pumps and fans for heating	75.0000	13.1900	9.8925	(249)
Energy for lighting	851.9556	13.1900	112.3729	(250)
Additional standing charges			120.0000	(251)
Total energy cost			734.9490	(255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.4200 (256)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	1.0192 (257)
SAP value		85.7815
SAP rating (Section 12)		86 (258)
SAP band		B

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	9214.0855	0.2160	1990.2425	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2378.4251	0.2160	513.7398	(264)
Space and water heating			2503.9823	(265)
Pumps and fans	751.7565	0.5190	390.1616	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Total kg/year			3336.3089	(272)
CO2 emissions per m2			12.9400	(273)
EI value			85.2381	
EI rating			85	(274)
EI band			B	

Calculation of stars for heating and DHW

Main heating energy efficiency	3.48 × (1 + 0.29 × 0.00) / 0.9070 = 3.837, stars = 4
Main heating environmental impact	0.216 × (1 + 0.29 × 0.00) / 0.9070 = 0.2381, stars = 4
Water heating energy efficiency	3.48 / 0.9093 = 3.827, stars = 4
Water heating environmental impact	0.216 / 0.9093 = 0.2376, stars = 4

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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	4.6000	4.5000	4.4000	4.1000	4.1000	3.7000	3.8000	3.7000	3.7000	4.0000	3.9000	4.3000	(22)
Wind factor	1.1500	1.1250	1.1000	1.0250	1.0250	0.9250	0.9500	0.9250	0.9250	1.0000	0.9750	1.0750	(22a)
Adj infilt rate	0.1955	0.1913	0.1870	0.1743	0.1743	0.1573	0.1615	0.1573	0.1573	0.1700	0.1658	0.1828	(22b)

Balanced mechanical ventilation with heat recovery	
If mechanical ventilation:	0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	76.5000 (23c)

Effective ac	0.3130	0.3088	0.3045	0.2918	0.2918	0.2748	0.2790	0.2748	0.2748	0.2875	0.2833	0.3003	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.0000	5.6600			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		88.6890			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	57.1786	(36)
Total fabric heat loss (33) + (36) =	145.8676	(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	69.4507	68.5077	67.5647	64.7356	64.7356	60.9636	61.9066	60.9636	60.9636	63.7926	62.8496	66.6217	(38)
Heat transfer coeff	215.3183	214.3753	213.4323	210.6032	210.6032	206.8312	207.7742	206.8312	206.8312	209.6602	208.7172	212.4893	(39)
Average = Sum(39)m / 12 =												210.2889	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8351	0.8314	0.8277	0.8168	0.8168	0.8021	0.8058	0.8021	0.8021	0.8131	0.8095	0.8241	(40)
HLP (average)												0.8155	(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	3.0771 (42)
Average daily hot water use (litres/day)	107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Total storage loss
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (56)
If cylinder contains dedicated solar storage
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (57)
Combi loss 40.2939 36.3954 40.2883 38.9763 40.2685 38.9472 40.2302 40.2544 38.9575 40.2702 38.9859 40.2877 (61)
Total heat required for water heating calculated for each month
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (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
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (64)
Total per year (kWh/year) = Sum(64)m = 2162.1186 (64)
Heat gains from water heating, kWh/month
68.2629 59.9917 62.5889 55.5295 53.9993 47.6470 45.1869 50.3750 50.5323 57.6077 61.6403 66.4252 (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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
120.6031 107.1186 87.1147 65.9515 49.2995 41.6207 44.9726 58.4571 78.4610 99.6243 116.2763 123.9551 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
631.5844 638.1383 621.6228 586.4631 542.0804 500.3669 472.4997 465.9459 482.4614 517.6210 562.0038 603.7173 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
91.7511 89.2733 84.1249 77.1243 72.5797 66.1763 60.7351 67.7084 70.1837 77.4297 85.6115 89.2812 (72)
Total internal gains
965.0214 955.6129 913.9450 850.6216 785.0423 729.2466 699.2901 713.1940 752.1888 815.7577 884.9742 938.0362 (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	2.3800	11.5821	0.6300	0.7000	0.7700	8.4243	(74)
South	2.4000	49.2853	0.6300	0.7000	0.7700	36.1494	(78)
Southwest	2.8200	39.1209	0.6300	0.7000	0.7700	33.7155	(79)
West	1.6000	21.5869	0.6300	0.7000	0.7700	10.5556	(80)
East	2.3900	28.6477	0.6300	0.7000	1.0000	27.4140	(82)
South	0.6800	50.5332	0.6300	0.7000	1.0000	13.6385	(82)
Southwest	0.6800	43.2691	0.6300	0.7000	1.0000	11.6780	(82)
West	0.6800	28.6477	0.6300	0.7000	1.0000	7.7318	(82)

Solar gains	149.3071	243.2089	368.4293	521.8214	607.3414	659.9368	628.0447	561.7797	457.0744	304.2265	187.9424	123.3636	(83)
Total gains	1114.3285	1198.8218	1282.3743	1372.4430	1392.3837	1389.1834	1327.3348	1274.9738	1209.2632	1119.9842	1072.9165	1061.3998	(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	83.1617	83.5276	83.8966	85.0236	85.0236	86.5742	86.1813	86.5742	86.5742	85.4060	85.7919	84.2690	
alpha	6.5441	6.5685	6.5931	6.6682	6.6682	6.7716	6.7454	6.7716	6.7716	6.6937	6.7195	6.6179	
util living area	0.9995	0.9991	0.9971	0.9861	0.9258	0.6798	0.4219	0.4689	0.8432	0.9881	0.9987	0.9997	(86)
MIT	20.1159	20.1949	20.3964	20.6428	20.8710	20.9892	20.9996	20.9992	20.9541	20.6891	20.3787	20.1108	(87)
Th 2	20.2231	20.2262	20.2294	20.2388	20.2388	20.2515	20.2483	20.2515	20.2515	20.2420	20.2451	20.2325	(88)
util rest of house	0.9994	0.9988	0.9959	0.9796	0.8896	0.5815	0.3049	0.3488	0.7660	0.9812	0.9981	0.9995	(89)
MIT 2	19.0227	19.1408	19.4376	19.8016	20.1124	20.2461	20.2483	20.2513	20.2193	19.8725	19.4244	19.0226	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	19.1157	19.2305	19.5192	19.8732	20.1770	20.3094	20.3122	20.3150	20.2819	19.9420	19.5056	19.1153	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.1157	19.2305	19.5192	19.8732	20.1770	20.3094	20.3122	20.3150	20.2819	19.9420	19.5056	19.1153	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9990	0.9982	0.9943	0.9754	0.8861	0.5895	0.3149	0.3591	0.7696	0.9773	0.9973	0.9993	(94)
Useful gains	1113.2468	1196.6978	1275.0469	1338.6542	1233.7411	818.9190	417.9695	457.8473	930.6263	1094.5732	1069.9774	1060.6266	(95)
Ext temp.	5.2000	5.7000	7.7000	10.2000	13.3000	16.3000	18.3000	18.1000	15.5000	11.9000	8.2000	5.2000	(96)
Heat loss rate W	2996.3116	2900.6048	2522.6028	2037.2166	1448.3104	829.2636	418.0878	458.1342	989.0419	1686.0958	2359.6767	2956.8458	(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	1401.0002	1145.0255	928.1816	502.9650	159.6395	0.0000	0.0000	0.0000	0.0000	440.0929	928.5835	1410.7871	(98)
Space heating												6916.2753	(98)
Space heating per m2											(98) / (4) =	26.8229	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	90.7000 (206)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)
Space heating requirement	7625.4413 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1401.0002	1145.0255	928.1816	502.9650	159.6395	0.0000	0.0000	0.0000	0.0000	440.0929	928.5835	1410.7871	(98)
Space heating efficiency (main heating system 1)													
	90.7000	90.7000	90.7000	90.7000	90.7000	0.0000	0.0000	0.0000	0.0000	90.7000	90.7000	90.7000	(210)
Space heating fuel (main heating system)													
	1544.6530	1262.4317	1023.3535	554.5369	176.0083	0.0000	0.0000	0.0000	0.0000	485.2182	1023.7966	1555.4433	(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													
	215.2996	189.4565	198.2336	176.6769	172.3954	152.9627	145.8823	161.4918	161.6429	183.2482	195.0575	209.7713	(64)
Efficiency of water heater													
(217)m	90.7663	90.7707	90.7876	90.8294	90.9589	91.2000	91.2000	91.2000	91.2000	90.8464	90.7864	90.7644	(217)
Fuel for water heating, kWh/month													
	237.2021	208.7200	218.3488	194.5149	189.5311	167.7223	159.9587	177.0743	177.2400	201.7120	214.8532	231.1163	(219)

Water heating fuel used	2377.9937 (219)
Annual totals kWh/year	
Space heating fuel - main system	7625.4413 (211)
Space heating fuel - secondary	0.0000 (215)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)	
mechanical ventilation fans (SFP = 0.8250)	676.7565 (230a)
central heating pump	30.0000 (230c)
main heating flue fan	45.0000 (230e)
Total electricity for the above, kWh/year	751.7565 (231)
Electricity for lighting (calculated in Appendix L)	851.9556 (232)
Total delivered energy for all uses	11607.1472 (238)

10a. Fuel costs - using BEDF prices (374)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	7625.4413	4.1800	318.7434	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	2377.9937	4.1800	99.4001	(247)
Mechanical ventilation fans	676.7565	14.8100	100.2276	(249)
Pumps and fans for heating	75.0000	14.8100	11.1075	(249)
Energy for lighting	851.9556	14.8100	126.1746	(250)
Additional standing charges			109.0000	(251)
Total energy cost			764.6534	(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	7625.4413	0.2160	1647.0953	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2377.9937	0.2160	513.6466	(264)
Space and water heating			2160.7420	(265)
Pumps and fans	751.7565	0.5190	390.1616	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Total kg/year			2993.0686	(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	7625.4413	1.2200	9303.0384	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2377.9937	1.2200	2901.1523	(264)
Space and water heating			12204.1907	(265)
Pumps and fans	751.7565	3.0700	2307.8925	(267)
Energy for lighting	851.9556	3.0700	2615.5038	(268)
Primary energy kWh/year			17127.5870	(272)
Primary energy kWh/m2/year			66.4246	(273)

SAP 2012 EPC IMPROVEMENTS

Current energy efficiency rating:	B 86
Current environmental impact rating:	B 85

(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	SAP increase too small
O	Not considered
P	Not considered
R	Not considered
S	Not considered
T	Not considered
U Solar photovoltaic panels	Recommended
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
U Solar photovoltaic panels	+ 4.4	-£ 265	-929 kg (31.0%)

Measures omitted - SAP change or cost saving too small:

N Solar water heating	+ 0.5	-£ 34	-190 kg (6.3%)

	Typical annual savings		Energy efficiency	Environmental impact
Recommended measures				
Solar photovoltaic panels	£265	3.60 kg/m²	B 90	B 89
Total Savings	£265	3.60 kg/m²		

Potential energy efficiency rating: B 90
Potential environmental impact rating: B 89

Fuel prices for cost data on this page from database revision number 374 TEST (25 Feb 2015)
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	£238	£238	£0
Mains gas	£527	£527	£0
Space heating	£539	£539	£0
Water heating	£99	£99	£0
Lighting	£126	£126	£0
Generated (PV)	-£0	-£265	£265
Total cost of fuels	£765	£500	£265
Total cost of uses	£764	£499	£265
Delivered energy	45 kWh/m²	38 kWh/m²	7 kWh/m²
Carbon dioxide emissions	3.0 tonnes	2.1 tonnes	0.9 tonnes
CO2 emissions per m²	12 kg/m²	8 kg/m²	4 kg/m²
Primary energy	66 kWh/m²	45 kWh/m²	21 kWh/m²

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.0000	5.6600			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		88.6890			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	57.1786	(36)
Total fabric heat loss (33) + (36) =	145.8676	(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	74.1659	73.2228	72.2798	67.5647	66.6217	61.9066	61.9066	60.9636	63.7926	66.6217	68.5077	70.3938	(38)
Heat transfer coeff	220.0335	219.0904	218.1474	213.4323	212.4893	207.7742	207.7742	206.8312	209.6602	212.4893	214.3753	216.2614	(39)
Average = Sum(39)m / 12 =												213.1966	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8533	0.8497	0.8460	0.8277	0.8241	0.8058	0.8058	0.8021	0.8131	0.8241	0.8314	0.8387	(40)
HLP (average)												0.8268	(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	3.0771 (42)
Average daily hot water use (litres/day)	107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Total storage loss
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (56)
If cylinder contains dedicated solar storage
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (57)
Combi loss 40.2939 36.3954 40.2883 38.9763 40.2685 38.9472 40.2302 40.2544 38.9575 40.2702 38.9859 40.2877 (61)
Total heat required for water heating calculated for each month
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (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
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (64)
Total per year (kWh/year) = Sum(64)m = 2162.1186 (64)
Heat gains from water heating, kWh/month
68.2629 59.9917 62.5889 55.5295 53.9993 47.6470 45.1869 50.3750 50.5323 57.6077 61.6403 66.4252 (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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
120.6031 107.1186 87.1147 65.9515 49.2995 41.6207 44.9726 58.4571 78.4610 99.6243 116.2763 123.9551 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
631.5844 638.1383 621.6228 586.4631 542.0804 500.3669 472.4997 465.9459 482.4614 517.6210 562.0038 603.7173 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
91.7511 89.2733 84.1249 77.1243 72.5797 66.1763 60.7351 67.7084 70.1837 77.4297 85.6115 89.2812 (72)
Total internal gains
965.0214 955.6129 913.9450 850.6216 785.0423 729.2466 699.2901 713.1940 752.1888 815.7577 884.9742 938.0362 (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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	1103.4799	1206.4824	1291.6852	1367.6244	1402.4187	1357.2913	1298.6206	1236.4588	1178.5657	1102.8443	1053.6828	1054.6016	(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	81.3797	81.7299	82.0833	83.8966	84.2690	86.1813	86.1813	86.5742	85.4060	84.2690	83.5276	82.7991	
alpha	6.4253	6.4487	6.4722	6.5931	6.6179	6.7454	6.7454	6.7716	6.6937	6.6179	6.5685	6.5199	
util living area	0.9997	0.9993	0.9982	0.9928	0.9676	0.8618	0.6831	0.7349	0.9408	0.9949	0.9993	0.9998	(86)
MIT	20.0099	20.1055	20.2775	20.5261	20.7603	20.9378	20.9895	20.9834	20.8689	20.5692	20.2549	20.0043	(87)
Th 2	20.2073	20.2105	20.2136	20.2294	20.2325	20.2483	20.2483	20.2515	20.2420	20.2325	20.2262	20.2199	(88)
util rest of house	0.9996	0.9991	0.9975	0.9897	0.9518	0.7997	0.5772	0.6322	0.9052	0.9922	0.9990	0.9997	(89)
MIT 2	18.8555	18.9978	19.2518	19.6261	19.9613	20.1982	20.2435	20.2430	20.1164	19.6923	19.2287	18.8569	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	18.9538	19.0920	19.3391	19.7027	20.0293	20.2611	20.3070	20.3060	20.1805	19.7669	19.3161	18.9545	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.9538	19.0920	19.3391	19.7027	20.0293	20.2611	20.3070	20.3060	20.1805	19.7669	19.3161	18.9545	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9993	0.9986	0.9964	0.9867	0.9464	0.8009	0.5859	0.6402	0.9015	0.9898	0.9985	0.9995	(94)
Useful gains	1102.7405	1204.8331	1287.0247	1349.5022	1327.2324	1087.0937	760.8094	791.5989	1062.5242	1091.6081	1052.0890	1054.0839	(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	3224.3243	3109.3424	2800.8245	2305.6453	1769.8856	1176.2351	770.2159	807.8840	1274.8365	1947.8781	2618.8291	3190.8383	(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	1578.4583	1279.8302	1126.2670	688.4230	329.3340	0.0000	0.0000	0.0000	0.0000	637.0649	1128.0529	1589.7452	(98)
Space heating												8357.1756	(98)
Space heating per m2											(98) / (4) =	32.4110	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												90.7000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												9214.0855	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1578.4583	1279.8302	1126.2670	688.4230	329.3340	0.0000	0.0000	0.0000	0.0000	637.0649	1128.0529	1589.7452	(98)
Space heating efficiency (main heating system 1)													
	90.7000	90.7000	90.7000	90.7000	90.7000	0.0000	0.0000	0.0000	0.0000	90.7000	90.7000	90.7000	(210)
Space heating fuel (main heating system)													
	1740.3068	1411.0587	1241.7498	759.0110	363.1025	0.0000	0.0000	0.0000	0.0000	702.3868	1243.7187	1752.7511	(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													
	215.2996	189.4565	198.2336	176.6769	172.3954	152.9627	145.8823	161.4918	161.6429	183.2482	195.0575	209.7713	(64)
Efficiency of water heater												91.2000	(216)
(217)m	90.7597	90.7642	90.7745	90.8017	90.8712	91.2000	91.2000	91.2000	91.2000	90.8112	90.7734	90.7580	(217)
Fuel for water heating, kWh/month													
	237.2193	208.7349	218.3803	194.5745	189.7141	167.7223	159.9587	177.0743	177.2400	201.7902	214.8840	231.1326	(219)
Water heating fuel used												2378.4251	(219)
Annual totals kWh/year													
Space heating fuel - main system												9214.0855	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)													
mechanical ventilation fans (SFP = 0.8250)												676.7565	(230a)
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												751.7565	(231)
Electricity for lighting (calculated in Appendix L)												851.9556	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 2.50 * 1080 * 0.80) =											-1727.2394	-1727.2394	(233)
Total delivered energy for all uses												11468.9834	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	9214.0855	3.4800	320.6502	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	2378.4251	3.4800	82.7692	(247)
Mechanical ventilation fans	676.7565	13.1900	89.2642	(249)
Pumps and fans for heating	75.0000	13.1900	9.8925	(249)
Energy for lighting	851.9556	13.1900	112.3729	(250)
Additional standing charges			120.0000	(251)
Energy saving/generation technologies				
PV Unit	-1727.2394	13.1900	-227.8229	(252)
Total energy cost			507.1261	(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] =	0.7033	(257)
SAP value		90.1890	
SAP rating (Section 12)		90	(258)
SAP band		B	

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	9214.0855	0.2160	1990.2425	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2378.4251	0.2160	513.7398	(264)
Space and water heating			2503.9823	(265)
Pumps and fans	751.7565	0.5190	390.1616	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Energy saving/generation technologies				
PV Unit	-1727.2394	0.5190	-896.4372	(269)
Total kg/year			2439.8717	(272)
CO2 emissions per m2			9.4600	(273)
EI value			89.2045	
EI rating			89	(274)
EI band			B	

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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	4.6000	4.5000	4.4000	4.1000	4.1000	3.7000	3.8000	3.7000	3.7000	4.0000	3.9000	4.3000	(22)
Wind factor	1.1500	1.1250	1.1000	1.0250	1.0250	0.9250	0.9500	0.9250	0.9250	1.0000	0.9750	1.0750	(22a)
Adj infilt rate	0.1955	0.1913	0.1870	0.1743	0.1743	0.1573	0.1615	0.1573	0.1573	0.1700	0.1658	0.1828	(22b)

Balanced mechanical ventilation with heat recovery
If mechanical ventilation: 0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 76.5000 (23c)

Effective ac	0.3130	0.3088	0.3045	0.2918	0.2918	0.2748	0.2790	0.2748	0.2748	0.2875	0.2833	0.3003	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.0000	5.6600			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		88.6890			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 145.8676 (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	69.4507	68.5077	67.5647	64.7356	64.7356	60.9636	61.9066	60.9636	60.9636	63.7926	62.8496	66.6217	(38)
Heat transfer coeff	215.3183	214.3753	213.4323	210.6032	210.6032	206.8312	207.7742	206.8312	206.8312	209.6602	208.7172	212.4893	(39)

Average = Sum(39)m / 12 = 210.2889 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8351	0.8314	0.8277	0.8168	0.8168	0.8021	0.8058	0.8021	0.8021	0.8131	0.8095	0.8241	(40)
HLP (average)												0.8155	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)

Energy content (annual) Total = Sum(45)m = 1687.9629 (45)

Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Total storage loss
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (56)
If cylinder contains dedicated solar storage
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (57)
Combi loss 40.2939 36.3954 40.2883 38.9763 40.2685 38.9472 40.2302 40.2544 38.9575 40.2702 38.9859 40.2877 (61)
Total heat required for water heating calculated for each month
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (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
215.2996 189.4565 198.2336 176.6769 172.3954 152.9627 145.8823 161.4918 161.6429 183.2482 195.0575 209.7713 (64)
Total per year (kWh/year) = Sum(64)m = 2162.1186 (64)
Heat gains from water heating, kWh/month
68.2629 59.9917 62.5889 55.5295 53.9993 47.6470 45.1869 50.3750 50.5323 57.6077 61.6403 66.4252 (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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
120.6031 107.1186 87.1147 65.9515 49.2995 41.6207 44.9726 58.4571 78.4610 99.6243 116.2763 123.9551 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
631.5844 638.1383 621.6228 586.4631 542.0804 500.3669 472.4997 465.9459 482.4614 517.6210 562.0038 603.7173 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
91.7511 89.2733 84.1249 77.1243 72.5797 66.1763 60.7351 67.7084 70.1837 77.4297 85.6115 89.2812 (72)
Total internal gains
965.0214 955.6129 913.9450 850.6216 785.0423 729.2466 699.2901 713.1940 752.1888 815.7577 884.9742 938.0362 (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	2.3800	11.5821	0.6300	0.7000	0.7700	8.4243	(74)
South	2.4000	49.2853	0.6300	0.7000	0.7700	36.1494	(78)
Southwest	2.8200	39.1209	0.6300	0.7000	0.7700	33.7155	(79)
West	1.6000	21.5869	0.6300	0.7000	0.7700	10.5556	(80)
East	2.3900	28.6477	0.6300	0.7000	1.0000	27.4140	(82)
South	0.6800	50.5332	0.6300	0.7000	1.0000	13.6385	(82)
Southwest	0.6800	43.2691	0.6300	0.7000	1.0000	11.6780	(82)
West	0.6800	28.6477	0.6300	0.7000	1.0000	7.7318	(82)

Solar gains	149.3071	243.2089	368.4293	521.8214	607.3414	659.9368	628.0447	561.7797	457.0744	304.2265	187.9424	123.3636	(83)
Total gains	1114.3285	1198.8218	1282.3743	1372.4430	1392.3837	1389.1834	1327.3348	1274.9738	1209.2632	1119.9842	1072.9165	1061.3998	(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	83.1617	83.5276	83.8966	85.0236	85.0236	86.5742	86.1813	86.5742	86.5742	85.4060	85.7919	84.2690	
alpha	6.5441	6.5685	6.5931	6.6682	6.6682	6.7716	6.7454	6.7716	6.7716	6.6937	6.7195	6.6179	
util living area	0.9995	0.9991	0.9971	0.9861	0.9258	0.6798	0.4219	0.4689	0.8432	0.9881	0.9987	0.9997	(86)
MIT	20.1159	20.1949	20.3964	20.6428	20.8710	20.9892	20.9996	20.9992	20.9541	20.6891	20.3787	20.1108	(87)
Th 2	20.2231	20.2262	20.2294	20.2388	20.2388	20.2515	20.2483	20.2515	20.2515	20.2420	20.2451	20.2325	(88)
util rest of house	0.9994	0.9988	0.9959	0.9796	0.8896	0.5815	0.3049	0.3488	0.7660	0.9812	0.9981	0.9995	(89)
MIT 2	19.0227	19.1408	19.4376	19.8016	20.1124	20.2461	20.2483	20.2513	20.2193	19.8725	19.4244	19.0226	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	19.1157	19.2305	19.5192	19.8732	20.1770	20.3094	20.3122	20.3150	20.2819	19.9420	19.5056	19.1153	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.1157	19.2305	19.5192	19.8732	20.1770	20.3094	20.3122	20.3150	20.2819	19.9420	19.5056	19.1153	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9990	0.9982	0.9943	0.9754	0.8861	0.5895	0.3149	0.3591	0.7696	0.9773	0.9973	0.9993	(94)
Useful gains	1113.2468	1196.6978	1275.0469	1338.6542	1233.7411	818.9190	417.9695	457.8473	930.6263	1094.5732	1069.9774	1060.6266	(95)
Ext temp.	5.2000	5.7000	7.7000	10.2000	13.3000	16.3000	18.3000	18.1000	15.5000	11.9000	8.2000	5.2000	(96)
Heat loss rate W	2996.3116	2900.6048	2522.6028	2037.2166	1448.3104	829.2636	418.0878	458.1342	989.0419	1686.0958	2359.6767	2956.8458	(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	1401.0002	1145.0255	928.1816	502.9650	159.6395	0.0000	0.0000	0.0000	0.0000	440.0929	928.5835	1410.7871	(98)
Space heating												6916.2753	(98)
Space heating per m2											(98) / (4) =	26.8229	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	90.7000 (206)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)
Space heating requirement	7625.4413 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1401.0002	1145.0255	928.1816	502.9650	159.6395	0.0000	0.0000	0.0000	0.0000	440.0929	928.5835	1410.7871	(98)
Space heating efficiency (main heating system 1)													
	90.7000	90.7000	90.7000	90.7000	90.7000	0.0000	0.0000	0.0000	0.0000	90.7000	90.7000	90.7000	(210)
Space heating fuel (main heating system)													
	1544.6530	1262.4317	1023.3535	554.5369	176.0083	0.0000	0.0000	0.0000	0.0000	485.2182	1023.7966	1555.4433	(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													
	215.2996	189.4565	198.2336	176.6769	172.3954	152.9627	145.8823	161.4918	161.6429	183.2482	195.0575	209.7713	(64)
Efficiency of water heater													
(217)m	90.7663	90.7707	90.7876	90.8294	90.9589	91.2000	91.2000	91.2000	91.2000	90.8464	90.7864	90.7644	(217)
Fuel for water heating, kWh/month													
	237.2021	208.7200	218.3488	194.5149	189.5311	167.7223	159.9587	177.0743	177.2400	201.7120	214.8532	231.1163	(219)

Water heating fuel used	2377.9937 (219)
Annual totals kWh/year	
Space heating fuel - main system	7625.4413 (211)
Space heating fuel - secondary	0.0000 (215)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)	
mechanical ventilation fans (SFP = 0.8250)	676.7565 (230a)
central heating pump	30.0000 (230c)
main heating flue fan	45.0000 (230e)
Total electricity for the above, kWh/year	751.7565 (231)
Electricity for lighting (calculated in Appendix L)	851.9556 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV Unit 0 (0.80 * 2.50 * 1118 * 0.80) =	-1789.3280 -1789.3280 (233)
Total delivered energy for all uses	9817.8191 (238)

10a. Fuel costs - using BEDF prices (374)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	7625.4413	4.1800	318.7434	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	2377.9937	4.1800	99.4001	(247)
Mechanical ventilation fans	676.7565	14.8100	100.2276	(249)
Pumps and fans for heating	75.0000	14.8100	11.1075	(249)
Energy for lighting	851.9556	14.8100	126.1746	(250)
Additional standing charges			109.0000	(251)
Energy saving/generation technologies				
PV Unit	-1789.3280	14.8100	-264.9995	(252)
Total energy cost			499.6539	(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	7625.4413	0.2160	1647.0953	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2377.9937	0.2160	513.6466	(264)
Space and water heating			2160.7420	(265)
Pumps and fans	751.7565	0.5190	390.1616	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Energy saving/generation technologies				
PV Unit	-1789.3280	0.5190	-928.6613	(269)
Total kg/year			2064.4073	(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	7625.4413	1.2200	9303.0384	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2377.9937	1.2200	2901.1523	(264)
Space and water heating			12204.1907	(265)
Pumps and fans	751.7565	3.0700	2307.8925	(267)
Energy for lighting	851.9556	3.0700	2615.5038	(268)
Energy saving/generation technologies				
PV Unit	-1789.3280	3.0700	-5493.2371	(269)
Primary energy kWh/year			11634.3499	(272)
Primary energy kWh/m2/year			45.1206	(273)

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

Overheating Calculation Input Data

Dwelling type	Detached House
Number of storeys	4

Cross ventilation possible	No
SAP Region	Thames Valley
Front of dwelling faces	North West
Overshading	Average or unknown
Thermal mass parameter	250.0
Night ventilation	Yes
Ventilation rate during hot weather (ach)	2.50 (Windows half open)

Overheating Calculation

Summer ventilation heat loss coefficient	554.72 (P1)
Transmission heat loss coefficient	145.87 (37)
Summer heat loss coefficient	700.59 (P2)

Overhangs

Orientation	Ratio	Z_overhangs	Overhang type
North	0.000	1.000	None
South	0.000	1.000	None
South West	0.000	1.000	None
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)
East	1.000	1.00	1.000	1.000 (P8)
South	1.000	1.00	1.000	1.000 (P8)
South	1.000	0.90	1.000	0.900 (P8)
South West	1.000	1.00	1.000	1.000 (P8)
South West	1.000	0.90	1.000	0.900 (P8)
West	1.000	1.00	1.000	1.000 (P8)
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	2.3800	81.1852	0.6300	0.7000	0.9000	69.0204
South	2.4000	112.2060	0.6300	0.7000	0.9000	96.1947
South West	2.8200	119.9223	0.6300	0.7000	0.9000	120.8016
West	1.6000	117.5071	0.6300	0.7000	0.9000	67.1595
East	2.3900	176.6135	0.6300	0.7000	1.0000	185.4425
South	0.6800	190.8804	0.6300	0.7000	1.0000	51.5171
South West	0.6800	187.7691	0.6300	0.7000	1.0000	50.6774
West	0.6800	176.6135	0.6300	0.7000	1.0000	47.6666
total:						688.4797

	Jun	Jul	Aug	
Solar gains	729	688	615	(P3)
Internal gains	726	696	710	
Total summer gains	1456	1385	1325	(P5)
Summer gain/loss ratio	2.08	1.98	1.89	(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	18.33	20.13	19.94	(P7)
Likelihood of high internal temperature	Not significant	Not significant	Not significant	

Assessment of likelihood of high internal temperature: Not significant

Sample Report Ltd
1 Sample Street
Sampletown

Full SAP Calculation Printout

Property Reference: 23602
Survey Reference: ASHP - CC - PV
Property: Camden, London, NW3 5UL

Issued on Date: 26.Mar.2015
Prop Type Ref:

SAP Rating:	86 B	**CO2 Emissions (t/year):**	2.64	**DER:**	12.54 Pass	**TER:**	22.00	**Percentage DER<TER:**	43.00 %
Environmental:	87 B	**General Requirements Compliance:**	Pass	**DFEE:**	52.68 Pass	**TFEE:**	58.12	**Percentage DFEE<TFEE:**	9.36 %

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

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

Software Version: Elmhurst Energy Systems SAP2012 Calculator (Design System) version 2.02r19
SAP version: SAP 2012, Regs Region: England (Part L1A 2013), Calculation Type: New Dwelling As Designed

CALCULATION DETAILS for survey reference no 'ASHP - CC - PV'
SAP2012 - 9.92 input data (DesignData) -


```
SAP2012 Input Data (House)     26/03/2015

FullRefNo:                     ASHP - CC - PV

Regs Region:                   England
SAP Region:                    Thames Valley
Postcode:                      NW3 5UL
DwellingOrientation:           North West
Property Type:                 House, Detached
Storeys:                       4
Date Built:                    2015
Sheltered Sides:               2
Sunlight Shade:                Average or unknown
Measurements                   Perimeter, Floor Area, Storey Height
    Basement:                 16.34, 16.32, 2.45
    1st Storey:               47.38, 112.42, 2.65
    2nd Storey:               32.92, 70.54, 2.5
    3rd Storey:               27.86, 58.57, 2.7
Living Area:                   21.95 m2, fraction: 8.5%
Thermal Mass:                  Simple calculation
Thermal Mass Simple:           Medium
Thermal MassValue:             250
External Walls                 Nett Area, Gross Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
Basement Wall 1 (Plant)        40.03, 40.03, 0, Other, Solid, 0.28, 0.106713232440823, Gross
Basement Wall (SP)             111.8, 111.8, 0, Other, Solid, 0.28, 0.106713232440823, Gross
Timber Clad Walling            145.13, 157.22, 0, Other, TimberFrame, 0, 0.11, Gross
Shelter Wall                   8.09, 13.75, 0, Other, Solid, 0.28, 0.106713232440823, Gross
External Roofs                 Nett Area, Gross Area, Kappa, Construction, Element, UValueFinal
    External Roof 1           101.96, 104.68, 0, Other, 0.11
    External Flat Roof        8.7, 10.41, 0, Other, 0.11
    Pool Basement Flat Roof   63.3, 63.3, 0, Other, 0.106713232440823
Heat Loss Floors               Area, Kappa, Construction, Element, Type, UValueFinal, ShelterFactor
    Heat Loss Floor 1         112.42, 110, Slab on ground, screed over insulation, Basement Floor, 0.28, 0.106713232440823
Description                    Data Source, Type, Glazing, Glazing Gap, Argon Filled, Solar Trans, Frame Type, Frame Factor, U Value
    Doors                     Manufacturer, Half Glazed Door, Double Low-E Soft 0.1, , , 0.63, , 0.7,
    Windows                   Manufacturer, Window, Double Low-E Soft 0.1, , , 0.63, , 0.7,
    Rooflight                 Manufacturer, Roof Window, Double Low-E Soft 0.1, , , 0.63, , 0.7,
    Shelter Wall Doors        Manufacturer, Door to Corridor, , , , , , ,
Openings                       Opening Type, Location, Orientation, Pitch, Curtain Type, Overhang Ratio, Wide Overhang, Width, Height, Count, Area, Curtain Closed
    Rooflight                 Roof Window, External Roof 1, West, 45, None, , , 0, 0, 0, 0.68,
    Rooflight                 Roof Window, External Roof 1, South West, 45, None, , , 0, 0, 0, 0.68,
    Rooflight                 Roof Window, External Roof 1, South, 45, None, , , 0, 0, 0, 0.68,
    Front Door                Half Glazed Door, Timber Clad Walling, North West, , , , , 0, 0, 0, 2.89,
    Rooflight                 Roof Window, External Roof 1, East, 45, None, , , 0, 0, 0, 0.68,
    Flat Rooflight            Roof Window, External Flat Roof, East, 0, None, , , 0, 0, 0, 1.71,
    S Face Window             Window, Timber Clad Walling, South, , None, 0, , 0, 0, 0, 2.40,
    SW Facing Windows         Window, Timber Clad Walling, South West, , None, 0, , 0, 0, 0, 2.82,
    W Facing Window           Window, Timber Clad Walling, West, , None, 0, , 0, 0, 0, 1.60,
    N Facing Windows          Window, Timber Clad Walling, North, , None, 0, , 0, 0, 0, 2.38,
    Basement Doors            Door to Corridor, Shelter Wall, South West, , , , , 0, 0, 0, 2.14,
    Basement Double Door      Door to Corridor, Shelter Wall, South West, , , , , 0, 0, 0, 3.52,
Conservatory:                  None
Draught Proofing:              100
Draught Lobby:                 No
Thermal Bridges
    Bridging:                 Calculate Bridges
    Y                         0.093
    List of Bridges           Junction with, Bridge Type, Source Type, Imported, Length, Psi, Adjusted, Result, Reference
    0.                        External wall, E2 Other lintels (including other steel lintels), Table K1 - Default, Yes, 9.33, 1, 1, 9.33,
    1.                        External wall, E3 Sill, Table K1 - Default, Yes, 5.75, 0.08, 0.08, 0.46,
    2.                        External wall, E4 Jamb, Table K1 - Default, Yes, 30.34, 0.1, 0.1, 3.03,
    3.                        External wall, E5 Ground floor (normal), Table K1 - Default, No, 63.72, 0.32, 0.32, 20.39,
    4.                        External wall, E6 Intermediate floor within a dwelling, Table K1 - Default, Yes, 108.16, 0.14, 0.14, 15.14,
    5.                        External wall, E11 Eaves (insulation at rafter level), Table K1 - Default, No, 30.88, 0.08, 0.08, 2.47,
    6.                        External wall, E16 Corner (normal), Table K1 - Default, No, 27.52, 0.18, 0.18, 4.95,
    7.                        External roof, R1 Head of roof window, Table K1 - Default, Yes, 4.43, 0.08, 0.08, 0.35,
    8.                        External roof, R2 Sill of roof window, Table K1 - Default, Yes, 4.43, 0.06, 0.06, 0.27,
    9.                        External roof, R3 Jamb of roof window, Table K1 - Default, Yes, 9.72, 0.08, 0.08, 0.78,
Pressure Test:                 True
Designed q50:                  4
AsBuilt q50:                   15
Property Tested:               False
Mechanical Ventilation
    MV System Present         Yes
    Windows In Hot Weather    Windows half open
    Cross Ventilation         No
    Night Ventilation         Yes
    Air Change Rate           2.50
    Approved Installation     Yes
```

```
    DataType                Database
    Type                    Balanced mechanical ventilation with heat recovery
    Database Ref Number     500366
    Configuration           4
    HR Duct Insulated       Yes
    ManufacturerSFP         0.66
    DuctType                Rigid
    HR Efficiency           90
    Wet Rooms               4
Chimneys MHS:                0
Chimneys SHS:                0
Chimneys Other:              0
Chimneys Total:              0
Open Flues MHS:              0
Open Flues SHS:              0
Open Flues Other:            0
Open Flues Total:            0
Intermittent Fans:           0
Passive Vents:               0
Flueless Gas Fires:          0
Cooling System
    Cooled Area             108.83
    Data Source             SAP table
    Type                    Split or Multi-Split
    Class                   A
    Control                 On/Off
Light Fittings:              18
LEL Fittings:                18
Percentage of LEL Fittings:  100
External Lights Fitted:      Yes
External LELs Fitted:        Yes
Electricity Tariff:          Standard
Main Heating 1
    Description             ASHP
    Percentage              100
    Sedbuk ID               100011
    Fuel Type               Electricity
    MHS                     Electricity PET Heat pump air-to-water
    SAP Code                224
    Boiler Efficiency Type  Split Efficiences
    Efficiency Winter       408.650811762171
    Efficiency Summer       140.9
    Controls by PCDF        0
    MHS Controls            CHD Time and temperature zone control
    Boiler Interlock        Yes
    Ctrl SAP Code           2207
    MCS Installation CertificateYes
    Pumped                  Pump in heated space
    Heat Emitter            Underfloor
    Flow Temperature        Normal (> 45°C)
    Under Floor Heating     Yes - Pipes in Wood
Main Heating 2               None
Heating Systems Interaction  Each system heats separate parts of dwelling
Smoke Control Area           Unknown
Community Heating            None
Secondary Heating            None
Water Heating
    Type                    MainHeating1
    WHS                     HWP From main heating 1
    Low Water Usage         Yes
    SAP Code                901
    Showers in Property     Non-electric only
    Hot Water Cylinder
    Cylinder Type           HotWaterCylinder
    Cylinder Insulation Type Foam
    Cylinder Volume         200.00
    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                         One Dwelling
PVUnit 1                     Cells Peak = 0.98, Orientation = South, Elevation = 45°, Overshading = Modest, , Connected to Dwelling = Yes
Wind Turbine                 None
Terrain Type:                Urban
Small Scale Hydro            None
Special Features             None



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

DWELLING AS DESIGNED

Detached House, total floor area 258 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) 22.00 kg/m²
Dwelling Carbon Dioxide Emission Rate (DER) 12.54 kg/m²OK
-------------------------------------------------------------------------------------------------
1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)58.1 kWh/m²
Dwelling Fabric Energy Efficiency (DFEE)52.7 kWh/m²OK
-------------------------------------------------------------------------------------------------
2 Fabric U-values
Element         Average                 Highest
External wall   0.11 (max. 0.30)        0.11 (max. 0.70)          OK
Floor           0.11 (max. 0.25)        0.11 (max. 0.70)          OK
Roof            0.11 (max. 0.20)        0.11 (max. 0.35)          OK
Openings        1.30 (max. 2.00)        1.60 (max. 3.30)          OK
-------------------------------------------------------------------------------------------------
2a Thermal bridging
Thermal bridging calculated from linear thermal transmittances for each junction
```

3 Air permeability		
Air permeability at 50 pascals:	4.00 (design value)	
Maximum	10.0	OK
4 Heating efficiency		
Main heating system:	Heat pump with radiators or underfloor - Electric	
Daikin Altherma ERHQ006BV3 + EKHBH008B		
Secondary heating system:	None	
5 Cylinder insulation		
Hot water storage	Nominal cylinder loss: 1.74 kWh/day	
Permitted by DBSCG 2.24	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:	0.66	
Maximum	1.5	OK
MVHR efficiency:	90%	
Minimum:	70%	OK
9 Summertime temperature		
Overheating risk (Thames Valley):	Not significant	OK
Based on:		
Overshading:	Average	
Windows facing North:	2.38 m², No overhang	
Windows facing South:	2.40 m², No overhang	
Windows facing South West:	2.82 m², No overhang	
Windows facing West:	1.60 m², No overhang	
Air change rate:	2.50 ach	
Blinds/curtains:	None	
10 Key features		
External wall U-value	0.11 W/m²K	
External wall U-value	0.11 W/m²K	
External wall U-value	0.11 W/m²K	
External wall U-value	0.11 W/m²K	
Roof U-value	0.11 W/m²K	
Roof U-value	0.11 W/m²K	
Roof U-value	0.11 W/m²K	
Floor U-value	0.11 W/m²K	
Photovoltaic array		

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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)

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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.6000	9.0560			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.0850			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 149.2636 (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	74.1659	73.2228	72.2798	67.5647	66.6217	61.9066	61.9066	60.9636	63.7926	66.6217	68.5077	70.3938	(38)
Heat transfer coeff	223.4295	222.4864	221.5434	216.8283	215.8853	211.1702	211.1702	210.2272	213.0562	215.8853	217.7713	219.6574	(39)

Average = Sum(39)m / 12 = 216.5926 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8665	0.8629	0.8592	0.8409	0.8373	0.8190	0.8190	0.8153	0.8263	0.8373	0.8446	0.8519	(40)
HLP (average)												0.8400	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)

Energy content (annual) Total = Sum(45)m = 1687.9629 (45)

Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Store volume 200.0000 (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 0.8434 (52)
Temperature factor from Table 2b 0.5400 (53)
Enter (49) or (54) in (55) 0.9372 (55)
Total storage loss
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (56)
If cylinder contains dedicated solar storage
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (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
227.3207 200.3134 210.2604 188.3280 184.4420 164.6430 157.9672 173.5524 173.3128 195.2930 206.6991 221.7987 (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
227.3207 200.3134 210.2604 188.3280 184.4420 164.6430 157.9672 173.5524 173.3128 195.2930 206.6991 221.7987 (64)
Total per year (kWh/year) = Sum(64)m = 2303.9309 (64)
Heat gains from water heating, kWh/month
100.0414 88.6947 94.3689 86.2874 85.7843 78.4122 76.9814 82.1635 81.2949 89.3922 92.3958 98.2054 (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	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	48.2413	42.8475	34.8459	26.3806	19.7198	16.6483	17.9891	23.3829	31.3844	39.8497	46.5105	49.5820	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	423.1616	427.5527	416.4873	392.9303	363.1939	335.2458	316.5748	312.1837	323.2491	346.8061	376.5425	404.4906	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	(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)													
	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	(71)
Water heating gains (Table 5)													
	134.4643	131.9861	126.8399	119.8437	115.3015	108.9058	103.4696	110.4348	112.9095	120.1508	128.3275	131.9965	(72)
Total internal gains													
	675.0242	671.5433	647.3301	608.3116	567.3721	529.9569	507.1905	515.1584	536.7001	575.9637	620.5376	655.2261	(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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	813.4827	922.4127	1025.0703	1125.3145	1184.7485	1158.0016	1106.5210	1038.4232	963.0771	863.0502	789.2462	771.7915	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	80.1427	80.4824	80.8250	82.5826	82.9434	84.7954	84.7954	85.1757	84.0447	82.9434	82.2250	81.5190	
alpha	6.3428	6.3655	6.3883	6.5055	6.5296	6.6530	6.6530	6.6784	6.6030	6.5296	6.4817	6.4346	
util living area													
	1.0000	0.9999	0.9995	0.9977	0.9867	0.9261	0.7826	0.8368	0.9780	0.9988	0.9999	1.0000	(86)
Tweekday	19.7209	19.8332	20.0396	20.3388	20.6302	20.8766	20.9721	20.9566	20.7666	20.3902	20.0148	19.7170	
Tweekend	20.2756	20.3392	20.4561	20.6255	20.7906	20.9301	20.9842	20.9754	20.8678	20.6546	20.4420	20.2734	
24 / 16	9	8	9	8	9	9	9	9	8	9	8	9	
24 / 9	22	20	22	22	22	21	22	22	22	22	22	22	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	20.1961	20.1992	20.2023	20.2180	20.2212	20.2369	20.2369	20.2401	20.2306	20.2212	20.2149	20.2086	(88)
util rest of house													
	0.9999	0.9998	0.9994	0.9966	0.9791	0.8810	0.6742	0.7398	0.9610	0.9981	0.9998	1.0000	(89)
Tweekday	18.6558	18.8023	19.0694	19.4647	19.8367	20.1403	20.2244	20.2179	20.0148	19.5335	19.0473	18.6604	
Tweekend	18.6558	18.8023	19.0694	19.4647	19.8367	20.1403	20.2244	20.2179	20.0148	19.5335	19.0473	18.6604	
MIT 2	20.1961	20.1992	20.2023	20.2180	20.2212	20.2369	20.2369	20.2401	20.2306	20.2212	20.2149	20.2086	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	20.2645	20.2674	20.2702	20.2846	20.2875	20.3019	20.3019	20.3048	20.2961	20.2875	20.2817	20.2760	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.2645	20.2674	20.2702	20.2846	20.2875	20.3019	20.3019	20.3048	20.2961	20.2875	20.2817	20.2760	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9999	0.9998	0.9994	0.9967	0.9799	0.8857	0.6844	0.7493	0.9629	0.9982	0.9998	1.0000	(94)
Useful gains	813.4295	922.2518	1024.4287	1121.6097	1160.9531	1025.5874	757.2791	778.0657	927.3595	861.4816	789.1134	771.7575	(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													
	3566.9390	3419.0294	3050.7031	2468.5006	1853.9072	1204.0681	781.7277	820.8898	1320.1199	2091.3810	2870.5986	3531.2041	(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													
	2048.6110	1677.8345	1507.5481	969.7614	515.5578	0.0000	0.0000	0.0000	0.0000	915.0452	1498.6693	2053.0283	(98)

Space heating 11186.0557 (98)
Space heating per m2 (98) / (4) = 43.3820 (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	1984.9997	1562.6593	1597.7264	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.7026	0.8120	0.7738	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1394.6748	1268.9198	1236.3007	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1447.2812	1386.5742	1319.4552	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	37.8766	87.5349	61.8670	0.0000	0.0000	0.0000	0.0000	(104)

Space cooling 187.2785 (104)
Cooled fraction fC = cooled area / (4) = 0.4221 (105)
Intermittency factor (Table 10b)

	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	3.9966	9.2364	6.5280	0.0000	0.0000	0.0000	0.0000	(107)

Space cooling 19.7610 (107)
Space cooling per m2 0.0766 (108)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0920 (201)
Fraction of space heat from main system(s) 0.9080 (202)
Efficiency of main space heating system 1 (in %) 388.2183 (206)
Efficiency of secondary/supplementary heating system, % 100.0000 (208)
Space heating requirement 2616.2959 (211)
Cooling System Energy Efficiency Ratio (see Table 10c) 4.0000 (209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	2048.6110	1677.8345	1507.5481	969.7614	515.5578	0.0000	0.0000	0.0000	0.0000	915.0452	1498.6693	2053.0283	(98)
Space heating efficiency (main heating system 1)	388.2183	388.2183	388.2183	388.2183	388.2183	0.0000	0.0000	0.0000	0.0000	388.2183	388.2183	388.2183	(210)
Space heating fuel (main heating system)	479.1477	392.4271	352.5990	226.8166	120.5833	0.0000	0.0000	0.0000	0.0000	214.0190	350.5223	480.1808	(211)
Water heating requirement	188.4722	154.3608	138.6944	89.2181	47.4313	0.0000	0.0000	0.0000	0.0000	84.1842	137.8776	188.8786	(215)
Water heating													
Water heating requirement	227.3207	200.3134	210.2604	188.3280	184.4420	164.6430	157.9672	173.5524	173.3128	195.2930	206.6991	221.7987	(64)
Efficiency of water heater												133.8550	(216)
(217)m	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	(217)
Fuel for water heating, kWh/month	169.8261	149.6495	157.0807	140.6956	137.7924	123.0010	118.0137	129.6571	129.4780	145.8989	154.4201	165.7007	(219)
Water heating fuel used												1721.2139	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.9992	2.3091	1.6320	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												4.9403	(221)
Annual totals kWh/year													
Space heating fuel - main system												2616.2959	(211)
Space heating fuel - secondary												1029.1171	(215)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)
mechanical ventilation fans (SFP = 0.8250) 676.7565 (230a)
Total electricity for the above, kWh/year 676.7565 (231)
Electricity for lighting (calculated in Appendix L) 851.9556 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV Unit 0 (0.80 * 0.98 * 1068 * 0.80) = -669.8938 -669.8938 (233)
Total delivered energy for all uses 6230.3855 (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	2616.2959	0.5190	1357.8575	(261)
Space heating - secondary	1029.1171	0.5190	534.1118	(263)
Water heating (other fuel)	1721.2139	0.5190	893.3100	(264)
Space and water heating			2785.2794	(265)
Space cooling	4.9403	0.5190	2.5640	(266)
Pumps and fans	676.7565	0.5190	351.2366	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Energy saving/generation technologies				
PV Unit	-669.8938	0.5190	-347.6749	(269)
Total CO2, kg/year			3233.5701	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			12.5400	(273)

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

DER		12.5400	ZC1
Total Floor Area	TFA	257.8500	
Assumed number of occupants	N	3.0771	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		9.7249	ZC2
CO2 emissions from cooking, equation (L16)		0.7479	ZC3
Total CO2 emissions		23.0128	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		23.0128	ZC8

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(5)

2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0595	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.3095	(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) =	0.2631	(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	0.3354	0.3288	0.3223	0.2894	0.2828	0.2499	0.2499	0.2433	0.2631	0.2828	0.2959	0.3091	(22b)
Effective ac	0.5562	0.5541	0.5519	0.5419	0.5400	0.5312	0.5312	0.5296	0.5346	0.5400	0.5438	0.5478	(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			5.6600	1.0000	5.6600			(26)
TER Semi-glazed door			2.8900	1.2000	3.4680			(26a)
TER Opening Type (Uw = 1.40)			9.2000	1.3258	12.1970			(27)
TER Room Window (Uw = 1.70)			4.4300	1.5918	7.0515			(27a)
Heat Loss Floor 1			112.4200	0.1300	14.6146			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1714	6.8597			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1714	19.1584			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1800	26.1234			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1714	1.3863			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1300	13.2548			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1300	1.1310			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1300	8.2290			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		119.1337			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		17.5760 (36)
Total fabric heat loss	(33) + (36) =	136.7097 (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	123.4248	122.9401	122.4651	120.2337	119.8163	117.8728	117.8728	117.5129	118.6214	119.8163	120.6608	121.5438	(38)
Heat transfer coeff	260.1345	259.6498	259.1748	256.9434	256.5259	254.5825	254.5825	254.2226	255.3311	256.5259	257.3705	258.2534	(39)
Average = Sum(39)m / 12 =												256.9414	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0089	1.0070	1.0051	0.9965	0.9949	0.9873	0.9873	0.9859	0.9902	0.9949	0.9981	1.0016	(40)
HLP (average)												0.9965	(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		3.0771 (42)
Average daily hot water use (litres/day)		107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:		
Store volume		200.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):		1.6525 (48)
Temperature factor from Table 2b		0.5400 (49)

Enter (49) or (54) in (55) 0.8924 (55)
Total storage loss
27.6637 24.9865 27.6637 26.7713 27.6637 26.7713 27.6637 27.6637 26.7713 27.6637 26.7713 27.6637 (56)
If cylinder contains dedicated solar storage
27.6637 24.9865 27.6637 26.7713 27.6637 26.7713 27.6637 27.6637 26.7713 27.6637 26.7713 27.6637 (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
225.9317 199.0588 208.8714 186.9838 183.0530 163.2988 156.5782 172.1634 171.9686 193.9040 205.3549 220.4097 (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
225.9317 199.0588 208.8714 186.9838 183.0530 163.2988 156.5782 172.1634 171.9686 193.9040 205.3549 220.4097 (64)
Total per year (kWh/year) = Sum(64)m = 2287.5764 (64)
Heat gains from water heating, kWh/month
98.9302 87.6910 93.2577 85.2121 84.6731 77.3368 75.8702 81.0523 80.2195 88.2810 91.3204 97.0942 (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	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
48.2413 42.8475 34.8459 26.3806 19.7198 16.6483 17.9891 23.3829 31.3844 39.8497 46.5105 49.5820 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
423.1616 427.5527 416.4873 392.9303 363.1939 335.2458 316.5748 312.1837 323.2491 346.8061 376.5425 404.4906 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 38.3857 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
132.9707 130.4926 125.3463 118.3501 113.8079 107.4122 101.9761 108.9412 111.4160 118.6573 126.8339 130.5029 (72)
Total internal gains
676.5306 673.0497 648.8365 609.8180 568.8786 531.4634 508.6970 516.6648 538.2066 577.4701 622.0440 656.7325 (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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	814.9892	923.9192	1026.5767	1126.8209	1186.2550	1159.5080	1108.0275	1039.9296	964.5835	864.5567	790.7526	773.2979	(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	68.8346	68.9631	69.0895	69.6895	69.8029	70.3357	70.3357	70.4353	70.1295	69.8029	69.5738	69.3360	
alpha	5.5890	5.5975	5.6060	5.6460	5.6535	5.6890	5.6890	5.6957	5.6753	5.6535	5.6383	5.6224	
util living area													
	0.9999	0.9998	0.9995	0.9979	0.9902	0.9536	0.8551	0.8957	0.9849	0.9988	0.9998	0.9999	(86)
MIT	19.6806	19.7821	19.9780	20.2564	20.5461	20.8035	20.9352	20.9107	20.6955	20.3237	19.9561	19.6653	(87)
Th 2	20.0760	20.0775	20.0791	20.0863	20.0876	20.0939	20.0939	20.0951	20.0915	20.0876	20.0849	20.0820	(88)
util rest of house													
	0.9999	0.9998	0.9993	0.9969	0.9842	0.9177	0.7438	0.8042	0.9717	0.9981	0.9998	0.9999	(89)
MIT 2	18.2751	18.4249	18.7128	19.1254	19.5474	19.9100	20.0580	20.0384	19.7659	19.2252	18.6851	18.2571	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	18.3948	18.5405	18.8205	19.2216	19.6324	19.9860	20.1327	20.1127	19.8451	19.3188	18.7933	18.3770	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.3948	18.5405	18.8205	19.2216	19.6324	19.9860	20.1327	20.1127	19.8451	19.3188	18.7933	18.3770	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9998	0.9996	0.9988	0.9954	0.9797	0.9118	0.7497	0.8065	0.9662	0.9972	0.9996	0.9999	(94)
Useful gains	814.8473	923.5495	1025.3734	1121.6412	1162.1805	1057.2399	830.6686	838.7012	932.0022	862.0928	790.4415	773.2005	(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													
	3666.5344	3541.7465	3193.1658	2652.0778	2034.8607	1371.1868	899.3594	943.8407	1466.8931	2236.5868	3009.5119	3661.2621	(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													
	2121.6552	1759.4284	1612.8376	1101.9143	649.2741	0.0000	0.0000	0.0000	0.0000	1022.6235	1597.7307	2148.7178	(98)
Space heating												12014.1816	(98)
Space heating per m2											(98) / (4) =	46.5937	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	93.5000 (206)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)
Space heating requirement	12849.3921 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	2121.6552	1759.4284	1612.8376	1101.9143	649.2741	0.0000	0.0000	0.0000	0.0000	1022.6235	1597.7307	2148.7178	(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)													
	2269.1499	1881.7416	1724.9600	1178.5180	694.4108	0.0000	0.0000	0.0000	0.0000	1093.7150	1708.8029	2298.0939	(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													
	225.9317	199.0588	208.8714	186.9838	183.0530	163.2988	156.5782	172.1634	171.9686	193.9040	205.3549	220.4097	(64)
Efficiency of water heater												79.8000	(216)
(217)m	89.3470	89.2832	89.1297	88.7732	87.9077	79.8000	79.8000	79.8000	79.8000	88.6063	89.1388	89.3850	(217)
Fuel for water heating, kWh/month													
	252.8699	222.9521	234.3453	210.6310	208.2333	204.6351	196.2133	215.7437	215.4995	218.8377	230.3766	246.5847	(219)
Water heating fuel used												2656.9222	(219)
Annual totals kWh/year													
Space heating fuel - main system												12849.3921	(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)												851.9556	(232)
Total delivered energy for all uses												16433.2699	(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	12849.3921	0.2160	2775.4687	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2656.9222	0.2160	573.8952	(264)
Space and water heating			3349.3639	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Total CO2, kg/m2/year			3830.4539	(272)
Emissions per m2 for space and water heating			12.9896	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			1.7148	(272b)
Emissions per m2 for pumps and fans			0.1510	(272c)
Target Carbon Dioxide Emission Rate (TER) = (12.9896 * 1.55) + 1.7148 + 0.1510, rounded to 2 d.p.			22.0000	(273)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(5)

2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0595	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
Infiltration rate		0.2595	(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) =	0.2206	(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	0.2812	0.2757	0.2702	0.2426	0.2371	0.2095	0.2095	0.2040	0.2206	0.2371	0.2481	0.2592	(22b)
Effective ac	0.5395	0.5380	0.5365	0.5294	0.5281	0.5220	0.5220	0.5208	0.5243	0.5281	0.5308	0.5336	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.6000	9.0560			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.0850			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							57.1786	(36)
Total fabric heat loss					(33) + (36) =		149.2636	(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	119.7178	119.3770	119.0431	117.4745	117.1810	115.8148	115.8148	115.5618	116.3410	117.1810	117.7747	118.3954	(38)
Heat transfer coeff	268.9814	268.6406	268.3067	266.7381	266.4446	265.0784	265.0784	264.8254	265.6046	266.4446	267.0383	267.6590	(39)
Average = Sum(39)m / 12 =												266.7367	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0432	1.0418	1.0406	1.0345	1.0333	1.0280	1.0280	1.0271	1.0301	1.0333	1.0356	1.0380	(40)
HLP (average)												1.0345	(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		3.0771 (42)
Average daily hot water use (litres/day)		107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(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													

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	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	37.1887	32.5255	33.5634	29.2614	28.0770	24.2283	22.4511	25.7629	26.0706	30.3828	33.1652	36.0153	(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	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	48.2413	42.8475	34.8459	26.3806	19.7198	16.6483	17.9891	23.3829	31.3844	39.8497	46.5105	49.5820	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	423.1616	427.5527	416.4873	392.9303	363.1939	335.2458	316.5748	312.1837	323.2491	346.8061	376.5425	404.4906	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	(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)	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	(71)
Water heating gains (Table 5)	49.9848	48.4010	45.1121	40.6408	37.7379	33.6504	30.1762	34.6276	36.2092	40.8371	46.0628	48.4076	(72)
Total internal gains	590.5447	587.9581	565.6022	529.1087	489.8086	454.7015	433.8971	439.3512	459.9998	496.6500	538.2729	571.6372	(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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	729.0032	838.8276	943.3425	1046.1116	1107.1849	1082.7462	1033.2276	962.6160	886.3767	783.7365	706.9815	688.2026	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	66.5706	66.6550	66.7380	67.1305	67.2044	67.5508	67.5508	67.6153	67.4169	67.2044	67.0550	66.8995	
alpha	5.4380	5.4437	5.4492	5.4754	5.4803	5.5034	5.5034	5.5077	5.4945	5.4803	5.4703	5.4600	
util living area	1.0000	0.9999	0.9997	0.9986	0.9933	0.9677	0.8926	0.9268	0.9904	0.9993	0.9999	1.0000	(86)
MIT	19.6022	19.7046	19.9046	20.1878	20.4871	20.7583	20.9091	20.8785	20.6445	20.2603	19.8822	19.5840	(87)
Th 2	20.0475	20.0486	20.0497	20.0547	20.0556	20.0600	20.0600	20.0609	20.0583	20.0556	20.0537	20.0518	(88)
util rest of house	0.9999	0.9999	0.9995	0.9979	0.9889	0.9399	0.7917	0.8493	0.9814	0.9989	0.9999	1.0000	(89)
MIT 2	18.7449	18.8482	19.0490	19.3361	19.6346	19.9000	20.0231	20.0043	19.7930	19.4094	19.0300	18.7301	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	18.8179	18.9211	19.1219	19.4086	19.7072	19.9731	20.0985	20.0787	19.8654	19.4818	19.1025	18.8028	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8179	18.9211	19.1219	19.4086	19.7072	19.9731	20.0985	20.0787	19.8654	19.4818	19.1025	18.8028	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9999	0.9998	0.9993	0.9972	0.9866	0.9362	0.7971	0.8514	0.9785	0.9984	0.9998	0.9999	(94)
Useful gains	728.9388	838.6442	942.6995	1043.1351	1092.3433	1013.7177	823.5640	819.5279	867.3194	782.5074	706.8401	688.1595	(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	3905.0354	3766.6402	3386.5280	2803.0412	2133.4745	1424.2808	927.3810	974.2078	1531.3298	2366.5186	3205.1331	3908.5641	(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	2363.0159	1967.6133	1818.2085	1267.1324	774.6016	0.0000	0.0000	0.0000	0.0000	1178.5043	1798.7709	2395.9810	(98)
Space heating												13563.8279	(98)
Space heating per m2											(98) / (4) =	52.6036	(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	2491.7369	1961.5801	2012.6730	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.5412	0.6432	0.6005	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1348.4277	1261.7857	1208.5973	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1372.0258	1313.2808	1243.6480	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	16.9906	38.3123	26.0778	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												81.3807	(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	4.2477	9.5781	6.5194	0.0000	0.0000	0.0000	0.0000 (107)
Space cooling												20.3452 (107)
Space cooling per m2												0.0789 (108)
Energy for space heating												52.6036 (99)
Energy for space cooling												0.0789 (108)
Total												52.6825 (109)
Dwelling Fabric Energy Efficiency (DFEE)												52.7 (109)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(5)

2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0595	(8)
Pressure test		Yes	
Measured/design q50		5.0000	
Infiltration rate		0.3095	(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) =	0.2631	(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	0.3354	0.3288	0.3223	0.2894	0.2828	0.2499	0.2499	0.2433	0.2631	0.2828	0.2959	0.3091	(22b)
Effective ac	0.5562	0.5541	0.5519	0.5419	0.5400	0.5312	0.5312	0.5296	0.5346	0.5400	0.5438	0.5478	(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			5.6600	1.0000	5.6600			(26)
TER Semi-glazed door			2.8900	1.2000	3.4680			(26a)
TER Opening Type (Uw = 1.40)			9.2000	1.3258	12.1970			(27)
TER Room Window (Uw = 1.70)			4.4300	1.5918	7.0515			(27a)
Heat Loss Floor 1			112.4200	0.1300	14.6146			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1714	6.8597			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1714	19.1584			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1800	26.1234			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1714	1.3863			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1300	13.2548			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1300	1.1310			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1300	8.2290			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		119.1337			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		17.5760 (36)
Total fabric heat loss	(33) + (36) =	136.7097 (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	123.4248	122.9401	122.4651	120.2337	119.8163	117.8728	117.8728	117.5129	118.6214	119.8163	120.6608	121.5438	(38)
Heat transfer coeff	260.1345	259.6498	259.1748	256.9434	256.5259	254.5825	254.5825	254.2226	255.3311	256.5259	257.3705	258.2534	(39)
Average = Sum(39)m / 12 =												256.9414	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0089	1.0070	1.0051	0.9965	0.9949	0.9873	0.9873	0.9859	0.9902	0.9949	0.9981	1.0016	(40)
HLP (average)												0.9965	(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		3.0771 (42)
Average daily hot water use (litres/day)		107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage													

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (59)
Heat gains from water heating, kWh/month												
	37.1887	32.5255	33.5634	29.2614	28.0770	24.2283	22.4511	25.7629	26.0706	30.3828	33.1652	36.0153 (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	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	153.8567	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	48.2413	42.8475	34.8459	26.3806	19.7198	16.6483	17.9891	23.3829	31.3844	39.8497	46.5105	49.5820	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	423.1616	427.5527	416.4873	392.9303	363.1939	335.2458	316.5748	312.1837	323.2491	346.8061	376.5425	404.4906	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	38.3857	(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)													
	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	(71)
Water heating gains (Table 5)													
	49.9848	48.4010	45.1121	40.6408	37.7379	33.6504	30.1762	34.6276	36.2092	40.8371	46.0628	48.4076	(72)
Total internal gains													
	590.5447	587.9581	565.6022	529.1087	489.8086	454.7015	433.8971	439.3512	459.9998	496.6500	538.2729	571.6372	(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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	729.0032	838.8276	943.3425	1046.1116	1107.1849	1082.7462	1033.2276	962.6160	886.3767	783.7365	706.9815	688.2026	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	68.8346	68.9631	69.0895	69.6895	69.8029	70.3357	70.3357	70.4353	70.1295	69.8029	69.5738	69.3360	
alpha	5.5890	5.5975	5.6060	5.6460	5.6535	5.6890	5.6890	5.6957	5.6753	5.6535	5.6383	5.6224	
util living area													
	1.0000	0.9999	0.9997	0.9986	0.9930	0.9649	0.8826	0.9199	0.9898	0.9993	0.9999	1.0000	(86)
MIT	19.6485	19.7503	19.9469	20.2265	20.5179	20.7806	20.9218	20.8934	20.6682	20.2936	19.9247	19.6335	(87)
Th 2	20.0760	20.0775	20.0791	20.0863	20.0876	20.0939	20.0939	20.0951	20.0915	20.0876	20.0849	20.0820	(88)
util rest of house													
	0.9999	0.9999	0.9995	0.9979	0.9885	0.9358	0.7802	0.8401	0.9805	0.9989	0.9999	1.0000	(89)
MIT 2	18.8143	18.9174	19.1152	19.4004	19.6914	19.9492	20.0626	20.0460	19.8436	19.4688	19.0978	18.8042	(90)
Living area fraction										fLA = Living area / (4) =		0.0851	(91)
MIT	18.8853	18.9883	19.1860	19.4707	19.7617	20.0200	20.1358	20.1181	19.9138	19.5390	19.1682	18.8748	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8853	18.9883	19.1860	19.4707	19.7617	20.0200	20.1358	20.1181	19.9138	19.5390	19.1682	18.8748	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9999	0.9998	0.9993	0.9972	0.9862	0.9325	0.7862	0.8428	0.9777	0.9985	0.9998	0.9999	(94)
Useful gains	728.9449	838.6576	942.7286	1043.1630	1091.9040	1009.6161	812.3077	811.2833	866.6086	782.5427	706.8517	688.1642	(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													
	3794.1399	3658.0310	3287.8949	2716.0836	2068.0420	1379.8371	900.1403	945.2331	1484.4464	2293.0895	3106.0045	3789.8214	(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													
	2280.5051	1894.6190	1744.8038	1204.5028	726.2466	0.0000	0.0000	0.0000	0.0000	1123.8468	1727.3900	2307.6330	(98)
Space heating												13009.5470	(98)
Space heating per m2											(98) / (4) =	50.4539	(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	2393.0757	1883.9107	1932.0920	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.5627	0.6673	0.6240	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1346.6947	1257.1914	1205.6175	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1372.0258	1313.2808	1243.6480	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	18.2384	41.7305	28.2947	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												88.2636	(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	4.5596	10.4326	7.0737	0.0000	0.0000	0.0000	0.0000 (107)
Space cooling												22.0659 (107)
Space cooling per m2												0.0856 (108)
Energy for space heating												50.4539 (99)
Energy for space cooling												0.0856 (108)
Total												50.5395 (109)
Target Fabric Energy Efficiency (TFEE)												58.1 (109)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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	4.6000	4.5000	4.4000	4.1000	4.1000	3.7000	3.8000	3.7000	3.7000	4.0000	3.9000	4.3000	(22)
Wind factor	1.1500	1.1250	1.1000	1.0250	1.0250	0.9250	0.9500	0.9250	0.9250	1.0000	0.9750	1.0750	(22a)
Adj infilt rate	0.1955	0.1913	0.1870	0.1743	0.1743	0.1573	0.1615	0.1573	0.1573	0.1700	0.1658	0.1828	(22b)

Balanced mechanical ventilation with heat recovery
If mechanical ventilation: 0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 76.5000 (23c)

Effective ac	0.3130	0.3088	0.3045	0.2918	0.2918	0.2748	0.2790	0.2748	0.2748	0.2875	0.2833	0.3003	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.6000	9.0560			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.0850			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 149.2636 (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	69.4507	68.5077	67.5647	64.7356	64.7356	60.9636	61.9066	60.9636	60.9636	63.7926	62.8496	66.6217	(38)
Heat transfer coeff	218.7143	217.7713	216.8283	213.9992	213.9992	210.2272	211.1702	210.2272	210.2272	213.0562	212.1132	215.8853	(39)

Average = Sum(39)m / 12 = 213.6849 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8482	0.8446	0.8409	0.8299	0.8299	0.8153	0.8190	0.8153	0.8153	0.8263	0.8226	0.8373	(40)
HLP (average)												0.8287	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)											Total = Sum(45)m =	1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Store volume 200.0000 (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 0.8434 (52)
Temperature factor from Table 2b 0.5400 (53)
Enter (49) or (54) in (55) 0.9372 (55)
Total storage loss
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (56)
If cylinder contains dedicated solar storage
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (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
227.3207 200.3134 210.2604 188.3280 184.4420 164.6430 157.9672 173.5524 173.3128 195.2930 206.6991 221.7987 (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
227.3207 200.3134 210.2604 188.3280 184.4420 164.6430 157.9672 173.5524 173.3128 195.2930 206.6991 221.7987 (64)
Total per year (kWh/year) = Sum(64)m = 2303.9309 (64)
RHI water heating demand 2304 (64)
Heat gains from water heating, kWh/month
100.0414 88.6947 94.3689 86.2874 85.7843 78.4122 76.9814 82.1635 81.2949 89.3922 92.3958 98.2054 (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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
120.6031 107.1186 87.1147 65.9515 49.2995 41.6207 44.9726 58.4571 78.4610 99.6243 116.2763 123.9551 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
631.5844 638.1383 621.6228 586.4631 542.0804 500.3669 472.4997 465.9459 482.4614 517.6210 562.0038 603.7173 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
134.4643 131.9861 126.8399 119.8437 115.3015 108.9058 103.4696 110.4348 112.9095 120.1508 128.3275 131.9965 (72)
Total internal gains
1004.7345 995.3257 953.6600 890.3409 824.7640 768.9760 739.0246 752.9205 791.9146 855.4788 924.6902 977.7514 (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	2.3800	11.5821	0.6300	0.7000	0.7700	8.4243	(74)
South	2.4000	49.2853	0.6300	0.7000	0.7700	36.1494	(78)
Southwest	2.8200	39.1209	0.6300	0.7000	0.7700	33.7155	(79)
West	1.6000	21.5869	0.6300	0.7000	0.7700	10.5556	(80)
East	2.3900	28.6477	0.6300	0.7000	1.0000	27.4140	(82)
South	0.6800	50.5332	0.6300	0.7000	1.0000	13.6385	(82)
Southwest	0.6800	43.2691	0.6300	0.7000	1.0000	11.6780	(82)
West	0.6800	28.6477	0.6300	0.7000	1.0000	7.7318	(82)

Solar gains	149.3071	243.2089	368.4293	521.8214	607.3414	659.9368	628.0447	561.7797	457.0744	304.2265	187.9424	123.3636	(83)
Total gains	1154.0417	1238.5346	1322.0893	1412.1623	1432.1054	1428.9128	1367.0693	1314.7002	1248.9891	1159.7053	1112.6326	1101.1151	(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	81.8705	82.2250	82.5826	83.6744	83.6744	85.1757	84.7954	85.1757	85.1757	84.0447	84.4184	82.9434	
alpha	6.4580	6.4817	6.5055	6.5783	6.5783	6.6784	6.6530	6.6784	6.6784	6.6030	6.6279	6.5296	
util living area													
	0.9994	0.9990	0.9966	0.9844	0.9205	0.6722	0.4163	0.4623	0.8339	0.9862	0.9984	0.9996	(86)
Tweekday	19.9872	20.0779	20.3100	20.5934	20.8545	20.9878	20.9996	20.9991	20.9492	20.6487	20.2908	19.9815	
Tweekend	20.4264	20.4777	20.6092	20.7697	20.9176	20.9931	20.9998	20.9995	20.9712	20.8011	20.5983	20.4231	
24 / 16	9	8	9	8	9	9	9	9	8	9	8	9	
24 / 9	22	20	22	22	22	21	22	22	22	22	22	22	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	20.2117	20.2149	20.2180	20.2275	20.2275	20.2401	20.2369	20.2401	20.2401	20.2306	20.2338	20.2212	(88)
util rest of house													
	0.9992	0.9986	0.9952	0.9772	0.8826	0.5732	0.2991	0.3420	0.7545	0.9783	0.9977	0.9994	(89)
Tweekday	19.0093	19.1280	19.4275	19.7936	20.1037	20.2348	20.2369	20.2400	20.2093	19.8676	19.4155	19.0093	
Tweekend	19.0093	19.1280	19.4275	19.7936	20.1037	20.2348	20.2369	20.2400	20.2093	19.8676	19.4155	19.0093	
MIT 2	20.2117	20.2149	20.2180	20.2275	20.2275	20.2401	20.2369	20.2401	20.2401	20.2306	20.2338	20.2212	(90)
Living area fraction										fLA = Living area / (4) =		0.0851	(91)
MIT	20.2788	20.2817	20.2846	20.2932	20.2932	20.3048	20.3019	20.3048	20.3048	20.2961	20.2990	20.2875	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.2788	20.2817	20.2846	20.2932	20.2932	20.3048	20.3019	20.3048	20.3048	20.2961	20.2990	20.2875	(93)

---

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9993	0.9986	0.9954	0.9780	0.8863	0.5820	0.3091	0.3523	0.7621	0.9791	0.9978	0.9994	(94)
Useful gains	1153.1898	1236.8432	1315.9499	1381.0564	1269.3423	831.6286	422.6197	463.2194	951.8858	1135.4906	1110.1519	1100.5023	(95)
Ext temp.	5.2000	5.7000	7.7000	10.2000	13.3000	16.3000	18.3000	18.1000	15.5000	11.9000	8.2000	5.2000	(96)
Heat loss rate W													
	3297.9579	3175.4784	2728.6945	2159.9428	1496.5452	841.9125	422.7384	463.5036	1010.0942	1788.8436	2566.3569	3257.1615	(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													

1595.7074	1302.7629	1051.0820	560.7982	169.0389	0.0000	0.0000	0.0000	0.0000	486.0946	1048.4676	1604.5545 (98)
Space heating											7818.5061 (98)
RHI space heating demand											7819 (98)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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)

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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.6000	9.0560			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.0850			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 149.2636 (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	74.1659	73.2228	72.2798	67.5647	66.6217	61.9066	61.9066	60.9636	63.7926	66.6217	68.5077	70.3938	(38)
Heat transfer coeff	223.4295	222.4864	221.5434	216.8283	215.8853	211.1702	211.1702	210.2272	213.0562	215.8853	217.7713	219.6574	(39)
Average = Sum(39)m / 12 =												216.5926	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8665	0.8629	0.8592	0.8409	0.8373	0.8190	0.8190	0.8153	0.8263	0.8373	0.8446	0.8519	(40)
HLP (average)												0.8400	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)											Total = Sum(45)m =	1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

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Water storage loss:
Store volume                                                                                                                    200.0000 (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                                                                                                     0.8434 (52)
 Temperature factor from Table 2b                                                                                                0.5400 (53)
Enter (49) or (54) in (55)                                                                                                       0.9372 (55)
Total storage loss
              29.0527    26.2411    29.0527    28.1155    29.0527    28.1155    29.0527    29.0527    28.1155    29.0527    28.1155    29.0527 (56)
If cylinder contains dedicated solar storage
              29.0527    26.2411    29.0527    28.1155    29.0527    28.1155    29.0527    29.0527    28.1155    29.0527    28.1155    29.0527 (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
             227.3207   200.3134   210.2604   188.3280   184.4420   164.6430   157.9672   173.5524   173.3128   195.2930   206.6991   221.7987 (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
             227.3207   200.3134   210.2604   188.3280   184.4420   164.6430   157.9672   173.5524   173.3128   195.2930   206.6991   221.7987 (64)
                                                                                                  Total per year (kWh/year) = Sum(64)m =   2303.9309 (64)
Heat gains from water heating, kWh/month
             100.0414    88.6947    94.3689    86.2874    85.7843    78.4122    76.9814    82.1635    81.2949    89.3922    92.3958    98.2054 (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         184.6281   184.6281   184.6281   184.6281   184.6281   184.6281   184.6281   184.6281   184.6281   184.6281   184.6281   184.6281 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
             120.6031   107.1186    87.1147    65.9515    49.2995    41.6207    44.9726    58.4571    78.4610    99.6243   116.2763   123.9551 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
             631.5844   638.1383   621.6228   586.4631   542.0804   500.3669   472.4997   465.9459   482.4614   517.6210   562.0038   603.7173 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
              56.5399    56.5399    56.5399    56.5399    56.5399    56.5399    56.5399    56.5399    56.5399    56.5399    56.5399    56.5399 (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)
            -123.0854  -123.0854  -123.0854  -123.0854  -123.0854  -123.0854  -123.0854  -123.0854  -123.0854  -123.0854  -123.0854  -123.0854 (71)
Water heating gains (Table 5)
             134.4643   131.9861   126.8399   119.8437   115.3015   108.9058   103.4696   110.4348   112.9095   120.1508   128.3275   131.9965 (72)
Total internal gains
            1004.7345   995.3257   953.6600   890.3409   824.7640   768.9760   739.0246   752.9205   791.9146   855.4788   924.6902   977.7514 (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                                2.3800            10.6334           0.6300             0.7000           0.7700             7.7343 (74)
South                                2.4000            46.7521           0.6300             0.7000           0.7700            34.2913 (78)
Southwest                            2.8200            36.7938           0.6300             0.7000           0.7700            31.7100 (79)
West                                 1.6000            19.6403           0.6300             0.7000           0.7700             9.6037 (80)
East                                 2.3900            25.9287           0.6300             0.7000           1.0000            24.6441 (82)
South                                0.6800            47.0123           0.6300             0.7000           1.0000            12.6882 (82)
Southwest                            0.6800            39.9751           0.6300             0.7000           1.0000            10.7890 (82)
West                                 0.6800            25.9287           0.6300             0.7000           1.0000             6.9980 (82)
------------------------------------------------------------------------------------------------

Solar gains    138.4586   250.8695   377.7402   517.0029   617.3764   628.0447   599.3305   523.2647   426.3769   287.0866   168.7086   116.5654 (83)
Total gains   1143.1931  1246.1952  1331.4003  1407.3438  1442.1404  1397.0207  1338.3551  1276.1852  1218.2916  1142.5654  1093.3988  1094.3168 (84)



------------------------------------------------------------------------------------------------
7. Mean internal temperature (heating season)
------------------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                     21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)
               Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
tau            80.1427    80.4824    80.8250    82.5826    82.9434    84.7954    84.7954    85.1757    84.0447    82.9434    82.2250    81.5190
alpha           6.3428     6.3655     6.3883     6.5055     6.5296     6.6530     6.6530     6.6784     6.6030     6.5296     6.4817     6.4346
util living area
               0.9996     0.9992     0.9979     0.9919     0.9646     0.8545     0.6743     0.7251     0.9348     0.9940     0.9991     0.9997 (86)

Tweekday       19.8653    19.9749    20.1730    20.4591    20.7282    20.9302    20.9882    20.9815    20.8537    20.5109    20.1484    19.8587
Tweekend       20.3573    20.4194    20.5316    20.6937    20.8460    20.9605    20.9933    20.9895    20.9171    20.7230    20.5177    20.3536
24 / 16            9          8          9          8          9          9          9          9          8          9          8          9
24 / 9            22         20         22         22         22         21         22         22         22         22         22         22
16 / 9             0          0          0          0          0          0          0          0          0          0          0          0
MIT            21.0000    21.0000    21.0000    21.0000    21.0000    21.0000    21.0000    21.0000    21.0000    21.0000    21.0000    21.0000 (87)
Th 2           20.1961    20.1992    20.2023    20.2180    20.2212    20.2369    20.2369    20.2401    20.2306    20.2212    20.2149    20.2086 (88)
util rest of house
               0.9995     0.9989     0.9971     0.9884     0.9475     0.7905     0.5677     0.6213     0.8967     0.9908     0.9988     0.9996 (89)
Tweekday       18.8410    18.9839    19.2401    19.6171    19.9535    20.1881    20.2322    20.2319    20.1094    19.6866    19.2184    18.8421
Tweekend       18.8410    18.9839    19.2401    19.6171    19.9535    20.1881    20.2322    20.2319    20.1094    19.6866    19.2184    18.8421
MIT 2          20.1961    20.1992    20.2023    20.2180    20.2212    20.2369    20.2369    20.2401    20.2306    20.2212    20.2149    20.2086 (90)
Living area fraction                                                                                    fLA = Living area / (4) =      0.0851 (91)
MIT            20.2645    20.2674    20.2702    20.2846    20.2875    20.3019    20.3019    20.3048    20.2961    20.2875    20.2817    20.2760 (92)
Temperature adjustment                                                                                                           0.0000
adjusted MIT   20.2645    20.2674    20.2702    20.2846    20.2875    20.3019    20.3019    20.3048    20.2961    20.2875    20.2817    20.2760 (93)



------------------------------------------------------------------------------------------------
8. Space heating requirement
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               Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation     0.9995     0.9990     0.9972     0.9887     0.9493     0.7967     0.5772     0.6308     0.9006     0.9911     0.9988     0.9996 (94)
Useful gains  1142.6230  1244.9103  1327.6347  1391.4716  1368.9655  1113.0101   772.4890   804.9745  1097.2130  1132.4523  1092.0993  1093.9147 (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
            3566.9390  3419.0294  3050.7031  2468.5006  1853.9072  1204.0681   781.7277   820.8898  1320.1199  2091.3810  2870.5986  3531.2041 (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
            1803.6911  1461.0080  1281.9628   775.4608   360.7966     0.0000     0.0000     0.0000     0.0000   713.4430  1280.5195  1813.3433 (98)
```

Space heating 9490.2252 (98)
Space heating per m2 (98) / (4) = 36.8052 (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	1984.9997	1562.6593	1597.7264	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.7026	0.8120	0.7738	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1394.6748	1268.9198	1236.3007	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1447.2812	1386.5742	1319.4552	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	37.8766	87.5349	61.8670	0.0000	0.0000	0.0000	0.0000	(104)

Space cooling 187.2785 (104)
Cooled fraction fC = cooled area / (4) = 0.4221 (105)
Intermittency factor (Table 10b)

	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	3.9966	9.2364	6.5280	0.0000	0.0000	0.0000	0.0000	(107)

Space cooling 19.7610 (107)
Space cooling per m2 0.0766 (108)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0920 (201)
Fraction of space heat from main system(s) 0.9080 (202)
Efficiency of main space heating system 1 (in %) 388.2183 (206)
Efficiency of secondary/supplementary heating system, % 100.0000 (208)
Space heating requirement 2219.6597 (211)
Cooling System Energy Efficiency Ratio (see Table 10c) 4.0000 (209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1803.6911	1461.0080	1281.9628	775.4608	360.7966	0.0000	0.0000	0.0000	0.0000	713.4430	1280.5195	1813.3433	(98)
Space heating efficiency (main heating system 1)	388.2183	388.2183	388.2183	388.2183	388.2183	0.0000	0.0000	0.0000	0.0000	388.2183	388.2183	388.2183	(210)
Space heating fuel (main heating system)	421.8636	341.7138	299.8371	181.3718	84.3864	0.0000	0.0000	0.0000	0.0000	166.8665	299.4995	424.1211	(211)
Water heating requirement	165.9396	134.4127	117.9406	71.3424	33.1933	0.0000	0.0000	0.0000	0.0000	65.6368	117.8078	166.8276	(215)

Water heating
Water heating requirement

227.3207	200.3134	210.2604	188.3280	184.4420	164.6430	157.9672	173.5524	173.3128	195.2930	206.6991	221.7987	(64)
Efficiency of water heater												133.8550 (216)
(217)m	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550 (217)
Fuel for water heating, kWh/month												
169.8261	149.6495	157.0807	140.6956	137.7924	123.0010	118.0137	129.6571	129.4780	145.8989	154.4201	165.7007	(219)
Water heating fuel used												1721.2139 (219)
Space cooling fuel requirement												
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.9992	2.3091	1.6320	0.0000	0.0000	0.0000	0.0000 (221)
Cooling												4.9403 (221)
Annual totals kWh/year												
Space heating fuel - main system												2219.6597 (211)
Space heating fuel - secondary												873.1007 (215)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)
mechanical ventilation fans (SFP = 0.8250) 676.7565 (230a)
Total electricity for the above, kWh/year 676.7565 (231)
Electricity for lighting (calculated in Appendix L) 851.9556 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV Unit 0 (0.80 * 0.98 * 1068 * 0.80) = -669.8938 -669.8938 (233)
Total delivered energy for all uses 5677.7329 (238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	2219.6597	13.1900	292.7731	(240)
Space heating - secondary	873.1007	13.1900	115.1620	(242)
Water heating (other fuel)	1721.2139	13.1900	227.0281	(247)
Space cooling	4.9403	13.1900	0.6516	(248)
Mechanical ventilation fans	676.7565	13.1900	89.2642	(249)
Pumps and fans for heating	0.0000	0.0000	0.0000	(249)
Energy for lighting	851.9556	13.1900	112.3729	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-669.8938	13.1900	-88.3590	(252)
Total energy cost			748.8930	(255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12): 0.4200 (256)
Energy cost factor (ECF) [(255) x (256)] / [(4) + 45.0] = 1.0386 (257)
SAP value 85.5118
SAP rating (Section 12) 86 (258)
SAP band B

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2219.6597	0.5190	1152.0034	(261)
Space heating - secondary	873.1007	0.5190	453.1393	(263)
Water heating (other fuel)	1721.2139	0.5190	893.3100	(264)
Space and water heating			2498.4527	(265)
Space cooling	4.9403	0.5190	2.5640	(266)
Pumps and fans	676.7565	0.5190	351.2366	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Energy saving/generation technologies				
PV Unit	-669.8938	0.5190	-347.6749	(269)
Total kg/year			2946.7434	(272)
CO2 emissions per m2			11.4300	(273)
EI value			86.9617	
EI rating			87	(274)
EI band			B	

Calculation of stars for heating and DHW

Main heating energy efficiency	13.19 × (1 + 0.29 × 0.00) / 3.8822 = 3.398, stars = 5
Main heating environmental impact	0.519 × (1 + 0.29 × 0.00) / 3.8822 = 0.1337, stars = 5
Water heating energy efficiency	13.19 / 1.3386 = 9.854, stars = 2
Water heating environmental impact	0.519 / 1.3386 = 0.3877, stars = 3

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)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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	4.6000	4.5000	4.4000	4.1000	4.1000	3.7000	3.8000	3.7000	3.7000	4.0000	3.9000	4.3000	(22)
Wind factor	1.1500	1.1250	1.1000	1.0250	1.0250	0.9250	0.9500	0.9250	0.9250	1.0000	0.9750	1.0750	(22a)
Adj infilt rate	0.1955	0.1913	0.1870	0.1743	0.1743	0.1573	0.1615	0.1573	0.1573	0.1700	0.1658	0.1828	(22b)

Balanced mechanical ventilation with heat recovery
If mechanical ventilation: 0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 76.5000 (23c)

Effective ac	0.3130	0.3088	0.3045	0.2918	0.2918	0.2748	0.2790	0.2748	0.2748	0.2875	0.2833	0.3003	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.6000	9.0560			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.0850			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 149.2636 (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	69.4507	68.5077	67.5647	64.7356	64.7356	60.9636	61.9066	60.9636	60.9636	63.7926	62.8496	66.6217	(38)
Heat transfer coeff	218.7143	217.7713	216.8283	213.9992	213.9992	210.2272	211.1702	210.2272	210.2272	213.0562	212.1132	215.8853	(39)

Average = Sum(39)m / 12 = 213.6849 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8482	0.8446	0.8409	0.8299	0.8299	0.8153	0.8190	0.8153	0.8153	0.8263	0.8226	0.8373	(40)
HLP (average)												0.8287	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)										Total = Sum(45)m =		1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Store volume 200.0000 (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 0.8434 (52)
Temperature factor from Table 2b 0.5400 (53)
Enter (49) or (54) in (55) 0.9372 (55)
Total storage loss
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (56)
If cylinder contains dedicated solar storage
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (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
227.3207 200.3134 210.2604 188.3280 184.4420 164.6430 157.9672 173.5524 173.3128 195.2930 206.6991 221.7987 (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
227.3207 200.3134 210.2604 188.3280 184.4420 164.6430 157.9672 173.5524 173.3128 195.2930 206.6991 221.7987 (64)
Total per year (kWh/year) = Sum(64)m = 2303.9309 (64)
Heat gains from water heating, kWh/month
100.0414 88.6947 94.3689 86.2874 85.7843 78.4122 76.9814 82.1635 81.2949 89.3922 92.3958 98.2054 (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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

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

	120.6031	107.1186	87.1147	65.9515	49.2995	41.6207	44.9726	58.4571	78.4610	99.6243	116.2763	123.9551	(67)

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

	631.5844	638.1383	621.6228	586.4631	542.0804	500.3669	472.4997	465.9459	482.4614	517.6210	562.0038	603.7173	(68)

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

	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	56.5399	(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)

	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	-123.0854	(71)

Water heating gains (Table 5)

	134.4643	131.9861	126.8399	119.8437	115.3015	108.9058	103.4696	110.4348	112.9095	120.1508	128.3275	131.9965	(72)

Total internal gains

	1004.7345	995.3257	953.6600	890.3409	824.7640	768.9760	739.0246	752.9205	791.9146	855.4788	924.6902	977.7514	(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	2.3800	11.5821	0.6300	0.7000	0.7700	8.4243	(74)
South	2.4000	49.2853	0.6300	0.7000	0.7700	36.1494	(78)
Southwest	2.8200	39.1209	0.6300	0.7000	0.7700	33.7155	(79)
West	1.6000	21.5869	0.6300	0.7000	0.7700	10.5556	(80)
East	2.3900	28.6477	0.6300	0.7000	1.0000	27.4140	(82)
South	0.6800	50.5332	0.6300	0.7000	1.0000	13.6385	(82)
Southwest	0.6800	43.2691	0.6300	0.7000	1.0000	11.6780	(82)
West	0.6800	28.6477	0.6300	0.7000	1.0000	7.7318	(82)

Solar gains	149.3071	243.2089	368.4293	521.8214	607.3414	659.9368	628.0447	561.7797	457.0744	304.2265	187.9424	123.3636	(83)
Total gains	1154.0417	1238.5346	1322.0893	1412.1623	1432.1054	1428.9128	1367.0693	1314.7002	1248.9891	1159.7053	1112.6326	1101.1151	(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	81.8705	82.2250	82.5826	83.6744	83.6744	85.1757	84.7954	85.1757	85.1757	84.0447	84.4184	82.9434	
alpha	6.4580	6.4817	6.5055	6.5783	6.5783	6.6784	6.6530	6.6784	6.6784	6.6030	6.6279	6.5296	
util living area													
	0.9994	0.9990	0.9966	0.9844	0.9205	0.6722	0.4163	0.4623	0.8339	0.9862	0.9984	0.9996	(86)
Tweekday	19.9872	20.0779	20.3100	20.5934	20.8545	20.9878	20.9996	20.9991	20.9492	20.6487	20.2908	19.9815	
Tweekend	20.4264	20.4777	20.6092	20.7697	20.9176	20.9931	20.9998	20.9995	20.9712	20.8011	20.5983	20.4231	
24 / 16	9	8	9	8	9	9	9	9	8	9	8	9	
24 / 9	22	20	22	22	22	21	22	22	22	22	22	22	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	20.2117	20.2149	20.2180	20.2275	20.2275	20.2401	20.2369	20.2401	20.2401	20.2306	20.2338	20.2212	(88)
util rest of house													
	0.9992	0.9986	0.9952	0.9772	0.8826	0.5732	0.2991	0.3420	0.7545	0.9783	0.9977	0.9994	(89)
Tweekday	19.0093	19.1280	19.4275	19.7936	20.1037	20.2348	20.2369	20.2400	20.2093	19.8676	19.4155	19.0093	
Tweekend	19.0093	19.1280	19.4275	19.7936	20.1037	20.2348	20.2369	20.2400	20.2093	19.8676	19.4155	19.0093	
MIT 2	20.2117	20.2149	20.2180	20.2275	20.2275	20.2401	20.2369	20.2401	20.2401	20.2306	20.2338	20.2212	(90)
Living area fraction									fLA = Living area / (4) =			0.0851	(91)
MIT	20.2788	20.2817	20.2846	20.2932	20.2932	20.3048	20.3019	20.3048	20.3048	20.2961	20.2990	20.2875	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.2788	20.2817	20.2846	20.2932	20.2932	20.3048	20.3019	20.3048	20.3048	20.2961	20.2990	20.2875	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9993	0.9986	0.9954	0.9780	0.8863	0.5820	0.3091	0.3523	0.7621	0.9791	0.9978	0.9994	(94)
Useful gains	1153.1898	1236.8432	1315.9499	1381.0564	1269.3423	831.6286	422.6197	463.2194	951.8858	1135.4906	1110.1519	1100.5023	(95)
Ext temp.	5.2000	5.7000	7.7000	10.2000	13.3000	16.3000	18.3000	18.1000	15.5000	11.9000	8.2000	5.2000	(96)
Heat loss rate W													
	3297.9579	3175.4784	2728.6945	2159.9428	1496.5452	841.9125	422.7384	463.5036	1010.0942	1788.8436	2566.3569	3257.1615	(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													
	1595.7074	1302.7629	1051.0820	560.7982	169.0389	0.0000	0.0000	0.0000	0.0000	486.0946	1048.4676	1604.5545	(98)

Space heating 7818.5061 (98)
Space heating per m2 (98) / (4) = 30.3219 (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.	5.2000	5.7000	7.7000	10.2000	13.3000	16.3000	18.3000	18.1000	15.5000	11.9000	8.2000	5.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	1618.7491	1203.6700	1240.3402	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8282	0.9288	0.9064	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1340.6408	1117.9348	1124.2223	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1481.4771	1417.3298	1360.7886	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	101.4021	222.7499	176.0053	0.0000	0.0000	0.0000	0.0000	(104)

Space cooling 500.1573 (104)
Cooled fraction fC = cooled area / (4) = 0.4221 (105)
Intermittency factor (Table 10b)

	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	10.6996	23.5038	18.5715	0.0000	0.0000	0.0000	0.0000	(107)

Space cooling 52.7750 (107)
Space cooling per m2 0.2047 (108)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0860 (201)
Fraction of space heat from main system(s) 0.9140 (202)
Efficiency of main space heating system 1 (in %) 387.3387 (206)
Efficiency of secondary/supplementary heating system, % 100.0000 (208)
Space heating requirement 1844.9268 (211)
Cooling System Energy Efficiency Ratio (see Table 10c) 4.0000 (209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1595.7074	1302.7629	1051.0820	560.7982	169.0389	0.0000	0.0000	0.0000	0.0000	486.0946	1048.4676	1604.5545	(98)
Space heating efficiency (main heating system 1)	387.3387	387.3387	387.3387	387.3387	387.3387	0.0000	0.0000	0.0000	0.0000	387.3387	387.3387	387.3387	(210)
Space heating fuel (main heating system)	376.5378	307.4119	248.0230	132.3311	39.8880	0.0000	0.0000	0.0000	0.0000	114.7034	247.4061	378.6255	(211)
Water heating requirement	137.2308	112.0376	90.3931	48.2286	14.5373	0.0000	0.0000	0.0000	0.0000	41.8041	90.1682	137.9917	(215)

Water heating
Water heating requirement

	227.3207	200.3134	210.2604	188.3280	184.4420	164.6430	157.9672	173.5524	173.3128	195.2930	206.6991	221.7987	(64)

Efficiency of water heater 133.8550 (216)

(217)m	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	(217)

Fuel for water heating, kWh/month

	169.8261	149.6495	157.0807	140.6956	137.7924	123.0010	118.0137	129.6571	129.4780	145.8989	154.4201	165.7007	(219)

Water heating fuel used 1721.2139 (219)
Space cooling fuel requirement

(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	2.6749	5.8760	4.6429	0.0000	0.0000	0.0000	0.0000	(221)

Cooling 13.1937 (221)
Annual totals kWh/year
Space heating fuel - main system 1844.9268 (211)
Space heating fuel - secondary 672.3915 (215)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)
mechanical ventilation fans (SFP = 0.8250) 676.7565 (230a)
Total electricity for the above, kWh/year 676.7565 (231)
Electricity for lighting (calculated in Appendix L) 851.9556 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV Unit 0 (0.80 * 0.98 * 1099 * 0.80) = -689.5023 -689.5023 (233)
Total delivered energy for all uses 5090.9358 (238)

10a. Fuel costs - using BEDF prices (374)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1844.9268	14.8100	273.2337	(240)
Space heating - secondary	672.3915	14.8100	99.5812	(242)
Water heating (other fuel)	1721.2139	14.8100	254.9118	(247)
Space cooling	13.1937	14.8100	1.9540	(248)
Mechanical ventilation fans	676.7565	14.8100	100.2276	(249)
Pumps and fans for heating	0.0000	0.0000	0.0000	(249)
Energy for lighting	851.9556	14.8100	126.1746	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-689.5023	14.8100	-102.1153	(252)
Total energy cost			753.9676	(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	1844.9268	0.5190	957.5170	(261)
Space heating - secondary	672.3915	0.5190	348.9712	(263)
Water heating (other fuel)	1721.2139	0.5190	893.3100	(264)
Space and water heating			2199.7982	(265)
Space cooling	13.1937	0.5190	6.8476	(266)
Pumps and fans	676.7565	0.5190	351.2366	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Energy saving/generation technologies				

PV Unit	-689.5023	0.5190	-357.8517 (269)
Total kg/year			2642.1957 (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	1844.9268	3.0700	5663.9251 (261)
Space heating - secondary	672.3915	3.0700	2064.2420 (263)
Water heating (other fuel)	1721.2139	3.0700	5284.1267 (264)
Space and water heating			13012.2938 (265)
Space cooling	13.1937	3.0700	40.5048 (266)
Pumps and fans	676.7565	3.0700	2077.6425 (267)
Energy for lighting	851.9556	3.0700	2615.5038 (268)
Energy saving/generation technologies			
PV Unit	-689.5023	3.0700	-2116.7720 (269)
Primary energy kWh/year			15629.1729 (272)
Primary energy kWh/m2/year			60.6134 (273)

SAP 2012 EPC IMPROVEMENTS

Current energy efficiency rating: B 86
Current environmental impact rating: B 87

(For testing purposes):

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

Recommended measures:	SAP change	Cost change	CO2 change
N Solar water heating	+ 1.7	-£ 100	-350 kg (13.3%)

	Typical annual savings		Energy efficiency	Environmental impact
Recommended measures				
Solar water heating	£100	1.36 kg/m²	B 87	B 88
Total Savings	£100	1.36 kg/m²		

Potential energy efficiency rating: B 87
Potential environmental impact rating: B 88

Fuel prices for cost data on this page from database revision number 374 TEST (25 Feb 2015)
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	£856	£756	£100
Space heating	£473	£474	-£1
Space cooling	£2	£2	£0
Water heating	£255	£154	£100
Lighting	£126	£126	£0
Generated (PV)	-£102	-£102	£0
Total cost of fuels	£754	£654	£100
Total cost of uses	£754	£654	£99
Delivered energy	20 kWh/m²	17 kWh/m²	3 kWh/m²
Carbon dioxide emissions	2.6 tonnes	2.3 tonnes	0.4 tonnes
CO2 emissions per m²	10 kg/m²	9 kg/m²	1 kg/m²
Primary energy	61 kWh/m²	53 kWh/m²	8 kWh/m²

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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)

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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.6000	9.0560			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	92.0850			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 149.2636 (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	74.1659	73.2228	72.2798	67.5647	66.6217	61.9066	61.9066	60.9636	63.7926	66.6217	68.5077	70.3938	(38)
Heat transfer coeff	223.4295	222.4864	221.5434	216.8283	215.8853	211.1702	211.1702	210.2272	213.0562	215.8853	217.7713	219.6574	(39)
Average = Sum(39)m / 12 =												216.5926	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8665	0.8629	0.8592	0.8409	0.8373	0.8190	0.8190	0.8153	0.8263	0.8373	0.8446	0.8519	(40)
HLP (average)												0.8400	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)
Energy content (annual)											Total = Sum(45)m =	1687.9629	(45)
Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Store volume 200.0000 (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 0.8434 (52)
Temperature factor from Table 2b 0.5400 (53)
Enter (49) or (54) in (55) 0.9372 (55)
Total storage loss
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (56)
If cylinder contains dedicated solar storage
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (57)
Primary loss 23.2624 21.0112 21.8667 15.7584 10.4681 9.9053 10.2355 11.1660 17.1091 21.8667 22.5120 23.2624 (59)
Total heat required for water heating calculated for each month
227.3207 200.3134 208.8646 181.5744 171.6477 152.0363 144.9403 161.4560 167.9099 193.8973 206.6991 221.7987 (62)
Aperture area of solar collector 3.0000 (H1)
Zero-loss collector efficiency 0.7000 (H2)
Collector heat loss coefficient 1.8000 (H3)
Collector 2nd order heat loss coefficient 0.0050 (H3a)
Collector effective heat loss coefficient 1.8063 (H3b)
Collector performance ratio 2.5804 (H4)
Annual solar radiation per m2 1079.5246 (H5)
Overshading factor 0.8000 (H6)
Solar energy available 1813.6014 (H7)
Adjustment factor for showers 1.0000 (H7a)
Solar-to-load ratio 1.0744 (H8)
Utilisation factor 0.6057 (H9)
Collector performance factor 0.8793 (H10)
Dedicated solar storage volume 75.0000 (H11)
Effective solar volume 75.0000 (H13)
Daily hot water demand 107.2820 (H14)
Volume ratio Veff/V 0.6991 (H15)
Solar storage volume factor 0.9284 (H16)
Solar input -896.7965 (H17)
Solar input -26.0053 -43.3954 -73.9073 -99.0504 -122.3684 -120.3076 -118.7177 -103.7242 -81.2369 -55.4752 -30.8460 -21.7620 (63)
Solar input (sum of months) = Sum(63)m = -896.7965 (63)
Output from w/h
201.3154 156.9180 134.9573 82.5241 49.2793 31.7287 26.2226 57.7318 86.6731 138.4220 175.8530 200.0367 (64)
Total per year (kWh/year) = Sum(64)m = 1341.6620 (64)
Heat gains from water heating, kWh/month
100.0414 88.6947 93.2523 80.8846 75.5488 68.3268 66.5598 72.4863 76.9726 88.2756 92.3958 98.2054 (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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
120.6031 107.1186 87.1147 65.9515 49.2995 41.6207 44.9726 58.4571 78.4610 99.6243 116.2763 123.9551 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
631.5844 638.1383 621.6228 586.4631 542.0804 500.3669 472.4997 465.9459 482.4614 517.6210 562.0038 603.7173 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
134.4643 131.9861 125.3391 112.3397 101.5441 94.8983 89.4622 97.4279 106.9063 118.6500 128.3275 131.9965 (72)
Total internal gains
1004.7345 995.3257 952.1592 882.8369 811.0067 754.9686 725.0172 739.9135 785.9114 853.9780 924.6902 977.7514 (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	2.3800	10.6334	0.6300	0.7000	0.7700	7.7343	(74)
South	2.4000	46.7521	0.6300	0.7000	0.7700	34.2913	(78)
Southwest	2.8200	36.7938	0.6300	0.7000	0.7700	31.7100	(79)
West	1.6000	19.6403	0.6300	0.7000	0.7700	9.6037	(80)
East	2.3900	25.9287	0.6300	0.7000	1.0000	24.6441	(82)
South	0.6800	47.0123	0.6300	0.7000	1.0000	12.6882	(82)
Southwest	0.6800	39.9751	0.6300	0.7000	1.0000	10.7890	(82)
West	0.6800	25.9287	0.6300	0.7000	1.0000	6.9980	(82)

Solar gains	138.4586	250.8695	377.7402	517.0029	617.3764	628.0447	599.3305	523.2647	426.3769	287.0866	168.7086	116.5654	(83)
Total gains	1143.1931	1246.1952	1329.8995	1399.8398	1428.3830	1383.0133	1324.3477	1263.1783	1212.2884	1141.0646	1093.3988	1094.3168	(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	80.1427	80.4824	80.8250	82.5826	82.9434	84.7954	84.7954	85.1757	84.0447	82.9434	82.2250	81.5190	
alpha	6.3428	6.3655	6.3883	6.5055	6.5296	6.6530	6.6530	6.6784	6.6030	6.5296	6.4817	6.4346	
util living area	0.9996	0.9992	0.9979	0.9921	0.9661	0.8591	0.6804	0.7310	0.9362	0.9940	0.9991	0.9997	(86)
Tweekday	19.8653	19.9749	20.1724	20.4560	20.7233	20.9277	20.9876	20.9807	20.8519	20.5102	20.1484	19.8587	
Tweekend	20.3573	20.4194	20.5313	20.6919	20.8433	20.9591	20.9930	20.9890	20.9161	20.7226	20.5177	20.3536	
24 / 16	9	8	9	8	9	9	9	9	8	9	8	9	
24 / 9	22	20	22	22	22	21	22	22	22	22	22	22	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	20.1961	20.1992	20.2023	20.2180	20.2212	20.2369	20.2369	20.2401	20.2306	20.2212	20.2149	20.2086	(88)
util rest of house	0.9995	0.9989	0.9971	0.9887	0.9497	0.7960	0.5733	0.6271	0.8985	0.9909	0.9988	0.9996	(89)
Tweekday	18.8410	18.9839	19.2393	19.6131	19.9479	20.1861	20.2320	20.2315	20.1077	19.6858	19.2184	18.8421	
Tweekend	18.8410	18.9839	19.2393	19.6131	19.9479	20.1861	20.2320	20.2315	20.1077	19.6858	19.2184	18.8421	
MIT 2	20.1961	20.1992	20.2023	20.2180	20.2212	20.2369	20.2369	20.2401	20.2306	20.2212	20.2149	20.2086	(90)

Living area fraction fLA = Living area / (4) = 0.0851 (91)

MIT	20.2645	20.2674	20.2702	20.2846	20.2875	20.3019	20.3019	20.3048	20.2961	20.2875	20.2817	20.2760 (92)
Temperature adjustment												0.0000
adjusted MIT	20.2645	20.2674	20.2702	20.2846	20.2875	20.3019	20.3019	20.3048	20.2961	20.2875	20.2817	20.2760 (93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9995	0.9990	0.9972	0.9890	0.9513	0.8021	0.5829	0.6366	0.9024	0.9912	0.9988	0.9996	(94)
Useful gains	1142.6230	1244.9103	1326.1620	1384.4931	1358.8887	1109.2630	771.9527	804.1159	1093.9829	1131.0363	1092.0993	1093.9147	(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													
	3566.9390	3419.0294	3050.7031	2468.5006	1853.9072	1204.0681	781.7277	820.8898	1320.1199	2091.3810	2870.5986	3531.2041	(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													
	1803.6911	1461.0080	1283.0586	780.4854	368.2938	0.0000	0.0000	0.0000	0.0000	714.4965	1280.5195	1813.3433	(98)
Space heating												9504.8961	(98)
Space heating per m2											(98) / (4) =	36.8621	(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	1984.9997	1562.6593	1597.7264	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.6970	0.8067	0.7683	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1383.5177	1260.6401	1227.5102	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1433.2737	1372.5667	1306.4483	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	35.8243	83.2734	58.7300	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												177.8277	(104)
Cooled fraction											fC = cooled area / (4) =	0.4221	(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	3.7801	8.7867	6.1970	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												18.7638	(107)
Space cooling per m2												0.0728	(108)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0920	(201)
Fraction of space heat from main system(s)	0.9080	(202)
Efficiency of main space heating system 1 (in %)	388.2183	(206)
Efficiency of secondary/supplementary heating system, %	100.0000	(208)
Space heating requirement	2223.0910	(211)
Cooling System Energy Efficiency Ratio (see Table 10c)	4.0000	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1803.6911	1461.0080	1283.0586	780.4854	368.2938	0.0000	0.0000	0.0000	0.0000	714.4965	1280.5195	1813.3433	(98)
Space heating efficiency (main heating system 1)													
	388.2183	388.2183	388.2183	388.2183	388.2183	0.0000	0.0000	0.0000	0.0000	388.2183	388.2183	388.2183	(210)
Space heating fuel (main heating system)													
	421.8636	341.7138	300.0933	182.5470	86.1399	0.0000	0.0000	0.0000	0.0000	167.1129	299.4995	424.1211	(211)
Water heating requirement													
	165.9396	134.4127	118.0414	71.8047	33.8830	0.0000	0.0000	0.0000	0.0000	65.7337	117.8078	166.8276	(215)
Water heating													
Water heating requirement													
	201.3154	156.9180	134.9573	82.5241	49.2793	31.7287	26.2226	57.7318	86.6731	138.4220	175.8530	200.0367	(64)
Efficiency of water heater												133.8550	(216)
(217)m	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	(217)
Fuel for water heating, kWh/month													
	150.3981	117.2298	100.8235	61.6518	36.8155	23.7038	19.5903	43.1301	64.7515	103.4119	131.3758	149.4428	(219)
Water heating fuel used												1002.3249	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.9450	2.1967	1.5492	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												4.6910	(221)
Annual totals kWh/year													
Space heating fuel - main system												2223.0910	(211)
Space heating fuel - secondary												874.4504	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)													
mechanical ventilation fans (SFP = 0.8250)												676.7565	(230a)
pump for solar water heating												50.0000	(230g)
Total electricity for the above, kWh/year												726.7565	(231)
Electricity for lighting (calculated in Appendix L)												851.9556	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 0.98 * 1068 * 0.80) =												-669.8938	(233)
Total delivered energy for all uses												5013.3757	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	2223.0910	13.1900	293.2257	(240)
Space heating - secondary	874.4504	13.1900	115.3400	(242)
Water heating (other fuel)	1002.3249	13.1900	132.2067	(247)
Space cooling	4.6910	13.1900	0.6187	(248)
Mechanical ventilation fans	676.7565	13.1900	89.2642	(249)
Pumps and fans for heating	0.0000	0.0000	0.0000	(249)
Pump for solar water heating	50.0000	13.1900	6.5950	(249)
Energy for lighting	851.9556	13.1900	112.3729	(250)
Additional standing charges			0.0000	(251)

Energy saving/generation technologies				
PV Unit	-669.8938		13.1900	-88.3590 (252)
Total energy cost				661.2643 (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] =	0.9171 (257)
SAP value		87.2070
SAP rating (Section 12)		87 (258)
SAP band		B

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2223.0910	0.5190	1153.7843	(261)
Space heating - secondary	874.4504	0.5190	453.8398	(263)
Water heating (other fuel)	1002.3249	0.5190	520.2066	(264)
Space and water heating			2127.8307	(265)
Space cooling	4.6910	0.5190	2.4346	(266)
Pumps and fans	726.7565	0.5190	377.1866	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Energy saving/generation technologies				
PV Unit	-669.8938	0.5190	-347.6749	(269)
Total kg/year			2601.9420	(272)
CO2 emissions per m2			10.0900	(273)
EI value			88.4874	
EI rating			88	(274)
EI band			B	

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	16.3200 (1a)	x	2.4500 (2a)	=	39.9840 (1a) - (3a)	
Ground floor	112.4200 (1b)	x	2.6500 (2b)	=	297.9130 (1b) - (3b)	
First floor	70.5400 (1c)	x	2.5000 (2c)	=	176.3500 (1c) - (3c)	
Second floor	58.5700 (1d)	x	2.7000 (2d)	=	158.1390 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	257.8500					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	672.3860	(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	4.6000	4.5000	4.4000	4.1000	4.1000	3.7000	3.8000	3.7000	3.7000	4.0000	3.9000	4.3000	(22)
Wind factor	1.1500	1.1250	1.1000	1.0250	1.0250	0.9250	0.9500	0.9250	0.9250	1.0000	0.9750	1.0750	(22a)
Adj infilt rate	0.1955	0.1913	0.1870	0.1743	0.1743	0.1573	0.1615	0.1573	0.1573	0.1700	0.1658	0.1828	(22b)

Balanced mechanical ventilation with heat recovery
If mechanical ventilation: 0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 76.5000 (23c)

Effective ac	0.3130	0.3088	0.3045	0.2918	0.2918	0.2748	0.2790	0.2748	0.2748	0.2875	0.2833	0.3003	(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	
Doors			2.8900	1.2000	3.4680			(26a)
Windows (Uw = 1.20)			9.2000	1.1450	10.5344			(27)
Shelter Wall Doors			5.6600	1.6000	9.0560			(26)
Rooflight (Uw = 1.20)			4.4300	1.1450	5.0725			(27a)
Heat Loss Floor 1			112.4200	0.1067	11.9967			(28)
Basement Wall 1 (Plant)	40.0300		40.0300	0.1067	4.2717			(29a)
Basement Wall (SP)	111.8000		111.8000	0.1067	11.9305			(29a)
Timber Clad Walling	157.2200	12.0900	145.1300	0.1100	15.9643			(29a)
Shelter Wall	13.7500	5.6600	8.0900	0.1067	0.8633			(29a)
External Roof 1	104.6800	2.7200	101.9600	0.1100	11.2156			(30)
External Flat Roof	10.4100	1.7100	8.7000	0.1100	0.9570			(30)
Pool Basement Flat Roof	63.3000		63.3000	0.1067	6.7549			(30)
Total net area of external elements Aum(A, m2)			613.6100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.0850			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 57.1786 (36)
Total fabric heat loss (33) + (36) = 149.2636 (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	69.4507	68.5077	67.5647	64.7356	64.7356	60.9636	61.9066	60.9636	60.9636	63.7926	62.8496	66.6217	(38)
Heat transfer coeff	218.7143	217.7713	216.8283	213.9992	213.9992	210.2272	211.1702	210.2272	210.2272	213.0562	212.1132	215.8853	(39)

Average = Sum(39)m / 12 = 213.6849 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8482	0.8446	0.8409	0.8299	0.8299	0.8153	0.8190	0.8153	0.8153	0.8263	0.8226	0.8373	(40)
HLP (average)												0.8287	(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 3.0771 (42)
Average daily hot water use (litres/day) 107.2820 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	118.0102	113.7189	109.4276	105.1363	100.8450	96.5538	96.5538	100.8450	105.1363	109.4276	113.7189	118.0102	(44)
Energy conte	175.0056	153.0611	157.9453	137.7005	132.1269	114.0155	105.6521	121.2374	122.6853	142.9779	156.0716	169.4836	(45)

Energy content (annual) Total = Sum(45)m = 1687.9629 (45)

Distribution loss (46)m = 0.15 x (45)m	26.2508	22.9592	23.6918	20.6551	19.8190	17.1023	15.8478	18.1856	18.4028	21.4467	23.4107	25.4225	(46)

Water storage loss:
Store volume 200.0000 (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 0.8434 (52)
Temperature factor from Table 2b 0.5400 (53)
Enter (49) or (54) in (55) 0.9372 (55)
Total storage loss
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (56)
If cylinder contains dedicated solar storage
29.0527 26.2411 29.0527 28.1155 29.0527 28.1155 29.0527 29.0527 28.1155 29.0527 28.1155 29.0527 (57)
Primary loss 23.2624 21.0112 21.8667 15.7584 10.4681 9.9053 10.2355 11.1660 17.1091 21.8667 22.5120 23.2624 (59)
Total heat required for water heating calculated for each month
227.3207 200.3134 208.8646 181.5744 171.6477 152.0363 144.9403 161.4560 167.9099 193.8973 206.6991 221.7987 (62)
Aperture area of solar collector 3.0000 (H1)
Zero-loss collector efficiency 0.7000 (H2)
Collector heat loss coefficient 1.8000 (H3)
Collector 2nd order heat loss coefficient 0.0050 (H3a)
Collector effective heat loss coefficient 1.8063 (H3b)
Collector performance ratio 2.5804 (H4)
Annual solar radiation per m2 1118.3300 (H5)
Overshading factor 0.8000 (H6)
Solar energy available 1878.7945 (H7)
Adjustment factor for showers 1.0000 (H7a)
Solar-to-load ratio 1.1131 (H8)
Utilisation factor 0.5928 (H9)
Collector performance factor 0.8793 (H10)
Dedicated solar storage volume 75.0000 (H11)
Effective solar volume 75.0000 (H13)
Daily hot water demand 107.2820 (H14)
Volume ratio Veff/V 0.6991 (H15)
Solar storage volume factor 0.9284 (H16)
Solar input -909.1853 (H17)
Solar input -27.5781 -41.3477 -70.7400 -97.9141 -117.7527 -123.6096 -121.6619 -108.9996 -85.3919 -57.7495 -33.7886 -22.6516 (63)
Solar input (sum of months) = Sum(63)m = -909.1853 (63)
Output from w/h
199.7427 158.9657 138.1246 83.6603 53.8950 28.4267 23.2784 52.4564 82.5180 136.1478 172.9105 199.1471 (64)
Total per year (kWh/year) = Sum(64)m = 1329.2731 (64)
Heat gains from water heating, kWh/month
100.0414 88.6947 93.2523 80.8846 75.5488 68.3268 66.5598 72.4863 76.9726 88.2756 92.3958 98.2054 (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	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	184.6281	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
120.6031 107.1186 87.1147 65.9515 49.2995 41.6207 44.9726 58.4571 78.4610 99.6243 116.2763 123.9551 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
631.5844 638.1383 621.6228 586.4631 542.0804 500.3669 472.4997 465.9459 482.4614 517.6210 562.0038 603.7173 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 56.5399 (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)
-123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 -123.0854 (71)
Water heating gains (Table 5)
134.4643 131.9861 125.3391 112.3397 101.5441 94.8983 89.4622 97.4279 106.9063 118.6500 128.3275 131.9965 (72)
Total internal gains
1004.7345 995.3257 952.1592 882.8369 811.0067 754.9686 725.0172 739.9135 785.9114 853.9780 924.6902 977.7514 (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	2.3800	11.5821	0.6300	0.7000	0.7700	8.4243	(74)
South	2.4000	49.2853	0.6300	0.7000	0.7700	36.1494	(78)
Southwest	2.8200	39.1209	0.6300	0.7000	0.7700	33.7155	(79)
West	1.6000	21.5869	0.6300	0.7000	0.7700	10.5556	(80)
East	2.3900	28.6477	0.6300	0.7000	1.0000	27.4140	(82)
South	0.6800	50.5332	0.6300	0.7000	1.0000	13.6385	(82)
Southwest	0.6800	43.2691	0.6300	0.7000	1.0000	11.6780	(82)
West	0.6800	28.6477	0.6300	0.7000	1.0000	7.7318	(82)

Solar gains 149.3071 243.2089 368.4293 521.8214 607.3414 659.9368 628.0447 561.7797 457.0744 304.2265 187.9424 123.3636 (83)
Total gains 1154.0417 1238.5346 1320.5885 1404.6583 1418.3480 1414.9054 1353.0619 1301.6933 1242.9859 1158.2045 1112.6326 1101.1151 (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	81.8705	82.2250	82.5826	83.6744	83.6744	85.1757	84.7954	85.1757	85.1757	84.0447	84.4184	82.9434	
alpha	6.4580	6.4817	6.5055	6.5783	6.5783	6.6784	6.6530	6.6784	6.6784	6.6030	6.6279	6.5296	
util living area	0.9994	0.9990	0.9966	0.9848	0.9235	0.6779	0.4206	0.4668	0.8363	0.9863	0.9984	0.9996	(86)
Tweekday	19.9872	20.0779	20.3094	20.5904	20.8508	20.9872	20.9995	20.9991	20.9483	20.6481	20.2908	19.9815	
Tweekend	20.4264	20.4777	20.6089	20.7680	20.9155	20.9927	20.9997	20.9995	20.9707	20.8007	20.5983	20.4231	
24 / 16	9	8	9	8	9	9	9	9	8	9	8	9	
24 / 9	22	20	22	22	22	21	22	22	22	22	22	22	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	20.2117	20.2149	20.2180	20.2275	20.2275	20.2401	20.2369	20.2401	20.2401	20.2306	20.2338	20.2212	(88)
util rest of house	0.9992	0.9986	0.9952	0.9778	0.8864	0.5785	0.3022	0.3454	0.7572	0.9784	0.9977	0.9994	(89)
Tweekday	19.0093	19.1280	19.4266	19.7899	20.0999	20.2345	20.2369	20.2399	20.2087	19.8669	19.4155	19.0093	
Tweekend	19.0093	19.1280	19.4266	19.7899	20.0999	20.2345	20.2369	20.2399	20.2087	19.8669	19.4155	19.0093	
MIT 2	20.2117	20.2149	20.2180	20.2275	20.2275	20.2401	20.2369	20.2401	20.2401	20.2306	20.2338	20.2212	(90)

Living area fraction fLA = Living area / (4) = 0.0851 (91)

MIT	20.2788	20.2817	20.2846	20.2932	20.2932	20.3048	20.3019	20.3048	20.3048	20.2961	20.2990	20.2875 (92)
Temperature adjustment												0.0000
adjusted MIT	20.2788	20.2817	20.2846	20.2932	20.2932	20.3048	20.3019	20.3048	20.3048	20.2961	20.2990	20.2875 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9993	0.9986	0.9954	0.9786	0.8901	0.5874	0.3123	0.3558	0.7648	0.9793	0.9978	0.9994	(94)
Useful gains	1153.1898	1236.8432	1314.4950	1374.5332	1262.5312	831.0703	422.6119	463.2016	950.6642	1134.1789	1110.1519	1100.5023	(95)
Ext temp.	5.2000	5.7000	7.7000	10.2000	13.3000	16.3000	18.3000	18.1000	15.5000	11.9000	8.2000	5.2000	(96)
Heat loss rate W	3297.9579	3175.4784	2728.6945	2159.9428	1496.5452	841.9125	422.7384	463.5036	1010.0942	1788.8436	2566.3569	3257.1615	(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	1595.7074	1302.7629	1052.1645	565.4950	174.1064	0.0000	0.0000	0.0000	0.0000	487.0705	1048.4676	1604.5545	(98)
Space heating												7830.3287	(98)
Space heating per m2											(98) / (4) =	30.3678	(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.	5.2000	5.7000	7.7000	10.2000	13.3000	16.3000	18.3000	18.1000	15.5000	11.9000	8.2000	5.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	1618.7491	1203.6700	1240.3402	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8234	0.9258	0.9029	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1332.8937	1114.3995	1119.9519	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1467.4696	1403.3223	1347.7816	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	96.8946	214.9585	169.5053	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												481.3585	(104)
Cooled fraction											fC = cooled area / (4) =	0.4221	(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	10.2240	22.6817	17.8857	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												50.7914	(107)
Space cooling per m2												0.1970	(108)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0860	(201)
Fraction of space heat from main system(s)	0.9140	(202)
Efficiency of main space heating system 1 (in %)	387.3387	(206)
Efficiency of secondary/supplementary heating system, %	100.0000	(208)
Space heating requirement	1847.7165	(211)
Cooling System Energy Efficiency Ratio (see Table 10c)	4.0000	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1595.7074	1302.7629	1052.1645	565.4950	174.1064	0.0000	0.0000	0.0000	0.0000	487.0705	1048.4676	1604.5545	(98)
Space heating efficiency (main heating system 1)	387.3387	387.3387	387.3387	387.3387	387.3387	0.0000	0.0000	0.0000	0.0000	387.3387	387.3387	387.3387	(210)
Space heating fuel (main heating system)	376.5378	307.4119	248.2784	133.4394	41.0838	0.0000	0.0000	0.0000	0.0000	114.9336	247.4061	378.6255	(211)
Water heating requirement	137.2308	112.0376	90.4861	48.6326	14.9732	0.0000	0.0000	0.0000	0.0000	41.8881	90.1682	137.9917	(215)
Water heating													
Water heating requirement	199.7427	158.9657	138.1246	83.6603	53.8950	28.4267	23.2784	52.4564	82.5180	136.1478	172.9105	199.1471	(64)
Efficiency of water heater												133.8550	(216)
(217)m	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	(217)
Fuel for water heating, kWh/month	149.2232	118.7596	103.1897	62.5007	40.2638	21.2369	17.3907	39.1889	61.6473	101.7129	129.1775	148.7782	(219)
Water heating fuel used												993.0695	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	2.5560	5.6704	4.4714	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												12.6978	(221)
Annual totals kWh/year													
Space heating fuel - main system												1847.7165	(211)
Space heating fuel - secondary												673.4083	(215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.8250)													
mechanical ventilation fans (SFP = 0.8250)												676.7565	(230a)
pump for solar water heating												50.0000	(230g)
Total electricity for the above, kWh/year												726.7565	(231)
Electricity for lighting (calculated in Appendix L)												851.9556	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 0.98 * 1099 * 0.80) =											-689.5023	-689.5023	(233)
Total delivered energy for all uses												4416.1020	(238)

10a. Fuel costs - using BEDF prices (374)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1847.7165	14.8100	273.6468	(240)
Space heating - secondary	673.4083	14.8100	99.7318	(242)
Water heating (other fuel)	993.0695	14.8100	147.0736	(247)
Space cooling	12.6978	14.8100	1.8806	(248)
Mechanical ventilation fans	676.7565	14.8100	100.2276	(249)
Pumps and fans for heating	0.0000	0.0000	0.0000	(249)
Pump for solar water heating	50.0000	14.8100	7.4050	(249)
Energy for lighting	851.9556	14.8100	126.1746	(250)
Additional standing charges			0.0000	(251)

Energy saving/generation technologies			
PV Unit	-689.5023	14.8100	-102.1153 (252)
Total energy cost			654.0247 (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	1847.7165	0.5190	958.9649	(261)
Space heating - secondary	673.4083	0.5190	349.4989	(263)
Water heating (other fuel)	993.0695	0.5190	515.4031	(264)
Space and water heating			1823.8668	(265)
Space cooling	12.6978	0.5190	6.5902	(266)
Pumps and fans	726.7565	0.5190	377.1866	(267)
Energy for lighting	851.9556	0.5190	442.1650	(268)
Energy saving/generation technologies				
PV Unit	-689.5023	0.5190	-357.8517	(269)
Total kg/year			2291.9569	(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	1847.7165	3.0700	5672.4897	(261)
Space heating - secondary	673.4083	3.0700	2067.3634	(263)
Water heating (other fuel)	993.0695	3.0700	3048.7233	(264)
Space and water heating			10788.5764	(265)
Space cooling	12.6978	3.0700	38.9824	(266)
Pumps and fans	726.7565	3.0700	2231.1425	(267)
Energy for lighting	851.9556	3.0700	2615.5038	(268)
Energy saving/generation technologies				
PV Unit	-689.5023	3.0700	-2116.7720	(269)
Primary energy kWh/year			13557.4331	(272)
Primary energy kWh/m2/year			52.5788	(273)

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

Overheating Calculation Input Data

Dwelling type	Detached House
Number of storeys	4
Cross ventilation possible	No
SAP Region	Thames Valley
Front of dwelling faces	North West
Overshading	Average or unknown
Thermal mass parameter	250.0
Night ventilation	Yes
Ventilation rate during hot weather (ach)	2.50 (Windows half open)

Overheating Calculation

Summer ventilation heat loss coefficient	554.72 (P1)
Transmission heat loss coefficient	149.26 (37)
Summer heat loss coefficient	703.98 (P2)

Overhangs

Orientation	Ratio	Z_overhangs	Overhang type
North	0.000	1.000	None
South	0.000	1.000	None
South West	0.000	1.000	None
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)
East	1.000	1.00	1.000	1.000	(P8)
South	1.000	1.00	1.000	1.000	(P8)
South	1.000	0.90	1.000	0.900	(P8)
South West	1.000	1.00	1.000	1.000	(P8)
South West	1.000	0.90	1.000	0.900	(P8)
West	1.000	1.00	1.000	1.000	(P8)
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	2.3800	81.1852	0.6300	0.7000	0.9000	69.0204
South	2.4000	112.2060	0.6300	0.7000	0.9000	96.1947
South West	2.8200	119.9223	0.6300	0.7000	0.9000	120.8016
West	1.6000	117.5071	0.6300	0.7000	0.9000	67.1595
East	2.3900	176.6135	0.6300	0.7000	1.0000	185.4425
South	0.6800	190.8804	0.6300	0.7000	1.0000	51.5171
South West	0.6800	187.7691	0.6300	0.7000	1.0000	50.6774
West	0.6800	176.6135	0.6300	0.7000	1.0000	47.6666
total:						688.4797

Jun Jul Aug

Solar gains	729	688	615	(P3)
Internal gains	769	739	753	
Total summer gains	1498	1428	1368	(P5)
Summer gain/loss ratio	2.13	2.03	1.94	(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	18.38	20.18	19.99	(P7)
Likelihood of high internal temperature	Not significant	Not significant	Not significant	

Assessment of likelihood of high internal temperature: Not significant