11-12 Grenville Street
London

Residential Development
Energy Strategy

Issue 1

Client Name	Calabar Properties Ltd
Client Address	Freshwater House 158-162 Shaftesbury Avenue London WC2H 8HR
Property:	11-12 Grenville Street London WC1N 1LZ
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EXECUTIVE SUMMARY

The energy strategy adopts a hierarchical approach using passive and low energy design technologies to reduce the existing development's energy demand and CO_2 emissions followed by the application of low and zero carbon technologies. This strategy is in line with the relevant GLA Policies from the Further Alterations to the London Plan 2015 and the related supplementary guidance. In accordance with the April 2014 issue of the GLA SPG 'Sustainable Design and Construction'. This strategy is also in line with Camden's planning guide (CPG3).

The focus of this energy strategy is on CO_2 reduction by using a highly efficient building envelope with high efficiency mechanical and electrical services, serving the space heating and domestic hot water. The result is a proposed development with a predicted performance of:

- This building comprises of a refurbishment and doesn't fall under the London Plan requirement of 35% carbon reduction and has no carbon requirement under Building Regulations. With the passive improvements proposed a 70.5% reduction is the result in carbon when compared to the existing development.

The carbon dioxide emission and savings values, for the development are as follows:

	CO_2 Emissions (Tonnes per annum)	
	Regulated	**Unregulated**
Existing Development	140.38	159.39
Proposed Development after passive/low energy (energy demand) reduction	41.46	60.47

	Regulated CO_2 Savings	
	Tonnes per annum	**%**
Savings from passive/low energy (energy demand) reduction	39.73	70.5

1.00 INTRODUCTION

1.01 Purpose

This report has been prepared on behalf of Calabar Properties Ltd for the proposed 11-12 Grenville Street development energy strategy.

The report contains the predicted energy and carbon emission assessment results and identifies savings from the proposed passive and building services technologies to be incorporated into the scheme.

The energy and carbon dioxide emission assessment also known as the SAP assessment (Standard Assessment Procedure) has been undertaken using NHER Plan Assessor 6.2 software. Based on the building design submitted with the planning application the modelling identifies the energy and carbon dioxide performance savings related to the building envelope design and efficient mechanical and electrical services systems for the scheme.

1.02 Existing Building

The existing building is to be retained. This consists of lower ground level, ground floor level and three upper floors. Grenville Street is situated within the London Borough of Camden. Although not listed, Grenville Street falls within the 'Bloomsbury Conservation Area'. This development is currently used as an office development on the upper floors with retail accommodation at ground level located in central London. 11-12 Grenville Street forms part of a Georgian terrace of town houses which dates back to the 1900s.

1.03 Proposed Development

The proposed development consists of the existing building with an extension into the existing roof creating a fourth floor. With the constraints of the conservation area a soft approach was proposed to the front and rear of the building keeping to the Georgian terrace style.

The building comprises of six residential apartments with a retail unit at ground level. As there are no restrictions internally the building fabric has been significantly improved beyond Building Regulation requirements.

High efficiency services have been proposed to provide heating, hot water and energy efficient lighting to create the most energy efficient dwellings within the restrains of the development.

1.04 Reservation

This report has been prepared solely for the use of the applicant and Watkins Payne Partnership accept no responsibility for its use by any third parties.

2.00 POLICY REVIEW

2.01 National Policy

The National Planning Policy Framework sets out the planning policies for England that are to be taken into account within local planning policies. The framework itself does not have specific policies but identifies the purpose of achieving sustainable development.

2.02 Further Alterations to the London Plan 2015

The Further Alterations to the London Plan 2015 identifies key policies associated with building design and energy strategy as noted below:

Policy 5.2 Minimising Carbon Dioxide Emissions

Planning Decisions

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

1 Be lean: use less energy

2 Be clean: supply energy efficiently

3 Be green: use renewable energy

B The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outline in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Residential Buildings:

Year	***Improvement on 2010 Building Regulations***
2010 – 2013	*25 per cent (code for sustainable homes level 4)*
2013 – 2016	*40 per cent*
2016 – 2031	*Zero carbon*

C Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

D As a minimum, energy assessments should include the following details:

a) Calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations (see paragraph 5.22) at each stage of the energy hierarchy

b) Proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services

c) *Proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as decentralised heating and cooling and combined heat and power (CHP)*

d) *Proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies*

E The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

Policy 5.4 Retrofitting

A The environmental impact of existing urban areas should be reduced through policies and programmes that bring existing buildings up to the Mayor's standards on sustainable design and construction. In particular, programmes should reduce carbon dioxide emissions, improve the efficiency of resource use (such as water) and minimise the generation of pollution and waste from existing building stock.

Policy 5.5 Decentralised Energy Networks

Strategic

A The Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. In order to achieve this target the Mayor prioritises the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

Policy 5.6 Decentralised Energy in Development Proposals

Planning Decisions

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

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

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

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

Policy 5.7 Renewable Energy

Strategic

A The Mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London.

Policy 5.9 Overheating and Cooling

Strategic

A The Mayor seeks to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating and excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis.

Planning Decisions

B Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

1. *Minimise internal heat generation through energy efficient design*
2. *Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls*
3. *Manage the heat within the building through exposed internal thermal mass and high ceilings*
4. *Passive ventilation*
5. *Mechanical ventilation*
6. *Active cooling systems (ensuring they are the lowest carbon options)*

C Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible.

2.03 GLA Supplementary Planning Guidance

The Further Alterations to the London Plan 2015 (FALP 2015) is supported by various supplementary planning guidance (SPG) that includes "Sustainable Design and Construction" dated April 2014 that relates specifically to sustainability issues.

The Sustainable Design and Construction SPG sets out the Mayor's priorities and the Mayor's best practice for new developments encompassing a wide range of sustainability topics.

The major change to the carbon emission savings targets for the April 2014 edition of the SPG is that the overall saving target is benchmarked against a Building Regulations Part L1A:2013 Baseline and not Part L1A:2010. This change gives a revised carbon emission reduction target of 35% less than Part L1A:2013.

The relevant sections from the Sustainable Design and Construction SPG are as follows:

Energy and Carbon Dioxide Emissions	
Mayor's Priority	**FALP Policy**
The overall carbon dioxide emissions from a development should be minimized through the implementation of the energy hierarchy set out in the FALP 2015 Policy 5.2.	5.2, 5.3
Developments should be designed to meet the following Regulated carbon dioxide standards, in line with FALP 2015 Policy 5.2.	5.2
Residential Buildings • Year - Improvements beyond 2010 Building Regulations. • 1st October 2013 – 2016 – 40 per cent • 2016 – 2031 – Zero carbon	
Mayor's Best Practice	**FALP Policy**
Developments should contribute to ensuring resilient energy infrastructure and a reliable energy supply, including from local low and zero carbon sources.	5.1, 5.5, 5.6, 5.7, 5.8, 5.17
Developers are encouraged to include innovative low and zero carbon technologies to minimize carbon dioxide emissions within developments and keep up to date with rapidly improving technologies.	5.2, 5.17
Energy Demand Assessment	
Mayor's Priority	**FALP Policy**
Development applications are to be accompanied by an energy demand assessment.	5.2
Use Less Energy	
Mayor's Priority	**FALP Policy**
The design of developments should prioritise passive measures.	5.2, 5.3, 5.9
Mayor's Best Practice	**FALP Policy**
Developers should aim to achieve Part L 2013 Building Regulations requirements through design and energy efficiency alone, as far as is practical.	5.2, 5.3
Efficient Energy Supply	
Mayor's Priority	**FALP Policy**
Where borough heat maps have identified district heating opportunities, boroughs should prepare more detailed Energy Master Plans (EMPs) to establish the extent of market competitive district heating networks.	5.5, 5.6
Mayor's Priority	**FALP Policy**
Developers should assess the potential for their development to: • connect to an existing district heating or cooling network; • expand an existing district heating or cooling network, and connect to it; or • establish a site wide network, and enable the connection of existing buildings in the vicinity of the development.	5.5, 5.6

Mayor's Priority	FALP Policy
Where opportunities arise, developers generating energy or waste heat should maximize long term carbon dioxide savings by feeding the decentralized energy network with low or zero carbon hot, and where required, cold water.	5.5, 5.6
Renewable Energy	
Mayor's Priority	**FALP Policy**
Boroughs and neighbourhoods should identify opportunities for the installation of renewable energy technologies in their boroughs and neighbourhoods.	5.4, 5.7
Major development should incorporate renewable energy technologies to minimize overall carbon dioxide emissions, where feasible.	5.7
Carbon Dioxide Off-setting	
Mayor's Priority	**FALP Policy**
Boroughs should establish a carbon off-set fund and identify suitable projects to be funded.	5.2, 5.4
Where developments do not achieve the Mayor's carbon dioxide reduction targets set out in FALP 2015 Policy 5.2, the developer should make a contribution to the local borough's carbon dioxide off-setting fund.	5.2, 5.4
Retrofitting	
Mayor's Priority	**FALP Policy**
Boroughs should set out policies to encourage the retrofitting of carbon dioxide and water saving measures in their borough.	5.4, 5.15
Where works to existing developments are proposed developers should retrofit carbon dioxide and water saving measures.	5.4, 5.15
Monitoring Energy Use	
Mayor's Best Practice	**FALP Policy**
Developers are encouraged to incorporate monitoring equipment and systems where appropriate to enable occupiers to monitor and reduce their energy use.	5.2, 5.3
Supporting a Resilient Energy Supply	
Mayor's Best Practice	**FALP Policy**
Developers are encouraged to incorporate equipment that would enable their schemes to participate in demand side response opportunities.	5.2, 5.3
Climate Change Adaptation	
Tackling Increased Temperature and Drought	
Overheating	
Mayor's Priority	**FALP Policy**
Developers should include measures, in the design of their schemes, in line with the cooling hierarchy set out in FALP 2015 Policy 5.9 to prevent overheating over the schemes life-time.	5.3, 5.9

2.04 Camden Council Planning Guidance

Camden Planning Guidance (CPG3) in regards to existing buildings states the following:

Energy efficiency: existing buildings

Key Messages

As a guide, at least 10% of the project cost should be spent on environmental improvements.

Potential measures are bespoke to each property.

Sensitive improvements can be made to historic buildings to reduce carbon dioxide emissions.

- Many of the sections in this guidance focus on reducing the environmental impact of new buildings, however Camden's existing buildings account for almost 80% of the borough's carbon emissions. Therefore it is essential that these buildings make a contribution towards the borough's reduction in carbon dioxide emissions.
- This section provides more information on how existing buildings can be more energy efficient. It builds on the previous section, which covered Stage 1 of the energy hierarchy and improving energy efficiency in new buildings.
- Camden Core Strategy Policy CS13, paragraph 13.9 expects development or alterations to existing buildings to include proportionate measures to be taken to improve their environmental sustainability, where possible.

What Does The Council Expect?

- All buildings, whether being updated or refurbished, are expected to reduce their carbon emissions by making improvements to the existing building. Work involving a change of use or an extension to an existing property is included. As a guide, at least 10% of the project cost should be spent on the improvements.
- Where retro-fitting measures are not identified at application stage we will most likely secure the implementation of environmental improvements by way of condition. Appendix 1 sets out a checklist of retro fit improvements for applicants.
- Development involving a change of use or a conversion of 5 or more dwellings or 500sq m of any floorspace, will be expected to achieve

  60% of the un-weighted credits in the Energy category in their EcoHomes or BREEAM assessment, whichever is applicable. (See the section on Sustainability assessment tools for more details).
- Special consideration will be given to buildings that are protected e.g. listed buildings to ensure that their historic and architectural features are preserved.

3.00 OUTLINE METHODOLOGY

3.01 Energy Strategy

The fundamental approach for the energy strategy is as follows:

- Establish the existing development energy demand in line with statutory requirements in terms of Building Regulations Part L1A:2013 compliance using SAP assessment methodology.
- Adopt passive and low energy design techniques in order to reduce the energy demand for the development beyond the existing developments energy demand requirements.
- Assess the potential decentralised heating, cooling and power measures available to suit this development and establish potential energy/carbon dioxide reduction for viable solutions (clean scheme).
- Assess the potential low and zero carbon (renewable) technologies to suit the development and establish potential energy/carbon dioxide reduction for viable solutions.
- Establish the anticipated energy and carbon dioxide emission reductions for the residential areas.

This approach is in line with the principles detailed within the relevant policy statements and regulatory guidelines listed in section 2.00. The development consists of only refurbished residential apartments. Unlike the Building Regulations L1A which applies to new builds there is no carbon emission or a fabric efficiency target for the refurbished apartments falling under Building Regulations L1B. The above mentioned methodologies shall be applied to the whole residential development.

3.02 Energy Strategy Targets

There is no set carbon emission target for this development. Above mentioned stages will demonstrate a meaningful reduction by applying passive measures and then looking at efficient technologies that could be applied to the development. The potential for low to zero carbon (renewable) technologies to suit the development shall also be reviewed within this report.

4.00 ENERGY DEMAND ASSESSMENT

4.01 General

4.01.01 Principles

The energy demand assessment work has been undertaken using the Standard Assessment Procedure (SAP) 2012 version 9.9.2 in line with Building Regulations Part L1A: 2013 requirements using NHER Plan Assessor software version 6.2.

Within the energy demand assessment the following fuel carbon dioxide emission intensity factors have been used in line with Part L1A:2013.

Fuel	kg CO_2 / kWhr
Natural gas	0.216
Grid supplied electricity	0.519
Grid displaced electricity	0.519

4.01.02 Regulated and Un-regulated Energy

The planning application energy strategy will be provided in a format that reflects the recommendations of the GLA document "Energy Planning – GLA Guidance on preparing energy assessments: April 2015" including also Camden's Planning Guide (CPG3).

Therefore this framework energy strategy shows how policy compliance for the "regulated" energy can be achieved at the development and makes reference to the estimated "un-regulated" energy usage by means of energy benchmarks.

For clarity "regulated" and "un-regulated" energy are summarised as follows:

- Regulated Energy — This is the energy covered by Approved Document L1A of the Building Regulations i.e. the energy used in heating, cooling, fans and pumps plus domestic hot water
- Un - regulated Energy — This is energy used within a building that is not covered by the Building Regulations i.e. the energy used for general small power loads, lifts, external lighting, catering electricity, etc.

The planning policy CO_2 reduction targets are based in "regulated" energy only. Hence the % CO_2 emission savings target is not adversely affected by the estimated "un-regulated" energy in a building.

The assessed un-regulated energy uses for the proposed development are as follows:

- Appliances
- Cooking

For this project the area weighted un-regulated energy equates to19.01 kgCO_2/m^2 (7.64 Tonnes CO_2/Year).

4.02 Existing Scheme

The carbon emission is derived from using the Standard Assessment Procedure (SAP) 2012 version 9.92. The review has been carried out utilising the NHER Plan Assessor software version 6.2.

As described in section 3.0 this building is a refurbished development and as such falls under the Building Regulation Part L1B: 2013. Under this regulation there is no carbon emission target but for consistency the carbon emissions are listed.

As there is no fabric data information for the existing development Reduced Data Standard Assessment Procedure (RDSAP) fabric data was utilised based on the age of the building. Same principals were used for the services within these dwellings again utilising RDSAP data.

The existing development CO_2 emissions for this residential development are modelled as follows:-

Apartments	Existing Scheme (kg CO_2/ m^2)
1	163.43
2	138.29
3	139.96
4	130.15
5	113.06
6	163.39
Area weighted carbon emission	**140.38**

The annual CO_2 emission resulting from the existing development demand equates to the following:

	CO_2 Emission (tonnes CO_2/year)
Without unregulated uses	56.38
With unregulated uses	64.02

4.03 Energy Efficiency Measures

4.03.01 General

The energy strategy prioritises the reduction in energy consumption and hence CO_2 emissions through the building envelope design together with the use of efficient mechanical and electrical services.

The passive and low energy design principles that have been adopted in the current design include:

- High performance glazing
- Enhanced thermal performance to the existing walls and roof by the introduction of thermal insulations. High degree of thermal insulations within the new walls and roof associated with the building

- Low building air leakage rate (5 $m^3/hr/m^2$ at 50 Pa)
- Low energy lighting (LED lamp sources)
- High efficiency gas fired boilers

4.03.02 Proposed Dwelling (Lean Scheme)

The Building Regulations SAP analysis identifies the following CO_2 emissions:

Apartments	Existing Scheme (kg CO_2/m^2/year)	Lean Scheme (kg CO_2/m^2/year)
1	163.43	34.29
2	138.29	55.65
3	139.96	49.89
4	130.15	44.95
5	113.06	33.38
6	163.39	27.31
Area weighted carbon emission	**140.38**	**41.46**
Unregulated Power	19.01	19.01
Total	**159.39**	**60.47**

The annual CO_2 emissions resulting from the passive/low energy scheme equates to the following:

	CO_2 Emission (tonnes CO_2/year)
Without unregulated uses	16.65
With unregulated uses	24.29

Apartments	Existing Scheme (kWh/m^2/year)	Lean Scheme (kWh/m^2/year)
1	300.7	115.1
2	250.6	214.8
3	215.9	176.5
4	194.8	154.7
5	186.6	113.4
6	267.7	76.7
Area weighted carbon emission	238.93	145.84

5.00 DECENTRALISED HEATING, COOLING AND POWER ASSESSMENT

5.01 General

The potential use of decentralised heating, cooling and power for the building has been assessed in relation to the following:

- Decentralised heating
- Decentralised cooling
- Combined heat and power (CHP)
- Combined cooling heat and power (CCHP/trigeneration)
- Community heating and cooling

5.02 Decentralised Heating and Cooling

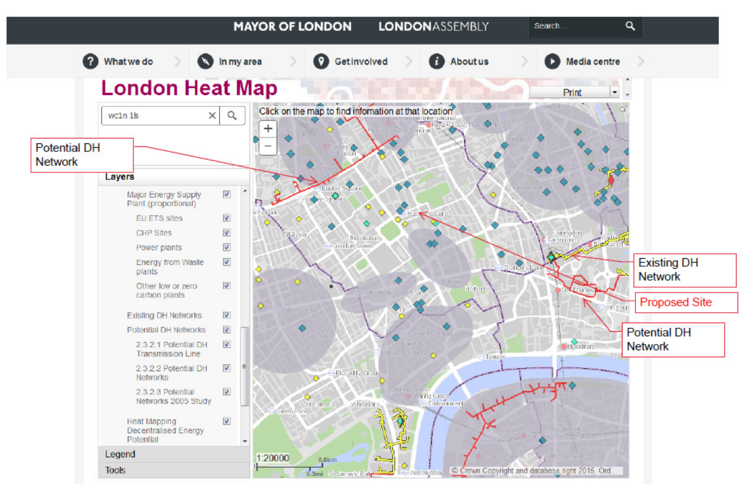
Decentralised heating and cooling relates to a central system that provides the necessary heating and cooling water to more than one use or part of a building or to more than one building. For example a decentralised heating system can comprise central boiler plant that provides heat to separate dwellings and similarly a decentralised cooling system can comprise central refrigeration plant that provides cooling to individual retail units in a shopping centre.

Two types of decentralised heating and cooling schemes have been considered for the development.

1. Connection to a district energy network (DEN)
2. The provision of a development decentralised energy centre

District Energy Network

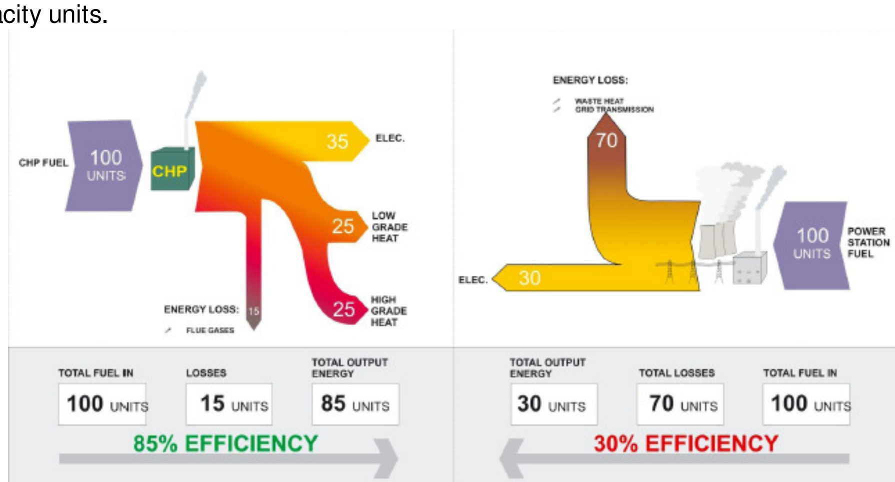
Investigations into existing or proposed district energy networks to provide decentralised heating to the development has established that there is an existing and potential district heating network near Farringdon and a potential district heating network near Euston. The Farringdon installation is approximately 1.8km away and the Euston installation is approximately over 1km away.



The heating and hot water demand for these apartments will be considerably low for a DEN system to be viable. The infrastructure required to connect in to the district heating network will be significant making the DEN system not viable.

5.03 Combined Heat and Power

Combined Heat and Power (CHP) generates electricity on site and recovers a proportion of the waste heat for use in heating and/or hot water generation for the building. This allows the overall efficiency to be significantly greater than the electricity generated via power stations feeding the National Grid. The CHP plant typically uses gas as the primary energy source and often incorporates a thermal store. Biomass fuelled CHP is possible however this is typically only for very large schemes due to operational difficulties with smaller capacity units.



CHP systems are typically considered only to be viable where they are able to run for at least 5000 hours per annum and have an appropriate year round heating demand.

The residential apartment will only have a very low base electricity and heating demand, CHP is not considered viable.

5.04 Combined Cooling, Heat and Power

The reason given in section 5.03 applies to CCHP and as no cooling is proposed for the apartments the benefit achieved using the waste heat within the absorption chiller is not utilised.

5.05 Community Heating and Cooling

Community heating and cooling relates to a central system that provides the necessary heating and cooling water to more than one use or part of a building. For example a community heating system can comprise central boiler plant that provides heat to separate dwellings and similarly a community cooling system can comprise central refrigeration plant that provides cooling to individual retail units in a shopping centre.

As there is not plant space associated with the residential demise a community system cannot be provided. The high efficiency gas boilers proposed as detailed in section 4.03.01 which forms part of the passive and low energy design measure shall provide the heating and hot water demands for the apartments.

6.00 RENEWABLE ENERGY ASSESSMENT

6.01 General

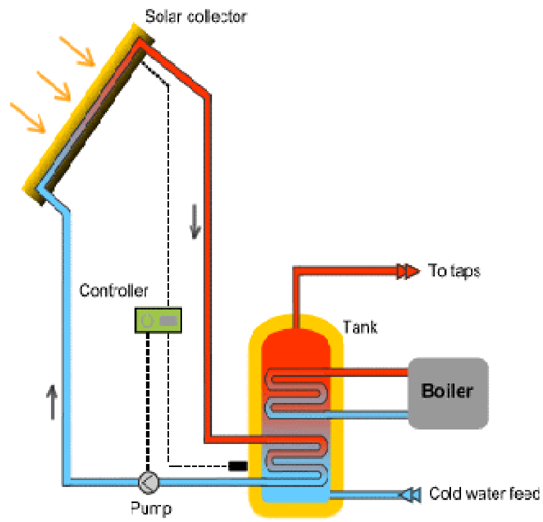
The potential use of renewable energy technology has been undertaken for the following:

- Solar water heating
- Wind turbines
- Photovoltaic cells
- Biomass
- Ground source heating and cooling
- Air source heating and cooling
- Fuel cell

6.02 Solar Water Heating

Solar thermal panels utilise the suns energy to generate hot water for use within the building. The panels are commonly provided in either flat plate or evacuated tube arrangements. The panels are ideally located facing south at an approximate 30° inclination angle in areas where they are not subjected to shade.

The development has a mansard roof which forms the top floor apartment. Mounted Based on the buildings orientation the best location would be along the front façade which is easterly facing. At this location the panels can be easily seen and the building opposite is taller which will shade the panels majority of the day. Rear façade is westerly facing which will not provide the radiance for the solar thermal system to be beneficial. There is also the shading due to the taller building on either side to the proposed building. The benefits of having solar thermal panels are limited and such not viable for the development.



6.03 Wind Turbines

Wind turbines generate electrical energy derived from kinetic energy provided by the local wind resource. The performance of wind turbines depends greatly on the wind speed and turbulence that in turn is influenced by the terrain and installation height.

In urban areas non-laminar wind flow occurs as a result of turbulence due primarily to adjacent buildings. There is growing evidence of urban wind turbines failing to perform in line with manufacturer's estimated outputs and as a result wind turbines are likely to produce only modest power outputs with corresponding low carbon dioxide emission reduction within urban sites. The use of wind turbines on the development would also have a significant visual impact.

For the reasons detailed above wind turbines are not considered viable for the development.

6.04 Photovoltaic Cells

Photovoltaic (PV) panels utilise the sun's energy to generate electricity. The optimum location for PV panels is south facing at an approximate 30° inclination angle in areas where they are not subjected to shade.

The installation of PV panels falls under the same criteria as the solar thermal panels. Please refer to section 6.02 for the viability of PV panels.

6.05 Biomass

Biomass is considered to be a renewable fuel source as the CO_2 absorbed during the growth period is assessed as being approximately equal to the CO_2 emitted during combustion and hence deemed "carbon neutral". Biomass for boilers is typically wood either in chip or pellet form.

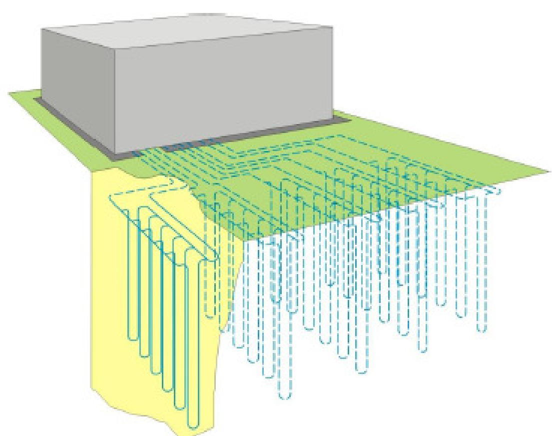
Biomass boilers require fuel storage together with associated transportation and delivery to the store location. Biomass boilers also increase the NOx emissions when compared to gas fired boilers.

For this development there is no realistic space within the overall development for fuel storage together with the site constraints related to the associated delivery requirements. In addition there are on-going concerns with regard to the potential impact on local air quality.

For the reasons defined above the use of biomass is not considered viable for the development.

6.06 Ground Source Heating and Cooling

Ground source heating and cooling systems utilises the principle during heating mode of upgrading heat from the ground to a usable temperature and during cooling mode of rejecting heat from the building into the ground. There are two primary methods utilising either open or closed loop systems.



The open loop system extracts water, typically from the chalk aquifer, and uses this water in either the heating or cooling process before rejecting this heat back to the aquifer in a separate borehole. The open loop system requires licence approval from the Environment Agency that typically has a 10 year duration.

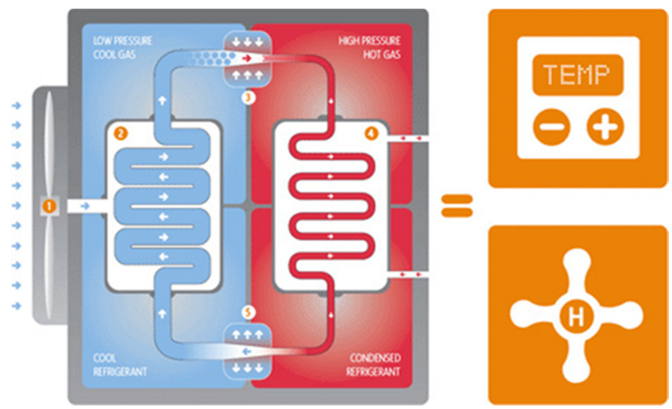
The closed loop system dissipates heat to or extracts heat from the ground via pipework circuits that are typically inserted into vertical boreholes. These generally do not require Environment Agency licences as no extraction of water from the aquifer takes place.

Generally for both the open and closed loop options heat pumps are used in order to generate the heating and cooling water temperatures needed within a building.

Incorporating ground source heating and cooling technology into the development poses a significant construction programme and operational risk. The building footprint is small and is located between existing buildings. The policy design will restrict the thermal energy generation capacity due to the minimal number of boreholes location available. As a result this option is not considered to be viable for this development.

6.07 Air Source Heating and Cooling

Air sourced heat pump (ASHP) works on the same principles as a ground source heat pump (GSHP) however the medium in which heat is extracted is the external air rather than the ground. The ASHP can be reversed to provide cooling when required. ASHP will generally have a lower seasonal coefficient of performance when compared to GSHP.



The development has no plant space available and the apartment will not be comfort cooled. The progressed high efficient gas fired boiler will offer a more efficient heating system than using an ASHP system.

6.08 Fuel Cell

The fuel cell technology essentially converts chemical energy into both electrical and heat energy. The cell needs to be continually supplied with hydrogen (derived from either a piped or storage source) and oxygen (derived from air) which are combined and the chemical reaction produces electrical energy, heat energy and water vapour.

The fuel cell requires a hydrogen fuel source that can either be from a piped source (not currently available) or from stored gas. However the more usual approach currently in the UK is to use natural gas in order to generate the hydrogen required to operate the fuel cell.

Fuel cells have various commercial and technical limitations. There is a high initial capital cost together with there being few established suppliers and a very limited specialist design, installation and maintenance capabilities. Certain fuel cell elements require regular replacement imposing a significant on-going cost implication. The fuel cells themselves are generally large, heavy and require fresh air ventilation.

Due to the initial capital cost, space requirements and on-going maintenance costs fuel cells are not considered viable for this development.

7.00 OVERHEATING

The building design has adopted the following principles in order to reduce potential overheating:

- Balance between solid and glazed elements within the façade whilst taking into account the building design aesthetic requirements
- Energy efficient design measures such as low energy LED lighting
- High performance glazing to reduce heat losses and solar heat gain

8.00 OVERALL BUILDING ANALYSIS

8.01 Carbon Reduction of the Development

The building analysis can then be summarised as follows:

	Area Weighted kg CO_2/m^2			
	Existing Scheme	**Lean Scheme**	**Clean Scheme**	**LZC Scheme**
Carbon Emission	140.38	41.46	n/a	n/a
Allowing for Un-regulated Uses	159.39	60.47	n/a	n/a

Utilising high performance fabric and building services the refurbished residential development shows a predicted improvement of 70.5 % over the existing development. With unregulated load this is a 62.1% improvement over the existing development. The relevant SAP work sheets are included within the appendix for each dwelling.

9.00 CONCLUSIONS

In line with the relevant planning policies and guidelines the energy strategy for the proposed development has adopted a hierarchical approach of using passive and low energy design technologies to reduce the existing developments energy demand and hence CO_2 emissions followed by the consideration of passive design measures as appropriate.

The focus of the energy strategy is on CO_2 reduction from the building by adopting a efficient building envelope solution together with high efficiency mechanical and electrical services. The renewable energy technologies assessment is based on using solutions that are technically proven with low maintenance implications taking into account the energy efficiency strategies being proposed in the current design.

The analysis has shown that by incorporating passive and low energy design measures there is a predicted reduction annual CO_2 emissions, as indicated in the table below, from the existing scheme.

Regulated CO_2 Savings	
Tonnes CO_2/Year	%
39.73	70.5

This is achieved by the following elements:

- High performance glazing
- Improved building fabric thermal insulation
- High efficiency heating plant
- Low energy lighting (LED lighting)

The decentralised heating, cooling and power assessment has indicated that the application of a clean system is not beneficial for the development.

The potential renewable energy technologies have been assessed taking into account the particular development constraints and have been concluded to be unviable for the reason stated within section 6.00.

As it can be seen from the analysis we are significantly improving the existing development by incorporating passive and low energy measures without the need for renewables. Development is located within the conservation area of Bloomsbury and the added site constraint doesn't permit the provision of onsite renewables.

APPENDIX

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Spyridon Karnezis	Assessor number	8658
Client		Last modified	12/08/2016
Address	1 11-12 Grenville, Camden, WC1		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		28.60	(1a)	x	2.50	(2a)	=	71.50	(3a)
+1		25.48	(1b)	x	3.50	(2b)	=	89.18	(3b)
+2		28.60	(1c)	x	3.10	(2c)	=	88.66	(3c)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	82.68	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			249.34	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	3	x 10 =	30	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	30	÷ (5) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.37	(18)
Number of sides on which the dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.26	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.33	0.32	0.32	0.29	0.28	0.25	0.25	0.24	0.26	0.28	0.29	0.30	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

d) natural ventilation or whole house positive input ventilation from loft

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.55	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.55	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			1.70	x	1.80	=	3.06			(26)
Window			9.80	x	1.50	=	14.74			(27)
Exposed floor			1.92	x	0.22	=	0.42			(28b
Ground floor			28.60	x	0.22	=	6.29			(28a)
External wall			131.09	x	0.28	=	36.71			(29a)
External wall			30.90	x	1.38	=	42.64			(29a)
Party wall			17.05	x	0.50	=	8.53			(32)
Roof			30.52	x	0.18	=	5.49			(30)
Total area of external elements ∑A, m²			234.53							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	117.88	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		35.18	(36)
Total fabric heat loss	(33) + (36) =	153.06	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	45.64	45.46	45.29	44.49	44.34	43.64	43.64	43.51	43.91	44.34	44.64	44.96	(38)
Heat transfer coefficient, W/K (37)m + (38)m	198.69	198.52	198.35	197.54	197.39	196.69	196.69	196.56	196.96	197.39	197.70	198.01	
Average = ∑(39)1...12/12 =												197.54	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	2.40	2.40	2.40	2.39	2.39	2.38	2.38	2.38	2.38	2.39	2.39	2.39	
Average = ∑(40)1...12/12 =												2.39	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	2.51	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	93.85	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	103.24	99.49	95.73	91.98	88.22	84.47	84.47	88.22	91.98	95.73	99.49	103.24	
∑(44)1...12 =												1126.25	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	153.10	133.90	138.18	120.47	115.59	99.74	92.43	106.06	107.33	125.08	136.54	148.27	
∑(45)1...12 =												1476.69	(45)
Distribution loss 0.15 x (45)m	22.97	20.09	20.73	18.07	17.34	14.96	13.86	15.91	16.10	18.76	20.48	22.24	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)

Primary circuit loss for each month from Table 3

	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)

Combi loss for each month from Table 3a, 3b or 3c

50.96	45.79	48.78	45.36	44.96	41.66	43.04	44.96	45.36	48.78	49.06	50.96	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

204.06	179.69	186.96	165.82	160.55	141.40	135.47	151.02	152.69	173.87	185.60	199.23	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

204.06	179.69	186.96	165.82	160.55	141.40	135.47	151.02	152.69	173.87	185.60	199.23

∑(64)1...12 = 2036.36 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

63.65	55.97	58.14	51.39	49.67	43.58	41.49	46.51	47.03	53.79	57.66	62.04	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)													
	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	59.98	53.27	43.32	32.80	24.52	20.70	22.37	29.07	39.02	49.54	57.82	61.64	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	335.75	339.23	330.45	311.76	288.17	265.99	251.18	247.69	256.47	275.16	298.76	320.93	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	(69)
Pump and fan gains (Table 5a)													
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)													
	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	(71)
Water heating gains (Table 5)													
	85.55	83.29	78.14	71.38	66.76	60.53	55.77	62.51	65.31	72.29	80.09	83.39	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	587.09	581.61	557.74	521.76	485.27	453.03	435.13	445.09	466.62	502.82	542.49	571.78	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
South	0.30	x	7.20	x	46.75	x 0.9 x	0.73	x	0.70	=	46.44	(78)
West	0.77	x	2.60	x	19.64	x 0.9 x	0.73	x	0.70	=	18.08	(80)

Solar gains in watts ∑(74)m...(82)m

64.53	111.44	155.15	194.47	218.24	216.41	208.78	191.37	168.97	124.01	77.60	55.00	(83)

Total gains - internal and solar (73)m + (83)m

651.61	693.04	712.88	716.23	703.50	669.44	643.91	636.46	635.59	626.83	620.09	626.78	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)													
	0.99	0.99	0.99	0.98	0.96	0.92	0.84	0.86	0.94	0.98	0.99	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

18.53	18.68	18.99	19.44	19.93	20.40	20.70	20.67	20.29	19.67	19.02	18.50	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)

19.08	19.08	19.08	19.09	19.09	19.09	19.09	19.09	19.09	19.09	19.09	19.08	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.99	0.98	0.97	0.94	0.84	0.64	0.67	0.88	0.96	0.99	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

16.96	17.11	17.42	17.86	18.35	18.79	19.02	19.00	18.70	18.09	17.46	16.93	(90)

Living area fraction — Living area ÷ (4) = 0.28 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

17.40	17.55	17.86	18.31	18.79	19.25	19.49	19.47	19.15	18.54	17.90	17.37	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

17.40	17.55	17.86	18.31	18.79	19.25	19.49	19.47	19.15	18.54	17.90	17.37	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.98	0.98	0.96	0.93	0.85	0.70	0.73	0.88	0.96	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	643.09	681.40	695.97	688.83	653.85	568.21	449.76	462.25	561.40	600.65	608.32	619.48	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	2602.88	2511.06	2253.19	1857.92	1399.37	913.76	568.63	603.18	993.83	1566.44	2134.31	2607.73	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	1458.09	1229.53	1158.57	841.75	554.67	0.00	0.00	0.00	0.00	718.55	1098.71	1479.25	

∑(98)1...5, 10...12 = 8539.12 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 103.28 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		95.80	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	1522.01	1283.44	1209.37	878.65	578.98	0.00	0.00	0.00	0.00	750.05	1146.88	1544.11

∑(211)1...5, 10...12 = 8913.49 (211)

Water heating

Efficiency of water heater

94.55	94.50	94.39	94.13	93.54	86.50	86.50	86.50	86.50	93.83	94.33	94.59	(217)

Water heating fuel, kWh/month

215.82	190.14	198.07	176.16	171.63	163.47	156.62	174.59	176.52	185.29	196.75	210.62

∑(219a)1...12 = 2215.66 (219)

Annual totals

Space heating fuel - main system 1 — 8913.49

Water heating fuel				2215.66	
Electricity for pumps, fans and electric keep-hot (Table 4f)					
central heating pump or water pump within warm air heating unit		30.00			(230c)
boiler flue fan		45.00			(230e)
Total electricity for the above, kWh/year				75.00	(231)
Electricity for lighting (Appendix L)				423.68	(232)
Total delivered energy for all uses			(211)...(221) + (231) + (232)...(237b) =	11627.83	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	8913.49	x	3.48	x 0.01 =	310.19	(240)
Water heating	2215.66	x	3.48	x 0.01 =	77.11	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	423.68	x	13.19	x 0.01 =	55.88	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	573.07	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.89	(257)
SAP value	73.70	
SAP rating (section 13)	74	(258)
SAP band	C	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	8913.49	x	0.216	=	1925.31	(261)
Water heating	2215.66	x	0.216	=	478.58	(264)
Space and water heating				(261) + (262) + (263) + (264) =	2403.90	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	423.68	x	0.519	=	219.89	(268)
Total CO_2, kg/year				(265)...(271) =	2662.71	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	32.21	(273)
EI value					72.05	
EI rating (section 14)					72	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	8913.49	x	1.22	=	10874.46	(261)
Water heating	2215.66	x	1.22	=	2703.11	(264)
Space and water heating				(261) + (262) + (263) + (264) =	13577.57	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	423.68	x	3.07	=	1300.70	(268)
Primary energy kWh/year					15108.52	(272)
Dwelling primary energy rate kWh/m2/year					182.73	(273)

SAP Worksheet
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Spyridon Karnezis	Assessor number	8658
Client		Last modified	12/08/2016
Address	2 11-12 Grenville, Camden, WC1		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		17.71	(1a)	x	3.50	(2a)	=	61.99	(3a)
+1		38.45	(1b)	x	3.10	(2b)	=	119.20	(3b)
+2		38.45	(1c)	x	2.90	(2c)	=	111.51	(3c)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	94.61	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			292.69	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	3	x 10 =	30	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	30	÷ (5) =	0.10	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.35	(18)
Number of sides on which the dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.25	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.31	0.31	0.30	0.27	0.27	0.23	0.23	0.23	0.25	0.27	0.28	0.29	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

d) natural ventilation or whole house positive input ventilation from loft

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			1.70	x	3.00	=	5.10			(26)
Window			16.77	x	1.50	=	25.22			(27)
Exposed floor			20.74	x	1.20	=	24.89			(28b
Ground floor			17.71	x	1.28	=	22.67			(28a)
External wall			16.15	x	0.28	=	4.52			(29a)
External wall			80.05	x	1.38	=	110.47			(29a)
Party wall			36.00	x	0.50	=	18.00			(32)
External wall			73.03	x	2.10	=	153.36			(29a)
Total area of external elements ∑A, m²			226.15							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	364.23	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		33.92	(36)
Total fabric heat loss	(33) + (36) =	398.15	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	53.07	52.89	52.71	51.85	51.69	50.95	50.95	50.81	51.23	51.69	52.01	52.35	(38)
Heat transfer coefficient, W/K (37)m + (38)m	451.22	451.04	450.86	450.00	449.84	449.10	449.10	448.96	449.38	449.84	450.17	450.50	
Average = ∑(39)1...12/12 =												450.00	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	4.77	4.77	4.77	4.76	4.75	4.75	4.75	4.75	4.75	4.75	4.76	4.76	
Average = ∑(40)1...12/12 =												4.76	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	2.68	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	97.94	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	107.73	103.81	99.90	95.98	92.06	88.14	88.14	92.06	95.98	99.90	103.81	107.73	
∑(44)1...12 =												1175.26	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	159.76	139.73	144.19	125.71	120.62	104.09	96.45	110.68	112.00	130.53	142.48	154.72	
∑(45)1...12 =												1540.95	(45)
Distribution loss 0.15 x (45)m	23.96	20.96	21.63	18.86	18.09	15.61	14.47	16.60	16.80	19.58	21.37	23.21	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)

Primary circuit loss for each month from Table 3

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)

Combi loss for each month from Table 3a, 3b or 3c

50.96	46.03	50.91	47.33	46.91	43.47	44.92	46.91	47.33	50.91	49.32	50.96	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

210.72	185.76	195.10	173.04	167.53	147.55	141.37	157.59	159.33	181.43	191.79	205.68	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

210.72	185.76	195.10	173.04	167.53	147.55	141.37	157.59	159.33	181.43	191.79	205.68	(63)

∑(64)1...12 = 2116.90 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

65.86	57.97	60.67	53.63	51.83	45.48	43.30	48.53	49.07	56.13	59.70	64.18	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	59.46	52.81	42.95	32.52	24.31	20.52	22.17	28.82	38.68	49.12	57.33	61.11	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	369.12	372.95	363.29	342.75	316.81	292.43	276.14	272.31	281.96	302.51	328.45	352.83	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	(71)
Water heating gains (Table 5)	88.52	86.26	81.54	74.49	69.67	63.16	58.20	65.23	68.16	75.44	82.92	86.27	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	627.56	622.48	598.25	560.21	521.24	486.57	466.97	476.82	499.27	537.53	579.16	610.68	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
North	0.30	x	2.90	x	10.63	x 0.9 x	0.73	x	0.70	=	4.25	(74)
East	0.30	x	6.80	x	19.64	x 0.9 x	0.73	x	0.70	=	18.43	(76)
West	0.77	x	6.35	x	19.64	x 0.9 x	0.73	x	0.70	=	44.16	(80)
North	0.77	x	0.72	x	10.63	x 0.9 x	0.73	x	0.70	=	2.71	(74)

Solar gains in watts ∑(74)m...(82)m

69.56	135.75	224.26	330.42	409.36	421.34	400.17	340.53	261.72	161.13	86.64	57.28	(83)

Total gains - internal and solar (73)m + (83)m

697.12	758.23	822.51	890.63	930.60	907.91	867.15	817.35	760.98	698.66	665.80	667.95	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Utilisation factor for gains for living area n1,m (see Table 9a)

0.99	0.99	0.99	0.98	0.96	0.93	0.88	0.90	0.95	0.98	0.99	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

16.91	17.11	17.58	18.26	19.03	19.78	20.27	20.20	19.58	18.61	17.65	16.87	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.99	0.98	0.96	0.93	0.82	0.58	0.65	0.89	0.96	0.98	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

14.81	15.01	15.47	16.16	16.91	17.63	18.02	17.98	17.45	16.51	15.55	14.77	(90)

Living area fraction — Living area ÷ (4) = 0.31 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

15.47	15.67	16.14	16.82	17.58	18.31	18.73	18.68	18.12	17.17	16.21	15.43	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

15.47	15.67	16.14	16.82	17.58	18.31	18.73	18.68	18.12	17.17	16.21	15.43	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.98	0.97	0.95	0.91	0.84	0.70	0.74	0.89	0.96	0.98	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	684.91	741.71	797.27	846.61	850.24	758.69	603.47	601.02	674.45	667.24	650.29	657.24	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	5040.40	4856.84	4344.10	3563.29	2644.63	1664.47	956.62	1023.64	1805.85	2954.08	4101.18	5059.47	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	3240.49	2765.36	2638.84	1956.01	1335.02	0.00	0.00	0.00	0.00	1701.41	2484.64	3275.26	

∑(98)1...5, 10...12 = 19397.02 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 205.02 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		95.80	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	3382.55	2886.60	2754.53	2041.76	1393.55	0.00	0.00	0.00	0.00	1776.00	2593.57	3418.85

∑(211)1...5, 10...12 = 20247.42 (211)

Water heating

Efficiency of water heater

95.18	95.16	95.10	94.97	94.67	86.50	86.50	86.50	86.50	94.82	95.07	95.20	(217)

Water heating fuel, kWh/month

221.40	195.21	205.16	182.20	176.97	170.58	163.43	182.19	184.20	191.35	201.74	216.06

∑(219a)1...12 = 2290.51 (219)

Annual totals

Space heating fuel - main system 1		20247.42	
Water heating fuel		2290.51	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
central heating pump or water pump within warm air heating unit	30.00		(230c)
Total electricity for the above, kWh/year		30.00	(231)
Electricity for lighting (Appendix L)		420.05	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	22987.97	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	20247.42	x	3.48	x 0.01 =	704.61	(240)
Water heating	2290.51	x	3.48	x 0.01 =	79.71	(247)
Pumps and fans	30.00	x	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	420.05	x	13.19	x 0.01 =	55.40	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		963.68	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	2.90	(257)
SAP value	59.56	
SAP rating (section 13)	60	(258)
SAP band	D	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	20247.42	x	0.216	=	4373.44	(261)
Water heating	2290.51	x	0.216	=	494.75	(264)
Space and water heating			(261) + (262) + (263) + (264) =		4868.19	(265)
Pumps and fans	30.00	x	0.519	=	15.57	(267)
Electricity for lighting	420.05	x	0.519	=	218.00	(268)
Total CO_2, kg/year			(265)...(271) =		5101.77	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		53.92	(273)
EI value					51.53	
EI rating (section 14)					52	(274)
EI band					E	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	20247.42	x	1.22	=	24701.85	(261)
Water heating	2290.51	x	1.22	=	2794.42	(264)
Space and water heating			(261) + (262) + (263) + (264) =		27496.27	(265)
Pumps and fans	30.00	x	3.07	=	92.10	(267)
Electricity for lighting	420.05	x	3.07	=	1289.54	(268)
Primary energy kWh/year					28877.91	(272)
Dwelling primary energy rate kWh/m2/year					305.23	(273)

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Spyridon Karnezis	Assessor number	8658
Client		Last modified	12/08/2016
Address	3 11-12 Grenville, Camden, WC1		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		47.75	(1a)	x	2.80	(2a)	=	133.70	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	47.75	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			133.70	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	3	x 10 =	30	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	30	÷ (5) =	0.22	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.47	(18)
Number of sides on which the dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.33	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.42	0.42	0.41	0.37	0.36	0.32	0.32	0.31	0.33	0.36	0.37	0.39	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
d) natural ventilation or whole house positive input ventilation from loft	0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.55	0.56	0.56	0.57	0.58	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.55	0.56	0.56	0.57	0.58	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			1.70	x	1.00	=	1.70			(26)
Window			7.26	x	1.50	=	10.92			(27)
Exposed floor			7.56	x	0.79	=	5.97			(28b
Exposed floor			40.19	x	0.60	=	24.11			(28b
External wall			20.18	x	2.10	=	42.38			(29a)
External wall			20.16	x	1.38	=	27.82			(29a)
Party wall			33.04	x	0.50	=	16.52			(32)
External wall			26.02	x	0.25	=	6.51			(29a)
Total area of external elements ∑A, m²			123.07							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	135.93	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		18.46	(36)
Total fabric heat loss	(33) + (36) =	154.39	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	26.01	25.86	25.71	25.00	24.87	24.26	24.26	24.14	24.49	24.87	25.14	25.42	(38)
Heat transfer coefficient, W/K (37)m + (38)m	180.40	180.25	180.10	179.39	179.26	178.64	178.64	178.53	178.88	179.26	179.53	179.81	
Average = ∑(39)1...12/12 =												179.39	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	3.78	3.77	3.77	3.76	3.75	3.74	3.74	3.74	3.75	3.75	3.76	3.77	
Average = ∑(40)1...12/12 =												3.76	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.62	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	72.77	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	80.05	77.14	74.23	71.32	68.41	65.50	65.50	68.41	71.32	74.23	77.14	80.05	
∑(44)1...12 =												873.27	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	118.71	103.83	107.14	93.41	89.63	77.34	71.67	82.24	83.22	96.99	105.87	114.97	
∑(45)1...12 =												1145.00	(45)
Distribution loss 0.15 x (45)m	17.81	15.57	16.07	14.01	13.44	11.60	10.75	12.34	12.48	14.55	15.88	17.24	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)

Combi loss for each month from Table 3a, 3b or 3c

40.79	35.51	37.83	35.17	34.86	32.30	33.38	34.86	35.17	37.83	38.04	40.79	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

159.50	139.33	144.97	128.58	124.48	109.64	105.04	117.10	118.39	134.81	143.91	155.76	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

159.50	139.33	144.97	128.58	124.48	109.64	105.04	117.10	118.39	134.81	143.91	155.76

∑(64)1...12 = 1581.51 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

49.67	43.40	45.08	39.85	38.52	33.79	32.17	36.06	36.46	41.70	44.71	48.42	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	33.22	29.50	23.99	18.17	13.58	11.46	12.39	16.10	21.61	27.44	32.03	34.14	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	211.03	213.22	207.71	195.96	181.13	167.19	157.88	155.69	161.21	172.96	187.79	201.72	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	(71)
Water heating gains (Table 5)	66.76	64.58	60.59	55.35	51.77	46.93	43.24	48.47	50.64	56.05	62.10	65.09	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	392.86	389.16	374.14	351.32	328.33	307.44	295.36	302.11	315.31	338.30	363.76	382.80	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	0.77	x	5.70	x	19.64	x 0.9 x	0.73	x	0.70	=	39.64	(76)
South	0.77	x	1.56	x	46.75	x 0.9 x	0.73	x	0.70	=	25.83	(78)

Solar gains in watts ∑(74)m...(82)m	65.47	119.85	181.60	247.16	291.74	294.75	282.14	249.05	204.82	137.64	80.05	54.92	(83)
Total gains - internal and solar (73)m + (83)m	458.34	509.01	555.74	598.49	620.06	602.19	577.51	551.16	520.14	475.95	443.81	437.72	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.98	0.97	0.96	0.93	0.87	0.79	0.81	0.91	0.96	0.98	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	17.59	17.80	18.24	18.87	19.54	20.17	20.56	20.50	19.98	19.13	18.25	17.55	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)

18.41	18.41	18.41	18.42	18.42	18.43	18.43	18.43	18.42	18.42	18.42	18.42	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.98	0.98	0.96	0.94	0.88	0.73	0.48	0.54	0.81	0.94	0.97	0.98	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

15.62	15.83	16.27	16.89	17.54	18.10	18.36	18.34	17.96	17.15	16.29	15.58	(90)

Living area fraction — Living area ÷ (4) = 0.56 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

16.72	16.93	17.37	17.99	18.65	19.25	19.58	19.54	19.08	18.25	17.38	16.68	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

16.72	16.93	17.37	17.99	18.65	19.25	19.58	19.54	19.08	18.25	17.38	16.68	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.97	0.96	0.93	0.88	0.79	0.66	0.70	0.85	0.94	0.97	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	447.60	493.40	531.23	556.41	546.87	477.69	382.88	384.28	441.41	445.69	429.65	428.46	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	2240.53	2168.17	1957.32	1630.74	1246.37	831.37	533.01	560.91	891.48	1370.73	1845.59	2243.73	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	1333.94	1125.44	1061.01	773.51	520.42	0.00	0.00	0.00	0.00	688.23	1019.48	1350.57	

∑(98)1...5, 10...12 = 7872.60 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 164.87 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		95.80	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	1392.42	1174.78	1107.53	807.43	543.24	0.00	0.00	0.00	0.00	718.40	1064.17	1409.78

∑(211)1...5, 10...12 = 8217.75 (211)

Water heating

Efficiency of water heater

94.71	94.68	94.58	94.35	93.85	86.50	86.50	86.50	86.50	94.14	94.54	94.75	(217)

Water heating fuel, kWh/month

168.41	147.16	153.28	136.27	132.64	126.75	121.44	135.37	136.87	143.20	152.22	164.39

∑(219a)1...12 = 1718.00 (219)

Annual totals

Space heating fuel - main system 1	8217.75
Water heating fuel	1718.00
Electricity for pumps, fans and electric keep-hot (Table 4f)	

central heating pump or water pump within warm air heating unit			30.00			(230c)
Total electricity for the above, kWh/year					30.00	(231)
Electricity for lighting (Appendix L)					234.66	(232)
Total delivered energy for all uses				(211)...(221) + (231) + (232)...(237b) =	10200.41	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	8217.75	x	3.48	x 0.01 =	285.98	(240)
Water heating	1718.00	x	3.48	x 0.01 =	59.79	(247)
Pumps and fans	30.00	x	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	234.66	x	13.19	x 0.01 =	30.95	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	500.67	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	2.27	(257)
SAP value	68.37	
SAP rating (section 13)	68	(258)
SAP band	D	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	8217.75	x	0.216	=	1775.03	(261)
Water heating	1718.00	x	0.216	=	371.09	(264)
Space and water heating				(261) + (262) + (263) + (264) =	2146.12	(265)
Pumps and fans	30.00	x	0.519	=	15.57	(267)
Electricity for lighting	234.66	x	0.519	=	121.79	(268)
Total CO_2, kg/year				(265)...(271) =	2283.48	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	47.82	(273)
EI value					67.01	
EI rating (section 14)					67	(274)
EI band					D	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	8217.75	x	1.22	=	10025.65	(261)
Water heating	1718.00	x	1.22	=	2095.96	(264)
Space and water heating				(261) + (262) + (263) + (264) =	12121.61	(265)
Pumps and fans	30.00	x	3.07	=	92.10	(267)
Electricity for lighting	234.66	x	3.07	=	720.41	(268)
Primary energy kWh/year					12934.13	(272)
Dwelling primary energy rate kWh/m2/year					270.87	(273)

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Spyridon Karnezis	Assessor number	8658
Client		Last modified	12/08/2016
Address	4 11-12 Grenville, Camden, WC1		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		47.75	(1a)	x	2.60	(2a)	=	124.15	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	47.75	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			124.15	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	3	x 10 =	30	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	30	÷ (5) =	0.24	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.49	(18)
Number of sides on which the dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.34	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.34	0.37	0.39	0.40	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
d) natural ventilation or whole house positive input ventilation from loft	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			1.70	x	1.00	=	1.70			(26)
Window			7.61	x	1.50	=	11.44			(27)
External wall			32.43	x	2.10	=	68.10			(29a)
External wall			18.72	x	1.38	=	25.83			(29a)
Party wall			16.12	x	0.50	=	8.06			(32)
External wall			24.04	x	0.25	=	6.01			(29a)
Total area of external elements ∑A, m²			84.50							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	121.15	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		12.68	(36)
Total fabric heat loss	(33) + (36) =	133.83	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	24.43	24.28	24.13	23.42	23.29	22.67	22.67	22.56	22.91	23.29	23.56	23.83	(38)
Heat transfer coefficient, W/K (37)m + (38)m	158.25	158.10	157.95	157.25	157.11	156.50	156.50	156.39	156.74	157.11	157.38	157.66	
Average = ∑(39)1...12/12 =												157.25	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	3.31	3.31	3.31	3.29	3.29	3.28	3.28	3.28	3.28	3.29	3.30	3.30	
Average = ∑(40)1...12/12 =												3.29	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.62	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	72.77	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	80.05	77.14	74.23	71.32	68.41	65.50	65.50	68.41	71.32	74.23	77.14	80.05	
∑(44)1...12 =												873.27	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	118.71	103.83	107.14	93.41	89.63	77.34	71.67	82.24	83.22	96.99	105.87	114.97	
∑(45)1...12 =												1145.00	(45)
Distribution loss 0.15 x (45)m	17.81	15.57	16.07	14.01	13.44	11.60	10.75	12.34	12.48	14.55	15.88	17.24	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c	40.79	35.51	37.83	35.17	34.86	32.30	33.38	34.86	35.17	37.83	38.04	40.79	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

	159.50	139.33	144.97	128.58	124.48	109.64	105.04	117.10	118.39	134.81	143.91	155.76	(62)
Solar DHW input calculated using Appendix G or Appendix H	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Output from water heater for each month (kWh/month) (62)m + (63)m	159.50	139.33	144.97	128.58	124.48	109.64	105.04	117.10	118.39	134.81	143.91	155.76	
											∑(64)1...12 =	1581.51	(64)
Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]	49.67	43.40	45.08	39.85	38.52	33.79	32.17	36.06	36.46	41.70	44.71	48.42	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	32.90	29.22	23.77	17.99	13.45	11.35	12.27	15.95	21.41	27.18	31.72	33.82	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	211.03	213.22	207.71	195.96	181.13	167.19	157.88	155.69	161.21	172.96	187.79	201.72	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	(71)
Water heating gains (Table 5)	66.76	64.58	60.59	55.35	51.77	46.93	43.24	48.47	50.64	56.05	62.10	65.09	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	392.55	388.88	373.92	351.15	328.20	307.33	295.24	301.95	315.11	338.04	363.46	382.48	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	0.77	x	4.60	x	19.64	x 0.9 x	0.73	x	0.70	=	31.99	(76)
South	0.77	x	1.56	x	46.75	x 0.9 x	0.73	x	0.70	=	25.83	(78)
West	0.77	x	1.45	x	19.64	x 0.9 x	0.73	x	0.70	=	10.08	(80)

Solar gains in watts ∑(74)m...(82)m	67.91	124.61	189.44	258.60	305.75	309.10	295.81	260.78	213.95	143.30	83.08	56.92	(83)
Total gains - internal and solar (73)m + (83)m	460.45	513.49	563.36	609.75	633.95	616.43	591.05	562.74	529.05	481.34	446.54	439.40	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.98	0.97	0.96	0.92	0.85	0.76	0.79	0.90	0.96	0.98	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	17.91	18.12	18.54	19.13	19.76	20.33	20.66	20.61	20.14	19.34	18.53	17.87	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)	18.60	18.60	18.60	18.61	18.61	18.62	18.62	18.62	18.62	18.61	18.61	18.61	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.98	0.98	0.96	0.93	0.86	0.71	0.47	0.53	0.80	0.94	0.97	0.98	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

16.05	16.25	16.67	17.25	17.85	18.35	18.57	18.55	18.21	17.47	16.66	16.01	(90)

Living area fraction — Living area ÷ (4) = 0.56 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

17.08	17.29	17.71	18.30	18.91	19.45	19.73	19.69	19.29	18.51	17.70	17.04	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

17.08	17.29	17.71	18.30	18.91	19.45	19.73	19.69	19.29	18.51	17.70	17.04	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.97	0.96	0.93	0.87	0.78	0.64	0.68	0.84	0.93	0.97	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	450.15	498.06	538.24	564.99	553.84	478.49	377.17	379.90	443.72	450.04	432.64	430.59	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	2023.18	1958.96	1770.64	1477.82	1132.89	758.77	489.83	514.97	812.83	1242.89	1668.12	2025.01	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	1170.33	981.73	916.91	657.24	430.81	0.00	0.00	0.00	0.00	589.89	889.55	1186.25	

∑(98)1...5, 10...12 = 6822.71 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 142.88 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		95.80	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	1221.64	1024.77	957.11	686.06	449.70	0.00	0.00	0.00	0.00	615.75	928.55	1238.26

∑(211)1...5, 10...12 = 7121.83 (211)

Water heating

Efficiency of water heater	94.58	94.54	94.41	94.14	93.55	86.50	86.50	86.50	86.50	93.92	94.39	94.62	(217)
Water heating fuel, kWh/month	168.64	147.38	153.54	136.57	133.07	126.75	121.44	135.37	136.87	143.54	152.47	164.62	

∑(219a)1...12 = 1720.27 (219)

Annual totals

Space heating fuel - main system 1	7121.83	
Water heating fuel	1720.27	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	30.00	(230c)

Total electricity for the above, kWh/year	30.00	(231)
Electricity for lighting (Appendix L)	232.43	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =	9104.53	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	7121.83	x	3.48	x 0.01 =	247.84	(240)
Water heating	1720.27	x	3.48	x 0.01 =	59.87	(247)
Pumps and fans	30.00	x	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	232.43	x	13.19	x 0.01 =	30.66	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	462.32	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	2.09	(257)
SAP value	70.80	
SAP rating (section 13)	71	(258)
SAP band	C	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	7121.83	x	0.216	=	1538.32	(261)
Water heating	1720.27	x	0.216	=	371.58	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1909.89	(265)
Pumps and fans	30.00	x	0.519	=	15.57	(267)
Electricity for lighting	232.43	x	0.519	=	120.63	(268)
Total CO_2, kg/year				(265)...(271) =	2046.09	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	42.85	(273)
EI value					70.44	
EI rating (section 14)					70	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	7121.83	x	1.22	=	8688.63	(261)
Water heating	1720.27	x	1.22	=	2098.73	(264)
Space and water heating				(261) + (262) + (263) + (264) =	10787.36	(265)
Pumps and fans	30.00	x	3.07	=	92.10	(267)
Electricity for lighting	232.43	x	3.07	=	713.56	(268)
Primary energy kWh/year					11593.02	(272)
Dwelling primary energy rate kWh/m2/year					242.79	(273)

SAP Worksheet
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Spyridon Karnezis	Assessor number	8658
Client		Last modified	12/08/2016
Address	5 11-12 Grenville, Camden, WC1		

1. Overall dwelling dimensions

		Area (m^2)			Average storey height (m)			Volume (m^3)	
Lowest occupied		82.76	(1a)	x	2.15	(2a)	=	177.93	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	82.76	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			177.93	(5)

2. Ventilation rate

			m^3 per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	4	x 10 =	40	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.22	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.47	(18)
Number of sides on which the dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.33	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.42	0.42	0.41	0.37	0.36	0.32	0.32	0.31	0.33	0.36	0.37	0.39	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
d) natural ventilation or whole house positive input ventilation from loft	0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.55	0.56	0.56	0.57	0.58	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.55	0.56	0.56	0.57	0.58	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			1.70	x	1.00	=	1.70			(26)
Window			12.41	x	1.50	=	18.66			(27)
External wall			30.38	x	2.10	=	63.80			(29a)
External wall			31.82	x	1.38	=	43.91			(29a)
External wall			19.59	x	0.25	=	4.90			(29a)
External wall			16.55	x	0.28	=	4.63			(29a)
Roof			17.55	x	0.18	=	3.16			(30)
Roof			20.18	x	0.17	=	3.43			(30)
Total area of external elements ∑A, m²			150.18							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	144.19	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		22.53	(36)
Total fabric heat loss	(33) + (36) =	166.72	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	34.63	34.43	34.23	33.28	33.11	32.29	32.29	32.13	32.60	33.11	33.46	33.84	(38)
Heat transfer coefficient, W/K (37)m + (38)m	201.35	201.15	200.95	200.00	199.83	199.01	199.01	198.85	199.32	199.83	200.18	200.56	
Average = ∑(39)1...12/12 =												200.00	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	2.43	2.43	2.43	2.42	2.41	2.40	2.40	2.40	2.41	2.41	2.42	2.42	
Average = ∑(40)1...12/12 =												2.42	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	2.51	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	93.89	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	103.28	99.52	95.76	92.01	88.25	84.50	84.50	88.25	92.01	95.76	99.52	103.28	
∑(44)1...12 =												1126.65	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	153.16	133.95	138.22	120.51	115.63	99.78	92.46	106.10	107.37	125.13	136.59	148.32	
∑(45)1...12 =												1477.21	(45)
Distribution loss 0.15 x (45)m	22.97	20.09	20.73	18.08	17.34	14.97	13.87	15.92	16.11	18.77	20.49	22.25	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)

Combi loss for each month from Table 3a, 3b or 3c

50.96	45.81	48.80	45.37	44.97	41.67	43.06	44.97	45.37	48.80	49.08	50.96	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

204.11	179.76	187.03	165.88	160.60	141.45	135.52	151.07	152.74	173.93	185.66	199.28	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

204.11	179.76	187.03	165.88	160.60	141.45	135.52	151.07	152.74	173.93	185.66	199.28

∑(64)1...12 = 2037.04 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

63.66	55.99	58.16	51.41	49.69	43.59	41.51	46.52	47.04	53.80	57.68	62.06	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	150.79	150.79	150.79	150.79	150.79	150.79	150.79	150.79	150.79	150.79	150.79	150.79	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	53.04	47.11	38.31	29.01	21.68	18.30	19.78	25.71	34.51	43.81	51.14	54.51	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	335.99	339.47	330.69	311.98	288.37	266.18	251.36	247.87	256.66	275.36	298.97	321.16	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	52.59	52.59	52.59	52.59	52.59	52.59	52.59	52.59	52.59	52.59	52.59	52.59	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	(71)
Water heating gains (Table 5)	85.57	83.32	78.17	71.41	66.79	60.55	55.79	62.53	65.34	72.32	80.12	83.41	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	580.45	575.76	553.03	518.25	482.70	450.89	432.78	441.97	462.36	497.35	536.08	564.94	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	0.77	x	6.50	x	19.64	x 0.9 x	0.73	x	0.70	=	45.21	(76)
South	0.77	x	1.30	x	46.75	x 0.9 x	0.73	x	0.70	=	21.52	(78)
West	0.77	x	4.25	x	19.64	x 0.9 x	0.73	x	0.70	=	29.56	(80)
North	0.77	x	0.36	x	10.63	x 0.9 x	0.73	x	0.70	=	1.36	(74)

Solar gains in watts ∑(74)m...(82)m

97.65	184.10	290.17	409.11	492.93	501.81	478.83	416.26	332.34	214.65	120.41	81.21	(83)

Total gains - internal and solar (73)m + (83)m

678.10	759.86	843.20	927.36	975.63	952.70	911.61	858.22	794.70	712.00	656.49	646.16	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.99	0.98	0.96	0.92	0.84	0.73	0.77	0.90	0.97	0.99	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

18.53	18.71	19.08	19.59	20.11	20.56	20.81	20.76	20.39	19.72	19.03	18.49	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.06	19.06	19.06	19.07	19.07	19.08	19.08	19.08	19.07	19.07	19.07	19.07	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.97	0.94	0.87	0.72	0.50	0.55	0.82	0.95	0.98	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

16.94	17.13	17.49	18.00	18.50	18.89	19.04	19.02	18.76	18.14	17.46	16.91	(90)

Living area fraction — Living area ÷ (4) = 0.41 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

17.59	17.78	18.14	18.65	19.16	19.57	19.76	19.74	19.43	18.78	18.10	17.56	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

17.59	17.78	18.14	18.65	19.16	19.57	19.76	19.74	19.43	18.78	18.10	17.56	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.98	0.97	0.94	0.88	0.76	0.60	0.64	0.84	0.95	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	668.64	744.49	814.91	868.48	854.80	723.38	543.32	551.98	668.56	675.05	642.83	638.31	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	2676.19	2590.03	2339.52	1950.25	1490.71	989.80	629.30	663.39	1062.28	1635.39	2202.23	2678.48	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	1493.62	1240.20	1134.32	778.88	473.11	0.00	0.00	0.00	0.00	714.49	1122.77	1517.89	

∑(98)1...5, 10...12 = 8475.27 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 102.41 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		95.80	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	1559.10	1294.57	1184.05	813.02	493.86	0.00	0.00	0.00	0.00	745.82	1171.99	1584.43

∑(211)1...5, 10...12 = 8846.84 (211)

Water heating

Efficiency of water heater

94.58	94.51	94.36	94.03	93.26	86.50	86.50	86.50	86.50	93.83	94.36	94.62	(217)

Water heating fuel, kWh/month

215.82	190.19	198.20	176.42	172.21	163.53	156.67	174.65	176.58	185.37	196.76	210.61

∑(219a)1...12 = 2217.02 (219)

Annual totals

Space heating fuel - main system 1 — 8846.84

Water heating fuel			2217.02	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
central heating pump or water pump within warm air heating unit	30.00			(230c)
Total electricity for the above, kWh/year			30.00	(231)
Electricity for lighting (Appendix L)			374.68	(232)
Total delivered energy for all uses		(211)...(221) + (231) + (232)...(237b) =	11468.54	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	8846.84	x	3.48	x 0.01 =	307.87	(240)
Water heating	2217.02	x	3.48	x 0.01 =	77.15	(247)
Pumps and fans	30.00	x	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	374.68	x	13.19	x 0.01 =	49.42	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	558.40	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.84	(257)
SAP value	74.39	
SAP rating (section 13)	74	(258)
SAP band	C	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	8846.84	x	0.216	=	1910.92	(261)
Water heating	2217.02	x	0.216	=	478.88	(264)
Space and water heating				(261) + (262) + (263) + (264) =	2389.79	(265)
Pumps and fans	30.00	x	0.519	=	15.57	(267)
Electricity for lighting	374.68	x	0.519	=	194.46	(268)
Total CO_2, kg/year				(265)...(271) =	2599.82	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	31.41	(273)
EI value					72.73	
EI rating (section 14)					73	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	8846.84	x	1.22	=	10793.14	(261)
Water heating	2217.02	x	1.22	=	2704.76	(264)
Space and water heating				(261) + (262) + (263) + (264) =	13497.90	(265)
Pumps and fans	30.00	x	3.07	=	92.10	(267)
Electricity for lighting	374.68	x	3.07	=	1150.28	(268)
Primary energy kWh/year					14740.28	(272)
Dwelling primary energy rate kWh/m2/year					178.11	(273)

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Spyridon Karnezis	Assessor number	8658
Client		Last modified	12/08/2016
Address	6 11-12 Grenville, Camden, WC1		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		46.08	(1a)	x	2.25	(2a)	=	103.68	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	46.08	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			103.68	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	20	÷ (5) =	0.19	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.44	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.38	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.48	0.47	0.46	0.41	0.40	0.36	0.36	0.35	0.38	0.40	0.42	0.44	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

d) natural ventilation or whole house positive input ventilation from loft

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(24d)	0.62	0.61	0.61	0.59	0.58	0.56	0.56	0.56	0.57	0.58	0.59	0.60	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.62	0.61	0.61	0.59	0.58	0.56	0.56	0.56	0.57	0.58	0.59	0.60	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m^2	Openings m^2	Net area A, m^2		U-value W/m^2K		A x U W/K	κ-value, $kJ/m^2.K$	A x κ, kJ/K	
Door			1.70	x	1.00	=	1.70			(26)
Window			6.30	x	1.50	=	9.47			(27)
External wall			5.40	x	1.38	=	7.45			(29a)
External wall			10.00	x	0.25	=	2.50			(29a)
External wall			50.40	x	0.28	=	14.11			(29a)
Roof			37.00	x	0.18	=	6.66			(30)
Total area of external elements ∑A, m^2			110.80							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	41.90	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m^2K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		16.62	(36)
Total fabric heat loss	(33) + (36) =	58.52	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	21.05	20.90	20.75	20.04	19.91	19.30	19.30	19.18	19.53	19.91	20.18	20.45	(38)
Heat transfer coefficient, W/K (37)m + (38)m	79.57	79.41	79.26	78.56	78.43	77.81	77.81	77.70	78.05	78.43	78.69	78.97	
Average = ∑(39)1...12/12 =												78.56	(39)
Heat loss parameter (HLP), W/m^2K (39)m ÷ (4)	1.73	1.72	1.72	1.70	1.70	1.69	1.69	1.69	1.69	1.70	1.71	1.71	
Average = ∑(40)1...12/12 =												1.70	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.58	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	71.62	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	78.78	75.92	73.05	70.19	67.32	64.46	64.46	67.32	70.19	73.05	75.92	78.78	
∑(44)1...12 =												859.46	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	116.83	102.18	105.44	91.93	88.21	76.12	70.53	80.94	81.91	95.45	104.19	113.15	
∑(45)1...12 =												1126.89	(45)
Distribution loss 0.15 x (45)m	17.53	15.33	15.82	13.79	13.23	11.42	10.58	12.14	12.29	14.32	15.63	16.97	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c	40.15	34.94	37.23	34.61	34.31	31.79	32.85	34.31	34.61	37.23	37.44	40.15	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

156.98	137.13	142.67	126.54	122.52	107.91	103.38	115.25	116.52	132.68	141.63	153.30	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

156.98	137.13	142.67	126.54	122.52	107.91	103.38	115.25	116.52	132.68	141.63	153.30

∑(64)1...12 = 1556.50 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

48.88	42.71	44.37	39.22	37.91	33.26	31.66	35.49	35.89	41.04	44.00	47.66	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	32.94	29.26	23.80	18.02	13.47	11.37	12.28	15.97	21.43	27.21	31.76	33.86	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	204.58	206.70	201.35	189.96	175.59	162.08	153.05	150.93	156.28	167.67	182.04	195.55	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	(71)
Water heating gains (Table 5)	65.70	63.56	59.63	54.47	50.95	46.19	42.56	47.70	49.84	55.17	61.12	64.06	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	383.77	380.07	365.33	342.99	320.55	300.18	288.44	295.14	308.09	330.59	355.46	374.01	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	0.77	x	3.60	x	19.64	x 0.9 x	0.73	x	0.70	=	25.04	(76)
West	0.77	x	2.70	x	19.64	x 0.9 x	0.73	x	0.70	=	18.78	(80)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts ∑(74)m...(82)m	43.82	85.72	141.16	205.87	252.31	258.28	245.89	211.22	164.18	101.71	54.63	36.03	(83)
Total gains - internal and solar (73)m + (83)m	427.59	465.78	506.49	548.87	572.85	558.46	534.33	506.36	472.27	432.30	410.10	410.05	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.98	0.97	0.94	0.87	0.74	0.59	0.64	0.84	0.95	0.98	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.33	19.49	19.79	20.20	20.57	20.84	20.95	20.93	20.73	20.25	19.72	19.30	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)	19.52	19.52	19.53	19.54	19.54	19.55	19.55	19.55	19.55	19.54	19.54	19.53	(88)

Utilisation factor for gains for rest of dwelling n2,m

	0.99	0.98	0.96	0.92	0.82	0.63	0.42	0.47	0.75	0.93	0.98	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.07	18.22	18.52	18.92	19.27	19.48	19.54	19.53	19.41	18.99	18.47	18.04	(90)

Living area fraction — Living area ÷ (4) = 0.46 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

18.64	18.80	19.10	19.50	19.86	20.11	20.18	20.17	20.02	19.56	19.04	18.62	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.64	18.80	19.10	19.50	19.86	20.11	20.18	20.17	20.02	19.56	19.04	18.62	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.98	0.96	0.92	0.83	0.67	0.50	0.55	0.78	0.93	0.97	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	420.31	454.39	485.24	502.68	475.25	376.68	266.64	276.05	368.24	401.98	399.22	404.01	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1141.26	1103.89	998.65	833.07	640.26	428.37	278.91	293.30	461.71	703.07	939.63	1138.52	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	536.39	436.46	381.97	237.88	122.77	0.00	0.00	0.00	0.00	224.01	389.09	546.47	

∑(98)1...5, 10...12 = 2875.05 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 62.39 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		95.80	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	559.90	455.60	398.72	248.31	128.15	0.00	0.00	0.00	0.00	233.84	406.15	570.43

∑(211)1...5, 10...12 = 3001.09 (211)

Water heating

Efficiency of water heater	93.52	93.40	93.08	92.35	90.92	86.50	86.50	86.50	86.50	92.12	93.13	93.60	(217)
Water heating fuel, kWh/month	167.85	146.82	153.28	137.02	134.76	124.75	119.52	133.23	134.70	144.04	152.08	163.78	

∑(219a)1...12 = 1711.83 (219)

Annual totals

Space heating fuel - main system 1		3001.09	
Water heating fuel		1711.83	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
central heating pump or water pump within warm air heating unit	30.00		(230c)
Total electricity for the above, kWh/year		30.00	(231)

Electricity for lighting (Appendix L)		232.72	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	4975.65	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3001.09	x	3.48	x 0.01 =	104.44	(240)
Water heating	1711.83	x	3.48	x 0.01 =	59.57	(247)
Pumps and fans	30.00	x	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	232.72	x	13.19	x 0.01 =	30.70	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	318.66	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.47	(257)
SAP value	79.50	
SAP rating (section 13)	80	(258)
SAP band	C	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	3001.09	x	0.216	=	648.24	(261)
Water heating	1711.83	x	0.216	=	369.76	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1017.99	(265)
Pumps and fans	30.00	x	0.519	=	15.57	(267)
Electricity for lighting	232.72	x	0.519	=	120.78	(268)
Total CO_2, kg/year				(265)...(271) =	1154.34	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	25.05	(273)
EI value					83.02	
EI rating (section 14)					83	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	3001.09	x	1.22	=	3661.33	(261)
Water heating	1711.83	x	1.22	=	2088.44	(264)
Space and water heating				(261) + (262) + (263) + (264) =	5749.77	(265)
Pumps and fans	30.00	x	3.07	=	92.10	(267)
Electricity for lighting	232.72	x	3.07	=	714.45	(268)
Primary energy kWh/year					6556.33	(272)
Dwelling primary energy rate kWh/m2/year					142.28	(273)