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DATE
20 OCTOBER 2017

SUSTAINABILITY & ENERGY STATEMENT
13A POND STREET, LONDON NW3 2PN

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DOCUMENT STATUS

PROJECT
13A Pond Street
London
NW3 2PN

PROJECT NO.
429

CLIENT
Spencer Baylin

IN CONJUNCTION WITH
Gianni Botsford Architects

REVISION	STATUS	CHECKED	DATE
-	Draft Issue for Comment	Dan Brooks	03.02.17
1	Planning Application Issue	Dan Brooks	20.02.17
2	Update to account for new Camden policies	Dan Brooks	20.10.17

CONTENTS

EXECUTIVE SUMMARY

This Sustainability & Energy Statement has been prepared by Integration Consultancy Limited in support of the planning application for the new property on the site at 13a Pond Street, in the London Borough of Camden.

National, Regional and Local Policy, in particular the London Plan (2016 - consolidated with alterations since 2011) and the Camden Local Plan, outline the sustainability and energy issues which should be addressed in the planning application for the proposed development. The main policy target related to the prosed minor development are:

- The development must demonstrate a 19% improvement in carbon dioxide emissions over the Target Emission Rate outlined in the national Building Regulations 2013;
- Water efficiency measures shall be incorporated to limit the daily water consumption to 110 litres per person (with 5 litres per person for external use).

To achieve the carbon dioxide emissions reduction targets, it is proposed to:

- Use building fabric with good thermal performance, triple glazing and high air tightness, exceeding the requirements of the Building Regulations Part L1A (2013);
- Utilise low energy building services systems, i.e. lighting, mechanical ventilation with heat recovery and a high efficiency condensing boiler for the heating system;
- Provide a 2kWp photovoltaic PV system located at roof level and orientated to maximise power generation throughout the year.

An energy assessment has been undertaken to demonstrate that by incorporating the above into the design of proposed development, a reduction in carbon dioxide emissions exceeding the targeted 19% will be achieved for the property.

The net improvement of Dwelling Emission Rate (DER) over the Target Emissions Rate (TER) from the improvements to the building fabric, building services systems and renewable energy technologies will be **32.7%** which significantly exceeds the requirement of 19%.

The proposed photovoltaic panels will be orientated to maximise power generation throughout the year without any over shading from surrounding buildings. The extent of the proposed PV installation will provide a minimum of 20% reduction in CO_2 emissions over the TER through on-site renewable energy generation.

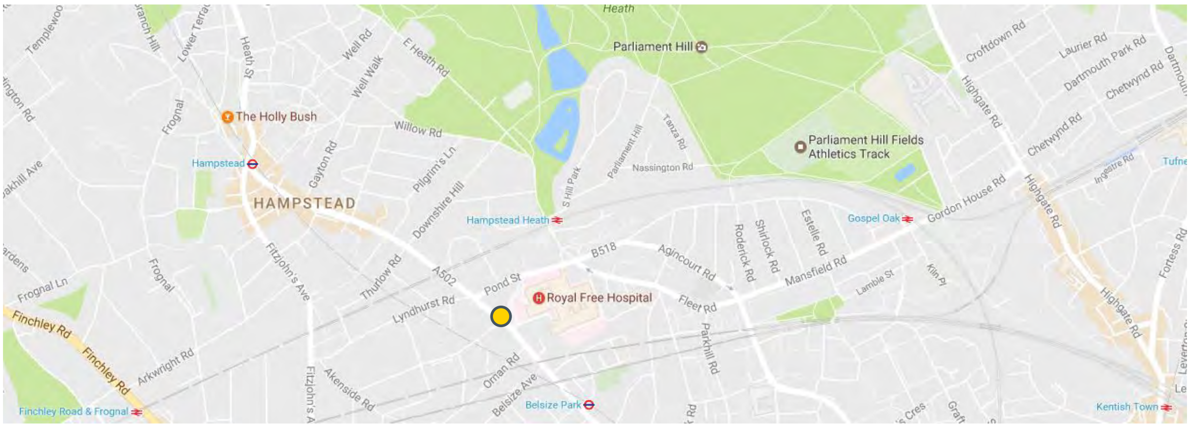
1 INTRODUCTION

This Sustainability & Energy Statement has been prepared by Integration Consultancy Limited in support of the planning application for the redevelopment of the site at 13a Pond Street, in the London Borough of Camden. The report is one of several documents that accompany the planning application and should be read in conjunction with these.

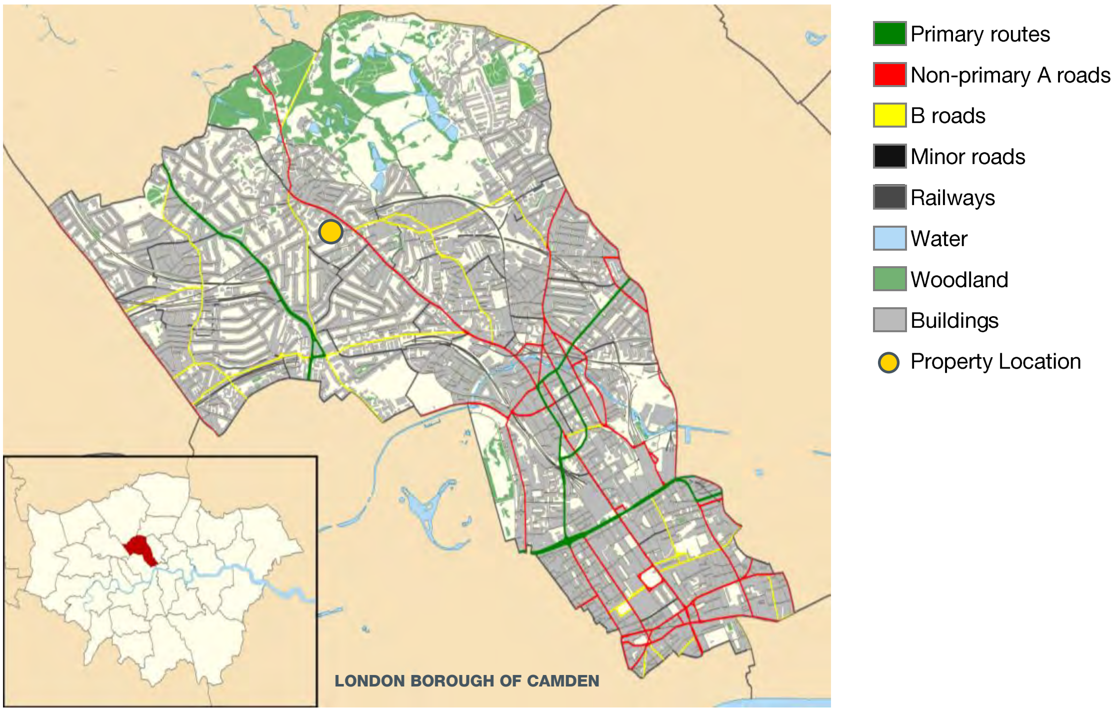
The purpose of this report is to set out how sustainability is integrated into the design and construction of the proposals, to demonstrate the design approach and the measures adopted to meet the sustainability targets set out in the London Borough of Camden Strategic and Development Policies and the London Plan.

1.1 THE DEVELOPMENT SITE

The site is currently occupied by an existing 2 storey dwelling of approximately 180m^2. The proposed extended property includes the creation of a new basement level, 3 above ground storeys and the retention of the 1960's ground floor extension, providing a total combined area of 280m^2. The extended building will be occupying a similar built envelope and site footprint as the original property.



Detail of Local Area (© Google)



Location of the Property within the London Borough of Camden

2 PLANNING POLICY CONTEXT

2.1 THE LONDON PLAN – CHAPTER 5: LONDON'S RESPONSE TO CLIMATE CHANGE

Regional policy in London is controlled by The Greater London Authority, and is set out in The London Plan, adopted March 2016 (consolidated with alterations since 2011). The Plan sets out policy and guidance in the London context and identifies several main objectives related to improving London as a workplace and living place.

The concept of sustainable development runs through the London Plan and all its policies regarding topics including Places, People, Economy, Response to climate change, Transport, and Living places and spaces. Chapter 5 of the London Plan sets out a range of policies in relation to climate change, including climate change mitigation and adaptation, waste, aggregates, contaminated land and hazardous substances.

Key policies within the London Plan which are applicable to the proposed development and addressed in this report are:

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) outlined 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
2013 – 2016	40 per cent *
2016 – 2031	Zero carbon

* equivalent to a minimum improvement of 35% beyond the 2013 edition of Part L.

Other key policies within the London Plan which are applicable to the proposed development and addressed in this report are:

- 5.3 - Sustainable Design & Construction
- 5.7 - Renewable Energy
- 5.8 – Innovative Energy Technologies
- 5.9 - Overheating & Cooling
- 5.15 - Water Use & Supplies

2.2 CAMDEN'S LOCAL PLAN CC1 (CLIMATE CHANGE MITIGATION)

Camden's Local Plan CC1 sets out the key elements of the Council's planning vision and strategy for the borough in terms of Climate Change Mitigation.

Related policy for the new development at 13a Pond Street is:

Policy CC1 Climate change mitigation

8.8 All developments involving five or more dwellings and/or more than 500 sqm of (gross internal) any floorspace will be required to submit an energy statement demonstrating how the energy hierarchy has been applied to make the fullest contribution to CO2 reduction. **All new residential development will also be required to demonstrate a 19% CO2 reduction below Part L 2013 Building Regulations (in addition to any requirements for renewable energy).**

Be lean
8.9 Proposals should demonstrate how passive design measures including the development orientation, form, mass, and window sizes and positions have been taken into consideration to reduce energy demand, demonstrating that the minimum energy efficiency requirements required under building regulations will be met and where possible exceeded. This is in line with stage one of the energy hierarchy 'Be lean'.

Be clean
8.10 The second stage of the energy hierarchy 'Be clean' should demonstrate how the development will supply energy efficiently through decentralised energy.

Be green
8.11 The Council will expect **developments of five or more dwellings and/or more than 500 sqm of any gross internal floorspace to achieve a 20% reduction in carbon dioxide emissions from on-site renewable energy generation** (which can include sources of site related decentralised renewable energy) unless it can be demonstrated that such provision is not feasible. This is in line with stage three of the energy hierarchy 'Be green'. The 20% reduction should be calculated from the regulated CO2 emissions of the development after all proposed energy efficiency measures and any CO2 reduction from non-renewable decentralised energy (e.g. CHP) have been incorporated.

8.17 All proposals for demolition and reconstruction should be fully justified in terms of the optimisation of resources and energy use, in comparison with the existing building. Where the demolition of a building cannot be avoided, we will expect developments to divert 85% of waste from landfill and comply with the Institute for Civil Engineer's Demolition Protocol and either reuse materials on-site or salvage appropriate materials to enable their reuse off-site. We will also require developments to consider the specification of materials and construction processes with low embodied carbon content.

8.18 We will expect all developments, whether for refurbishment or redevelopment, to optimise resource efficiency by:

- reducing waste;
- reducing energy and water use during construction;
- minimising materials required;
- using materials with low embodied carbon content; and
- enabling low energy and water demands once the building is in use.

The redevelopment of the existing building and development of the existing land is considered an efficient use of land and buildings. The proposed property will minimise carbon emissions through enhancements to the thermal performance of the building fabric, passive design measures, the use of energy efficient active building services systems and the incorporation of renewable energy technologies.

2.3 CAMDEN'S LOCAL PLAN CC2 (ADAPTING TO CLIMATE CHANGE)

Applicable policy for the proposed development is:

Policy CC2 Adapting to climate change

The Council will require development to be resilient to climate change.

All development should adopt appropriate climate change adaptation measures such as:

a. the protection of existing green spaces and **promoting new appropriate green infrastructure**;

b. **not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems**;

c. incorporating **bio-diverse roofs**, combination green and blue roofs and green walls where appropriate;

d. **measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy**.

Any development involving 5 or more residential units or 500 sqm or more of any additional floorspace is required to demonstrate the above in a Sustainability Statement

8.37 To support a sustainable approach to drainage all development should install green roofs, permeable landscaping, green walls and combination green and blue roofs, where appropriate.

Cooling

8.41 **All new developments will be expected to submit a statement demonstrating how the London Plan's 'cooling hierarchy'** has informed the building design. Any development that is likely to be at risk of overheating (for example due to large expanses of south or south west facing glazing) will be required to complete dynamic thermal modelling to demonstrate that any risk of overheating has been mitigated.

8.42 **Active cooling (air conditioning) will only be permitted where dynamic thermal modelling demonstrates there is a clear need for it** after all of the preferred measures are incorporated in line with the cooling hierarchy.

Appropriate climate change adaptation measures will be incorporated into the proposals, including green roof, rainwater collection and recycling and clean, renewable energy systems where feasible.

2.4 CAMDEN'S LOCAL PLAN CC3 (WATER AND FLOODING)

Applicable policy for the proposed property is:

> The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible.
>
> We will require development to:
>
> a. **incorporate water efficiency measures**;
>
> b. avoid harm to the water environment and improve water quality;
>
> c. consider the impact of development in areas at risk of flooding (including drainage);
>
> d. incorporate flood resilient measures in areas prone to flooding;
>
> e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy, unless inappropriate, to achieve a greenfield run-off rate where feasible; and
>
> f. not locate vulnerable development (such as basement dwellings) in flood-prone areas. Where an assessment of flood risk is required, developments should consider surface water flooding in detail and groundwater flooding where applicable.
>
> 8.55 Developments must be designed to be water efficient. This can be achieved through the installation of water efficient fittings and appliances (which can help reduce energy consumption as well as water consumption) and by capturing and re-using rain water and grey water on-site. **Residential developments will be expected to meet the requirement of 110 litres per person per day (including 5 litres for external water use).**

Rainwater collection tanks will be included in the design to collect run-off from all roofs and hard standing areas. The water will be re-used wherever possible including for garden irrigation and WC flushing systems. A greywater recycling system will be provided to collect waste water from basins, baths and shower for re-use for WC flushing. Water efficiency measure will ensure the target of 110 litres per person per day (including 5 litres for external water use) is met.

It is proposed that these measures will significantly reduce the rate of run-off into the sewer network compared to that of the existing property.

The proposed Lower Ground Floor is not in a flood prone area.

2.5 SUMMARY OF KEY POLICY REQUIREMENTS

- The development must demonstrate a **19%** improvement in carbon dioxide emissions over the Target Emission Rate outlined in the national Building Regulations 2013;

- Water efficiency measures shall be incorporated to limit the daily water consumption to **110 litres** per person including 5 litres for external water use

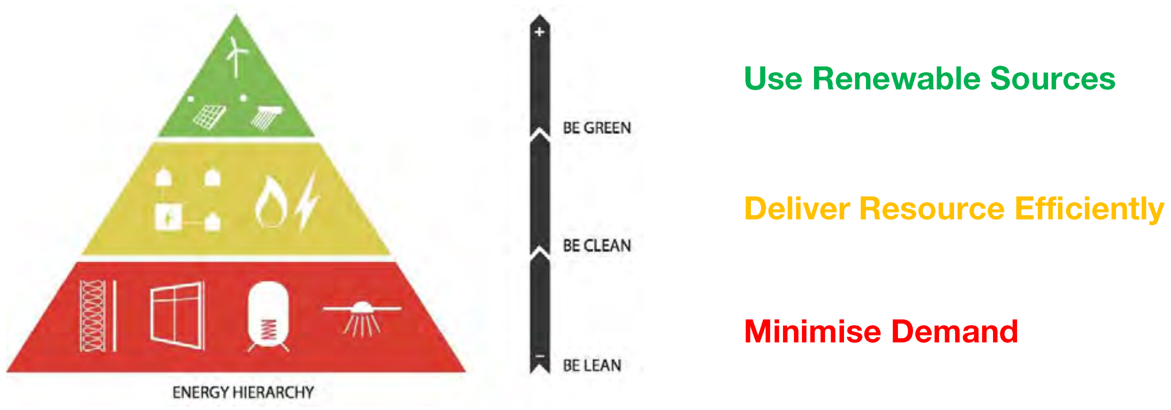
3 DESIGN APPROACH TO SUSTAINABILITY

The Energy Strategy for the property at 13a Pond Street will have the potential to generate significant carbon savings over the lifetime of the development. The objective is to develop an energy infrastructure that supplies low carbon energy, utilises renewable sources, reduces energy bills for the occupants, provides a high quality internal environment, is adaptable and able to accommodate future upgrades.

Sustainability will be integral to the design, construction, operation and performance of the proposed development, the design principles will encompass a wide range of criteria, i.e. energy, water use, selection of construction materials, waste generation and management, pollution, Health & Well-Being of the occupants, and the ecological impact of the building both during construction and operational use.

3.1 THE ENERGY HIERARCHY

The energy hierarchy referred to in the London Plan suggests a three-step approach to decision making and prioritizing strategies for the reduction of resource consumption and carbon emissions from energy. This approach is applicable to other resources such as water, waste and construction materials.



The purpose of this approach is to reduce the resource consumption and consequent carbon emissions of development without compromising the occupant comfort and quality of the development. This will be achieved by developing design strategies that respond to the opportunities and challenges of the climate, site and the local external environment as well as implementing efficient energy infrastructure that also integrates on-site renewable sources.

3.2 MINIMISING DEMAND

The incorporation of appropriate passive measures in the building design is essential if the building services systems are to be efficient and economic. Passive design measures are integral to the building form and fabric and therefore have the greatest influence on carbon emissions throughout the life cycle of a building.

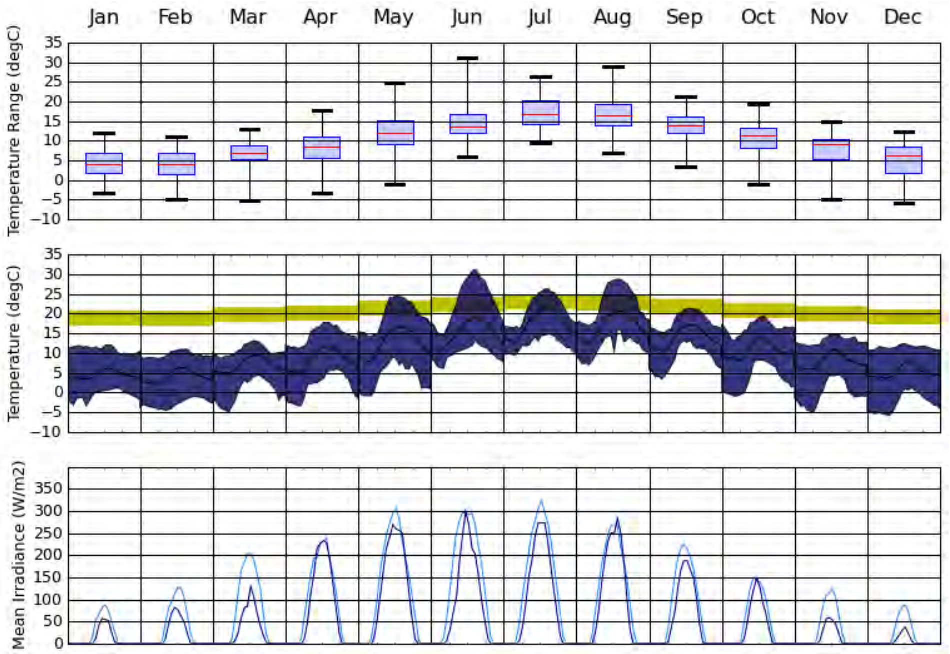
The development of passive design strategies starts by identifying site-specific challenges and opportunities, considering the microclimate, location and surroundings and applying them to the building form, façade and orientation.

The existing property will be substantially modified and rebuilt, resulting in a significant potential for reduction in the energy demand of the site (per m^2 of habitable floor area) by constructing new thermal elements to current Building Regulations standards.

Climate Analysis

The London climate is heating dominated, hence the key passive measure to be implemented are high levels of insulation and air-tightness. Temperatures in the summer can occasionally rise above comfortable levels; this will intensify because of the climate change and further urbanisation.

Diurnal temperature variations are high, with average daily swing of 8-10°C even during peak summer, this creates potential for passive cooling using night-time purging of heat via openable windows. Other passive measures to reduce the risk of overheating include solar shading, daytime natural ventilation and providing local vegetation to mitigate the heat island effect.



Average climate data for Central London

Building Fabric Performance & Insulation

Thermal insulation must be able to deliver significant carbon emissions reductions throughout the life of the development. High levels of insulation will significantly reduce energy consumption and ensure optimum occupant comfort all year round by retaining heat in the winter and reducing heat gain in the summer.

This is particularly relevant for glazed surfaces that may suffer from overheating in summer or overcooling and condensation formation in winter. A low U-value for all glazed elements is recommended to avoid radiant temperature asymmetry in winter. Considering the extent of the proposed glazing to the property, triple glazing should be considered to minimise heat loss.

The thermal performance of all new exposed elements will exceed the minimum requirements for Building Regulations compliance.

Air Tightness & Infiltration

The target air-permeability rate is 4 $m^3/m^2/h$, however it is possible to achieve as low as 3 $m^3/m^2/h$ though appropriate selection of materials and seals and design of airtight details.

The key to achieving high levels of airtightness is the quality of construction. Selection of Accredited or Improved Robust Details improves air-tightness of the building envelope in practice.

Thermal Bridging

By implementing Accredited or Enhanced Construction Details overall thermal bridging heat loss factor can be reduced to as low as 0.04, for the purposes of the Energy Calculations a value of 0.06 is assumed.

Natural Ventilation & Thermal Mass

Daytime natural ventilation is essential to purge excess heat during the summer months and enables rapid dilution of pollutants. When used in combination with exposed thermal mass, natural ventilation will reduce high internal daily temperature variations which will minimise the overheating risk in the summer. Therefore, occupant comfort can be maintained without reliance on mechanical cooling or ventilation systems.

Solar Exposure and Daylight

Maximising exposure to solar energy and daylight is essential to reduce reliance on artificial lighting reducing winter daytime heating requirements and to contribute to the general wellbeing of occupants.

The site has limited access to direct solar radiation as the surrounding buildings and trees are either higher or of a similar height as the proposed property. The surrounding buildings could overshadow portions of the roofs which could significantly reduce the efficiency and electrical output of any PV panels.

The proposed glazing elements in the façades of the property and areas of rooflights are extensive and will receive good level of natural daylight all year round and will benefit from low angle solar energy in winter. Due to the extent of the proposed glazing, all rooms can achieve an average Daylight Factor of 1%, as set out in the BRE Guidelines.

Active Building Services Systems

All building services systems will be in accordance with, and where possible exceed the energy efficiency requirements of the Domestic Building Service Compliance Guide.

The heating and ventilation systems will be controlled via automatic controls systems, providing weather compensation, optimised start and time clock and temperature control to each individual room.

The property will be mechanically ventilated via local supply and extract air handling plant (MVHR) incorporating heat recovery. This will negate any requirement for trickle vents in the façade and contribute to achieving low air permeability rates. Systems will be designed and low energy fans selected to ensure a low specific fan power (SFP) and electrical consumption.

Low energy fixed lighting, generally comprising LED fittings, will be installed throughout the development.

3.3 COOLING AND OVERHEATING

The cooling and overheating strategies are summarised in the table below using the cooling hierarchy which has been applied to the design.

Cooling Hierarchy Measure	Application to proposed development
1. MINIMISE INTERNAL HEAT GAINS Minimise internal heat generation through energy efficient design.	High insulation on hot water pipework lengths. Low energy LED lighting.
2. MINIMISE EXTERNAL HEAT GAINS Reduce the amount of heat (from solar irradiation and high outside air temperatures) that can enter the building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls.	High level of insulation Green roof to minimise solar gains through the roof and add to green mass (external greenery) which helps creates a cool microclimate through transpiration. Internal blinds with light coloured external facing surfaces (with relatively high reflective properties).
3 & 4 HEAT MANAGEMENT AND PASSIVE VENTILATION Manage heat within the building through exposed internal thermal mass and high ceilings as well as natural ventilation strategies such as night cooling, the stack effect and promotion of cross-flow ventilation.	Excellent day time natural night-time ventilation potential.
5. MECHANICAL VENTILATION	Mechanical Ventilation with Heat Recovery (MVHR) is specified. System will have "heat recovery by-pass" mode in order to be operable in summer night-cooling mode for periods when the natural ventilation system needs supplementary flow.
6. ACTIVE COOLING Ensuring they are the lowest carbon options.	Not required. If required in the future the proposed solar PV will provide significant local electricity generation during the summer daytime period when the demand for cooling is greatest.

3.4 DELIVERING RESOURCES EFFICIENTLY

Policy 5.9 of the London Plan 2015 requires developments to connect to a decentralised energy network and use the heat unless it can demonstrate it is not technically feasible or financially viable.

The property is in the Hampstead Town area of the London Borough of Camden, therefore connection to an existing district heating network is unlikely to be viable at the time of construction.

3.5 RENEWABLE & LOW ENERGY TECHNOLOGY SYSTEMS

A viability assessment for the most applicable renewable energy and low carbon technologies that could be installed has been developed in the following section. Capital and operational costs, local availability of renewable energy resource, local pollution, environmental impact, commercial availability, maintenance, control and operational issues, and carbon emissions are considered.

4 ENERGY STRATEGY

The energy strategy for the property has been established using the following process:

- Qualitative assessment of the viable options for conventional, renewable & low energy technologies, considering CO_2 reduction potential, suitability and practicalities of incorporating into the scheme and financial viability to determine the most applicable system.
- Determine the baseline Target Emissions Rate for evaluation of the proposed option in terms of achieving the CO_2 emission reduction targets.
- Calculate the Dwelling Emissions Rate (TER) for the dwelling for the preferred options to enable quantitative assessment of CO_2 reductions.
- Quantitative assessment of CO_2 emissions reductions from the proposed renewable energy systems.

4.1 RENEWABLE & LOW ENERGY TECHNOLOGY SYSTEMS ASSESSMENT

Technology		Assessment / Viability
Wind Power	Wind turbine installed on the roof of the development.	Due to the urban location, and the impacts in terms of visual appearance, noise and shadow flicker, wind turbines are not considered a viable technology for the development. CONCLUSION: **VISUALLY AND TECHNICALLY INAPPROPRIATE**
Ground Source Heat Pumps	Open or closed loop GSHP system requiring extraction of ground water and / or deep boreholes.	Significant investment required, limits to how many can be installed in an area and the capacity achievable within a confined site. No external visual or noise impact. CONCLUSION: **POTENTIALLY VIABLE (SEE BELOW)**
Air Source Heat Pumps	Electric powered external plant serving each residential unit providing heating and cooling	Simple and economic system utilises grid electricity - resultant CO_2 reductions lesser other options available, siting of external units will have a visual / noise / planning impact. CONCLUSION: **POTENTIALLY VIABLE (SEE BELOW)**
Solar Thermal Collectors	Roof mounted solar thermal panels providing heating energy to a centralised domestic hot water system	PV systems have a greater carbon reduction potential and are more cost effective over the lifetime of the building for the same roof area coverage. CONCLUSION: **NOT CONSIDERED VIABLE**
Solar Photovoltaic Panels	Roof mounted Photovoltaic panels (PV) provide electricity directly to the development, exporting any surplus production to the grid.	Roofs have some potential for solar power generation. PV electricity is clean and zero-carbon and will offset carbon intensive grid power. Unlike solar thermal systems, all electricity produced by PVs can be utilised with negligible losses regardless of the installation size/capacity. CONCLUSION: **POTENTIALLY VIABLE (SEE BELOW)**
Biomass Heating	Biomass fired community heating system.	Biomass heating is proven technology and is likely to provide a significant CO_2 reduction. The size of fuel storage, delivery management and local increase in pollution, notably particulates (PM10), SO_2 and NO_X emissions should be considered. The entire borough of Camden is an Air Quality Management Area (AQMA) which states that small biomass boilers are not suitable in AQMA's unless they have no adverse effects on local air quality compared to conventional gas fired boilers. CONCLUSION: **NOT CONSIDERED TECHNICALLY VIABLE**
Combined Heat & Power	Mains gas fired electricity generation plant to supply electrical power and waste heat recovered and used to community heating and domestic hot water.	CHP is proven technology and well suited to community heating systems in conjunction with other heat sources. Electricity is generated more efficiently than grid power as waste heat is fully utilised and transmission losses are minimised. CONCLUSION: **NOT TECHNICALLY OR FINANCIALLY VIABLE FOR A MINOR DEVELOPMENT**

The table above summarises the viability assessment for the most applicable renewable energy and low carbon technologies. Capital and operational costs, local availability of renewable energy resource, local pollution, environmental impact, commercial availability, maintenance, control and operational issues, and carbon emissions are considered.

The following technologies are considered further with an analysis of each option relative to the specific site conditions:

Ground Source Heat Pump

An appropriately sized ground source heat pump installation would provide a significant proportion of the annual heat requirement for the proposed property from a renewable energy source. However, due to the urban location, the GSHP earth heat exchange network would require a number of vertical boreholes (estimated 3-5), it is therefore unlikely that a GSHP installation would be feasible due to the limited area of external space within the site and the technical requirements for the spacing of the boreholes (minimum 6m apart) and proximity to the property (minimum of 5m).

Considering the above a ground source heat pump installation is not considered technically viable.

Air Source Heat Pump

An air source heat pump will be capable of delivering a proportion of renewable energy to the property, however, due to the year-round domestic hot water demand and high temperatures required the seasonal efficient of an air source heat pump will be relatively low. It is envisaged that the potential for carbon reduction will be equal or inferior to that of an efficient gas fired condensing boiler in this instance.

In addition to the limited renewable energy generation, the air source heat pump will need to be located externally, this will have an impact on the limited external amenity space and visual and noise issues will need to be addressed.

Considering the above an air source heat pump installation is not considered appropriate or the best solution for this property.

Solar Photovoltaic Panels

Solar PV panels will deliver clean, renewable energy in the form of electricity to the property, however the geometry of the roof and the overshading from the adjacent properties and trees, the annual efficiency of PV panels on the property will be limited, this is discussed further below.

4.2 ENERGY ASSESSMENT METHODOLOGY

The proposed energy strategy and compliance with the required CO_2 emissions reductions targets are demonstrated using SAP 2012 software. A Target Emissions Rate (TER) is calculated for the property and is used for comparison/evaluation.

The SAP calculations have been repeated to evaluate the CO_2 reduction potential of improvements for each stage of the energy hierarchy to the building fabric and the following systems:

- Building Regulations 2013 compliant scheme (base case) achieved with a local gas fired boiler.
- 19% Improvement on Building Regulations 2013 achieved by enhanced building fabric performance and heating via efficient condensing gas boilers.
- Renewable energy systems

4.3 BUILDING FABRIC PERFORMANCE

The following building fabric properties have been used in the SAP calculations

Element	Building Regulations Part L1A 2013 Notional Dwelling (base case)		Enhanced Building Fabric – Target 19% Improvement	
	U Value (W/m²K)	G Value	U Value (W/m²K)	G Value
External Walls	0.18	-	0.15	-
Floor	0.13	-	0.11	-
Roof	0.13	-	0.11	-
Windows	1.40	0.63	0.8	0.7
External Doors	1.40	-	0.8	-
Air Permeability	5.0 m³/m²/h		3.0 m³/m²/h	
Thermal Bridging	accredited details		accredited details	

4.4 BUILDING SERVICES SYSTEM DATA

The following building services systems have been used in the SAP calculations

System	Building Regulations Part L1A 2013 Notional Dwelling (base case)	Proposed system (target 19% Improvement on Part L 2013)
Space Heating	local gas condensing system boiler 89% efficient. Underfloor heating in insulated floor	local gas condensing system boiler 92% efficient. Underfloor heating in insulated floor
Heating Controls	Time and temperature zone control, weather compensation modulating boiler with interlock	Time and temperature zone control, weather compensation modulating boiler with interlock
Hot Water Storage	Indirect cylinder served via boiler with 100 mm factory applied insulation and fully insulated primary pipework. Cylinder in heated space with cylinderstat and water heating timed separately	Indirect cylinder served via boiler with 100 mm factory applied insulation and fully insulated primary pipework. Cylinder in heated space with cylinderstat and water heating timed separately
Ventilation	Local intermittent extract fans	local MVHR – 89% efficient
Lighting	100% low energy	100% low energy

4.5 ENERGY DEMAND & CO_2 EMISSIONS

The energy demand and carbon emissions calculations for Regulated Energy have been prepared using SAP 2012 software. The calculations are based on the proposed building fabric performance and building services systems detailed in this report.

Non-Regulated Energy demand and associated CO_2 emissions associated with small power and any other process or plant equipment not covered under Building Regulations Part L have been estimated based on a benchmarking exercise, following the methodologies outlined in the BRE Domestic Energy Model (BREDEM).

Energy Demand (BE LEAN)

Energy Use	Primary Energy Demand (kWh/year)		Primary Energy Demand Rate (kWh/m²/year)	
	Part L1A 2013 Notional Dwelling	Proposed Building	Part L1A 2013 Notional Building	Proposed Building
Space Heating	16,535	8,937	59.10	31.92
Domestic Hot Water	2,612	2,674	9.33	9.33
Regulated Electricity	784	2,128	2.80	7.6
Total Regulated Energy	**19,931**	**13,739**	**71.23**	**48.85**
Non-regulated Electricity	6,608	6,608	23.58	23.58

The predicted total annual regulated energy demand of the proposed property following the introduction of energy efficiency measures and passive design is 13,739 kWh compared to a Building Regulations Part L1A (2013) compliant building demand of 19,931 kWh. This represents a significant improvement in energy efficiency, equating to a reduction of 22.38 kWh per m^2 or 30%.

The following table details the potential subsequent reduction in CO_2 emissions because of the improvements to the energy demand.

CO_2 Emissions (BE LEAN)

Energy Use	Emissions (kg CO_2/year) (1)		Emissions Rate (kg CO_2/m²/year) (1)	
	Part L 2013 Compliant Building	Proposed Building	Part L 2013 Compliant Building	Proposed Building
Space Heating	3,572	1,930	12.80	6.90
Domestic Hot Water	564	586	2.00	2.0
Regulated Electricity	407	1,104	1.50	3.9
Total	**4,543**	**3,620**	**16.20**	**12.80**
Non-regulated Electricity	3,427	3,427	12.20	12.20

(1) Carbon Emissions conversion factors have been taken from SAP 2012:

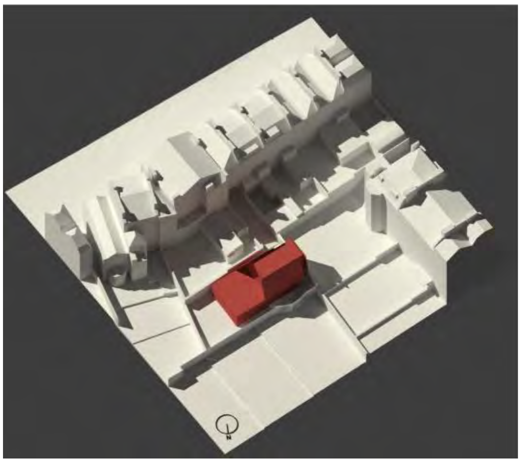
- Grid Electricity – 0.519 kgCO_2 / kWh
- Natural Gas – 0.216 kgCO_2 / kWh

The predicted total regulated energy annual CO_2 emissions of the proposed property following the introduction of energy efficiency measures and passive design is 3,590 kg CO_2 compared to the Building Regulations Part L1A (2013) compliant building of 4,543 kg. This represents a significant improvement in carbon emissions, equating to a reduction of 3.4 kg per m^2 or 20%.

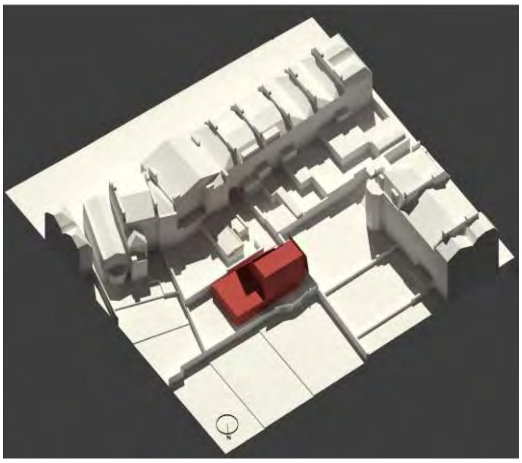
4.6 ON-SITE RENEWABLE ENERGY GENERATION

The following series of images taken from the Overshadowing Survey prepared by Gianni Botsford Architects demonstrate the solar availability and shadowing from the proposed property and surrounding buildings. The existing trees are not considered; however, this will provide further reduction in the annual solar radiation.

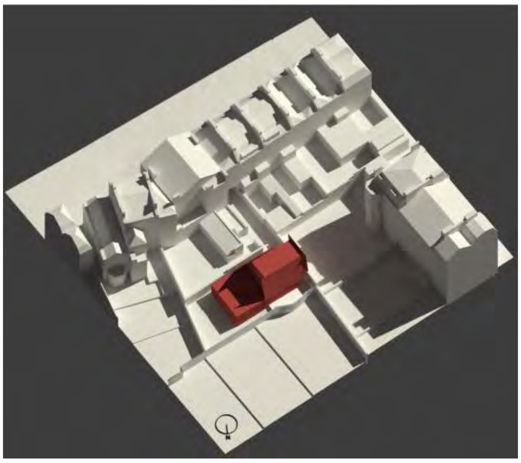
Solar Availability & Shadowing - SUMMER



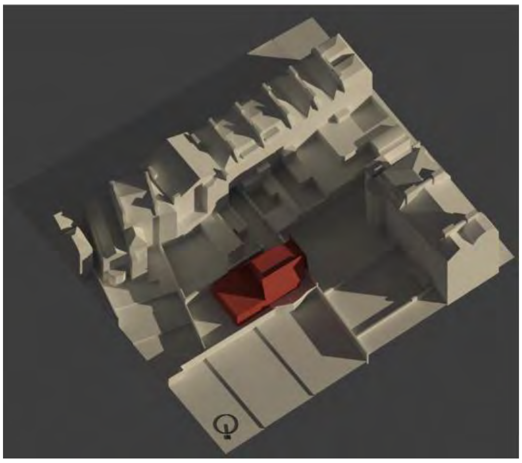
Summer (21 June) 9.00



Summer (21 June) 12.00

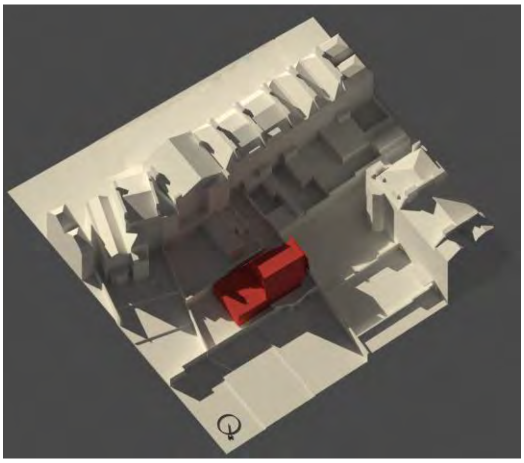


Summer (21 June) 15.00

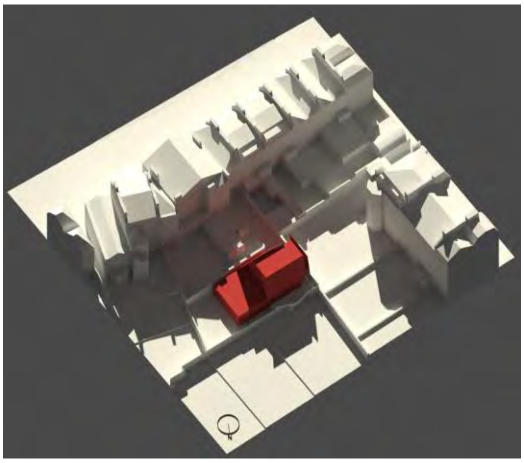


Summer (21 June) 18.00

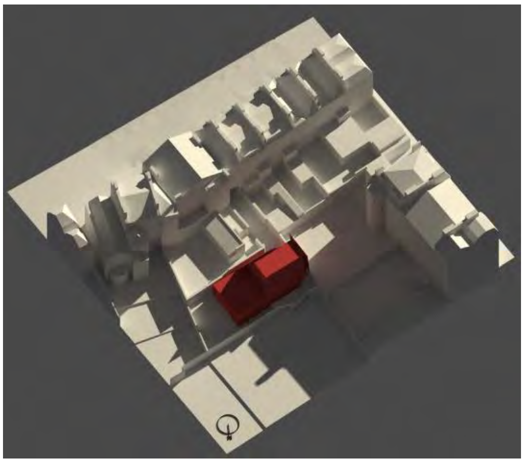
Solar Availability & Shadowing – SPRING / AUTUMN



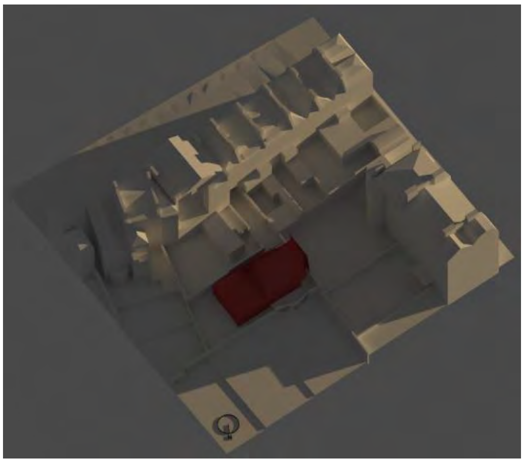
Spring / Autumn (21 March) 9.00



Spring / Autumn (21 March) 12.00

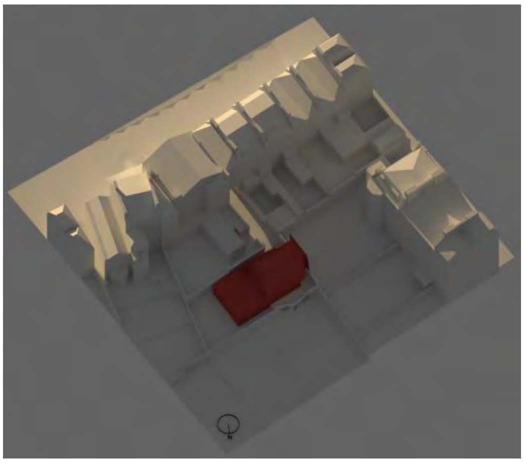


Spring / Autumn (21 March) 15.00

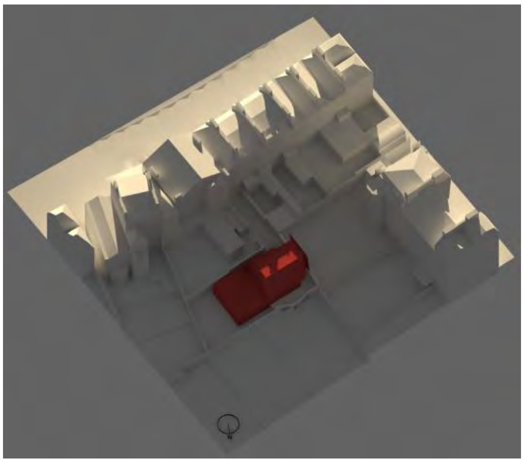


Spring / Autumn (21 March) 18.00

Solar Availability & Shadowing – WINTER

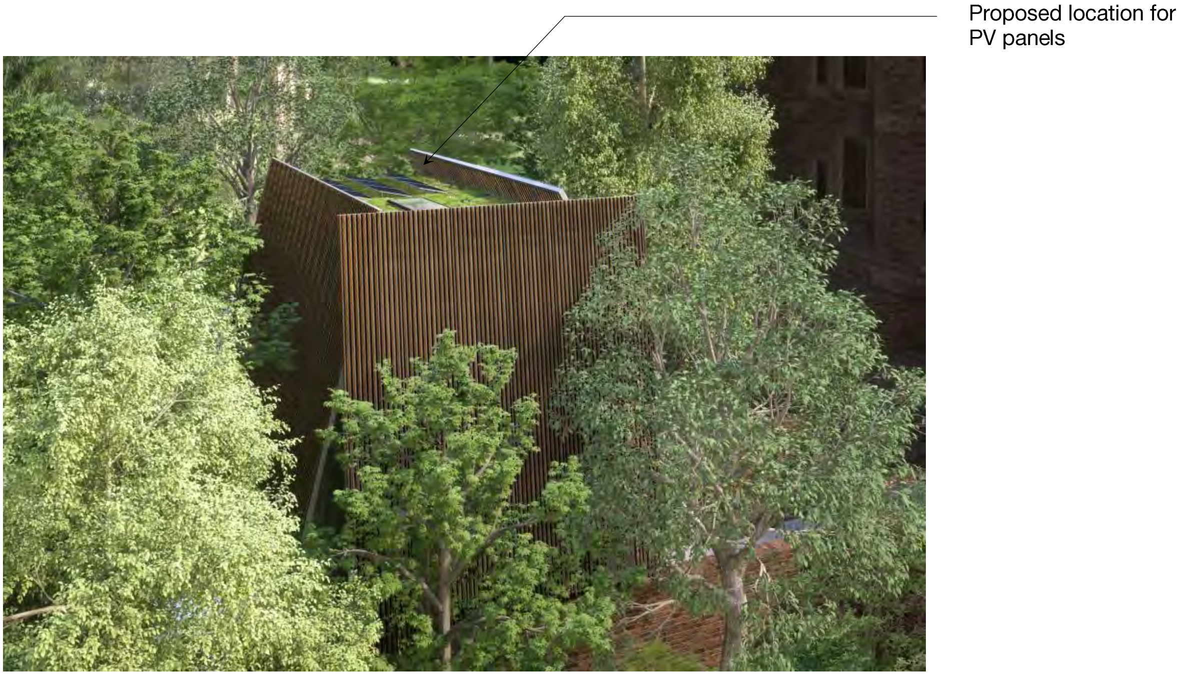


Winter (21 December) 10.00

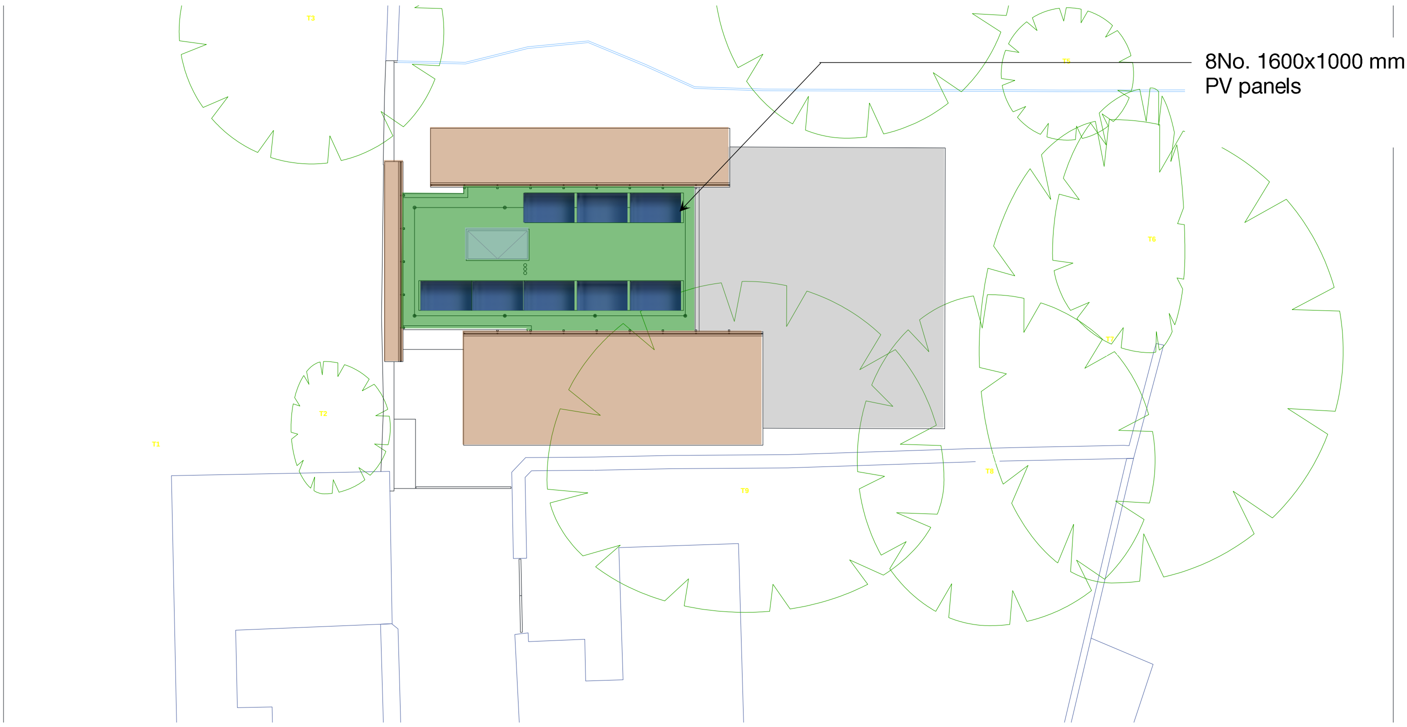


Winter (21 December) 12.00

It is proposed that photovoltaic panels are located on the flat roof facing South East. Although this arrangement will not enable the optimal orientation of photovoltaic panels, it will allow relatively unobstructed solar availability to be achieved for a significant proportion of the year.



CGI (Gianni Botsford Architects)



Roof Plan

The available roof area for the PV panels without obscuring the roof light is 9 m^2. Providing up to 8 panels with an installed capacity of $2kW_p$. It is recommended that the panels are surface mounted on the roof with 15° inclination and South-East orientation to minimise over shading of adjacent panels and reduce the visual impact. This will maximise the available roof area of the installation of the PV panels, however the following should be considered:

- The green roof area will be reduced due to the installation of the panels.
- A zone of 1 meter form the edge of the roof will be required and a fall restraint system should be provided to facilitate access for maintenance.

Following the inclusion of 2kWp of photovoltaic panels the reduction in CO2 emissions from renewable energy sources is as follows. The generated electricity from the PV panels considers the orientation and significant overshading.

CO_2 Emissions (BE GREEN)

	Generated Energy (kWh /year)	**Equivalent CO_2 Emissions (Kg CO_2/year)**	**Proportion (CO_2) of Total Demand**
Total Energy Demand	12,667	2,735	100%
Generated Solar Photovoltaic Energy	1,057	548	**20%**

Net improvement of Dwelling Emission Rate (DER/TER): 32.7%

5 SUSTAINABILITY APPRAISAL

The following appraisal addresses the sustainable features of the proposed property following policy guidelines.

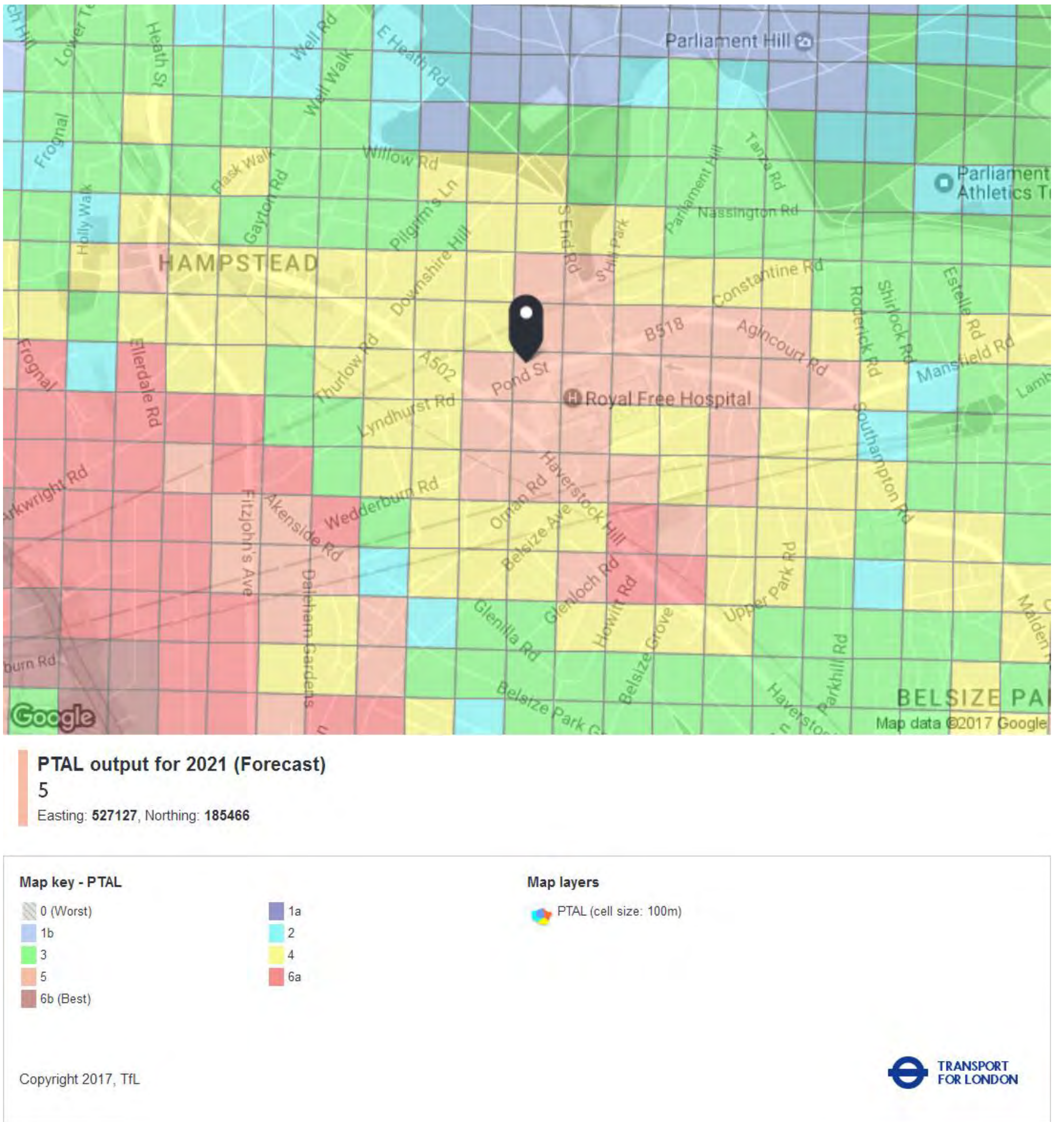
5.1 LAND & BUILDING USE

The site at 13a Pond Street, is located in Hampstead within the London Borough of Camden. The site is within the Hampstead Conservation area and does not contain any Listed Buildings.

The site is currently occupied by an existing residential building and soft landscaping. The proposed building largely occupies the footprint of the previously proposed building.

5.2 SITE LOCATION & PUBLIC TRANSPORT ACCESSIBILITY

The site is located in the urbanised area of Hampstead, within the London Borough of Camden, which has a range of frequent transport links. The nearest tube station is Belsize Park which is within 540m and the nearest Overground rail station, Hampstead Heath is within 340m of the site. There are numerous local bus routes with bus stops between 20 and 250 m from the site.



The Transport for London Web PTAL report for the site states that the Accessibility Index is 24.71, which translates as a PTAL Rating of 5. This demonstrates the site is well placed for public transport.

The property will include provision for cycle storage facilities which will be provided to encourage cycling rather than car usage. The cycle storage will be located within the building at Ground Floor Level adjacent to the main entrance, providing a secure facility.

5.3 ENERGY CONSERVATION & EFFICIENCY

The energy efficient design of the development is discussed in detail in section 4

5.4 WATER CONSERVATION & RECYCLING

The water management strategy will adopt the same *Lean-Clean-Renewable* hierarchy that is applied in property of the energy strategy. To reduce potable water demand and use the resource efficiently, a combination of the following strategies will be adopted:

- Rainwater harvesting and reuse for garden irrigation, WC flushing and façade cleaning.
- Specification of water efficient appliances, including washing machines and dishwashers, all white goods provided will have maximum water efficiency ratings.
- Dual and low flush toilets; flow restrictors on piped water supplies to sinks and basins.
- A pulsed water meter will be installed to the dwelling.

These will reduce potable water demand, when compared to a typical UK dwelling, from 155 litres / person per day to 110 litres / person per day.

5.5 MATERIALS

It is proposed that high quality materials be used throughout the property. The materials selected for the property will therefore:

- Be selected to suit the hierarchy within the BRE Green Guide to Specification, maximising the use of A & A+ materials where ever possible;
- Be sourced from the demolition materials where possible. Where possible, the recovered demolition materials will be reused on-site.
- Be sourced responsibly from certified and accredited suppliers and manufacturers, e.g. Chain of Custody certification, FSC, EWMAS, BES6001 etc.;
- Be manufactured off site where possible;
- Comprise low VOC content products;
- Be locally sourced where possible, with a sourcing hierarchy starting within London, then South East England, England, and then the UK.

5.6 WASTE

The construction of a building involves the production of a variety of waste streams. These can arise at each stage of the development life cycle including demolition of the existing buildings, excavations, construction and the building operation. By careful planning, appropriate design and management of these waste streams the waste volumes can be substantially reduced or in some cases even removed completely.

The waste strategy will be developed with the intention of reducing waste disposal to landfill sites. This includes a waste hierarchy which is consistent with the basic sustainability principles of reduce, reuse and recycle. This hierarchy follows the steps below.

- Waste prevention
- Re-use
- Recycle
- Disposal

The property design will be developed with full consideration given to selection of materials and promotion of construction techniques that can reduce waste. The use of standard material sizes, and proprietary products can reduce waste generation, as can the specification of materials such as plasterboard which have an inherent recyclable option for off cuts.

The contractor will be required to implement a Site Waste Management Plan for the management of construction materials, to demonstrate how they will be recycled or re-used and confirm how waste discharge to landfill will be kept to a minimum.

External storage areas will be provided within the garden of the property for recyclable and non-recyclable waste.

The London Borough of Camden is well serviced with regard to refuse collection, with both municipal waste and recycling regularly collected. Waste management and storage provision will be designed to make full benefit of these waste collection facilities.

5.7 MANAGEMENT OF CONSTRUCTION

The Contractor should be required to meet best practice under a nationally or locally recognised certification scheme such as the Considerate Constructors Scheme. This will include the management, control and monitoring of the following arising from site activities:

- water consumption
- water (ground and surface) pollution
- air (dust) pollution
- the use of reclaimed, re-used and responsibly sourced site timber
- waste generation, mitigation measures and maximising waste diversion from landfill

5.8 ECOLOGY

The site is largely made up of the proposed building some associated hard standing with garden areas surrounding the property on 3 sides. The gardens are accessed from the living accommodation and have been planned as outdoor rooms, making the most use of the available space.

The net internal floor area to net internal ground floor area is in excess of 2.4:1, therefore it can be considered that proposed development provides efficient use of the building footprint by ensuring that land and material use is optimised across the site.

6 SUMMARY

Minimise Demand

Passive design measures will be incorporated into the design of the proposed property to reduce energy consumption whilst enhancing occupant comfort and wellbeing. Key sustainable design features include maximising exposure to solar energy and daylight through considered façade design, minimising overheating and glare via passive shading, providing facilities for effective, controlled natural ventilation.

The thermal performance of the building fabric will be enhanced with appropriate construction materials and details providing low U-values, minimising cold bridging, enhanced air tightness and reduced air infiltration.

Deliver Resource Efficiently

The dwelling will include efficient building services systems including mechanical ventilation systems incorporating heat recovery, low energy lighting and time, temperature and weather compensated heating controls.

Use Renewable Sources

A number of photovoltaic panels will be provided to generate a supply of clean, zero-carbon electricity to the property. The PV panels will be located on the new flat element of the roof and tilted to maximise power generation throughout the year with some shading from surrounding buildings.

Decentralised Energy in Development Proposals

Due to the size and location of the proposed development and availability of local district heating networks it is not deemed feasible to connect to any heat network at this stage.

Achieving CO_2 Emissions Reduction Targets

Improvements to the building fabric and the proposed active building services systems can achieve an average reduction of CO_2 emissions over the TER of 19%, this is predominantly achieved by the use of triple glazing and high insulated building fabric.

The proposed photovoltaic panels will be tilted to maximise power generation throughout the year with minimal over shading from surrounding buildings. The extent of the proposed photovoltaic cell panel installation will provide a further 20% reduction in CO_2 emissions over the energy use of the entire development.

This strategy represents the maximum energy and CO_2 emissions reductions that could be achieved for this development and therefore it confirms that the development complies with the minimum requirements set by London Plan and the London Borough of Camden’s sustainability targets.

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

7 APPENDICES

7.1 EXAMPLE SAP DER WORKSHEET (BE GREEN)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.5

Property Address: Pond Street New

Address : 13A, Pond Street, LONDON, NW3 2PN

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	69.86	(1a) x	2.95	(2a) =	206.09	(3a)
Ground floor	115.85	(1b) x	3.26	(2b) =	377.67	(3b)
First floor	58.25	(1c) x	2.48	(2c) =	144.46	(3c)
Second floor	45.86	(1d) x	2.42	(2d) =	111.12	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	289.82	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	839.34	(5)

2. Ventilation rate:

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

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				Air changes per hour	
Infiltration due to chimneys, flues and fans =	(6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.15	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed

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

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SAP WorkSheet: New dwelling design stage

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0.5	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.25	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0.3	0.3	0.29	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.28	0.29	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.3	0.3	0.29	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.28	0.29	(25)

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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)	k-value kJ/m²·K	A X k kJ/K	
Windows Type 1			5.77	x1/[1/(0.8)+ 0.04] =	4.47			(27)
Windows Type 2			10.54	x1/[1/(0.8)+ 0.04] =	8.17			(27)
Windows Type 3			5.78	x1/[1/(0.8)+ 0.04] =	4.48			(27)
Windows Type 4			8.24	x1/[1/(0.8)+ 0.04] =	6.39			(27)
Windows Type 5			31.56	x1/[1/(0.8)+ 0.04] =	24.46			(27)
Windows Type 6			16.62	x1/[1/(0.8)+ 0.04] =	12.88			(27)
Windows Type 7			25.81	x1/[1/(0.8)+ 0.04] =	20.01			(27)
Windows Type 8			2.9	x1/[1/(0.8)+ 0.04] =	2.25			(27)
Windows Type 9			17	x1/[1/(0.8)+ 0.04] =	13.18			(27)
Windows Type 10			7.16	x1/[1/(0.8)+ 0.04] =	5.55			(27)
Windows Type 11			16.28	x1/[1/(0.8)+ 0.04] =	12.62			(27)
Windows Type 12			34	x1/[1/(0.8)+ 0.04] =	26.36			(27)
Rooflights Type 1			1.85	x1/[1/(0.8) + 0.04] =	1.48			(27b)
Rooflights Type 2			1.6	x1/[1/(0.8) + 0.04] =	1.28			(27b)

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SAP WorkSheet: New dwelling design stage

Floor			69.88	x	0.11	=	7.6846			(28)
Walls Type1	31.55	31.55	0	x	0.15	=	0			(29)
Walls Type2	16.62	16.62	0	x	0.15	=	0			(29)
Walls Type3	36.29	0	36.29	x	0.15	=	5.44			(29)
Walls Type4	25.8	25.81	-0.01	x	0.15	=	0			(29)
Walls Type5	23.27	2.9	20.37	x	0.15	=	3.06			(29)
Walls Type6	20.81	17	3.81	x	0.15	=	0.57			(29)
Walls Type7	16.28	16.28	0	x	0.15	=	0			(29)
Walls Type8	7.16	7.16	0	x	0.15	=	0			(29)
Walls Type9	11.73	0	11.73	x	0.15	=	1.76			(29)
Walls Type10	14.75	0	14.75	x	0.15	=	2.21			(29)
Walls Type11	5.77	5.77	0	x	0.13	=	0			(29)
Walls Type12	29.15	0	29.15	x	0.15	=	4.37			(29)
Walls Type13	12.4	0	12.4	x	0.15	=	1.86			(29)
Walls Type14	5.78	5.78	0	x	0.13	=	0			(29)
Walls Type15	11.56	0	11.56	x	0.15	=	1.73			(29)
Walls Type16	10.54	10.54	0	x	0.13	=	0			(29)
Walls Type17	5.24	5.24	0	x	0.13	=	0			(29)
Walls Type18	3.84	0	3.84	x	0.15	=	0.58			(29)
Walls Type19	31	31	0	x	0.15	=	0			(29)
Roof Type1	12.36	1.85	10.51	x	0.11	=	1.16			(30)
Roof Type2	58.02	0	58.02	x	0.11	=	6.38			(30)
Roof Type3	29.51	0	29.51	x	0.11	=	3.25			(30)
Roof Type4	36.85	0	36.85	x	0.11	=	4.05			(30)
Roof Type5	20.92	0	20.92	x	0.11	=	2.3			(30)
Roof Type6	33.57	1.6	31.97	x	0.11	=	3.52			(30)
Total area of elements, m²			586.64							(31)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	193.41	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	30959.77	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: Medium	250	(35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K		40.07	(36)

if details of thermal bridging are not known (36) = 0.15 x (31)

Total fabric heat loss	(33) + (36) =	233.49	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	83.46	82.58	81.69	77.28	76.39	71.98	71.98	71.1	73.75	76.39	78.16	79.93	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

(39)m=	316.94	316.06	315.18	310.76	309.88	305.47	305.47	304.58	307.23	309.88	311.65	313.41	

Average = Sum(39)₁…₁₂ /12= 310.54 (39)

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SAP WorkSheet: New dwelling design stage

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

(40)m=	1.09	1.09	1.09	1.07	1.07	1.05	1.05	1.05	1.06	1.07	1.08	1.08

Average = Sum(40)1...12 /12= 1.07 (40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31

(41)

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 3.12 (42)
if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 108.27 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

	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)												
(44)m=	119.1	114.77	110.43	106.1	101.77	97.44	97.44	101.77	106.1	110.43	114.77	119.1

Total = Sum(44)1...12 = 1299.23 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	176.62	154.47	159.4	138.97	133.34	115.06	106.62	122.35	123.81	144.29	157.51	171.04

Total = Sum(45)1...12 = 1703.49 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	26.49	23.17	23.91	20.85	20	17.26	15.99	18.35	18.57	21.64	23.63	25.66

(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 150 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.01 (51)

If community heating see section 4.3

Volume factor from Table 2a 0.93 (52)

Temperature factor from Table 2b 0.54 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.77 (54)

Enter (50) or (54) in (55) 0.77 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	23.98	21.66	23.98	23.21	23.98	23.21	23.98	23.98	23.21	23.98	23.21	23.98

(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	23.98	21.66	23.98	23.21	23.98	23.21	23.98	23.98	23.21	23.98	23.21	23.98

(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26

(59)

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Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	223.86	197.14	206.64	184.69	180.59	160.79	153.87	169.8	169.53	191.54	203.23	218.29	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	223.86	197.14	206.64	184.69	180.59	160.79	153.87	169.8	169.53	191.54	203.23	218.29	

Output from water heater (annual) 1…12: 2259.76 (64)

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

(65)m=	96.52	85.5	90.8	82.78	82.13	74.84	73.25	78.48	77.74	85.77	88.95	94.67	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	187.12	187.12	187.12	187.12	187.12	187.12	187.12	187.12	187.12	187.12	187.12	187.12	(66)

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

(67)m=	100.29	89.07	72.44	54.84	40.99	34.61	37.4	48.61	65.24	82.84	96.69	103.07	(67)

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

(68)m=	671.59	678.56	661	623.61	576.42	532.06	502.43	495.46	513.02	550.41	597.61	641.96	(68)

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

(69)m=	56.83	56.83	56.83	56.83	56.83	56.83	56.83	56.83	56.83	56.83	56.83	56.83	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-124.75	-124.75	-124.75	-124.75	-124.75	-124.75	-124.75	-124.75	-124.75	-124.75	-124.75	-124.75	(71)

Water heating gains (Table 5)

(72)m=	129.73	127.23	122.04	114.98	110.39	103.94	98.45	105.48	107.98	115.29	123.54	127.24	(72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	1023.82	1017.07	977.68	915.64	850.01	792.82	760.49	771.76	808.45	870.75	940.04	994.48	(73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	25.81	x	11.28	x	0.45	x	0.9	=	81.73	(75)
Northeast 0.9x	0.77	x	34	x	11.28	x	0.45	x	0.92	=	110.06	(75)
Northeast 0.9x	0.77	x	25.81	x	22.97	x	0.45	x	0.9	=	166.37	(75)
Northeast 0.9x	0.77	x	34	x	22.97	x	0.45	x	0.92	=	224.03	(75)
Northeast 0.9x	0.77	x	25.81	x	41.38	x	0.45	x	0.9	=	299.75	(75)

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Northeast 0.9x	0.77	x	34	x	41.38	x	0.45	x	0.92	=	403.64	(75)
Northeast 0.9x	0.77	x	25.81	x	67.96	x	0.45	x	0.9	=	492.27	(75)
Northeast 0.9x	0.77	x	34	x	67.96	x	0.45	x	0.92	=	662.89	(75)
Northeast 0.9x	0.77	x	25.81	x	91.35	x	0.45	x	0.9	=	661.71	(75)
Northeast 0.9x	0.77	x	34	x	91.35	x	0.45	x	0.92	=	891.05	(75)
Northeast 0.9x	0.77	x	25.81	x	97.38	x	0.45	x	0.9	=	705.45	(75)
Northeast 0.9x	0.77	x	34	x	97.38	x	0.45	x	0.92	=	949.95	(75)
Northeast 0.9x	0.77	x	25.81	x	91.1	x	0.45	x	0.9	=	659.93	(75)
Northeast 0.9x	0.77	x	34	x	91.1	x	0.45	x	0.92	=	888.66	(75)
Northeast 0.9x	0.77	x	25.81	x	72.63	x	0.45	x	0.9	=	526.11	(75)
Northeast 0.9x	0.77	x	34	x	72.63	x	0.45	x	0.92	=	708.45	(75)
Northeast 0.9x	0.77	x	25.81	x	50.42	x	0.45	x	0.9	=	365.25	(75)
Northeast 0.9x	0.77	x	34	x	50.42	x	0.45	x	0.92	=	491.84	(75)
Northeast 0.9x	0.77	x	25.81	x	28.07	x	0.45	x	0.9	=	203.32	(75)
Northeast 0.9x	0.77	x	34	x	28.07	x	0.45	x	0.92	=	273.79	(75)
Northeast 0.9x	0.77	x	25.81	x	14.2	x	0.45	x	0.9	=	102.84	(75)
Northeast 0.9x	0.77	x	34	x	14.2	x	0.45	x	0.92	=	138.49	(75)
Northeast 0.9x	0.77	x	25.81	x	9.21	x	0.45	x	0.9	=	66.75	(75)
Northeast 0.9x	0.77	x	34	x	9.21	x	0.45	x	0.92	=	89.88	(75)
Southeast 0.9x	0.54	x	5.78	x	36.79	x	0.45	x	0.8	=	37.21	(77)
Southeast 0.9x	0.77	x	31.55	x	36.79	x	0.45	x	0.9	=	325.81	(77)
Southeast 0.9x	0.54	x	5.78	x	62.67	x	0.45	x	0.8	=	63.38	(77)
Southeast 0.9x	0.77	x	31.55	x	62.67	x	0.45	x	0.9	=	554.97	(77)
Southeast 0.9x	0.54	x	5.78	x	85.75	x	0.45	x	0.8	=	86.72	(77)
Southeast 0.9x	0.77	x	31.55	x	85.75	x	0.45	x	0.9	=	759.34	(77)
Southeast 0.9x	0.54	x	5.78	x	106.25	x	0.45	x	0.8	=	107.45	(77)
Southeast 0.9x	0.77	x	31.55	x	106.25	x	0.45	x	0.9	=	940.86	(77)
Southeast 0.9x	0.54	x	5.78	x	119.01	x	0.45	x	0.8	=	120.35	(77)
Southeast 0.9x	0.77	x	31.55	x	119.01	x	0.45	x	0.9	=	1053.84	(77)
Southeast 0.9x	0.54	x	5.78	x	118.15	x	0.45	x	0.8	=	119.48	(77)
Southeast 0.9x	0.77	x	31.55	x	118.15	x	0.45	x	0.9	=	1046.22	(77)
Southeast 0.9x	0.54	x	5.78	x	113.91	x	0.45	x	0.8	=	115.19	(77)
Southeast 0.9x	0.77	x	31.55	x	113.91	x	0.45	x	0.9	=	1008.66	(77)
Southeast 0.9x	0.54	x	5.78	x	104.39	x	0.45	x	0.8	=	105.57	(77)
Southeast 0.9x	0.77	x	31.55	x	104.39	x	0.45	x	0.9	=	924.38	(77)
Southeast 0.9x	0.54	x	5.78	x	92.85	x	0.45	x	0.8	=	93.9	(77)
Southeast 0.9x	0.77	x	31.55	x	92.85	x	0.45	x	0.9	=	822.2	(77)
Southeast 0.9x	0.54	x	5.78	x	69.27	x	0.45	x	0.8	=	70.05	(77)
Southeast 0.9x	0.77	x	31.55	x	69.27	x	0.45	x	0.9	=	613.36	(77)
Southeast 0.9x	0.54	x	5.78	x	44.07	x	0.45	x	0.8	=	44.57	(77)
Southeast 0.9x	0.77	x	31.55	x	44.07	x	0.45	x	0.9	=	390.24	(77)

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Southeast 0.9x	0.54	x	5.78	x	31.49	x	0.45	x	0.8	=	31.84	(77)
Southeast 0.9x	0.77	x	31.55	x	31.49	x	0.45	x	0.9	=	278.82	(77)
Southwest 0.9x	0.54	x	10.54	x	36.79		0.45	x	0.8	=	67.35	(79)
Southwest 0.9x	0.54	x	8.24	x	36.79		0.45	x	0.8	=	53.04	(79)
Southwest 0.9x	0.77	x	16.62	x	36.79		0.45	x	0.9	=	171.63	(79)
Southwest 0.9x	0.77	x	7.16	x	36.79		0.45	x	0.9	=	73.94	(79)
Southwest 0.9x	0.54	x	10.54	x	62.67		0.45	x	0.8	=	115.57	(79)
Southwest 0.9x	0.54	x	8.24	x	62.67		0.45	x	0.8	=	90.35	(79)
Southwest 0.9x	0.77	x	16.62	x	62.67		0.45	x	0.9	=	292.35	(79)
Southwest 0.9x	0.77	x	7.16	x	62.67		0.45	x	0.9	=	125.95	(79)
Southwest 0.9x	0.54	x	10.54	x	85.75		0.45	x	0.8	=	158.13	(79)
Southwest 0.9x	0.54	x	8.24	x	85.75		0.45	x	0.8	=	123.63	(79)
Southwest 0.9x	0.77	x	16.62	x	85.75		0.45	x	0.9	=	400.01	(79)
Southwest 0.9x	0.77	x	7.16	x	85.75		0.45	x	0.9	=	172.33	(79)
Southwest 0.9x	0.54	x	10.54	x	106.25		0.45	x	0.8	=	195.94	(79)
Southwest 0.9x	0.54	x	8.24	x	106.25		0.45	x	0.8	=	153.18	(79)
Southwest 0.9x	0.77	x	16.62	x	106.25		0.45	x	0.9	=	495.63	(79)
Southwest 0.9x	0.77	x	7.16	x	106.25		0.45	x	0.9	=	213.52	(79)
Southwest 0.9x	0.54	x	10.54	x	119.01		0.45	x	0.8	=	219.46	(79)
Southwest 0.9x	0.54	x	8.24	x	119.01		0.45	x	0.8	=	171.57	(79)
Southwest 0.9x	0.77	x	16.62	x	119.01		0.45	x	0.9	=	555.14	(79)
Southwest 0.9x	0.77	x	7.16	x	119.01		0.45	x	0.9	=	239.16	(79)
Southwest 0.9x	0.54	x	10.54	x	118.15		0.45	x	0.8	=	217.88	(79)
Southwest 0.9x	0.54	x	8.24	x	118.15		0.45	x	0.8	=	170.33	(79)
Southwest 0.9x	0.77	x	16.62	x	118.15		0.45	x	0.9	=	551.13	(79)
Southwest 0.9x	0.77	x	7.16	x	118.15		0.45	x	0.9	=	237.43	(79)
Southwest 0.9x	0.54	x	10.54	x	113.91		0.45	x	0.8	=	210.06	(79)
Southwest 0.9x	0.54	x	8.24	x	113.91		0.45	x	0.8	=	164.22	(79)
Southwest 0.9x	0.77	x	16.62	x	113.91		0.45	x	0.9	=	531.35	(79)
Southwest 0.9x	0.77	x	7.16	x	113.91		0.45	x	0.9	=	228.91	(79)
Southwest 0.9x	0.54	x	10.54	x	104.39		0.45	x	0.8	=	192.5	(79)
Southwest 0.9x	0.54	x	8.24	x	104.39		0.45	x	0.8	=	150.5	(79)
Southwest 0.9x	0.77	x	16.62	x	104.39		0.45	x	0.9	=	486.95	(79)
Southwest 0.9x	0.77	x	7.16	x	104.39		0.45	x	0.9	=	209.78	(79)
Southwest 0.9x	0.54	x	10.54	x	92.85		0.45	x	0.8	=	171.23	(79)
Southwest 0.9x	0.54	x	8.24	x	92.85		0.45	x	0.8	=	133.86	(79)
Southwest 0.9x	0.77	x	16.62	x	92.85		0.45	x	0.9	=	433.12	(79)
Southwest 0.9x	0.77	x	7.16	x	92.85		0.45	x	0.9	=	186.59	(79)
Southwest 0.9x	0.54	x	10.54	x	69.27		0.45	x	0.8	=	127.73	(79)
Southwest 0.9x	0.54	x	8.24	x	69.27		0.45	x	0.8	=	99.86	(79)
Southwest 0.9x	0.77	x	16.62	x	69.27		0.45	x	0.9	=	323.11	(79)

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Southwest 0.9x	0.77	x	7.16	x	69.27		0.45	x	0.9	=	139.2	(79)
Southwest 0.9x	0.54	x	10.54	x	44.07		0.45	x	0.8	=	81.27	(79)
Southwest 0.9x	0.54	x	8.24	x	44.07		0.45	x	0.8	=	63.54	(79)
Southwest 0.9x	0.77	x	16.62	x	44.07		0.45	x	0.9	=	205.57	(79)
Southwest 0.9x	0.77	x	7.16	x	44.07		0.45	x	0.9	=	88.56	(79)
Southwest 0.9x	0.54	x	10.54	x	31.49		0.45	x	0.8	=	58.07	(79)
Southwest 0.9x	0.54	x	8.24	x	31.49		0.45	x	0.8	=	45.4	(79)
Southwest 0.9x	0.77	x	16.62	x	31.49		0.45	x	0.9	=	146.88	(79)
Southwest 0.9x	0.77	x	7.16	x	31.49		0.45	x	0.9	=	63.28	(79)
Northwest 0.9x	0.54	x	5.77	x	11.28	x	0.45	x	0.8	=	11.39	(81)
Northwest 0.9x	0.77	x	2.9	x	11.28	x	0.45	x	0.9	=	9.18	(81)
Northwest 0.9x	0.77	x	17	x	11.28	x	0.45	x	0.9	=	53.83	(81)
Northwest 0.9x	0.77	x	16.28	x	11.28	x	0.45	x	0.9	=	51.55	(81)
Northwest 0.9x	0.54	x	5.77	x	22.97	x	0.45	x	0.8	=	23.19	(81)
Northwest 0.9x	0.77	x	2.9	x	22.97	x	0.45	x	0.9	=	18.69	(81)
Northwest 0.9x	0.77	x	17	x	22.97	x	0.45	x	0.9	=	109.58	(81)
Northwest 0.9x	0.77	x	16.28	x	22.97	x	0.45	x	0.9	=	104.94	(81)
Northwest 0.9x	0.54	x	5.77	x	41.38	x	0.45	x	0.8	=	41.77	(81)
Northwest 0.9x	0.77	x	2.9	x	41.38	x	0.45	x	0.9	=	33.68	(81)
Northwest 0.9x	0.77	x	17	x	41.38	x	0.45	x	0.9	=	197.43	(81)
Northwest 0.9x	0.77	x	16.28	x	41.38	x	0.45	x	0.9	=	189.07	(81)
Northwest 0.9x	0.54	x	5.77	x	67.98	x	0.45	x	0.8	=	68.6	(81)
Northwest 0.9x	0.77	x	2.9	x	67.98	x	0.45	x	0.9	=	56.31	(81)
Northwest 0.9x	0.77	x	17	x	67.98	x	0.45	x	0.9	=	324.24	(81)
Northwest 0.9x	0.77	x	16.28	x	67.98	x	0.45	x	0.9	=	310.51	(81)
Northwest 0.9x	0.54	x	5.77	x	91.35	x	0.45	x	0.8	=	92.22	(81)
Northwest 0.9x	0.77	x	2.9	x	91.35	x	0.45	x	0.9	=	74.35	(81)
Northwest 0.9x	0.77	x	17	x	91.35	x	0.45	x	0.9	=	435.84	(81)
Northwest 0.9x	0.77	x	16.28	x	91.35	x	0.45	x	0.9	=	417.38	(81)
Northwest 0.9x	0.54	x	5.77	x	97.38	x	0.45	x	0.8	=	98.31	(81)
Northwest 0.9x	0.77	x	2.9	x	97.38	x	0.45	x	0.9	=	79.26	(81)
Northwest 0.9x	0.77	x	17	x	97.38	x	0.45	x	0.9	=	464.65	(81)
Northwest 0.9x	0.77	x	16.28	x	97.38	x	0.45	x	0.9	=	444.97	(81)
Northwest 0.9x	0.54	x	5.77	x	91.1	x	0.45	x	0.8	=	91.97	(81)
Northwest 0.9x	0.77	x	2.9	x	91.1	x	0.45	x	0.9	=	74.15	(81)
Northwest 0.9x	0.77	x	17	x	91.1	x	0.45	x	0.9	=	434.67	(81)
Northwest 0.9x	0.77	x	16.28	x	91.1	x	0.45	x	0.9	=	416.26	(81)
Northwest 0.9x	0.54	x	5.77	x	72.63	x	0.45	x	0.8	=	73.32	(81)
Northwest 0.9x	0.77	x	2.9	x	72.63	x	0.45	x	0.9	=	59.11	(81)
Northwest 0.9x	0.77	x	17	x	72.63	x	0.45	x	0.9	=	346.53	(81)
Northwest 0.9x	0.77	x	16.28	x	72.63	x	0.45	x	0.9	=	331.85	(81)

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Northwest 0.9x	0.54	x	5.77	x	50.42	x	0.45	x	0.8	=	50.9	(81)
Northwest 0.9x	0.77	x	2.9	x	50.42	x	0.45	x	0.9	=	41.04	(81)
Northwest 0.9x	0.77	x	17	x	50.42	x	0.45	x	0.9	=	240.57	(81)
Northwest 0.9x	0.77	x	16.28	x	50.42	x	0.45	x	0.9	=	230.38	(81)
Northwest 0.9x	0.54	x	5.77	x	28.07	x	0.45	x	0.8	=	28.33	(81)
Northwest 0.9x	0.77	x	2.9	x	28.07	x	0.45	x	0.9	=	22.84	(81)
Northwest 0.9x	0.77	x	17	x	28.07	x	0.45	x	0.9	=	133.92	(81)
Northwest 0.9x	0.77	x	16.28	x	28.07	x	0.45	x	0.9	=	128.25	(81)
Northwest 0.9x	0.54	x	5.77	x	14.2	x	0.45	x	0.8	=	14.33	(81)
Northwest 0.9x	0.77	x	2.9	x	14.2	x	0.45	x	0.9	=	11.56	(81)
Northwest 0.9x	0.77	x	17	x	14.2	x	0.45	x	0.9	=	67.74	(81)
Northwest 0.9x	0.77	x	16.28	x	14.2	x	0.45	x	0.9	=	64.87	(81)
Northwest 0.9x	0.54	x	5.77	x	9.21	x	0.45	x	0.8	=	9.3	(81)
Northwest 0.9x	0.77	x	2.9	x	9.21	x	0.45	x	0.9	=	7.5	(81)
Northwest 0.9x	0.77	x	17	x	9.21	x	0.45	x	0.9	=	43.96	(81)
Northwest 0.9x	0.77	x	16.28	x	9.21	x	0.45	x	0.9	=	42.1	(81)
Rooflights 0.9x	1	x	1.85	x	26	x	0.6	x	0.8	=	20.78	(82)
Rooflights 0.9x	1	x	1.6	x	26	x	0.6	x	0.8	=	17.97	(82)
Rooflights 0.9x	1	x	1.85	x	54	x	0.6	x	0.8	=	43.16	(82)
Rooflights 0.9x	1	x	1.6	x	54	x	0.6	x	0.8	=	37.32	(82)
Rooflights 0.9x	1	x	1.85	x	96	x	0.6	x	0.8	=	76.72	(82)
Rooflights 0.9x	1	x	1.6	x	96	x	0.6	x	0.8	=	66.36	(82)
Rooflights 0.9x	1	x	1.85	x	150	x	0.6	x	0.8	=	119.88	(82)
Rooflights 0.9x	1	x	1.6	x	150	x	0.6	x	0.8	=	103.68	(82)
Rooflights 0.9x	1	x	1.85	x	192	x	0.6	x	0.8	=	153.45	(82)
Rooflights 0.9x	1	x	1.6	x	192	x	0.6	x	0.8	=	132.71	(82)
Rooflights 0.9x	1	x	1.85	x	200	x	0.6	x	0.8	=	159.84	(82)
Rooflights 0.9x	1	x	1.6	x	200	x	0.6	x	0.8	=	138.24	(82)
Rooflights 0.9x	1	x	1.85	x	189	x	0.6	x	0.8	=	151.05	(82)
Rooflights 0.9x	1	x	1.6	x	189	x	0.6	x	0.8	=	130.64	(82)
Rooflights 0.9x	1	x	1.85	x	157	x	0.6	x	0.8	=	125.47	(82)
Rooflights 0.9x	1	x	1.6	x	157	x	0.6	x	0.8	=	108.52	(82)
Rooflights 0.9x	1	x	1.85	x	115	x	0.6	x	0.8	=	91.91	(82)
Rooflights 0.9x	1	x	1.6	x	115	x	0.6	x	0.8	=	79.49	(82)
Rooflights 0.9x	1	x	1.85	x	66	x	0.6	x	0.8	=	52.75	(82)
Rooflights 0.9x	1	x	1.6	x	66	x	0.6	x	0.8	=	45.62	(82)
Rooflights 0.9x	1	x	1.85	x	33	x	0.6	x	0.8	=	26.37	(82)
Rooflights 0.9x	1	x	1.6	x	33	x	0.6	x	0.8	=	22.81	(82)
Rooflights 0.9x	1	x	1.85	x	21	x	0.6	x	0.8	=	16.78	(82)
Rooflights 0.9x	1	x	1.6	x	21	x	0.6	x	0.8	=	14.52	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	1085.99	1969.86	3008.56	4243.94	5218.23	5383.15	5105.72	4349.02	3432.28	2262.12	1322.76	915.08	(83)

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Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	2109.81	2986.94	3986.25	5159.58	6068.24	6175.97	5886.21	5120.78	4240.73	3132.87	2262.79	1909.56	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.97	0.89	0.69	0.47	0.32	0.23	0.27	0.49	0.85	0.98	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.95	20.29	20.67	20.93	20.99	21	21	21	20.99	20.82	20.31	19.9	(87)

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

(88)m=	20.01	20.01	20.01	20.02	20.03	20.04	20.04	20.04	20.03	20.03	20.02	20.02	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.97	0.87	0.64	0.42	0.27	0.18	0.22	0.43	0.81	0.98	1	(89)

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

(90)m=	18.62	19.1	19.63	19.95	20.02	20.04	20.04	20.04	20.03	19.84	19.15	18.55	(90)

fLA = Living area ÷ (4) = | 0.34 | (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	19.07	19.5	19.98	20.28	20.35	20.36	20.36	20.37	20.35	20.17	19.54	19	(92)

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

(93)m=	19.07	19.5	19.98	20.28	20.35	20.36	20.36	20.37	20.35	20.17	19.54	19	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

Utilisation factor for gains, hm:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m=	0.99	0.96	0.87	0.65	0.44	0.28	0.2	0.24	0.45	0.82	0.98	0.99	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	2091.82	2871.81	3450.7	3372.83	2660.49	1759.16	1149.7	1207.53	1906.47	2563.37	2208.82	1899.19	(95)

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	4682.78	4615.49	4248	3537.43	2679.79	1760.8	1149.84	1207.91	1921.58	2966.78	3877.53	4640.01	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	1927.68	1171.75	593.19	118.52	14.36	0	0	0	0	300.14	1202.91	2039.17	

Total per year (kWh/year) = Sum(98)1...5,9...12 = | 7367.72 | (98)

Space heating requirement in kWh/m²/year | 25.42 | (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system | 0 | (201)

Fraction of space heat from main system(s) (202) = 1 – (201) = | 1 | (202)

Fraction of total heating from main system 1 (204) = (202) × [1 – (203)] = | 1 | (204)

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Efficiency of main space heating system 1		93.2	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)														
	1927.68	1171.75	593.19	118.52	14.36	0	0	0	0	300.14	1202.91	2039.17		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	2068.32	1257.24	636.47	127.16	15.41	0	0	0	0	322.03	1290.68	2187.95		
Total (kWh/year) =Sum(211)₁...₅,₁₀...₁₂ =													7905.28	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)₁...₅,₁₀...₁₂ =													0	(215)
Water heating														
Output from water heater (calculated above)														
	223.86	197.14	206.64	184.69	180.59	160.79	153.87	169.6	169.53	191.54	203.23	218.29		
Efficiency of water heater													79.5	(216)
(217)m=	88.95	88.48	87.17	83.37	80.2	79.5	79.5	79.5	79.5	85.71	88.48	89.04		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	[illegible]	222.8	237.06	221.54	225.17	202.25	193.55	213.33	213.25	[illegible]	[illegible]	245.15		
Total = Sum(219a)₁...₁₂ =													[illegible]	(219)

	kWh/year	kWh/year	
Annual totals			
Space heating fuel used, main system 1		7905.28	
Water heating fuel used		[illegible]	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	1343.99		(230a)
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)...(230g) =		1418.99	(231)
Electricity for lighting		708.44	(232)
Electricity generated by PVs		-1070.35	(233)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	275.1	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	93.23	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	187.16	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	13.19	x 0.01 =	93.44	(250)

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Additional standing charges (Table 12)				120	(251)
	one of (233) to (235) x)	13.19	x 0.01 =	-141.18	(252)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)...(254) =			627.76	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)			0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =		0.79	(257)
SAP rating (Section 12)			89.01	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	1707.54	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	578.65	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2286.19	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	736.45	(267)
Electricity for lighting	(232) x	0.519	=	387.68	(268)
Energy saving/generation technologies Item 1		0.519	=	-555.51	(269)
Total CO2, kg/year	sum of (265)...(271) =			2834.81	(272)
CO2 emissions per m²	(272) ÷ (4) =			9.78	(273)
EI rating (section 14)				89	(274)

13a. Primary Energy

	Energy kWh/year	Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211) x	1.22	=	9644.44	(261)
Space heating (secondary)	(215) x	3.07	=	0	(263)
Energy for water heating	(219) x	1.22	=	3268.29	(264)
Space and water heating	(261) + (262) + (263) + (264) =			12912.73	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	4356.29	(267)
Electricity for lighting	(232) x	0	=	2174.92	(268)
Energy saving/generation technologies Item 1		3.07	=	-3285.99	(269)
'Total Primary Energy	sum of (265)...(271) =			16157.96	(272)
Primary energy kWh/m²/year	(272) ÷ (4) =			55.75	(273)