ENERGY STATEMENT

FOR

13 + 13A West Hampstead Mews
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ENERGY STATEMENT

1.0 EXECUTIVE SUMMARY

This Report has been produced by Johns Slater and Haward in response to Condition 12 of the London Borough of Camden. Full Planning Permission dated 4th April 2014. Ref 2014/1182/P.

To meet the planning requirement and achieve compliance under Part L of the Building Regulations 2010 the energy strategy for 13 + 13A West Hampstead Mews should demonstrate:

i. a reduction in carbon dioxide emmisions of 20% from on-site renewable energy generation.

This Report demonstrates that the strategy proposed for 13 + 13A West Hampstead Mews can not practically meet the required CO_2 emmissions reduction target by renewable sources due to the constraints of the site and the existing building that is to be converted to a dwelling.

Due to the lack of available roof, PV cells and solar thermal solutions are physically not practical.

The dwelling is not suitable for micro CHP and wind is not appropriate.

ASHP appears a suitable solution for both the commercial element and the domestic element.

In accordance with the London Plan toolkit the reduction in CO_2 emissions have been estimated as 32.88%.

By utilising ASHPs to provide the energy for the residential and commercial elements, an on-site renewable energy contribution of 30.39% can be demonstrated.

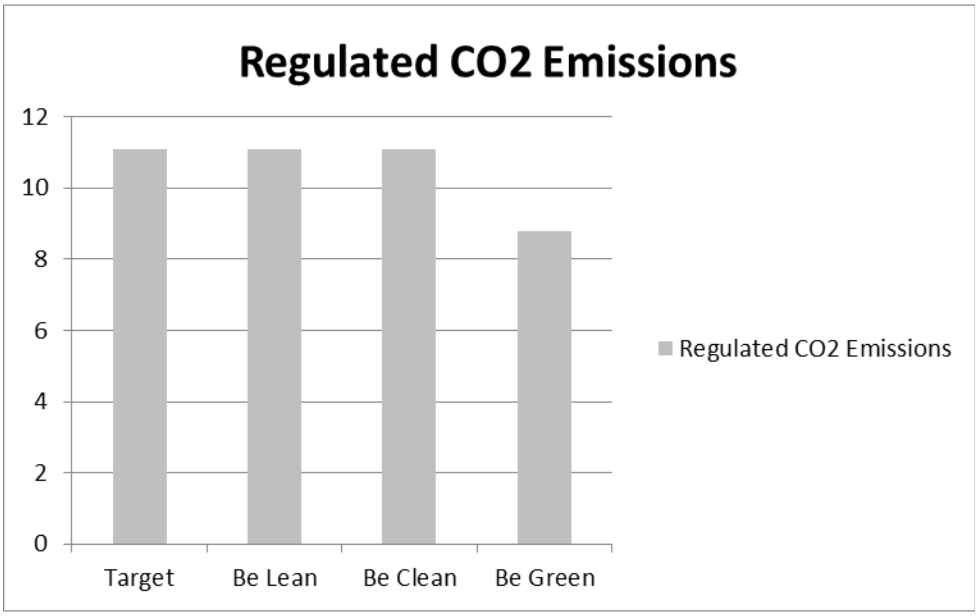


Fig. 1 - Carbon Dioxide Emissions after each stage of the Energy Hierarchy as proposed by Johns Slater and Haward.

	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L of the Building Regulations Compliant Development	11.1	7.82
After energy demand reduction	8.05	7.82

After CHP	8.05	7.82
After renewable energy	7.45	7.82

Table 1 – CO_2 Emissions Summary

	Regulated Carbon dioxide savings	
	(Tonnes CO_2 per annum)	
Savings from energy demand reduction	3.05	27.48
Savings from CHP	0	0
Savings from renewable energy	0.60	5.4%
Total Cumulative Savings	**3.65**	**32.88%**
Total Target Savings	3.08	20%

Table 2 - CO_2 Savings

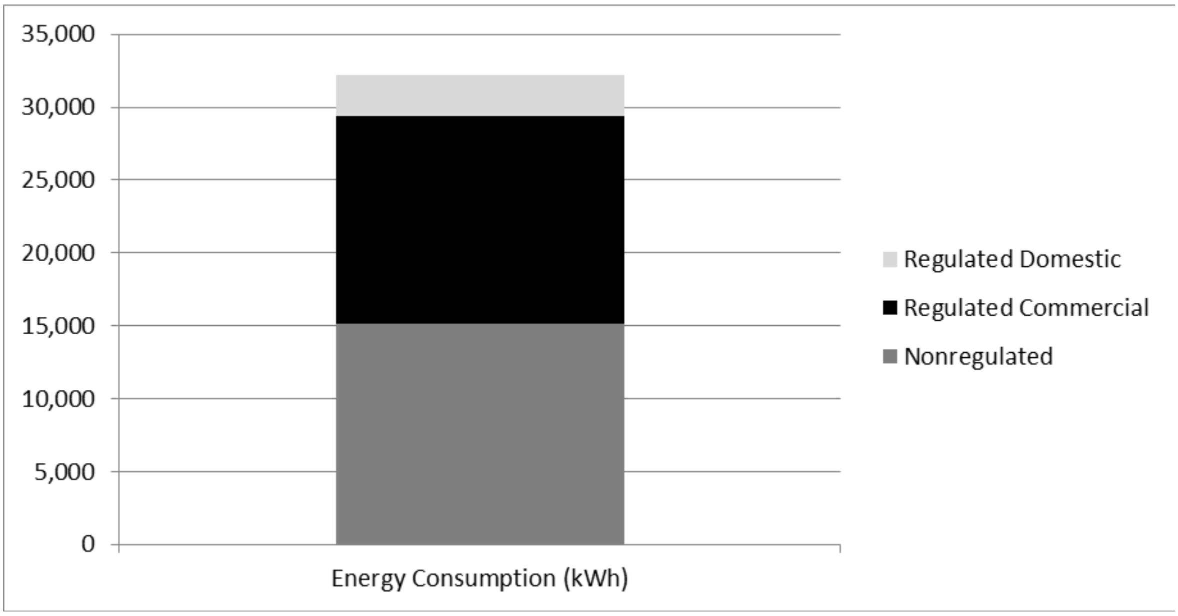


Fig. 2 - Energy Consumption for Baseline Building Total kWh per annum

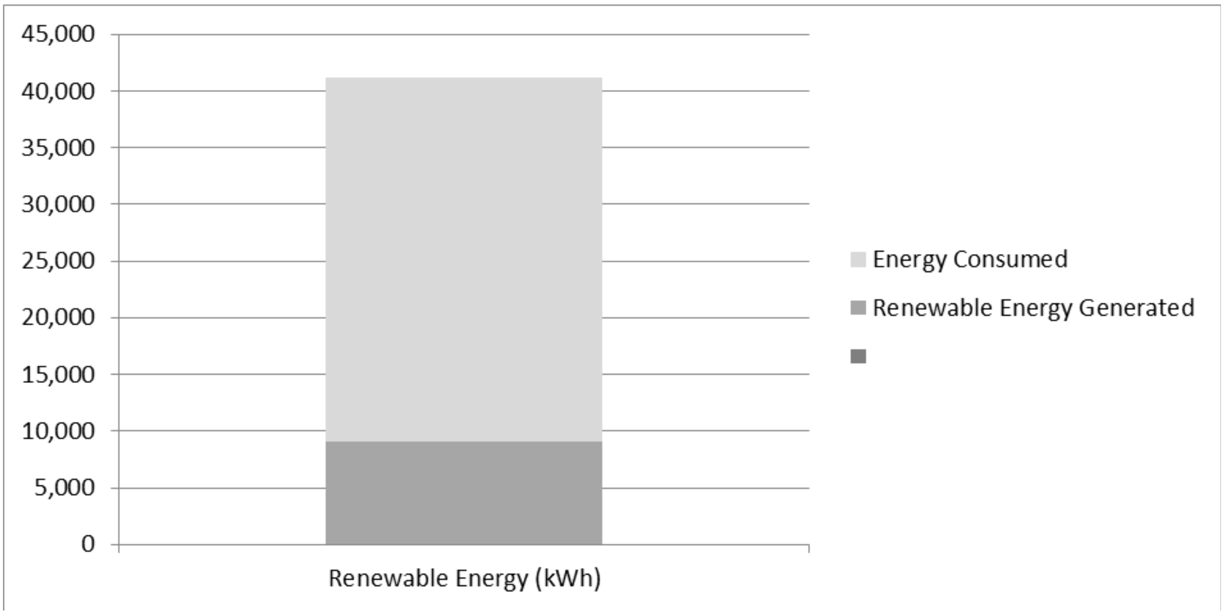


Fig. 3 - Renewable Energy Generation kWh Per Annum

2.0 INTRODUCTION

2.1 About Us

Johns Slater and Haward are Building Services Consultants with expertise in Mechanical and Electrical installations for buildings with particular emphasis on energy installations. Johns Slater and Haward are accredited CIBSE Low Carbon Consultants.

2.2 The Development

The development at 13+ 13A West Hampstead Mews compises the conversion and refurbishment of an existing 2 story building fronting the road into a 2 bedroom house with attic space. The rear of the site which formerly was used as a vehicle workshop is to be rebuilt as new to provide office accomodation on ground, first and second floor

2.3 The Criteria

Clause 12 of the Full Planning permission granted by Camden Regeneration and Planning Development Management ref 2014/1182/P dated 4th April 2014 states:

‘Before the development commences, an energy statement shall be submitted to the Council specifying how the proposed development follows the steps of the energy hierarchy and minimises its energy needs during both construction and occupation’

This Report outlines the expected energy performance of the residential and commercial elements of the development and the energy efficient measures that will be adopted.

It demonstrates how the development fulfils the relevant energy policies of the Camden Council

This Report also addresses the relevant energy policies contained within the London Plan:

- Policy 5.2 - Minimising Carbon Dioxide Emissions
- Policy 5.3 - Sustainable Design and Construction
- Policy 5.5 - Decentralised Energy Networks
- Policy 5.6 – Decentralised Energy in Development Proposals

- Policy 5.7 – Renewable Energy where feasible

The methodology employed to determine the potential CO_2 savings for this development is in accordance with the three step Energy Hierarchy outlined in the London Plan and Camden Council's Planning Guidance on Sustainability CPG 3 September 2013:

- **Be Lean** – uses less energy - improve the energy efficiency of the scheme
- **Be Clean** – use energy efficiently - supply as much of the remaining energy requirement efficiently using district networks or site wide networks and technology such as combined heat and power (CHP)
- **Be Green** – use renewable energy - offset a proportion of the remaining carbon dioxide emission by using renewable technologies.

Policy SC2.3 Passive Solar Design Maximising the efficient use of energy through passive solar design.

European Directive 2009/28/EC of 23rd April 2009 includes energy generated from 'aerothermal' sources, i.e. Air Source Heat Pumps (ASHP) as renewable energy technology.

It is noted that Camden Council's Planning Guidance on sustainability CPG 3 includes Air Source Heat Pumps (ASHP) as renewable energy technology.

It should be noted that the April 2014 Greater London Authority guidance on preparing energy assessments Clause 9.2 states:

> "Detailed requirements for different types of renewable energy
>
> Appendix 3 provides further guidance in relation to particular types of renewable energy systems. Where a particular type of renewable energy system is proposed, the relevant section should be consulted and required information provided as part of the energy assessment.
>
> For the avoidance of doubt, heat pumps are categorised under this third and final element of the energy hierarchy (not the first element, 'be lean')".

2.4 Basis of Report

The residential unit has been assessed using SAP calculated by Elmhurst Energy Systems Software.

Full SAP worksheets for the residential unit are included in Appendix 1 of this Report.

The figures obtained from the completed SAP) have been used to generate the figures in this Report.

The commercial element of the building has been thermally modelled using dynamic software developed by TAS and incorporating standard weather data to provide thermal loads.

The resulting BRUKL output document is included in Appendix 2 of this report.

The following technologies have been appraised, in terms of technical, physical and financial feasibility, as potential low and zero carbon (LZC) systems for use on the Project:

- Gas fired combined heat and power (CHP)
- Photovoltaics
- Solar Thermal

- Air Source Heat Pumps (ASHP)
- Ground Source Heat Pumps
- Biomass CHP
- Biomass heating systems
- Wind turbines

3.0 BASELINE CALCULATIONS

For the purpose of this study the energy consumption and carbon dioxide emissions for the development have been estimated for different parts of the development using both preliminary design stage SAP calculation and preliminary SBEM calculations.

The baseline energy requirements (commercial) will be compliant with Part L2 2013. The baseline for the residential part is not compliant as it is an existing dwelling. We have however taken the residential baseline as gas fired boilers and the default air permeability (15m^3/hr.m^2).

Notional	KWh/yr	Tonnes/CO_2/yr
Domestic Regulated Energy Use		
Total	11,269	3,730
Non Domestic Regulated Energy Use		
Offices	14,256	7,370
Regulated Energy Use		
Total	25,525	11,100

Table 3 – Total Regulated Energy Use and CO_2 Emissions Baseline Building

4.0 DEMAND REDUCTION

4.1 Passive Design Measures

The development has been conceived initially to comply with Building Regulations Approved Document L. To meet the Regulations, the building has been optimised before any low or zero carbon (LZC) technologies are considered.

In optimising the proposal's energy efficiency at the outset, the benefits of any additional LZC technologies could also be fully recognised, rather than used to mask an otherwise low quality and energy intensive proposal. Further, the relatively low cost uplift in improving the basic build specification will reduce the requirement placed on any proposed LZC technology. As such, a generally superior benchmark construction would allow smaller installatons of particular technologies to be considered, making them inherently more economically viable.

4.1.1 General

The following passive design measures will be considered for incorporation into the scheme design to limit the building's baseline energy consumption.

- Façade treatment/solar shading
- Thermal mass/thermal insulation
- Passive solar heating

- Measures to maximise natural daylighting

Whilst every measure that can be incorporated, within the normal commerical constraints, to minimise the effect of the solar gain it is not practically possible to totally prevent the solar gain from affecting the internal environment adversly with higher temperatures than would be normally comfortable.

4.1.2 Enhanced Building Fabric

The heat loss of different building elements is dependant upon their U value. A building with low U values provides better levels of insulation and reduced heating demand during the cooler months.

The proposed development at West Hampstead Mews will incorporate high levels of insulation and high performance glazing where possible to reduce the demand for space heating.

4.1.3 U values (W/m^2K)

The U value of most components will be better than the minimum required for compliance under Part L 2013 of the Building Regulations. Some elements do not meet compliance as the building is part existing.

4.1.4 Air Tightness

Heat loss also occurs due to air infiltration. Although this cannot be eliminated altogether good construction detailing and the use of best practice construction techniques can minimise the amount of air infiltration.

Previous Part L Building Regulations (2013) sets a maximum air permeability of $5m^3/m^2$ at 50Pa.

The West Hampstead Mews development is likely to improve upon this to achieve $8m^3/m^2/hr$ at 50Pa through the application of best practice construction techniques for the residential unit and $3m^3/m^2/hr$ at 50 Pa for the commercial unit.

By improving the air tightness the natural air infiltration is reduced..

4.1.5 Orientation and Site Layout

Passive solar gain reduces the amount of energy required for space heating during the winter months.

The site is a confined one with the proposed development occupying nearly all of the site.

There is therefore little that can be done to affect the orientation of the buildings which naturally utilise the full extent of the site.

4.1.6 Lighting

The development has been designed where possible to improve daylighting in habitable spaces as a way of improving the health and wellbeing of its occupants.

4.2 Active Design Measures

4.2.1 High Efficiency Lighting

The development intends to incorporate low energy lighting fittings throughout. All light fittings will be specified as low energy lighting and will accommodate compact fluorescent (CFLs), fluorescent luminaires or LED luminaires.

Internal areas which are not frequently used will be fitted with occupany sensors whereas daylight areas will be fitted with daylight sensors.

4.2.2 Controls

The development will include good, simple to use controls for heating/cooling and domestic hot water in all apartments by dedicated room thermostats and programmable time clocks.

4.2.3 Energy Efficient Plant

All central plant will incorporate variable speed motors and controls to minimize energy consumption and optimize efficiency.

5.0 ENERGY DEMAND (BE LEAN)

The first step addresses reductions in energy use through the adoption of sustainable design and construction measures.

In accordance with this strategy, the proposed development will incorporate a range of energy efficiency measures including levels of insulation exceeding current Building Regulations and the installation of high performance glazing for both the residential and commercial units. The implementation of these measures would potentially reduce regulated CO_2 emissions when compared to a notional building.

The dwelling energy and CO_2 figures for the buildings have been drawn from the preliminary SAP assessments together with information from preliminary SBEM assessement for the non-domestic areas of the building.

Lean measures are expected to achieve a regulated CO_2 emission over Part L Building Regulation (baseline).

Actual	KWh/yr	Tonnes/CO_2/yr
Domestic Regulated Energy Use		
Total	2,573	1.34
Non-Domestic Regulated Energy Use		
Total	12,977	6.71
Regulated Energy Use		
Total	15,550	8.05

Table 4 – Total Regulated Energy Use and CO_2 Emissions after Be Lean

6.0 HEATING AND COOLING INFRASTRUCTURE (BE CLEAN)

6.1 Energy System Hierarchy

The second strategy takes into account the efficient supply of energy by prioritising decentralised energy generation.

Local heat and power sources minimise distribution losses and achieve greater efficiencies when compared to individual energy systems, thus reducing CO_2 emissions.

In accordance with the development at 13+13A West Hampstead Mews has been assesed in accordance with Section 5 of the Camden Planning Guidance on Sustainability CPG 3 with respect to Decentralised Energy have been determined in accordance with the following hierarchy as detailed in Fig 3 Decentralised Energy Flow Chart:

1. Is there a heat demand- YES

2. Is there an existing network in the vicinity- NO

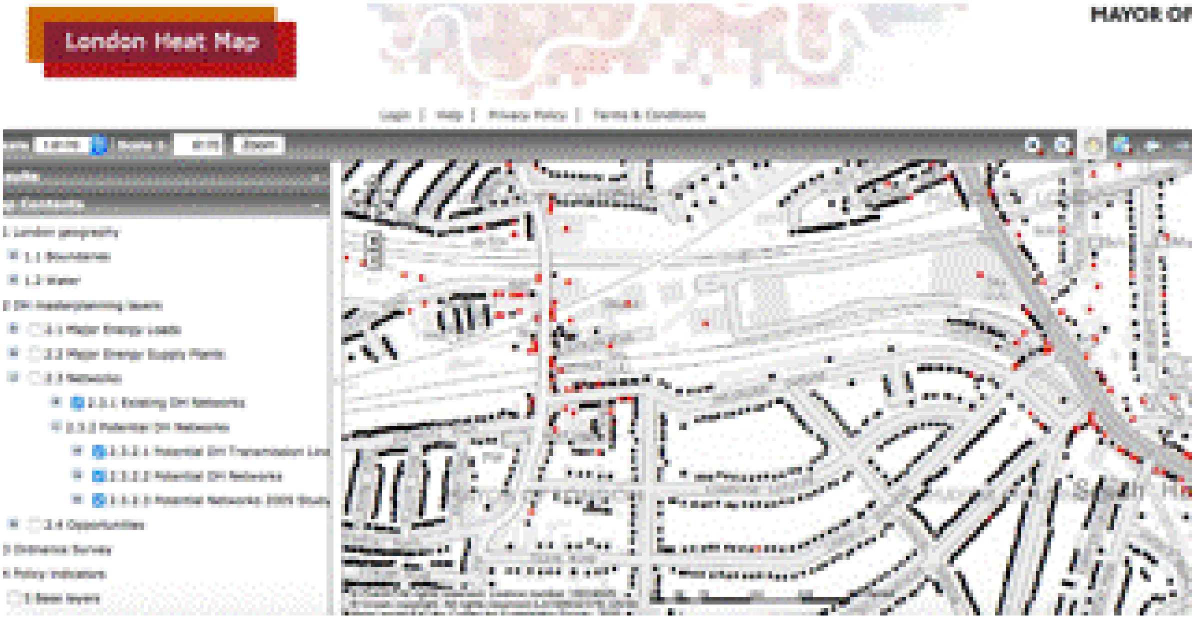
3. Is there a network proposed in the next 3 years- NO

4. Can onsite CHP be provided- NO

6.2 Connnection to Existing Low Carbon Heat Distribution Networks

The London Heat Map identifies existing and potential opportunites for decentralised energy projects in London.

An excerpt from the London Heat Map below shows that there are district heating mains in the vicinity of the site.



It can be seen that the proposed development at 13+13A West Hampstead Mews is not in the vicinity of an existing Decentralised Energy network (1000m) or a proposed network within the next 3 years (500m)

6.3 Gas Fired Combined Heat and Power (CHP)

Combined heat and power (CHP), also known as cogeneration, is the generation of heat and power (usually electricity) at the same time.

In its simplest form a CHP system comprises a gas turbine, engine or steam turbine to drive an alternator. The resulting electricity is used primarily on site. The waste heat, in the form of steam or hot water, is collected and can be used to provide heat for industrial processes, for community heating and for space heating. It can also provide cooling using advanced absorption cooling technology. Not only does CHP enable the conversion of a high proportion of otherwise waste heat to usable heat, but it is very efficient because power is generated close to where it is being used (and thus electricity transmission lossed are minimised).

However, absorbtion cooling is significantly less efficient that cooling using compressor technology.

The predominate fuel used for CHP schemes is natural gas. Other fuels include oil, coal or even renewables (such as municipal and industrial waste, sewage gases, biogases, from anaerboic digestion, biodiesel, gasification, etc. and wood).

A total of around 70 – 80% (Gross Calorific Value) of the energy value of the gas is converted into heat, principally in the form of hot water which is used for space heating and domestic hot water, as in a normal central heating system. Between 10 – 25% is converted into electricity and the remainder(5 – 10%) is lost in the flue gases. This compares with a conventional gas central heating boiler where 85% of the energy in the gas in converted into heat and the remaining 15% is lost in the flue gases.

CHP or Cogeneration is the production of electricity and useful heat from a single plant, improving the overall energy conversion efficiency from between 25 – 35% to around 80%. For a wide range of buildings, CHP can offer an economical method of providing heat and power which is less environmentally harmful than conventional methods. However, the economic viability of CHP is dependant on a consistent demand for heat and power.

Within the residential environment electricity demand is relatively consistent throughout the year. However, the heat load is weighted to the winter months when there is a space heating demand. A CHP engine would therefore be sized to meet the hot water load of the building, which stays relatively consistent throughout the year.

Unfortunately to provide hot water in summer requires the continous circulation via hot water at 75ºC to provide local domestic hot water. These internal mains have both a significant energy loss and tend to lead to significant problems of overheating in internal corridors and also within the apartments.

It should be noted that the Greater London Authority guidance on preparing energy assessments April 2014 states:

> **"By way of general guidance, it is not expected that small purely residential developments (for example, less than 300 dwellings) include on-site CHP.** Due to the small landlord electricity supplies, CHP installed to meet the base heat load would require the export of electricity to the grid. It is recognised that the administrative burden of managing CHP electricity sales at this small scale, where energy service companies (ESCOs) are generally not active, is too great for operators of residential developments to bear. If CHP is installed but does not operate because arrangement for CHP electricity sales are not concluded, the projected CO_2 savings will not materialise".

The residential element of this scheme relates to only 1 dwelling.

If CHP is not suitable for small residential schemes it is even less suited to small commercial schemes since they have no base load as the hot water demand is minimal.

It is therefore concluded that gas fired CHP is a totally inappropriate solution for this development.

7.0 RENEWABLE ENERGY (BE GREEN)

7.1 General

The Report has so far assessed the Lean and Clean measures which are appropriate at West Hampstead Mews The Report has identified that the proposed development will benefit from a high performing building fabric.

The third step in the London Plan assesses the feasibility of on-site renewable energy (Green) once Lean and Clean measures have been taken into account.

A range of renewable technologies were assessed to determine the most suitable technology for this development. Details for each renewable technology are outlined in the following sections. These included:

- Photovoltaic Panels
- Solar Thermal
- Ground Source Heat Pumps (GSHP)
- Air Source Heat Pumps

- Biomass Heating
- Wind Turbines

In determining the most appropriate renewable technology for the site, the following factors were considered:

- CO_2 savings achieved
- the site constraints
- payback and maintenance costs
- any potential visual impacts

The analysis identified ASHP as the most suitable renewable technology for this development.

7.2 Photovoltaic Panels

Photovoltaic (PV) generates electricity from sunlight. Small scale PV modules are available as roof mounted panels, roof tiles and conservatory or atrium roof systems. A typical PV cell consists of two or more thin layers of semi-conducting material, which is most commonly silicone. The electrical charge is generated when the silicon is exposed to light and is conducted away by metal contacts as direct current (DC).

Although the electrical output from a single cell is small, when coupled together a useful electrical output can be achieved. Therefore, PV cells are connected together and encapsulated, usually behind glass, to form a module or panel and any number of modules can be connected together.

The PV system generates no greenhouse gases and save approximatley 325kg of CO_2 per year or about 8 tonnes over the system's lifetime – for each kWp. A typical 1.5 – 2kWp system will produce enough electricity to supply almost half of an average family's annual demand, assuming that the heating is fuelled by gas and that the house has no other energy efficiency savings.

Photovoltaics are potentially a suitable renewable technology for most projects since:

- the installation of photovoltaics is relatively simple when compared to other renewable technologies
- photovoltaics are less visually instrusive when compared to other technologies such as wind turbines

Assesment of both the roof of the dwelling and the commercial unit indicate that it is impractical to provide a PV array due to the form and shape of the roof.

PV panels are therefore considered inappropriate for this development.

7.3 Solar Thermal

Solar thermal is one of the most commonly installed form of solar renewable is use today. Solar water heating can typically provided almost all of a domestic dwelling's hot water requirements during the summer months and about 50% year round.

There are three main components for domestic hot water systems – solar panels, a heat transfer system (pump) and a hot water cylinder. The solar panels (collectors) are usually fitted to the roof and collect heat from the sun's radiation. This heat is used to raise the temperature of the household water and is delivered by the heat transfer system which takes the heated water to the hot water cylinder for storage until use.

Solar thermal arrays have similar requirements as PV arrays in terms of their orientation and inclination.

The most effective use of solar thermal arrays would be to orientate them to the south at an inclination of about 30º.

Solar thermal arrays are available as evacuated tubes and flat plate collectors. Evacuated tubes are more efficient, produce higher temperatures and are more suited to the UK climate in general when compared to flat plate collectors.

The installation of solar thermal would not achieve a significant CO_2 savings as demonstrated by the SAP. In addition, solar thermal requires additional plumbing and space for hot water storage and the collector which is not available in the dwelling.

The hot water load for the commercial element is too small for solar thermal to be viable.

Solar thermal is therefore not considered inappropriate for this development.

7.4 Ground Source Heat Pumps

A heat pump works against natural flows to move heat energy betweem environments with different temperatures. An example of a commonly known heat pump is a domestic refrigerator.

Where heat pumps are used for heating applications, heat is removed from the source (ambient air, water, soil or earth) and then discharged where the heat is needed. Where cooling is required, the reverse happens and heat is removed and discharged into air, water, soil or earth.

A heat pump absorbs energy from one source, upgrades it in the compressor and then delivers this higher-grade energy to the desired location. It is this ability to absorb surrounding energy that makes a heat pump a renewable energy device. Heat pumps of the size required by this site generally have a reverse cycle, in which they reject heat into the ground, air or water, thus providing a low level of cooling that could be incorporated with careful design.

Heat pump efficiency is measured by what is called the Coefficient of Performance (COP). The COP is a measure of the amount of energy delivered (in kW), divided by the amount of energy needed to run the compressor and pumps (also in kW).

A ground source heat pump, as the name implies, extracts energy from the ground and has a COP of around 4. The high COP is due to the stable temperature found within the ground.

Ground source heat pumps would deliver space heating through a low temperature efficient distribution such as underfloor heating.

Ground loops each 100m deep, would be required to meet the peak load. This would require a significant amount of space on site and increase the amount of construction time. In addition, the capital cost of installing these ground loops would be very high.

Ground loops need to be seperated by a sufficient distance to avoid problems of interference between boreholes.

GSHPs are therefore considered to be totally inappropriate for this development.

7.5 Air Source Heat Pumps

Air source heat pumps (ASHPs) employ the same technology as ground source heat pumps (GSHPs). However, instead of using heat exchangers buried in the ground, heat is extracted from the external ambient air.

An advantage of heat pumps is that they can be used to provide cooling as well as heating. Due to the high levels of thermal insulation provided to new buildings and the internal gains from the occupants, equipment such as computers and artificial lighting commercial areas used as offices will generally have a cooling requirement rather than a heating requirement.
ASHP's are considered appropriate for this development due to the renewable 'portion' of energy they supply, which meets the councils Carbon Dioxide reduction targets.

A high temperature heat pump giving a COP of 3.44 has been assumed for the residential part of the development due to the use of radiators as heat emitters in some rooms.

7.6 Biomass Heating

Biomass heating usually involves the use of commercial energy crops in the form of fast growing trees such as willow or poplar for woodchips or waste wood products such as sawdust, pallets or untreated recylced wood for pellets.

These fuels are burned in either pellet stoves or larger scale boilers to provide heating and/or water heating. Man has been producing energy from biomass for centuries, and in many parts of the world it is still the principle source of heat. However, modern technologies are far more efficient that open fires and an increasing range of fuels are now being utilized.

Biomass is often called 'bioenergy' or 'biofuels'. These biofuels are produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products.

A biomass system designed for this development would be fuelled by wood pellets which have a high energy content. Wood pellets require less volume of storage than other biomass fuels. Pellet boilers also required less maintenance and produce considerably less ash residue.

A biomass boiler could supply the space heating and hot water demand to a communal heating scheme.

A biomass system, however, would not be an appropriate low carbon technology for the site for the following reasons:

- There is insufficient space onsite to accommodate a biomass installation.
- the burning of wood pellets releases substanially more NO_2 emissions when compared to high condensing gas boilers. As the development is situated within an urban area, the installation of a biomass boiler would reduce the air quality in this area
- the storage and delivery of wood pellets would be difficult. Due to the very constricted nature of the site delivery of the fuel would be a substanial problem.
- pellets would need to be transported from other sites within the UK or abroad due to the lack of local pellet suppliers

The height of the flue to be taken to the top of the building with the corresponding high cost to ensure the products of combustion for the biomass boiler do not pollute the atmosphere to the detrimental effect on the residents and neighbours. The Clean Air Act prevents discharge of solid fuel flues in central London.

Whilst the use of biomass in the form of wood pellets is accepted as 'renewable' energy as trees can be planted to replace the trees that are used to make the pellets this is not always the case.

However, for a City centre site where the biomass will be obtained using commercial criteria (lowest price) it is highly unlikely that the origin of the timber is known or even traceable and extremely unlikely that any replacement planting of trees will be undertaken.

Indeed it is highly likely that the timber will have orginated from a distance, possibly abroad.

Accordingly, the associated energy use and CO_2 emissions due to the delivery of the fuel to the site will far exceed any theoretical considerations used to substaniate the use.

Biomass is therefore considered totally inappropriate for this development.

7.7 Wind Turbines

Wind turbines harness the wind to produce electrical power. The efficiency of a domestic system will depend on factors such as location and surrounding environment, and the electricity output is usually between 2.5 and 6kWs, but can be as low as 1kW. Calculating electricity generation from a wind turbine requires consideration of the characteristics of wind. Wind power is proportional to the cube of the wind's speed which mean that large changes in potential output can result from relatively minor increases in wind speed. Since wind speed increases with height, a typical wind turbine is mounted high on a mast or tower and a ideal location is on a smooth top hill with a flat, clear exposure and is free from obstructions such as buildings, forests or other large trees that can cause excessive turbulance.

Wind turbines were not considered appropriate for this development due to the low CO_2 savings achieved, the significant impact on the roof space and proximity of the adjacent buildings. The installation of wind turbines also has a significant visual impact on the building.

It is generally acknowledged that urban wind turbines do not, in practice, achieve anything like the theroretical output generated by desk top studies.

The use of wind turbines in urban locations can also generate problems related to noise, flicker and vibration.

There is insufficient space on the site for a wind turbine installation.

Wind turbines are therefore considered to be totally inappropriate for this development.

8.0 RENEWABLE ENERGY SUMMARY

The factors taken into account in determining the appropriate renewable technology for this Project included carbon reduction capability, renewable energy produced estimated capital cost, simple payback, lifetime, level of maintenance and level of impact on external appearance.

The feasibilty study demonstrates that ASHPs would be the most feasible option for the proposed development at West Hampstead Mews.

By using ASHP's on this development to heat the office, a saving of 707kgCO_2/annum can be saved by not using gas.

9.0 CONCLUSIONS

9.1 CO_2 Emissions

In line with the London Plan three step energy hierarchy, the regulated CO_2 emissions for the development at West Hampstead Mews have been reduced once energy efficiency measures and on-site renewable energy generation are taken into account.

i. Be Lean - use less energy

In accordance with this strategy, the development will incorporate a range of energy efficient measures including levels of insulation exceeding Building Regulations, efficient light fittings and the installation of high performance glazing.

ii. Be Clean – supply energy efficiently

Both CHP and district systems have been considered for West Hampstead Mews and have both been rejected since they both use significantly more energy and the estimated CO_2 emissions are significantly better than if CHP were used and of the same order as using the district mains.

To impliment CHP or use the district systems would require a central heat network through the building using low temperature hot water which would cause the communal areas to overheat.

The West Hampstead Mews Development is below the recognised threshold applicable to CHP of 300 units.

iii. Be Green – use renewable energy

The feasibility study undertaken determined the most appropriate renewable technology for this development was the use of ASHPs.

ASHPs were considered to be best suited to this development due to:

- the amount of CO_2 savings achieved 32.88% over the notional building
- the significant on site renewable energy generation at 30.39%
- The ease of installation compared to other renewable technologies

The solutions proposed by Johns Slater and Howard will ensure that a high quality internal environment will be provided for all the residents from renewable and efficient energy sources.

The figures show a significant CO_2 reduction in regulated emissions when compared to a baseline scheme). This illustrates that the Energy Strategy proposed for West Hampstead Mews achieves a significant CO_2 saving.

The total percentage saving in CO_2 emissions afforded by the 3 step hierarchy for West Hampstead Mews is estimated as 32.88%.

	Energy Element	Tonnes CO_2 emissions per annum	Comments
1.	Baseline Part L (2013) (Regulated)	11.1	Derived from target emission rates from both SAP and SBEM (regulated energy)
2.	**Domestic (Regulated)**	**1.34**	
3.	Offices	6.11	
4.	**Regulated Emissions Total (2+3)**	**7.45**	
5.	CO_2 savings	3.65	
6.	**Non Regulated Emissions Total**	**7.82 equipment**	
7.	**Total Building Emissions (4+6)**	**15.27**	
8.	Total Baseline CO_2 Emissions	11.1	Estimated for basic building
9.	20% Carbon Emissions Target	3.08	

Table 5 – CO_2 Emissions

9.2 <u>On Site Renewable Generation</u>

The use of ASHPs for the generation of heat for space heating will lead to a significant on-site renewables generation.

	Energy Element	KWh/y	Comments
1.	**Domestic (Dwelling) (Regulated)**	**2,573**	Based on SAP Data.
2.	Offices (Grd / 2nd)	14,256	Based on SBEM Data.
3.	**Regulated Energy Total (1+2)**	**16,829**	
4.	**Non Regulated Energy Total**	**15,123**	Refer to notes titled 'Non Regulated Energy'
5.	**Total Building Energy (3+4)**	**31,952**	
6.	10% Renewables Requirement	3,195	
7.	Renewable Energy Generated	9,710	Equates to 30.39% renewable energy contribution (Total energy) 8,242.00 kWh commercial 1,468.00 kWh residential

<u>Table 6 – Renewable Energy</u>

APPENDIX 1

13+13A WEST HAMPSTEAD MEWS

SAP WORKSHEET FOR RESIDENTIAL UNIT

Full SAP Calculation Printout

Property Reference: S1502-HOUSE **Issued on Date:** 05.Aug.2015
Survey Reference: ASHP **Prop Type Ref:**
Property: NW6

SAP Rating: 74 C	**CO2 Emissions (t/year):** 2.35	**DER:** 26.23 Pass	**TER:** 26.23	**Percentage DER<TER:** -0.01 %
Environmental: 77 C	**General Requirements Compliance:** Fail	**DFEE:** 66.86 Fail	**TFEE:** 58.95	**Percentage DFEE<TFEE:** -13.42 %

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

Surveyor: Ian Turvey, Tel: 01763 273315 Surveyor ID: 6195-0001
Address: The Folly, Buntingford, Herts, SG9 9EB
Client:

Software Version: Elmhurst Energy Systems SAP2012 Calculator (Design System) version 3.04r05
SAP version: SAP 2012, Regs Region: England (Part L1A 2013), Calculation Type: New Build (As Designed)

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

```
SAP2012 Input Data (House)    29/02/2016

FullRefNo:                    ASHP

Regs Region:                  England
SAP Region:                   Thames Valley
Postcode:                     NW6
DwellingOrientation:          North
Property Type:                House, Detached
Storeys:                      3
Date Built:                   2015
Sheltered Sides:              2
Sunlight Shade:               Average or unknown
Measurements                  Perimeter, Floor Area, Storey Height
    1st Storey:               25.2, 41.18, 2.7
    2nd Storey:               25.2, 40.32, 2.7
    3rd Storey:               20.8, 24.73, 1.98
Living Area:                  35 m2, fraction: 32.9%
Thermal Mass:                 Simple calculation
Thermal Mass Simple:          Low
Thermal MassValue:            100
External Walls                Nett Area, Gross Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
Wall 1                        103.33, 124.74, 9, SolidWallPlasterOnDabsInsul, Solid, 0, 0.24, Gross
Wall 2                        11.34, 11.34, 9, SolidWallPlasterOnDabsInsul, Solid, 0, 0.32, Gross
Wall 3                        20.8, 20.8, 18, TimberWallTwoLayers, TimberFrame, 0, 0.15, Gross
External Roofs                Nett Area, Gross Area, Kappa, Construction, Element, UValueFinal
    External Roof 1           32.32, 33.63, 9, Plasterboard, insulated slope, 0.15
    External Roof 2           5.4, 5.4, 9, Plasterboard, insulated flat roof, 0.13
    External Roof 3           15.59, 15.59, 9, Plasterboard, insulated flat roof, 0.16
Heat Loss Floors              Area, Kappa, Construction, Element, Type, ShelterFactor, UValueFinal
    Heat Loss Floor 1         41.18, 110, Slab on ground, screed over insulation, Ground Floor - Solid, 0, 0.18
Description                   Data Source, Type, Glazing, Glazing Gap, Argon Filled, Solar Trans, Frame Type, Frame Factor, U Value
    Opening Type 1            Manufacturer, Window, Double Low-E Hard 0.15, , , 0.72, , 0.7,
    Opening Type 2            SAP table, Solid Door, , , , , , , 3.00
    Opening Type 3            Manufacturer, Roof Window, Double Low-E Hard 0.15, , , 0.72, , 0.7,
Openings                      Opening Type, Location, Orientation, Pitch, Curtain Type, Overhang Ratio, Wide Overhang, Width, Height, Count, Area, Curtain Closed
    Opening 1                 Solid Door, Wall 1, North, , , , , 0, 0, 0, 2.21,
    Opening 2                 Window, Wall 1, East, , None, 0, , 0, 0, 0, 5.40,
    Opening 3                 Window, Wall 1, East, , None, 0, , 0, 0, 0, 5.40,
    Opening 4                 Window, Wall 1, North, , None, 0, , 0, 0, 0, 1.20,
    Opening 5                 Window, Wall 1, East, , None, 0, , 0, 0, 0, 1.80,
    Opening 6                 Window, Wall 1, East, , None, 0, , 0, 0, 0, 5.40,
    Opening 7                 Roof Window, External Roof 1, South, 0, None, , , 0, 0, 0, 1.31,
Conservatory:                 None
Draught Proofing:             100
Draught Lobby:                No
Thermal Bridges
    Bridging:                 Default
    Y                         0.15
Pressure Test:                True
Designed q50:                 5
AsBuilt q50:                  10
Property Tested:              False
Mechanical Ventilation
    MV System Present         Yes
    Windows In Hot Weather    Windows half open
    Cross Ventilation         Yes
    Night Ventilation         Yes
    Air Change Rate           4.00
    Approved Installation     Yes
    DataType                  Database
    Type                      Mechanical extract ventilation - decentralised
    Database Ref Number       500017
    DuctType                  Rigid
Decentralised MV              Sfp, Fan & Room Type, Count
    1                         0.35, In Room Fan Kitchen, 1
    2                         0.25, Through Wall Fan Other Wet Room, 3
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:               12
LEL Fittings:                 12
Percentage of LEL Fittings:   100
External Lights Fitted:       No
External LELs Fitted:         No
Electricity Tariff:           Standard
Main Heating 1
    Description              ASHP
    Percentage               100
    MHS                      Electricity PET Heat pump air-to-water
    SAP Code                 224
    Boiler Efficiency Type   SAP Table
    Efficiency               175.1
    Controls by PCDF         0
    MHS Controls             CHD Time and temperature zone control
    Boiler Interlock         No
    Ctrl SAP Code            2207
    MCS Installation CertificateYes
    Pumped                   Pump in heated space
    Heat Pump Age            2013 or later
    Heat Emitter             Radiators and Underfloor
    Flow Temperature         Normal (> 35°C)
    Under Floor Heating      Yes - Pipes in thin screed
Main Heating 2                None
Heating Systems Interaction   Each system heats separate parts of dwelling
Smoke Control Area            Unknown
Community Heating             None
Secondary Heating             None
Water Heating
    Type                     MainHeating1
    WHS                      HWP From main heating 1
    Low Water Usage          Yes
    SAP Code                 901
    Showers in Property      Non-electric only
    Suplementary Immersion   No
    Hot Water Cylinder
    Cylinder Type            HotWaterCylinder
    Cylinder Insulation Type MeasuredLoss
    Loss Factor              1.70
    Cylinder Volume          125.00
    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                       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 106 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) 26.23 kg/m²
Dwelling Carbon Dioxide Emission Rate (DER) 26.23 kg/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)59.0 kWh/m²
Dwelling Fabric Energy Efficiency (DFEE)66.9 kWh/m²Fail
Excess energy =7.9 kWh/m² (13.4%)

---

2 Fabric U-values

Element	Average	Highest	
External wall	0.23 (max. 0.30)	0.32 (max. 0.70)	OK
Floor	0.18 (max. 0.25)	0.18 (max. 0.70)	OK
Roof	0.15 (max. 0.20)	0.16 (max. 0.35)	OK
Openings	1.74 (max. 2.00)	3.00 (max. 3.30)	OK

2a Thermal bridging
Thermal bridging calculated using default y-value of 0.15

---

3 Air permeability

Air permeability at 50 pascals:	5.00 (design value)	
Maximum	10.0	OK

---

4 Heating efficiency
Main heating system: Heat pump with radiators or underfloor - Electric
Air-to-water heat pump

Secondary heating system: None

---

5 Cylinder insulation

Hot water storage	Measured cylinder loss: 1.70 kWh/day	
Permitted by DBSCG 1.70	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 extract system (decentralised)
Specific fan power:                   0.3500  0.2500
Maximum                               0.7                                                  OK
-----------------------------------------------------------------------------------------------
9 Summertime temperature
Overheating risk (Thames Valley):     Medium                                               OK
Based on:
Overshading:                          Average
Windows facing North:                 1.20 m², No overhang
Windows facing East:                  18.00 m², No overhang
Air change rate:                      4.00 ach
Blinds/curtains:                      None
-----------------------------------------------------------------------------------------------
10 Key features
None


-----------------------------------------------------------------------------------------------
```

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	41.1800 (1b)	x	2.7000 (2b)	=	111.1860 (1b) - (3b)
First floor	40.3200 (1c)	x	2.7000 (2c)	=	108.8640 (1c) - (3c)
Second floor	24.7300 (1d)	x	1.9800 (2d)	=	48.9654 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	269.0154 (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		5.0000
Infiltration rate		0.2500 (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) =	0.2125 (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	0.2709	0.2656	0.2603	0.2338	0.2284	0.2019	0.2019	0.1966	0.2125	0.2284	0.2391	0.2497 (22b)

Mechanical extract ventilation - decentralised
If mechanical ventilation: 0.5000 (23a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective ac	0.5209	0.5156	0.5103	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
Opening Type 1 (Uw = 1.60)			19.2000	1.5038	28.8722		(27)
Opening Type 2			2.2100	3.0000	6.6300		(26)
Opening Type 3 (Uw = 1.60)			1.3100	1.5038	1.9699		(27a)
Heat Loss Floor 1			41.1800	0.1800	7.4124		(28a)
Wall 1	124.7400	21.4100	103.3300	0.2400	24.7992		(29a)
Wall 2	11.3400		11.3400	0.3200	3.6288		(29a)
Wall 3	20.8000		20.8000	0.1500	3.1200		(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1500	4.8480		(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020		(30)
External Roof 3	15.5900		15.5900	0.1600	2.4944		(30)
Total net area of external elements Aum(A, m2)			252.6800				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		84.4769		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		100.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area)		37.9020 (36)
Total fabric heat loss	(33) + (36) =	122.3789 (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	46.2463	45.7747	45.3030	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875 (38)
Heat transfer coeff	168.6252	168.1536	167.6819	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664 (39)

Average = Sum(39)m / 12 = 167.1132 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	1.5874	1.5829	1.5785	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699 (40)
HLP (average)												1.5731 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.7902 (42)
Average daily hot water use (litres/day) 100.4673 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140 (44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178 (45)

Energy content (annual) Total = Sum(45)m = 1580.7412 (45)
Distribution loss (46)m = 0.15 x (45)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	24.5834	21.5008	22.1869	19.3430	18.5601	16.0160	14.8411	17.0304	17.2338	20.0844	21.9237	23.8077 (46)

Water storage loss:
Store volume 125.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 1.7000 (48)
Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.9180 (55)

Total storage loss	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(56)
If cylinder contains dedicated solar storage	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(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	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(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	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(64)

Total per year (kWh/year) = Sum(64)m = 2189.7072 (64)

Heat gains from water heating, kWh/month	95.8694	85.0322	90.5572	82.9187	82.5179	75.5437	74.2742	79.1271	78.2432	85.8967	88.6390	94.1500	(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	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	23.9425	21.2655	17.2943	13.0929	9.7871	8.2627	8.9281	11.6051	15.5763	19.7777	23.0835	24.6080	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	266.0241	268.7846	261.8282	247.0189	228.3249	210.7551	199.0174	196.2569	203.2133	218.0225	236.7166	254.2864	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	(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)	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	(71)
Water heating gains (Table 5)	128.8568	126.5360	121.7167	115.1648	110.9111	104.9217	99.8309	106.3536	108.6712	115.4525	123.1098	126.5457	(72)
Total internal gains	486.6763	484.4391	468.6921	443.1296	416.8761	391.7925	375.6294	382.0687	395.3138	421.1058	450.7629	473.2930	(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	1.2000	10.6334	0.7200	0.7000	0.7700	4.4567	(74)
East	18.0000	19.6403	0.7200	0.7000	0.7700	123.4763	(76)
South	1.3100	26.0000	0.7200	0.7000	1.0000	15.4496	(82)

Solar gains	143.3826	282.1505	469.3089	692.5343	856.4069	880.2044	836.5364	713.3408	548.3836	335.9712	179.0675	117.7348	(83)
Total gains	630.0590	766.5896	938.0010	1135.6640	1273.2830	1271.9969	1212.1658	1095.4095	943.6974	757.0770	629.8304	591.0278	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	17.4994	17.5484	17.5978	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	
alpha	2.1666	2.1699	2.1732	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	
util living area	0.9695	0.9527	0.9185	0.8512	0.7500	0.6236	0.5050	0.5579	0.7504	0.9003	0.9568	0.9733	(86)
MIT	18.4613	18.7087	19.1531	19.7200	20.2214	20.5758	20.7437	20.7058	20.3902	19.7183	18.9886	18.4259	(87)
Th 2	19.6226	19.6259	19.6292	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	(88)
util rest of house	0.9640	0.9444	0.9037	0.8227	0.6986	0.5364	0.3789	0.4329	0.6779	0.8750	0.9477	0.9685	(89)
MIT 2	16.2806	16.6387	17.2774	18.0792	18.7585	19.2032	19.3812	19.3514	19.0006	18.0979	17.0532	16.2357	(90)

Living area fraction fLA = Living area / (4) = 0.3295 (91)

MIT	16.9991	17.3207	17.8954	18.6198	19.2405	19.6554	19.8301	19.7976	19.4585	18.6318	17.6909	16.9573	(92)

Temperature adjustment 0.0000

adjusted MIT	16.9991	17.3207	17.8954	18.6198	19.2405	19.6554	19.8301	19.7976	19.4585	18.6318	17.6909	16.9573	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9491	0.9250	0.8789	0.7965	0.6812	0.5378	0.3988	0.4496	0.6666	0.8502	0.9294	0.9550	(94)
Useful gains	597.9959	709.0578	824.3838	904.5371	867.3766	684.0870	483.3852	492.4871	629.0833	643.6794	585.3357	564.4030	(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	2141.3853	2088.5867	1910.7990	1620.9407	1257.5019	843.0767	538.6704	566.6119	893.6104	1339.4344	1766.2060	2127.4879	(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	1148.2817	927.0434	808.2929	515.8106	290.2532	0.0000	0.0000	0.0000	0.0000	517.6418	850.2266	1162.9352	(98)

Space heating 6220.4852 (98)

Space heating per m2 (98) / (4) = 58.5568 (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 %) 175.1000 (206)

Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	3552.5330	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1148.2817	927.0434	808.2929	515.8106	290.2532	0.0000	0.0000	0.0000	0.0000	517.6418	850.2266	1162.9352	(98)
Space heating efficiency (main heating system 1)	175.1000	175.1000	175.1000	175.1000	175.1000	0.0000	0.0000	0.0000	0.0000	175.1000	175.1000	175.1000	(210)
Space heating fuel (main heating system)	655.7862	529.4365	461.6179	294.5806	165.7642	0.0000	0.0000	0.0000	0.0000	295.6264	485.5663	664.1549	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	123.1350	108.5400	114.0107	102.2305	100.2024	89.5632	86.0430	94.3784	94.2000	106.0058	112.0558	120.1817	(219)

Water heating fuel used	1250.5467	(219)
Annual totals kWh/year		
Space heating fuel - main system	3552.5330	(211)
Space heating fuel - secondary	0.0000	(215)

Electricity for pumps and fans
(MEVDecentralised, Database: total watage = 12.8150, total flow = 37.0000, SFP = 0.3464)

mechanical ventilation fans (SFP = 0.3464)	113.6721	(230a)
central heating pump	30.0000	(230c)
Total electricity for the above, kWh/year	143.6721	(231)
Electricity for lighting (calculated in Appendix L)	422.8324	(232)
Total delivered energy for all uses	5369.5841	(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	3552.5330	0.5190	1843.7646	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1250.5467	0.5190	649.0337	(264)
Space and water heating			2492.7983	(265)
Pumps and fans	143.6721	0.5190	74.5658	(267)
Energy for lighting	422.8324	0.5190	219.4500	(268)
Total CO2, kg/year			2786.8141	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			26.2300	(273)

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

DER		26.2300	ZC1
Total Floor Area	TFA	106.2300	
Assumed number of occupants	N	2.7902	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		14.8395	ZC2
CO2 emissions from cooking, equation (L16)		1.7506	ZC3
Total CO2 emissions		42.8201	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		42.8201	ZC8

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	41.1800 (1b)	x	2.7000 (2b)	=	111.1860 (1b) - (3b)
First floor	40.3200 (1c)	x	2.7000 (2c)	=	108.8640 (1c) - (3c)
Second floor	24.7300 (1d)	x	1.9800 (2d)	=	48.9654 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	269.0154 (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) =	0.1487 (8)
Pressure test		Yes
Measured/design q50		5.0000
Infiltration rate		0.3987 (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) =	0.3389 (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	0.4321	0.4236	0.4151	0.3728	0.3643	0.3219	0.3219	0.3135	0.3389	0.3643	0.3812	0.3982	(22b)
Effective ac	0.5933	0.5897	0.5862	0.5695	0.5664	0.5518	0.5518	0.5491	0.5574	0.5664	0.5727	0.5793	(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			2.2100	1.0000	2.2100			(26)
TER Opening Type (Uw = 1.40)			19.2000	1.3258	25.4545			(27)
TER Room Window (Uw = 1.70)			1.3100	1.5918	2.0852			(27a)
Heat Loss Floor 1			41.1800	0.1300	5.3534			(28a)
Wall 1	124.7400	21.4100	103.3300	0.1800	18.5994			(29a)
Wall 2	11.3400		11.3400	0.1800	2.0412			(29a)
Wall 3	20.8000		20.8000	0.1800	3.7440			(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1300	4.2016			(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020			(30)
External Roof 3	15.5900		15.5900	0.1300	2.0267			(30)
Total net area of external elements Aum(A, m2)			252.6800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		66.4181			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (User defined value 0.050 * total exposed area)		12.6340 (36)
Total fabric heat loss	(33) + (36) =	79.0521 (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	52.6744	52.3526	52.0372	50.5557	50.2785	48.9882	48.9882	48.7492	49.4852	50.2785	50.8393	51.4255	(38)
Heat transfer coeff	131.7265	131.4047	131.0893	129.6078	129.3306	128.0402	128.0402	127.8013	128.5372	129.3306	129.8913	130.4775	(39)
Average = Sum(39)m / 12 =												129.6064	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2400	1.2370	1.2340	1.2201	1.2175	1.2053	1.2053	1.2031	1.2100	1.2175	1.2227	1.2283	(40)
HLP (average)												1.2201	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.7902 (42)
Average daily hot water use (litres/day)	100.4673 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140	(44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178	(45)
Energy content (annual)										Total = Sum(45)m =		1580.7412	(45)
Distribution loss (46)m = 0.15 x (45)m	24.5834	21.5008	22.1869	19.3430	18.5601	16.0160	14.8411	17.0304	17.2338	20.0844	21.9237	23.8077	(46)

Water storage loss:	
Store volume	125.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):	1.2538 (48)
Temperature factor from Table 2b	0.5400 (49)
Enter (49) or (54) in (55)	0.6770 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	20.9878	18.9567	20.9878	20.3108	20.9878	20.3108	20.9878	20.9878	20.3108	20.9878	20.3108	20.9878	(56)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
If cylinder contains dedicated solar storage	20.9878	18.9567	20.9878	20.3108	20.9878	20.3108	20.9878	20.9878	20.3108	20.9878	20.3108	20.9878	(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	208.1392	183.3063	192.1626	171.7764	167.9842	149.5958	143.1911	157.7864	157.7149	178.1459	188.9804	202.9680	(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	208.1392	183.3063	192.1626	171.7764	167.9842	149.5958	143.1911	157.7864	157.7149	178.1459	188.9804	202.9680	(64)
Total per year (kWh/year) = Sum(64)m =												2101.7513	(64)
Heat gains from water heating, kWh/month	89.8932	79.6343	84.5810	77.1353	76.5417	69.7603	68.2980	73.1509	72.4598	79.9205	82.8556	88.1738	(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	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	23.9425	21.2655	17.2943	13.0929	9.7871	8.2627	8.9281	11.6051	15.5763	19.7777	23.0835	24.6080	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	266.0241	268.7846	261.8282	247.0189	228.3249	210.7551	199.0174	196.2569	203.2133	218.0225	236.7166	254.2864	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	(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)	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	(71)
Water heating gains (Table 5)	120.8243	118.5035	113.6842	107.1323	102.8786	96.8892	91.7984	98.3211	100.6387	107.4200	115.0773	118.5132	(72)
Total internal gains	478.6438	476.4066	460.6596	435.0971	408.8436	383.7600	367.5969	374.0362	387.2813	413.0733	442.7304	465.2605	(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	1.2000	10.6334	0.6300	0.7000	0.7700	3.8996	(74)
East	18.0000	19.6403	0.6300	0.7000	0.7700	108.0418	(76)
South	1.3100	26.0000	0.6300	0.7000	1.0000	13.5184	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	125.4598	246.8817	410.6453	605.9675	749.3560	770.1788	731.9694	624.1732	479.8356	293.9748	156.6841	103.0179	(83)
Total gains	604.1037	723.2883	871.3049	1041.0647	1158.1996	1153.9388	1099.5663	998.2094	867.1169	707.0481	599.4145	568.2785	(84)

7. Mean internal temperature (heating season)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	56.0030	56.1402	56.2753	56.9185	57.0405	57.6154	57.6154	57.7231	57.3926	57.0405	56.7943	56.5391	
alpha	4.7335	4.7427	4.7517	4.7946	4.8027	4.8410	4.8410	4.8482	4.8262	4.8027	4.7863	4.7693	
util living area	0.9984	0.9959	0.9865	0.9480	0.8429	0.6647	0.5024	0.5695	0.8376	0.9779	0.9966	0.9988	(86)
MIT	19.6112	19.7857	20.0934	20.4926	20.8022	20.9541	20.9904	20.9830	20.8595	20.4291	19.9459	19.5841	(87)
Th 2	19.8881	19.8905	19.8929	19.9040	19.9061	19.9158	19.9158	19.9176	19.9120	19.9061	19.9019	19.8975	(88)
util rest of house	0.9978	0.9945	0.9816	0.9288	0.7896	0.5701	0.3837	0.4451	0.7614	0.9664	0.9951	0.9984	(89)
MIT 2	18.0401	18.2965	18.7446	19.3168	19.7183	19.8866	19.9124	19.9109	19.8008	19.2406	18.5391	18.0070	(90)
Living area fraction									fLA = Living area / (4) =			0.3295	(91)
MIT	18.5577	18.7872	19.1890	19.7042	20.0754	20.2383	20.2676	20.2641	20.1496	19.6322	19.0026	18.5266	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.5577	18.7872	19.1890	19.7042	20.0754	20.2383	20.2676	20.2641	20.1496	19.6322	19.0026	18.5266	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9968	0.9925	0.9774	0.9245	0.7988	0.5998	0.4231	0.4863	0.7803	0.9626	0.9934	0.9976	(94)
Useful gains	602.1920	717.8422	851.6158	962.4931	925.2160	692.0977	465.1891	485.4718	676.6459	680.5764	595.4612	566.9253	(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	1878.1220	1824.8413	1663.3891	1400.3057	1083.2001	721.9356	469.5957	493.8366	777.6021	1168.1355	1546.0470	1869.2974	(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	949.2920	743.9034	603.9593	315.2251	117.5402	0.0000	0.0000	0.0000	0.0000	362.7440	684.4218	968.9649	(98)
Space heating												4746.0506	(98)
Space heating per m2										(98) / (4) =		44.6771	(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	5075.9900	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	949.2920	743.9034	603.9593	315.2251	117.5402	0.0000	0.0000	0.0000	0.0000	362.7440	684.4218	968.9649	(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)	1015.2855	795.6186	645.9458	337.1391	125.7115	0.0000	0.0000	0.0000	0.0000	387.9615	732.0020	1036.3261	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	208.1392	183.3063	192.1626	171.7764	167.9842	149.5958	143.1911	157.7864	157.7149	178.1459	188.9804	202.9680	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.3692	88.1630	87.6628	86.4131	83.8827	79.8000	79.8000	79.8000	79.8000	86.6724	87.9484	88.4461	(217)
Fuel for water heating, kWh/month	235.5336	207.9176	219.2064	198.7851	200.2608	187.4635	179.4375	197.7273	197.6378	205.5394	214.8765	229.4822	(219)

Water heating fuel used	2473.8677	(219)
Annual totals kWh/year		
Space heating fuel - main system	5075.9900	(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)	422.8324	(232)
Total delivered energy for all uses	8047.6900	(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	5075.9900	0.2160	1096.4138	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2473.8677	0.2160	534.3554	(264)
Space and water heating			1630.7693	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	422.8324	0.5190	219.4500	(268)
Total CO2, kg/m2/year			1889.1443	(272)
Emissions per m2 for space and water heating			15.3513	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			2.0658	(272b)
Emissions per m2 for pumps and fans			0.3664	(272c)
Target Carbon Dioxide Emission Rate (TER) = (15.3513 * 1.55) + 2.0658 + 0.3664, rounded to 2 d.p.			26.2300	(273)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	41.1800 (1b)	x	2.7000 (2b)	=	111.1860 (1b) - (3b)
First floor	40.3200 (1c)	x	2.7000 (2c)	=	108.8640 (1c) - (3c)
Second floor	24.7300 (1d)	x	1.9800 (2d)	=	48.9654 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	269.0154 (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) =	0.1487 (8)
Pressure test		Yes
Measured/design q50		5.0000
Infiltration rate		0.3987 (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) =	0.3389 (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	0.4321	0.4236	0.4151	0.3728	0.3643	0.3219	0.3219	0.3135	0.3389	0.3643	0.3812	0.3982	(22b)
Effective ac	0.5933	0.5897	0.5862	0.5695	0.5664	0.5518	0.5518	0.5491	0.5574	0.5664	0.5727	0.5793	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 1.60)			19.2000	1.5038	28.8722			(27)
Opening Type 2			2.2100	3.0000	6.6300			(26)
Opening Type 3 (Uw = 1.60)			1.3100	1.5038	1.9699			(27a)
Heat Loss Floor 1			41.1800	0.1800	7.4124			(28a)
Wall 1	124.7400	21.4100	103.3300	0.2400	24.7992			(29a)
Wall 2	11.3400		11.3400	0.3200	3.6288			(29a)
Wall 3	20.8000		20.8000	0.1500	3.1200			(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1500	4.8480			(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020			(30)
External Roof 3	15.5900		15.5900	0.1600	2.4944			(30)
Total net area of external elements Aum(A, m2)			252.6800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		84.4769			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		100.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area)		37.9020 (36)
Total fabric heat loss	(33) + (36) =	122.3789 (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	52.6744	52.3526	52.0372	50.5557	50.2785	48.9882	48.9882	48.7492	49.4852	50.2785	50.8393	51.4255	(38)
Heat transfer coeff	175.0533	174.7315	174.4161	172.9346	172.6574	171.3671	171.3671	171.1281	171.8641	172.6574	173.2182	173.8044	(39)
Average = Sum(39)m / 12 =												172.9333	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.6479	1.6448	1.6419	1.6279	1.6253	1.6132	1.6132	1.6109	1.6178	1.6253	1.6306	1.6361	(40)
HLP (average)												1.6279	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.7902 (42)
Average daily hot water use (litres/day)	100.4673 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140	(44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178	(45)
Energy content (annual)											Total = Sum(45)m =	1580.7412	(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

34.8264	30.4594	31.4314	27.4026	26.2935	22.6893	21.0250	24.1264	24.4146	28.4528	31.0585	33.7275	(65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	23.9425	21.2655	17.2943	13.0929	9.7871	8.2627	8.9281	11.6051	15.5763	19.7777	23.0835	24.6080	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	266.0241	268.7846	261.8282	247.0189	228.3249	210.7551	199.0174	196.2569	203.2133	218.0225	236.7166	254.2864	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	(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)													
	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	(71)
Water heating gains (Table 5)													
	46.8097	45.3265	42.2465	38.0592	35.3407	31.5129	28.2593	32.4280	33.9092	38.2431	43.1368	45.3327	(72)
Total internal gains													
	401.6293	400.2296	386.2220	363.0240	338.3057	315.3837	301.0579	305.1430	317.5518	340.8964	367.7900	389.0800	(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	1.2000	10.6334	0.7200	0.7000	0.7700	4.4567	(74)
East	18.0000	19.6403	0.7200	0.7000	0.7700	123.4763	(76)
South	1.3100	26.0000	0.7200	0.7000	1.0000	15.4496	(82)

Solar gains	143.3826	282.1505	469.3089	692.5343	856.4069	880.2044	836.5364	713.3408	548.3836	335.9712	179.0675	117.7348	(83)
Total gains	545.0119	682.3801	855.5308	1055.5584	1194.7126	1195.5880	1137.5943	1018.4838	865.9354	676.8675	546.8575	506.8148	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	16.8568	16.8878	16.9184	17.0633	17.0907	17.2194	17.2194	17.2434	17.1696	17.0907	17.0354	16.9779	
alpha	2.1238	2.1259	2.1279	2.1376	2.1394	2.1480	2.1480	2.1496	2.1446	2.1394	2.1357	2.1319	
util living area													
	0.9769	0.9623	0.9318	0.8700	0.7751	0.6524	0.5356	0.5914	0.7811	0.9189	0.9671	0.9802	(86)
MIT	17.5705	17.9040	18.5115	19.3059	20.0186	20.5410	20.7902	20.7319	20.2627	19.3053	18.2912	17.5122	(87)
Th 2	19.5784	19.5806	19.5828	19.5929	19.5948	19.6037	19.6037	19.6053	19.6003	19.5948	19.5910	19.5870	(88)
util rest of house													
	0.9727	0.9553	0.9187	0.8436	0.7251	0.5641	0.4033	0.4619	0.7114	0.8969	0.9599	0.9765	(89)
MIT 2	16.5025	16.8338	17.4334	18.2096	18.8775	19.3384	19.5227	19.4922	19.1237	18.2289	17.2283	16.4500	(90)
Living area fraction									fLA = Living area / (4) =			0.3295	(91)
MIT	16.8544	17.1864	17.7886	18.5708	19.2535	19.7347	19.9403	19.9006	19.4990	18.5836	17.5785	16.8000	(92)
Temperature adjustment												0.0000	
adjusted MIT	16.8544	17.1864	17.7886	18.5708	19.2535	19.7347	19.9403	19.9006	19.4990	18.5836	17.5785	16.8000	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9606	0.9386	0.8964	0.8195	0.7108	0.5735	0.4386	0.4929	0.7052	0.8755	0.9448	0.9657	(94)
Useful gains	523.5258	640.5046	766.8872	865.0056	849.1961	685.6487	498.9073	501.9699	610.6848	592.6050	516.6823	489.4358	(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													
	2197.6890	2146.8229	1968.9080	1672.4209	1304.1608	879.9140	572.4132	599.0529	927.8878	1378.4225	1815.0694	2189.9278	(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													
	1245.5774	1012.2459	894.3035	581.3390	338.4937	0.0000	0.0000	0.0000	0.0000	584.6482	934.8387	1265.1660	(98)
Space heating												6856.6125	(98)
Space heating per m2											(98) / (4) =	64.5450	(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	1610.8506	1268.1164	1300.5738	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.6544	0.7193	0.6778	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1054.0981	912.1151	881.4853	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1485.8107	1416.7649	1282.7213	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	310.8331	375.4595	298.5196	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												984.8121	(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	77.7083	93.8649	74.6299	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												246.2030	(107)
Space cooling per m2												2.3176	(108)
Energy for space heating												64.5450	(99)
Energy for space cooling												2.3176	(108)
Total												66.8626	(109)
Dwelling Fabric Energy Efficiency (DFEE)												66.9	(109)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	41.1800 (1b)	x	2.7000 (2b)	=	111.1860 (1b) - (3b)
First floor	40.3200 (1c)	x	2.7000 (2c)	=	108.8640 (1c) - (3c)
Second floor	24.7300 (1d)	x	1.9800 (2d)	=	48.9654 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	269.0154 (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) =	0.1487 (8)
Pressure test		Yes
Measured/design q50		5.0000
Infiltration rate		0.3987 (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) =	0.3389 (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	0.4321	0.4236	0.4151	0.3728	0.3643	0.3219	0.3219	0.3135	0.3389	0.3643	0.3812	0.3982	(22b)
Effective ac	0.5933	0.5897	0.5862	0.5695	0.5664	0.5518	0.5518	0.5491	0.5574	0.5664	0.5727	0.5793	(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			2.2100	1.0000	2.2100		(26)
TER Opening Type (Uw = 1.40)			19.2000	1.3258	25.4545		(27)
TER Room Window (Uw = 1.70)			1.3100	1.5918	2.0852		(27a)
Heat Loss Floor 1			41.1800	0.1300	5.3534		(28a)
Wall 1	124.7400	21.4100	103.3300	0.1800	18.5994		(29a)
Wall 2	11.3400		11.3400	0.1800	2.0412		(29a)
Wall 3	20.8000		20.8000	0.1800	3.7440		(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1300	4.2016		(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020		(30)
External Roof 3	15.5900		15.5900	0.1300	2.0267		(30)
Total net area of external elements Aum(A, m2)			252.6800				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		66.4181		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (User defined value 0.050 * total exposed area)		12.6340 (36)
Total fabric heat loss	(33) + (36) =	79.0521 (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	52.6744	52.3526	52.0372	50.5557	50.2785	48.9882	48.9882	48.7492	49.4852	50.2785	50.8393	51.4255	(38)
Heat transfer coeff	131.7265	131.4047	131.0893	129.6078	129.3306	128.0402	128.0402	127.8013	128.5372	129.3306	129.8913	130.4775	(39)
Average = Sum(39)m / 12 =												129.6064	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2400	1.2370	1.2340	1.2201	1.2175	1.2053	1.2053	1.2031	1.2100	1.2175	1.2227	1.2283	(40)
HLP (average)												1.2201	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.7902 (42)
Average daily hot water use (litres/day)	100.4673 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140	(44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178	(45)
Energy content (annual)										Total = Sum(45)m =		1580.7412	(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

34.8264	30.4594	31.4314	27.4026	26.2935	22.6893	21.0250	24.1264	24.4146	28.4528	31.0585	33.7275	(65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	139.5100	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	23.9425	21.2655	17.2943	13.0929	9.7871	8.2627	8.9281	11.6051	15.5763	19.7777	23.0835	24.6080	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	266.0241	268.7846	261.8282	247.0189	228.3249	210.7551	199.0174	196.2569	203.2133	218.0225	236.7166	254.2864	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	36.9510	(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)													
	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	(71)
Water heating gains (Table 5)													
	46.8097	45.3265	42.2465	38.0592	35.3407	31.5129	28.2593	32.4280	33.9092	38.2431	43.1368	45.3327	(72)
Total internal gains													
	401.6293	400.2296	386.2220	363.0240	338.3057	315.3837	301.0579	305.1430	317.5518	340.8964	367.7900	389.0800	(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	1.2000	10.6334	0.6300	0.7000	0.7700	3.8996	(74)
East	18.0000	19.6403	0.6300	0.7000	0.7700	108.0418	(76)
South	1.3100	26.0000	0.6300	0.7000	1.0000	13.5184	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	125.4598	246.8817	410.6453	605.9675	749.3560	770.1788	731.9694	624.1732	479.8356	293.9748	156.6841	103.0179	(83)
Total gains	527.0891	647.1113	796.8672	968.9916	1087.6617	1085.5625	1033.0272	929.3162	797.3874	634.8711	524.4740	492.0980	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	56.0030	56.1402	56.2753	56.9185	57.0405	57.6154	57.6154	57.7231	57.3926	57.0405	56.7943	56.5391	
alpha	4.7335	4.7427	4.7517	4.7946	4.8027	4.8410	4.8410	4.8482	4.8262	4.8027	4.7863	4.7693	
util living area													
	0.9991	0.9975	0.9906	0.9595	0.8665	0.6961	0.5318	0.6055	0.8693	0.9855	0.9981	0.9994	(86)
MIT	19.5446	19.7205	20.0322	20.4426	20.7727	20.9441	20.9877	20.9779	20.8305	20.3717	19.8814	19.5180	(87)
Th 2	19.8881	19.8905	19.8929	19.9040	19.9061	19.9158	19.9158	19.9176	19.9120	19.9061	19.9019	19.8975	(88)
util rest of house													
	0.9988	0.9966	0.9871	0.9438	0.8174	0.6009	0.4077	0.4762	0.8003	0.9776	0.9973	0.9992	(89)
MIT 2	18.5600	18.7374	19.0490	19.4573	19.7556	19.8909	19.9128	19.9115	19.8168	19.3970	18.9073	18.5407	(90)
Living area fraction									fLA = Living area / (4) =			0.3295	(91)
MIT	18.8844	19.0614	19.3730	19.7819	20.0907	20.2379	20.2670	20.2628	20.1508	19.7181	19.2283	18.8627	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8844	19.0614	19.3730	19.7819	20.0907	20.2379	20.2670	20.2628	20.1508	19.7181	19.2283	18.8627	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9984	0.9956	0.9849	0.9416	0.8267	0.6309	0.4490	0.5193	0.8179	0.9757	0.9965	0.9989	(94)
Useful gains	526.2494	644.2880	784.8085	912.4223	899.1882	684.9169	463.8293	482.6249	652.1604	619.4700	522.6608	491.5348	(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													
	1921.1508	1860.8682	1687.5078	1410.3838	1085.1721	721.8827	469.5171	493.6752	777.7502	1179.2507	1575.3572	1913.1551	(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													
	1037.8067	817.5419	671.6083	358.5323	138.3721	0.0000	0.0000	0.0000	0.0000	416.4768	757.9414	1057.6855	(98)
Space heating												5255.9649	(98)
Space heating per m2										(98) / (4) =		49.4772	(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	1203.5781	947.4977	971.2897	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8751	0.9298	0.8988	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1053.3047	881.0232	873.0276	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1359.7174	1296.9138	1180.4683	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	220.6172	309.4226	228.7358	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												758.7756	(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	55.1543	77.3556	57.1840	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												189.6939	(107)
Space cooling per m2												1.7857	(108)
Energy for space heating												49.4772	(99)
Energy for space cooling												1.7857	(108)
Total												51.2629	(109)
Target Fabric Energy Efficiency (TFEE)												59.0	(109)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	41.1800 (1b)	x	2.7000 (2b)	=	111.1860 (1b) - (3b)
First floor	40.3200 (1c)	x	2.7000 (2c)	=	108.8640 (1c) - (3c)
Second floor	24.7300 (1d)	x	1.9800 (2d)	=	48.9654 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	269.0154 (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		5.0000
Infiltration rate		0.2500 (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) =	0.2125 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	4.3000	4.2000	4.1000	3.9000	3.9000	3.4000	3.6000	3.4000	3.4000	3.7000	3.6000	4.0000 (22)
Wind factor	1.0750	1.0500	1.0250	0.9750	0.9750	0.8500	0.9000	0.8500	0.8500	0.9250	0.9000	1.0000 (22a)
Adj infilt rate	0.2284	0.2231	0.2178	0.2072	0.2072	0.1806	0.1913	0.1806	0.1806	0.1966	0.1913	0.2125 (22b)
Mechanical extract ventilation - decentralised												
If mechanical ventilation:												0.5000 (23a)
Effective ac	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
Opening Type 1 (Uw = 1.60)			19.2000	1.5038	28.8722		(27)
Opening Type 2			2.2100	3.0000	6.6300		(26)
Opening Type 3 (Uw = 1.60)			1.3100	1.5038	1.9699		(27a)
Heat Loss Floor 1			41.1800	0.1800	7.4124		(28a)
Wall 1	124.7400	21.4100	103.3300	0.2400	24.7992		(29a)
Wall 2	11.3400		11.3400	0.3200	3.6288		(29a)
Wall 3	20.8000		20.8000	0.1500	3.1200		(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1500	4.8480		(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020		(30)
External Roof 3	15.5900		15.5900	0.1600	2.4944		(30)
Total net area of external elements Aum(A, m2)			252.6800				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		84.4769		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		100.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area)		37.9020 (36)
Total fabric heat loss	(33) + (36) =	122.3789 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875 (38)
Heat transfer coeff	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664 (39)
Average = Sum(39)m / 12 =												166.7664 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699 (40)
HLP (average)												1.5699 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.7902 (42)
Average daily hot water use (litres/day)	100.4673 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140 (44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178 (45)
Energy content (annual)											Total = Sum(45)m =	1580.7412 (45)
Distribution loss (46)m = 0.15 x (45)m	24.5834	21.5008	22.1869	19.3430	18.5601	16.0160	14.8411	17.0304	17.2338	20.0844	21.9237	23.8077 (46)

Water storage loss:	
Store volume	125.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):	1.7000 (48)
Temperature factor from Table 2b	0.5400 (49)

Enter (49) or (54) in (55) 0.9180 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(56)
If cylinder contains dedicated solar storage	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(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	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Output from w/h	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(64)

Total per year (kWh/year) = Sum(64)m = 2189.7072 (64)

RHI water heating demand 2190 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	95.8694	85.0322	90.5572	82.9187	82.5179	75.5437	74.2742	79.1271	78.2432	85.8967	88.6390	94.1500	(65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts (66)m	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	59.8563	53.1638	43.2357	32.7322	24.4677	20.6567	22.3203	29.0127	38.9408	49.4443	57.7088	61.5199	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	397.0508	401.1710	390.7883	368.6850	340.7834	314.5598	297.0409	292.9208	303.3034	325.4068	353.3084	379.5319	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	(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)	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	(71)
Water heating gains (Table 5)	128.8568	126.5360	121.7167	115.1648	110.9111	104.9217	99.8309	106.3536	108.6712	115.4525	123.1098	126.5457	(72)
Total internal gains	699.0993	694.2062	669.0761	629.9174	589.4977	553.4737	532.5275	541.6226	564.2508	603.6390	647.4624	680.9329	(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	1.2000	11.5683	0.7200	0.7000	0.7700	4.8486	(74)
East	18.0000	21.5704	0.7200	0.7000	0.7700	135.6105	(76)
South	1.3100	29.0000	0.7200	0.7000	1.0000	17.2323	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	157.6914	278.5330	464.2402	705.0441	846.4422	927.8264	879.9502	771.0888	594.9254	362.0738	203.3798	127.1094	(83)
Total gains	856.7907	972.7392	1133.3164	1334.9615	1435.9399	1481.3000	1412.4777	1312.7114	1159.1762	965.7129	850.8422	808.0422	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	
alpha	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	
util living area	0.9386	0.9189	0.8686	0.7752	0.6371	0.4425	0.2803	0.3204	0.5957	0.8162	0.9121	0.9447	(86)
MIT	18.8984	19.0889	19.5559	20.0706	20.5076	20.7729	20.8545	20.8449	20.6464	20.1112	19.4183	18.8535	(87)
Th 2	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	(88)
util rest of house	0.9279	0.9048	0.8447	0.7330	0.5642	0.3285	0.1326	0.1667	0.4901	0.7701	0.8937	0.9349	(89)
MIT 2	16.9158	17.1870	17.8479	18.5528	19.1138	19.3982	19.4533	19.4504	19.2878	18.6311	17.6651	16.8522	(90)

Living area fraction fLA = Living area / (4) = 0.3295 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
MIT	17.5690	17.8136	18.4106	19.0528	19.5730	19.8511	19.9149	19.9098	19.7354	19.1188	18.2428	17.5116	(92)

Temperature adjustment 0.0000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
adjusted MIT	17.5690	17.8136	18.4106	19.0528	19.5730	19.8511	19.9149	19.9098	19.7354	19.1188	18.2428	17.5116	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9057	0.8800	0.8179	0.7117	0.5605	0.3479	0.1642	0.1994	0.4988	0.7485	0.8688	0.9139	(94)
Useful gains	776.0027	856.0041	926.8896	950.1391	804.7955	515.3175	231.9745	261.7031	578.1964	722.8435	739.1698	738.4475	(95)
Ext temp.	5.4000	5.9000	7.9000	10.4000	13.5000	16.5000	18.5000	18.3000	15.6000	12.1000	8.4000	5.4000	(96)
Heat loss rate W	2029.3826	1986.7896	1752.8201	1443.0039	1012.7787	558.8591	235.9654	268.4629	689.6474	1170.4946	1641.4437	2019.8014	(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	932.5146	759.8879	614.4923	354.8626	154.7395	0.0000	0.0000	0.0000	0.0000	333.0524	649.6372	953.3273	(98)

Space heating 4752.5139 (98)

RHI space heating demand 4753 (98)

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	41.1800 (1b)	x	2.7000 (2b)	=	111.1860 (1b) - (3b)
First floor	40.3200 (1c)	x	2.7000 (2c)	=	108.8640 (1c) - (3c)
Second floor	24.7300 (1d)	x	1.9800 (2d)	=	48.9654 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	269.0154 (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		5.0000
Infiltration rate		0.2500 (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) =	0.2125 (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	0.2709	0.2656	0.2603	0.2338	0.2284	0.2019	0.2019	0.1966	0.2125	0.2284	0.2391	0.2497	(22b)

Mechanical extract ventilation - decentralised
If mechanical ventilation: 0.5000 (23a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.5209	0.5156	0.5103	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
Opening Type 1 (Uw = 1.60)			19.2000	1.5038	28.8722		(27)
Opening Type 2			2.2100	3.0000	6.6300		(26)
Opening Type 3 (Uw = 1.60)			1.3100	1.5038	1.9699		(27a)
Heat Loss Floor 1			41.1800	0.1800	7.4124		(28a)
Wall 1	124.7400	21.4100	103.3300	0.2400	24.7992		(29a)
Wall 2	11.3400		11.3400	0.3200	3.6288		(29a)
Wall 3	20.8000		20.8000	0.1500	3.1200		(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1500	4.8480		(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020		(30)
External Roof 3	15.5900		15.5900	0.1600	2.4944		(30)
Total net area of external elements Aum(A, m2)			252.6800				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		84.4769		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		100.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area)		37.9020 (36)
Total fabric heat loss	(33) + (36) =	122.3789 (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	46.2463	45.7747	45.3030	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	(38)
Heat transfer coeff	168.6252	168.1536	167.6819	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	(39)

Average = Sum(39)m / 12 = 167.1132 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.5874	1.5829	1.5785	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	(40)
HLP (average)												1.5731	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.7902 (42)
Average daily hot water use (litres/day)	100.4673 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140	(44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178	(45)
Energy content (annual)										Total = Sum(45)m =		1580.7412	(45)
Distribution loss (46)m = 0.15 x (45)m	24.5834	21.5008	22.1869	19.3430	18.5601	16.0160	14.8411	17.0304	17.2338	20.0844	21.9237	23.8077	(46)

Water storage loss:	
Store volume	125.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):	1.7000 (48)
Temperature factor from Table 2b	0.5400 (49)

Enter (49) or (54) in (55) 0.9180 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(56)
If cylinder contains dedicated solar storage	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(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	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Output from w/h	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(64)

Total per year (kWh/year) = Sum(64)m = 2189.7072 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	95.8694	85.0322	90.5572	82.9187	82.5179	75.5437	74.2742	79.1271	78.2432	85.8967	88.6390	94.1500	(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	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	59.8563	53.1638	43.2357	32.7322	24.4677	20.6567	22.3203	29.0127	38.9408	49.4443	57.7088	61.5199	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	397.0508	401.1710	390.7883	368.6850	340.7834	314.5598	297.0409	292.9208	303.3034	325.4068	353.3084	379.5319	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	(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)	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	(71)
Water heating gains (Table 5)	128.8568	126.5360	121.7167	115.1648	110.9111	104.9217	99.8309	106.3536	108.6712	115.4525	123.1098	126.5457	(72)
Total internal gains	699.0993	694.2062	669.0761	629.9174	589.4977	553.4737	532.5275	541.6226	564.2508	603.6390	647.4624	680.9329	(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	1.2000	10.6334	0.7200	0.7000	0.7700	4.4567	(74)
East	18.0000	19.6403	0.7200	0.7000	0.7700	123.4763	(76)
South	1.3100	26.0000	0.7200	0.7000	1.0000	15.4496	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	143.3826	282.1505	469.3089	692.5343	856.4069	880.2044	836.5364	713.3408	548.3836	335.9712	179.0675	117.7348	(83)
Total gains	842.4819	976.3567	1138.3850	1322.4517	1445.9046	1433.6780	1369.0639	1254.9634	1112.6344	939.6102	826.5299	798.6677	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	17.4994	17.5484	17.5978	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	
alpha	2.1666	2.1699	2.1732	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	
util living area	0.9475	0.9272	0.8877	0.8144	0.7092	0.5802	0.4619	0.5085	0.6969	0.8595	0.9294	0.9528	(86)
MIT	18.6667	18.9006	19.3167	19.8415	20.2989	20.6183	20.7659	20.7356	20.4644	19.8571	19.1709	18.6304	(87)
Th 2	19.6226	19.6259	19.6292	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	(88)
util rest of house	0.9388	0.9152	0.8686	0.7816	0.6547	0.4932	0.3419	0.3882	0.6196	0.8270	0.9156	0.9449	(89)
MIT 2	16.5742	16.9103	17.5039	18.2390	18.8503	19.2432	19.3953	19.3722	19.0804	18.2823	17.3105	16.5288	(90)

Living area fraction fLA = Living area / (4) = 0.3295 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
MIT	17.2636	17.5661	18.1011	18.7670	19.3276	19.6962	19.8469	19.8214	19.5364	18.8012	17.9234	17.2213	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.2636	17.5661	18.1011	18.7670	19.3276	19.6962	19.8469	19.8214	19.5364	18.8012	17.9234	17.2213	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9181	0.8911	0.8416	0.7566	0.6406	0.4975	0.3621	0.4062	0.6130	0.8018	0.8922	0.9254	(94)
Useful gains	773.5018	870.0579	958.0731	1000.5472	926.2639	713.2628	495.7355	509.7891	682.0990	753.4206	737.4443	739.1227	(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	2185.9926	2129.8440	1945.3007	1645.4807	1272.0242	849.8820	541.4733	570.5772	906.6118	1367.6809	1804.9846	2171.5077	(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	1050.8932	846.5763	734.4973	464.3521	257.2457	0.0000	0.0000	0.0000	0.0000	457.0096	768.6290	1065.6944	(98)

Space heating 5644.8976 (98)

Space heating per m2 (98) / (4) = 53.1385 (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 %) 175.1000 (206)

Efficiency of secondary/supplementary heating system, %	0.0000 (208)
Space heating requirement	3223.8136 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1050.8932	846.5763	734.4973	464.3521	257.2457	0.0000	0.0000	0.0000	0.0000	457.0096	768.6290	1065.6944	(98)
Space heating efficiency (main heating system 1)	175.1000	175.1000	175.1000	175.1000	175.1000	0.0000	0.0000	0.0000	0.0000	175.1000	175.1000	175.1000	(210)
Space heating fuel (main heating system)	600.1674	483.4816	419.4731	265.1925	146.9136	0.0000	0.0000	0.0000	0.0000	260.9992	438.9657	608.6205	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	123.1350	108.5400	114.0107	102.2305	100.2024	89.5632	86.0430	94.3784	94.2000	106.0058	112.0558	120.1817	(219)

Water heating fuel used	1250.5467 (219)
Annual totals kWh/year	
Space heating fuel - main system	3223.8136 (211)
Space heating fuel - secondary	0.0000 (215)

Electricity for pumps and fans:
(MEVDecentralised, Database: total watage = 12.8150, total flow = 37.0000, SFP = 0.3464)

mechanical ventilation fans (SFP = 0.3464)	113.6721 (230a)
central heating pump	30.0000 (230c)
Total electricity for the above, kWh/year	143.6721 (231)
Electricity for lighting (calculated in Appendix L)	422.8324 (232)
Total delivered energy for all uses	5040.8647 (238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	3223.8136	13.1900	425.2210	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	1250.5467	13.1900	164.9471	(247)
Mechanical ventilation fans	113.6721	13.1900	14.9933	(249)
Pumps and fans for heating	30.0000	13.1900	3.9570	(249)
Energy for lighting	422.8324	13.1900	55.7716	(250)
Additional standing charges			0.0000	(251)
Total energy cost			664.8901	(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] =	1.8466 (257)
SAP value		74.2406
SAP rating (Section 12)		74 (258)
SAP band		C

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	3223.8136	0.5190	1673.1593	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1250.5467	0.5190	649.0337	(264)
Space and water heating			2322.1930	(265)
Pumps and fans	143.6721	0.5190	74.5658	(267)
Energy for lighting	422.8324	0.5190	219.4500	(268)
Total kg/year			2616.2088	(272)
CO2 emissions per m2			24.6300	(273)
EI value			76.8186	
EI rating			77	(274)
EI band			C	

Calculation of stars for heating and DHW

Main heating energy efficiency	13.19 * (1 + 0.29 * 0.25) / 1.7510 = 8.079, stars = 2
Main heating environmental impact	0.519 * (1 + 0.29 * 0.25) / 1.7510 = 0.3179, stars = 4
Water heating energy efficiency	13.19 / 1.7510 = 7.533, stars = 2
Water heating environmental impact	0.519 / 1.7510 = 0.2964, stars = 4

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	41.1800 (1b)	x	2.7000 (2b)	=	111.1860 (1b) - (3b)
First floor	40.3200 (1c)	x	2.7000 (2c)	=	108.8640 (1c) - (3c)
Second floor	24.7300 (1d)	x	1.9800 (2d)	=	48.9654 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		269.0154 (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 5.0000
Infiltration rate 0.2500 (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) = 0.2125 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.3000	4.2000	4.1000	3.9000	3.9000	3.4000	3.6000	3.4000	3.4000	3.7000	3.6000	4.0000	(22)
Wind factor	1.0750	1.0500	1.0250	0.9750	0.9750	0.8500	0.9000	0.8500	0.8500	0.9250	0.9000	1.0000	(22a)
Adj infilt rate	0.2284	0.2231	0.2178	0.2072	0.2072	0.1806	0.1913	0.1806	0.1806	0.1966	0.1913	0.2125	(22b)

Mechanical extract ventilation - decentralised
If mechanical ventilation: 0.5000 (23a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
Opening Type 1 (Uw = 1.60)			19.2000	1.5038	28.8722		(27)
Opening Type 2			2.2100	3.0000	6.6300		(26)
Opening Type 3 (Uw = 1.60)			1.3100	1.5038	1.9699		(27a)
Heat Loss Floor 1			41.1800	0.1800	7.4124		(28a)
Wall 1	124.7400	21.4100	103.3300	0.2400	24.7992		(29a)
Wall 2	11.3400		11.3400	0.3200	3.6288		(29a)
Wall 3	20.8000		20.8000	0.1500	3.1200		(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1500	4.8480		(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020		(30)
External Roof 3	15.5900		15.5900	0.1600	2.4944		(30)
Total net area of external elements Aum(A, m2)			252.6800				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		84.4769		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 100.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area) 37.9020 (36)
Total fabric heat loss (33) + (36) = 122.3789 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	(38)
Heat transfer coeff	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	(39)

Average = Sum(39)m / 12 = 166.7664 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	(40)

HLP (average) 1.5699 (40)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.7902 (42)
Average daily hot water use (litres/day) 100.4673 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140	(44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178	(45)

Energy content (annual) Total = Sum(45)m = 1580.7412 (45)
Distribution loss (46)m = 0.15 x (45)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	24.5834	21.5008	22.1869	19.3430	18.5601	16.0160	14.8411	17.0304	17.2338	20.0844	21.9237	23.8077	(46)

Water storage loss:
Store volume 125.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 1.7000 (48)
Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.9180 (55)

Total storage loss	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(56)
If cylinder contains dedicated solar storage	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(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	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(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)
Output from w/h	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(64)
Heat gains from water heating, kWh/month	95.8694	85.0322	90.5572	82.9187	82.5179	75.5437	74.2742	79.1271	78.2432	85.8967	88.6390	94.1500	(65)

Solar input (sum of months) = Sum(63)m = 0.0000 (63)

Total per year (kWh/year) = Sum(64)m = 2189.7072 (64)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts (66)m	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	59.8563	53.1638	43.2357	32.7322	24.4677	20.6567	22.3203	29.0127	38.9408	49.4443	57.7088	61.5199	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	397.0508	401.1710	390.7883	368.6850	340.7834	314.5598	297.0409	292.9208	303.3034	325.4068	353.3084	379.5319	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	(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)	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	(71)
Water heating gains (Table 5)	128.8568	126.5360	121.7167	115.1648	110.9111	104.9217	99.8309	106.3536	108.6712	115.4525	123.1098	126.5457	(72)
Total internal gains	699.0993	694.2062	669.0761	629.9174	589.4977	553.4737	532.5275	541.6226	564.2508	603.6390	647.4624	680.9329	(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	1.2000	11.5683	0.7200	0.7000	0.7700	4.8486	(74)
East	18.0000	21.5704	0.7200	0.7000	0.7700	135.6105	(76)
South	1.3100	29.0000	0.7200	0.7000	1.0000	17.2323	(82)

Solar gains	157.6914	278.5330	464.2402	705.0441	846.4422	927.8264	879.9502	771.0888	594.9254	362.0738	203.3798	127.1094	(83)
Total gains	856.7907	972.7392	1133.3164	1334.9615	1435.9399	1481.3000	1412.4777	1312.7114	1159.1762	965.7129	850.8422	808.0422	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	
alpha	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	
util living area	0.9386	0.9189	0.8686	0.7752	0.6371	0.4425	0.2803	0.3204	0.5957	0.8162	0.9121	0.9447	(86)
MIT	18.8984	19.0889	19.5559	20.0706	20.5076	20.7729	20.8545	20.8449	20.6464	20.1112	19.4183	18.8535	(87)
Th 2	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	(88)
util rest of house	0.9279	0.9048	0.8447	0.7330	0.5642	0.3285	0.1326	0.1667	0.4901	0.7701	0.8937	0.9349	(89)
MIT 2	16.9158	17.1870	17.8479	18.5528	19.1138	19.3982	19.4533	19.4504	19.2878	18.6311	17.6651	16.8522	(90)
MIT	17.5690	17.8136	18.4106	19.0528	19.5730	19.8511	19.9149	19.9098	19.7354	19.1188	18.2428	17.5116	(92)
adjusted MIT	17.5690	17.8136	18.4106	19.0528	19.5730	19.8511	19.9149	19.9098	19.7354	19.1188	18.2428	17.5116	(93)

Living area fraction fLA = Living area / (4) = 0.3295 (91)

Temperature adjustment 0.0000

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9057	0.8800	0.8179	0.7117	0.5605	0.3479	0.1642	0.1994	0.4988	0.7485	0.8688	0.9139	(94)
Useful gains	776.0027	856.0041	926.8896	950.1391	804.7955	515.3175	231.9745	261.7031	578.1964	722.8435	739.1698	738.4475	(95)
Ext temp.	5.4000	5.9000	7.9000	10.4000	13.5000	16.5000	18.5000	18.3000	15.6000	12.1000	8.4000	5.4000	(96)
Heat loss rate W	2029.3826	1986.7896	1752.8201	1443.0039	1012.7787	558.8591	235.9654	268.4629	689.6474	1170.4946	1641.4437	2019.8014	(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	932.5146	759.8879	614.4923	354.8626	154.7395	0.0000	0.0000	0.0000	0.0000	333.0524	649.6372	953.3273	(98)

Space heating 4752.5139 (98)

Space heating per m2 (98) / (4) = 44.7380 (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 %) 175.1000 (206)

Efficiency of secondary/supplementary heating system, %	0.0000 (208)
Space heating requirement	2714.1712 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	932.5146	759.8879	614.4923	354.8626	154.7395	0.0000	0.0000	0.0000	0.0000	333.0524	649.6372	953.3273	(98)
Space heating efficiency (main heating system 1)	175.1000	175.1000	175.1000	175.1000	175.1000	0.0000	0.0000	0.0000	0.0000	175.1000	175.1000	175.1000	(210)
Space heating fuel (main heating system)	532.5612	433.9737	350.9379	202.6628	88.3721	0.0000	0.0000	0.0000	0.0000	190.2070	371.0093	544.4473	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	215.6094	190.0536	199.6328	179.0056	175.4545	156.8251	150.6614	165.2566	164.9442	185.6162	196.2097	210.4382	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	123.1350	108.5400	114.0107	102.2305	100.2024	89.5632	86.0430	94.3784	94.2000	106.0058	112.0558	120.1817	(219)

Water heating fuel used	1250.5467 (219)
Annual totals kWh/year	
Space heating fuel - main system	2714.1712 (211)
Space heating fuel - secondary	0.0000 (215)

Electricity for pumps and fans:
(MEVDecentralised, Database: total watage = 12.8150, total flow = 37.0000, SFP = 0.3464)

mechanical ventilation fans (SFP = 0.3464)	113.6721 (230a)
central heating pump	30.0000 (230c)
Total electricity for the above, kWh/year	143.6721 (231)
Electricity for lighting (calculated in Appendix L)	422.8324 (232)
Total delivered energy for all uses	4531.2224 (238)

10a. Fuel costs - using BEDF prices (387)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	2714.1712	15.3200	415.8110 (240)
Space heating - secondary	0.0000	0.0000	0.0000 (242)
Water heating (other fuel)	1250.5467	15.3200	191.5837 (247)
Mechanical ventilation fans	113.6721	15.3200	17.4146 (249)
Pumps and fans for heating	30.0000	15.3200	4.5960 (249)
Energy for lighting	422.8324	15.3200	64.7779 (250)
Additional standing charges			0.0000 (251)
Total energy cost			694.1833 (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	2714.1712	0.5190	1408.6549 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	1250.5467	0.5190	649.0337 (264)
Space and water heating			2057.6886 (265)
Pumps and fans	143.6721	0.5190	74.5658 (267)
Energy for lighting	422.8324	0.5190	219.4500 (268)
Total kg/year			2351.7044 (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	2714.1712	3.0700	8332.5057 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	1250.5467	3.0700	3839.1782 (264)
Space and water heating			12171.6839 (265)
Pumps and fans	143.6721	3.0700	441.0733 (267)
Energy for lighting	422.8324	3.0700	1298.0954 (268)
Primary energy kWh/year			13910.8527 (272)
Primary energy kWh/m2/year			130.9503 (273)

SAP 2012 EPC IMPROVEMENTS

Current energy efficiency rating:	C 74
Current environmental impact rating:	C 77

(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	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
N Solar water heating	+ 2.5	-£ 75	-254 kg (10.8%)
U Solar photovoltaic panels	+ 8.8	-£ 274	-928 kg (44.2%)

	Typical annual savings		Energy efficiency	Environmental impact
Recommended measures				
Solar water heating	£75	2.39 kg/m²	C 77	C 79
Solar photovoltaic panels	£274	8.73 kg/m²	B 86	B 87
Total Savings	£349	11.13 kg/m²		

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

Fuel prices for cost data on this page from database revision number 387 TEST (20 Jan 2016)
Recommendation texts revision number 4.9c (22 Feb 2014)

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

	Current	Potential	Saving
Electricity	£694	£619	£75
Space heating	£438	£438	-£0
Water heating	£192	£116	£75
Lighting	£65	£65	£0
Generated (PV)	-£0	-£274	£274
Total cost of fuels	£694	£345	£349
Total cost of uses	£695	£345	£349
Delivered energy	43 kWh/m²	21 kWh/m²	21 kWh/m²
Carbon dioxide emissions	2.4 tonnes	1.2 tonnes	1.2 tonnes
CO2 emissions per m²	22 kg/m²	11 kg/m²	11 kg/m²
Primary energy	131 kWh/m²	65 kWh/m²	66 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)	
Ground floor	41.1800	(1b)	x	2.7000	(2b)	=	111.1860	(1b) - (3b)
First floor	40.3200	(1c)	x	2.7000	(2c)	=	108.8640	(1c) - (3c)
Second floor	24.7300	(1d)	x	1.9800	(2d)	=	48.9654	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300								(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =				269.0154	(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		5.0000	
Infiltration rate		0.2500	(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) =	0.2125	(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	0.2709	0.2656	0.2603	0.2338	0.2284	0.2019	0.2019	0.1966	0.2125	0.2284	0.2391	0.2497	(22b)

Mechanical extract ventilation - decentralised
If mechanical ventilation: 0.5000 (23a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.5209	0.5156	0.5103	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 1.60)			19.2000	1.5038	28.8722			(27)
Opening Type 2			2.2100	3.0000	6.6300			(26)
Opening Type 3 (Uw = 1.60)			1.3100	1.5038	1.9699			(27a)
Heat Loss Floor 1			41.1800	0.1800	7.4124			(28a)
Wall 1	124.7400	21.4100	103.3300	0.2400	24.7992			(29a)
Wall 2	11.3400		11.3400	0.3200	3.6288			(29a)
Wall 3	20.8000		20.8000	0.1500	3.1200			(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1500	4.8480			(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020			(30)
External Roof 3	15.5900		15.5900	0.1600	2.4944			(30)
Total net area of external elements Aum(A, m2)			252.6800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		84.4769			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		100.0000	(35)
Thermal bridges (Default value 0.150 * total exposed area)		37.9020	(36)
Total fabric heat loss	(33) + (36) =	122.3789	(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	46.2463	45.7747	45.3030	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	(38)
Heat transfer coeff	168.6252	168.1536	167.6819	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	(39)
Average = Sum(39)m / 12 =												167.1132	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.5874	1.5829	1.5785	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	(40)
HLP (average)												1.5731	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.7902	(42)
Average daily hot water use (litres/day)	100.4673	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140	(44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178	(45)
Energy content (annual)										Total = Sum(45)m =		1580.7412	(45)
Distribution loss (46)m = 0.15 x (45)m	24.5834	21.5008	22.1869	19.3430	18.5601	16.0160	14.8411	17.0304	17.2338	20.0844	21.9237	23.8077	(46)

Water storage loss:		
Store volume	125.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):	1.7000	(48)
Temperature factor from Table 2b	0.5400	(49)

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Enter (49) or (54) in (55)                                                                                                  0.9180 (55)
Total storage loss
            28.4580   25.7040   28.4580   27.5400   28.4580   27.5400   28.4580   28.4580   27.5400   28.4580   27.5400   28.4580 (56)
If cylinder contains dedicated solar storage
            28.4580   25.7040   28.4580   27.5400   28.4580   27.5400   28.4580   28.4580   27.5400   28.4580   27.5400   28.4580 (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
           215.6094  190.0536  198.2371  172.2520  162.6601  144.2184  137.6344  153.1602  159.5413  184.2204  196.2097  210.4382 (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                                                                                                         1.1473 (H8)
Utilisation factor                                                                                                          0.5817 (H9)
Collector performance factor                                                                                                0.8793 (H10)
Dedicated solar storage volume                                                                                             75.0000 (H11)
Effective solar volume                                                                                                     75.0000 (H13)
Daily hot water demand                                                                                                    100.4673 (H14)
Volume ratio Veff/V                                                                                                         0.7465 (H15)
Solar storage volume factor                                                                                                 0.9415 (H16)
Solar input                                                                                                              -873.4221 (H17)
Solar input    -25.3275  -42.2643  -71.9810  -96.4687 -119.1789 -117.1719 -115.6234 -101.0207  -79.1195  -54.0293  -30.0421  -21.1948 (63)
                                                                          Solar input (sum of months) = Sum(63)m =      -873.4221 (63)
Output from w/h
           190.2819  147.7893  126.2561   75.7833   43.4812   27.0465   22.0110   52.1394   80.4218  130.1911  166.1676  189.2434 (64)
                                                                            Total per year (kWh/year) = Sum(64)m =     1250.8127 (64)
Heat gains from water heating, kWh/month
            95.8694   85.0322   89.4406   77.5158   72.2824   65.4583   63.8526   69.4499   73.9209   84.7801   88.6390   94.1500 (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      167.4120  167.4120  167.4120  167.4120  167.4120  167.4120  167.4120  167.4120  167.4120  167.4120  167.4120  167.4120 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
            59.8563   53.1638   43.2357   32.7322   24.4677   20.6567   22.3203   29.0127   38.9408   49.4443   57.7088   61.5199 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
           397.0508  401.1710  390.7883  368.6850  340.7834  314.5598  297.0409  292.9208  303.3034  325.4068  353.3084  379.5319 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
            54.5314   54.5314   54.5314   54.5314   54.5314   54.5314   54.5314   54.5314   54.5314   54.5314   54.5314   54.5314 (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)
          -111.6080 -111.6080 -111.6080 -111.6080 -111.6080 -111.6080 -111.6080 -111.6080 -111.6080 -111.6080 -111.6080 -111.6080 (71)
Water heating gains (Table 5)
           128.8568  126.5360  120.2159  107.6608   97.1538   90.9143   85.8234   93.3467  102.6680  113.9517  123.1098  126.5457 (72)
Total internal gains
           699.0993  694.2062  667.5753  622.4134  575.7403  539.4662  518.5200  528.6156  558.2476  602.1382  647.4624  680.9329 (73)
```

```
-----------------------------------------------------------------------------------------
6. Solar gains
-----------------------------------------------------------------------------------------
[Jan]                              Area      Solar flux            g                FF           Access          Gains
                                    m2        Table 6a      Specific data    Specific data       factor             W
                                                W/m2         or Table 6b      or Table 6c       Table 6d
-----------------------------------------------------------------------------------------
North                            1.2000       10.6334          0.7200          0.7000          0.7700          4.4567 (74)
East                            18.0000       19.6403          0.7200          0.7000          0.7700        123.4763 (76)
South                            1.3100       26.0000          0.7200          0.7000          1.0000         15.4496 (82)
-----------------------------------------------------------------------------------------

Solar gains    143.3826  282.1505  469.3089  692.5343  856.4069  880.2044  836.5364  713.3408  548.3836  335.9712  179.0675  117.7348 (83)
Total gains    842.4819  976.3567 1136.8842 1314.9477 1432.1472 1419.6706 1355.0564 1241.9564 1106.6312  938.1094  826.5299  798.6677 (84)
```

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-----------------------------------------------------------------------------------------
7. Mean internal temperature (heating season)
-----------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                               21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)
               Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
tau         17.4994   17.5484   17.5978   17.6944   17.6944   17.6944   17.6944   17.6944   17.6944   17.6944   17.6944   17.6944
alpha        2.1666    2.1699    2.1732    2.1796    2.1796    2.1796    2.1796    2.1796    2.1796    2.1796    2.1796    2.1796
util living area
             0.9475    0.9272    0.8879    0.8158    0.7123    0.5838    0.4655    0.5123    0.6988    0.8599    0.9294    0.9528 (86)

MIT         18.6667   18.9006   19.3155   19.8369   20.2931   20.6149   20.7641   20.7334   20.4620   19.8560   19.1709   18.6304 (87)
Th 2        19.6226   19.6259   19.6292   19.6355   19.6355   19.6355   19.6355   19.6355   19.6355   19.6355   19.6355   19.6355 (88)
util rest of house
             0.9388    0.9152    0.8689    0.7832    0.6580    0.4967    0.3450    0.3915    0.6215    0.8274    0.9156    0.9449 (89)
MIT 2       16.5742   16.9103   17.5023   18.2330   18.8436   19.2401   19.3942   19.3708   19.0779   18.2809   17.3105   16.5288 (90)
Living area fraction                                                                       fLA = Living area / (4) =      0.3295 (91)
MIT         17.2636   17.5661   18.0997   18.7615   19.3212   19.6931   19.8456   19.8197   19.5339   18.7999   17.9234   17.2213 (92)
Temperature adjustment                                                                                                    0.0000
adjusted MIT   17.2636   17.5661   18.0997   18.7615   19.3212   19.6931   19.8456   19.8197   19.5339   18.7999   17.9234   17.2213 (93)
```

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

               Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
Utilisation     0.9181    0.8911    0.8419    0.7581    0.6437    0.5008    0.3651    0.4095    0.6148    0.8022    0.8922    0.9254 (94)
Useful gains  773.5018  870.0579  957.1261  996.9259  921.9026  710.9656  494.7602  508.5486  680.4036  752.5834  737.4443  739.1227 (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
          2185.9926 2129.8440 1945.0561 1644.5592 1270.9570  849.3505  541.2529  570.2947  906.2004 1367.4658 1804.9846 2171.5077 (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
```

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	1050.8932	846.5763	735.0200	466.2960	259.6965	0.0000	0.0000	0.0000	0.0000	457.4725	768.6290	1065.6944	(98)

Space heating	5650.2777	(98)
Space heating per m2 (98) / (4) =	53.1891	(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 %)	175.1000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	3226.8862	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1050.8932	846.5763	735.0200	466.2960	259.6965	0.0000	0.0000	0.0000	0.0000	457.4725	768.6290	1065.6944	(98)
Space heating efficiency (main heating system 1)	175.1000	175.1000	175.1000	175.1000	175.1000	0.0000	0.0000	0.0000	0.0000	175.1000	175.1000	175.1000	(210)
Space heating fuel (main heating system)	600.1674	483.4816	419.7715	266.3027	148.3132	0.0000	0.0000	0.0000	0.0000	261.2636	438.9657	608.6205	(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	190.2819	147.7893	126.2561	75.7833	43.4812	27.0465	22.0110	52.1394	80.4218	130.1911	166.1676	189.2434	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	108.6704	84.4028	72.1051	43.2800	24.8322	15.4463	12.5705	29.7769	45.9291	74.3524	94.8987	108.0773	(219)

Water heating fuel used		714.3419	(219)
Annual totals kWh/year			
Space heating fuel - main system		3226.8862	(211)
Space heating fuel - secondary		0.0000	(215)
Electricity for pumps and fans:			
(MEVDecentralised, Database: total watage = 12.8150, total flow = 37.0000, SFP = 0.3464)			
mechanical ventilation fans (SFP = 0.3464)		113.6721	(230a)
central heating pump		30.0000	(230c)
pump for solar water heating		50.0000	(230g)
Total electricity for the above, kWh/year		193.6721	(231)
Electricity for lighting (calculated in Appendix L)		422.8324	(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		2830.4932	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	3226.8862	13.1900	425.6263	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	714.3419	13.1900	94.2217	(247)
Mechanical ventilation fans	113.6721	13.1900	14.9933	(249)
Pumps and fans for heating	30.0000	13.1900	3.9570	(249)
Pump for solar water heating	50.0000	13.1900	6.5950	(249)
Energy for lighting	422.8324	13.1900	55.7716	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-1727.2394	13.1900	-227.8229	(252)
Total energy cost			373.3421	(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] =	1.0369	(257)
SAP value		85.5359	
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	3226.8862	0.5190	1674.7539	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	714.3419	0.5190	370.7435	(264)
Space and water heating			2045.4974	(265)
Pumps and fans	193.6721	0.5190	100.5158	(267)
Energy for lighting	422.8324	0.5190	219.4500	(268)
Energy saving/generation technologies				
PV Unit	-1727.2394	0.5190	-896.4372	(269)
Total kg/year			1469.0260	(272)
CO2 emissions per m2			13.8300	(273)
EI value			86.9834	
EI rating			87	(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)
Ground floor	41.1800 (1b)	x	2.7000 (2b)	=	111.1860 (1b) - (3b)
First floor	40.3200 (1c)	x	2.7000 (2c)	=	108.8640 (1c) - (3c)
Second floor	24.7300 (1d)	x	1.9800 (2d)	=	48.9654 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 106.2300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		269.0154 (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		5.0000
Infiltration rate		0.2500 (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) =	0.2125 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.3000	4.2000	4.1000	3.9000	3.9000	3.4000	3.6000	3.4000	3.4000	3.7000	3.6000	4.0000	(22)
Wind factor	1.0750	1.0500	1.0250	0.9750	0.9750	0.8500	0.9000	0.8500	0.8500	0.9250	0.9000	1.0000	(22a)
Adj infilt rate	0.2284	0.2231	0.2178	0.2072	0.2072	0.1806	0.1913	0.1806	0.1806	0.1966	0.1913	0.2125	(22b)

Mechanical extract ventilation - decentralised
If mechanical ventilation: 0.5000 (23a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 1.60)			19.2000	1.5038	28.8722			(27)
Opening Type 2			2.2100	3.0000	6.6300			(26)
Opening Type 3 (Uw = 1.60)			1.3100	1.5038	1.9699			(27a)
Heat Loss Floor 1			41.1800	0.1800	7.4124			(28a)
Wall 1	124.7400	21.4100	103.3300	0.2400	24.7992			(29a)
Wall 2	11.3400		11.3400	0.3200	3.6288			(29a)
Wall 3	20.8000		20.8000	0.1500	3.1200			(29a)
External Roof 1	33.6300	1.3100	32.3200	0.1500	4.8480			(30)
External Roof 2	5.4000		5.4000	0.1300	0.7020			(30)
External Roof 3	15.5900		15.5900	0.1600	2.4944			(30)
Total net area of external elements Aum(A, m2)			252.6800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		84.4769			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		100.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area)		37.9020 (36)
Total fabric heat loss	(33) + (36) =	122.3789 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	44.3875	(38)
Heat transfer coeff	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	166.7664	(39)
Average = Sum(39)m / 12 =												166.7664	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	1.5699	(40)
HLP (average)												1.5699	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.7902 (42)
Average daily hot water use (litres/day)	100.4673 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	110.5140	106.4953	102.4766	98.4579	94.4392	90.4205	90.4205	94.4392	98.4579	102.4766	106.4953	110.5140	(44)
Energy conte	163.8890	143.3384	147.9124	128.9536	123.7341	106.7731	98.9410	113.5362	114.8922	133.8958	146.1577	158.7178	(45)
Energy content (annual)										Total = Sum(45)m =		1580.7412	(45)
Distribution loss (46)m = 0.15 x (45)m	24.5834	21.5008	22.1869	19.3430	18.5601	16.0160	14.8411	17.0304	17.2338	20.0844	21.9237	23.8077	(46)

Water storage loss:

Store volume	125.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):	1.7000 (48)
Temperature factor from Table 2b	0.5400 (49)

Enter (49) or (54) in (55) 0.9180 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(56)
If cylinder contains dedicated solar storage	28.4580	25.7040	28.4580	27.5400	28.4580	27.5400	28.4580	28.4580	27.5400	28.4580	27.5400	28.4580	(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	215.6094	190.0536	198.2371	172.2520	162.6601	144.2184	137.6344	153.1602	159.5413	184.2204	196.2097	210.4382	(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	1117.3717	(H5)
Overshading factor	0.8000	(H6)
Solar energy available	1877.1845	(H7)
Adjustment factor for showers	1.0000	(H7a)
Solar-to-load ratio	1.1875	(H8)
Utilisation factor	0.5692	(H9)
Collector performance factor	0.8793	(H10)
Dedicated solar storage volume	75.0000	(H11)
Effective solar volume	75.0000	(H13)
Daily hot water demand	100.4673	(H14)
Volume ratio Veff/V	0.7465	(H15)
Solar storage volume factor	0.9415	(H16)
Solar input	-884.5663	(H17)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar input	-26.8138	-40.2066	-68.8048	-95.2656	-114.5952	-120.3077	-118.4067	-106.0626	-83.0662	-56.1605	-32.8532	-22.0234	(63)
Output from w/h	188.7956	149.8470	129.4322	76.9864	48.0650	23.9106	19.2277	47.0975	76.4751	128.0599	163.3565	188.4148	(64)
Heat gains from water heating, kWh/month	95.8694	85.0322	89.4406	77.5158	72.2824	65.4583	63.8526	69.4499	73.9209	84.7801	88.6390	94.1500	(65)

Solar input (sum of months) = Sum(63)m = -884.5663 (63)

Total per year (kWh/year) = Sum(64)m = 1239.6684 (64)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts (66)m	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	167.4120	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	59.8563	53.1638	43.2357	32.7322	24.4677	20.6567	22.3203	29.0127	38.9408	49.4443	57.7088	61.5199	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	397.0508	401.1710	390.7883	368.6850	340.7834	314.5598	297.0409	292.9208	303.3034	325.4068	353.3084	379.5319	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	54.5314	(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)	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	-111.6080	(71)
Water heating gains (Table 5)	128.8568	126.5360	120.2159	107.6608	97.1538	90.9143	85.8234	93.3467	102.6680	113.9517	123.1098	126.5457	(72)
Total internal gains	699.0993	694.2062	667.5753	622.4134	575.7403	539.4662	518.5200	528.6156	558.2476	602.1382	647.4624	680.9329	(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	1.2000	11.5683	0.7200	0.7000	0.7700	4.8486	(74)
East	18.0000	21.5704	0.7200	0.7000	0.7700	135.6105	(76)
South	1.3100	29.0000	0.7200	0.7000	1.0000	17.2323	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	157.6914	278.5330	464.2402	705.0441	846.4422	927.8264	879.9502	771.0888	594.9254	362.0738	203.3798	127.1094	(83)
Total gains	856.7907	972.7392	1131.8156	1327.4575	1422.1826	1467.2926	1398.4702	1299.7045	1153.1730	964.2121	850.8422	808.0422	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	17.6944	
alpha	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	2.1796	
util living area	0.9386	0.9189	0.8689	0.7768	0.6405	0.4457	0.2828	0.3232	0.5976	0.8166	0.9121	0.9447	(86)
MIT	18.8984	19.0889	19.5548	20.0666	20.5034	20.7714	20.8540	20.8443	20.6448	20.1103	19.4183	18.8535	(87)
Th 2	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	19.6355	(88)
util rest of house	0.9279	0.9048	0.8450	0.7348	0.5677	0.3312	0.1339	0.1683	0.4919	0.7705	0.8937	0.9349	(89)
MIT 2	16.9158	17.1870	17.8464	18.5478	19.1094	19.3972	19.4532	19.4502	19.2865	18.6300	17.6651	16.8522	(90)
MIT	17.5690	17.8136	18.4093	19.0482	19.5687	19.8500	19.9148	19.9095	19.7340	19.1177	18.2428	17.5116	(92)
adjusted MIT	17.5690	17.8136	18.4093	19.0482	19.5687	19.8500	19.9148	19.9095	19.7340	19.1177	18.2428	17.5116	(93)

Living area fraction fLA = Living area / (4) = 0.3295 (91)

Temperature adjustment 0.0000

---

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9057	0.8800	0.8182	0.7134	0.5637	0.3506	0.1658	0.2012	0.5005	0.7489	0.8688	0.9139	(94)
Useful gains	776.0027	856.0041	926.0095	947.0360	801.7086	514.4459	231.8653	261.5287	577.2082	722.1399	739.1698	738.4475	(95)
Ext temp.	5.4000	5.9000	7.9000	10.4000	13.5000	16.5000	18.5000	18.3000	15.6000	12.1000	8.4000	5.4000	(96)
Heat loss rate W	2029.3826	1986.7896	1752.5937	1442.2244	1012.0473	558.6634	235.9346	268.4171	689.4173	1170.3158	1641.4437	2019.8014	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	932.5146	759.8879	614.9786	356.5356	156.4920	0.0000	0.0000	0.0000	0.0000	333.4429	649.6372	953.3273	(98)
Space heating												4756.8161	(98)
Space heating per m2											(98) / (4) =	44.7785	(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 %)	175.1000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	2716.6283	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	932.5146	759.8879	614.9786	356.5356	156.4920	0.0000	0.0000	0.0000	0.0000	333.4429	649.6372	953.3273	(98)
Space heating efficiency (main heating system 1)	175.1000	175.1000	175.1000	175.1000	175.1000	0.0000	0.0000	0.0000	0.0000	175.1000	175.1000	175.1000	(210)
Space heating fuel (main heating system)	532.5612	433.9737	351.2157	203.6183	89.3729	0.0000	0.0000	0.0000	0.0000	190.4300	371.0093	544.4473	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	188.7956	149.8470	129.4322	76.9864	48.0650	23.9106	19.2277	47.0975	76.4751	128.0599	163.3565	188.4148	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	107.8216	85.5779	73.9190	43.9671	27.4500	13.6554	10.9810	26.8975	43.6751	73.1353	93.2933	107.6041	(219)

Water heating fuel used	707.9774	(219)
Annual totals kWh/year		
Space heating fuel - main system	2716.6283	(211)
Space heating fuel - secondary	0.0000	(215)

Electricity for pumps and fans:
(MEVDecentralised, Database: total watage = 12.8150, total flow = 37.0000, SFP = 0.3464)

mechanical ventilation fans (SFP = 0.3464)	113.6721	(230a)
central heating pump	30.0000	(230c)
pump for solar water heating	50.0000	(230g)
Total electricity for the above, kWh/year	193.6721	(231)
Electricity for lighting (calculated in Appendix L)	422.8324	(232)

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

PV Unit 0 (0.80 * 2.50 * 1117 * 0.80) =	-1787.7948	-1787.7948	(233)
Total delivered energy for all uses		2253.3154	(238)

10a. Fuel costs - using BEDF prices (387)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	2716.6283	15.3200	416.1875	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating (other fuel)	707.9774	15.3200	108.4621	(247)
Mechanical ventilation fans	113.6721	15.3200	17.4146	(249)
Pumps and fans for heating	30.0000	15.3200	4.5960	(249)
Pump for solar water heating	50.0000	15.3200	7.6600	(249)
Energy for lighting	422.8324	15.3200	64.7779	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit	-1787.7948	15.3200	-273.8902	(252)
Total energy cost			345.2079	(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	2716.6283	0.5190	1409.9301	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	707.9774	0.5190	367.4403	(264)
Space and water heating			1777.3704	(265)
Pumps and fans	193.6721	0.5190	100.5158	(267)
Energy for lighting	422.8324	0.5190	219.4500	(268)
Energy saving/generation technologies				
PV Unit	-1787.7948	0.5190	-927.8655	(269)
Total kg/year			1169.4707	(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	2716.6283	3.0700	8340.0488	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	707.9774	3.0700	2173.4906	(264)
Space and water heating			10513.5395	(265)
Pumps and fans	193.6721	3.0700	594.5733	(267)
Energy for lighting	422.8324	3.0700	1298.0954	(268)
Energy saving/generation technologies				
PV Unit	-1787.7948	3.0700	-5488.5299	(269)
Primary energy kWh/year			6917.6782	(272)

Primary energy kWh/m2/year 65.1198 (273)

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

Overheating Calculation Input Data

Dwelling type	Detached House
Number of storeys	3
Cross ventilation possible	Yes
SAP Region	Thames Valley
Front of dwelling faces	North
Overshading	Average or unknown
Thermal mass parameter	100.0
Night ventilation	Yes
Ventilation rate during hot weather (ach)	4.00 (Windows half open)

Overheating Calculation

Summer ventilation heat loss coefficient	355.10	(P1)
Transmission heat loss coefficient	122.38	(37)
Summer heat loss coefficient	477.48	(P2)

Overhangs

Orientation	Ratio	Z_overhangs	Overhang type
North	0.000	1.000	None
East	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	0.90	1.000	0.900	(P8)
South	1.000	1.00	1.000	1.000	(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	1.2000	81.1852	0.7200	0.7000	0.9000	39.7716
East	18.0000	117.5071	0.7200	0.7000	0.9000	863.4795
South	1.3100	203.0000	0.7200	0.7000	1.0000	120.6258
total:						1023.8770

	Jun	Jul	Aug	
Solar gains	1089	1024	895	(P3)
Internal gains	550	530	539	
Total summer gains	1639	1553	1433	(P5)
Summer gain/loss ratio	3.43	3.25	3.00	(P6)
Summer external temperature	16.00	17.90	17.80	
Thermal mass temperature increment (TMP = 100.0)	1.30	1.30	1.30	
Threshold temperature	20.73	22.45	22.10	(P7)
Likelihood of high internal temperature	Slight	Medium	Medium	

Assessment of likelihood of high internal temperature: Medium

APPENDIX 2

13+13A WEST HAMPSTEAD MEWS

BRUKL REPORTS FOR COMMERCIAL UNIT (BE LEAN)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

West Hampsted Mews - Improved COP - Zone 1

As designed

Date: Fri Feb 26 09:00:25 2016

Administrative information

Building Details

Address: West Hampsted Mews, London, NW6 3BB

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.3.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.3.3

BRUKL compliance check version: v5.2.d.2

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	18.7
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	18.7
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	16.2
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.17	0.17	External Wall
Floor	0.25	0.15	0.22	Exposed Floor
Roof	0.25	0.15	0.15	Roof
Windows***, roof windows, and rooflights	2.2	1.5	1.59	Stairwell Rooflight
Personnel doors	2.2	1.55	1.61	Rooflight Access Doors (1)
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	1.97	1.97	GF ENTRANCE DOOR

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- Comfort Cooling - Supply and Extract (3 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.98	4.42	-	1.1	0.8
Standard value	0.91*	2.6	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

1- Boiler

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.98	0
Standard value	0.9*	N/A

* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	**Luminous efficacy [lm/W]**			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Ground Floor Office	-	-	-	338386
First Floor Office	-	-	-	303327
Second Floor Office	-	-	-	171780
Kitchenette	-	-	-	40137
Second Floor Store	-	-	-	726
Ground Floor WC	-	-	-	4266
Ground Floor Acc WC	-	-	-	7880
First Floor MWC	-	-	-	4266
First Floor FWC	-	-	-	4343
Second Floor MWC	-	-	-	4266
Second Floor FWC	-	-	-	5696
Entrance / Corridor / Stairs	-	-	-	18615

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Ground Floor Office	NO (-81%)	NO
First Floor Office	NO (-79%)	NO
Second Floor Office	YES (+409%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	339	339
External area [m²]	712	712
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	424	266
Average U-value [W/m²K]	0.6	0.37
Alpha value* [%]	11.96	11.96

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
100	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	9.04	4.16
Cooling	6.35	9.6
Auxiliary	2.71	3.47
Lighting	17.07	20.73
Hot water	3.11	3.17
Equipment*	41.87	41.87
TOTAL**	**38.28**	**41.15**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	125.93	143.93
Primary energy* [kWh/m²]	95.05	110.16
Total emissions [kg/m²]	16.2	18.7

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	30.2	95.7	9.5	6.7	5	0.88	3.98	0.98	4.42
	Notional	12.8	131	4.4	10.1	4.7	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.17	External Wall
Floor	0.2	0.15	Ground Floor
Roof	0.15	0.15	Roof
Windows, roof windows, and rooflights	1.5	1.47	Lightwell Vertical
Personnel doors	1.5	1.52	Rooflight Access Doors
Vehicle access & similar large doors	1.5	-	No vehicle doors in project
High usage entrance doors	1.5	1.97	GF ENTRANCE DOOR

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	3

APPENDIX 3

13+13A WEST HAMPSTEAD MEWS

BRUKL REPORTS FOR COMMERCIAL UNIT (BE GREEN)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

1.3.16 - West Hampsted Mews - Improved U-values

As designed

Date: Tue Mar 01 16:18:41 2016

Administrative information

Building Details

Address: West Hampsted Mews, London, NW6 3BB

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.3.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.3.3

BRUKL compliance check version: v5.2.d.2

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	18.3
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	18.3
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	18.1
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.17	0.17	External Wall
Floor	0.25	0.15	0.22	Exposed Floor
Roof	0.25	0.15	0.15	Roof
Windows***, roof windows, and rooflights	2.2	1.5	1.59	Stairwell Rooflight
Personnel doors	2.2	1.55	1.61	Rooflight Access Doors (1)
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	1.97	1.97	GF ENTRANCE DOOR

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]

$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- Comfort Cooling - Supply and Extract (3 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.42	4.42	-	1.1	0.8
Standard value	0.91*	2.6	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

2- Electric Panel Heating - No Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	-	-	-
Standard value	0.86	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

3- Electric Panel Heating - Extract Only (7 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	-	-	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

1- Electric Water Heating

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0
Standard value	0.9*	N/A

* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	**Luminous efficacy [lm/W]**			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Ground Floor Office	-	-	-	338386
First Floor Office	-	-	-	303327
Second Floor Office	-	-	-	171780
Kitchenette	-	-	-	40137
Second Floor Store	-	-	-	726
Ground Floor WC	-	-	-	4266
Ground Floor Acc WC	-	-	-	7880
First Floor MWC	-	-	-	4266
First Floor FWC	-	-	-	4343
Second Floor MWC	-	-	-	4266

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Second Floor FWC	-	-	-	5696
Entrance / Corridor / Stairs	-	-	-	18615

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Ground Floor Office	NO (-81%)	NO
First Floor Office	NO (-79%)	NO
Second Floor Office	YES (+409%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	405	405
External area [m²]	712	712
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	424	291
Average U-value [W/m²K]	0.6	0.41
Alpha value* [%]	11.96	11.96

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
100	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	7.11	4.84
Cooling	5.31	7.99
Auxiliary	2.45	3.15
Lighting	17.64	19.82
Hot water	2.33	2.7
Equipment*	37.34	37.34
TOTAL**	**34.85**	**38.51**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	123.91	131.15
Primary energy* [kWh/m²]	106.98	103.17
Total emissions [kg/m²]	18.1	18.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Electricity, [CFT] Electricity										
	Actual	27.1	95.5	1.9	6.7	2.9	3.98	3.98	4.42	4.42
	Notional	12.6	130.2	1.5	10	3.7	2.43	3.6	----	----
[ST] Other local room heater - unfanned, [HS] Direct or storage electric heater, [HFT] Electricity, [CFT] Electricity										
	Actual	159.3	0	44.2	0	0	1	0	1	0
	Notional	94.2	0	32	0	0	0.82	0	----	----
[ST] Other local room heater - unfanned, [HS] Direct or storage electric heater, [HFT] Electricity, [CFT] Electricity										
	Actual	128.7	0	35.8	0	3.8	1	0	1	0
	Notional	54.1	0	18.4	0	5	0.82	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.17	External Wall
Floor	0.2	0.15	Ground Floor
Roof	0.15	0.15	Roof
Windows, roof windows, and rooflights	1.5	1.47	Lightwell Vertical
Personnel doors	1.5	1.52	Rooflight Access Doors
Vehicle access & similar large doors	1.5	-	No vehicle doors in project
High usage entrance doors	1.5	1.97	GF ENTRANCE DOOR

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	3