RIBA Stage 2
Sustainability Statement
14a Hampstead Hill

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About the Scheme

The project consists of a new detached house in the London Borough of Camden.

The aspiration for the scheme is to significantly improve the existing site and its immediate environment by providing an efficient and inclusive development, which meets the policy recommendations of the London Borough of Camden.

This Sustainability Statement will be provided as evidence to the London Borough of Camden to demonstrate the development's holistic approach to sustainable design and construction. It summarises the contribution that the design will make to creating a more sustainable development, drawing on information provided by specialist consultants and design reports, and identifying key features intrinsic to achieving low carbon developments.

The key sustainability proposals are as follows:

- The development will reduce total carbon emissions by 19.4% Building Regulations based on SAP 2012 carbon factors and by 20.5% using the SAP 10 carbon factors.
- MVHR and natural ventilation through opening windows will be used as a passive cooling measure.
- High insulation standards and reduced air permeability will be used as efficient energy measures.
- Photovoltaic panels system will be used as a renewable energy source
- Minimise embodied carbon through efficient design, procurement of materials from a local source, and/or with a high-recycled content.
- Ensure all materials are responsibly sourced and of low environmental impact.
- Implement a site waste management plan.
- Best-practice guidance for reducing water consumption by specifying efficient water-consuming appliances and sanitaryware (110 litres/person/day throughout the scheme).
- Any features of ecological value on the site will be protected in accordance with best-practice guidance.
- The implementation of health and wellbeing measures such as enhanced indoor air quality and improved thermal comfort.

Key sustainability measures

In summary, the key measures incorporated to meet planning requirements and to achieve a low carbon development address the following key areas of sustainable design and construction:

- Energy and CO_2
- Adaptation to climate change
- Waste
- Transport and connectivity
- Materials
- Health and wellbeing

Introduction
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Sustainability introduction

The design team has significant experience in delivering schemes that are considered highly sustainable, either through application of formal green building rating systems, such as BREEAM as well as applying benchmarks from standards such as Passivhaus Design and adopting precedents from industry exemplar sustainable developments.

The scheme will reflect the expectations of sustainable development of the London Borough of Camden. The development will provide high quality housing in an area of need and will use local labour to boost employment. Health and wellbeing will be incorporated in the design by utilising healthy materials and contributing to the alleviation of fuel poverty in the region. The ecological value of the site will be maintained and protected, and where possible will enhance the ecological value of the site with native planting.

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National Context: The 2008 Climate Change Act

The UK Government is committed to reducing the UK's carbon emissions by 100% over 1990 levels through the Climate Change Act 2008. Achieving truly sustainable design and construction and forwarding the green agenda within the construction industry across the UK is inherent to meeting these emission targets. This development aims to do both of these.

To help monitor carbon reductions and to plot progress being made for future plans and investments in the UK's low-carbon economy, intermediary targets have been established to ensure that the UK remains on course for meeting the 100% reduction by 2050.

Concurrent with reducing CO_2 emissions by 100% by 2050 is the European Climate Change Policy targets. It sets the objective of ensuring 20% of energy consumption is generated from renewable sources by 2020 whilst also reducing Europe's carbon footprint by 20%. Ensuring a fabric first approach with consideration to renewable energy production fits both the climate change act and the European Commission's 2020 targets for reducing greenhouse gas (GHG) emissions.

National Context: National Planning Policy Framework 2019

The National Planning Policy Framework (NPPF) published in 2019 sets out the UK Government's planning policies for England. Planning law requires that applications for planning permission must be determined in accordance with the local development plan unless material considerations indicate otherwise. The National Planning Policy Framework must be taken into account in preparing the development plan and is a material consideration in planning decisions. Planning policies and decisions must also reflect relevant international obligations and statutory requirements.

The NPPF is supported by a series of Planning Practice Guidance (PPG) documents. The guidance in relation to air quality provides guiding principles on how planning can take account of the impact of new development on air quality. The following policies are relevant to the Sustainability Statement:

- Achieving sustainable development
- Promoting healthy and safe communities
- Promoting sustainable transport
- Achieving well-designed places
- Meeting the challenge of climate change, flooding and coastal change
- Conserving and enhancing the natural environment

Regional Context: London Plan March 2021

The London Plan (March 2021) is the overall strategic plan (Spatial development Strategy) for London and replaces the previous (2016) iteration. This document, therefore, plays a key role in the planning process in all the 32 London Boroughs and the City of London.

The London Plan aims to shape the planning process and sets out an integrated economic, environmental, transport and social framework for the 32 London Boroughs, the City of London and the Mayoral Development Corporations (MDCs) over the next 20-25 years (2019-2041), including the following key aspects of the Mayor of London's other strategies:

- Transport;
- Economic Development;
- Housing;
- Culture;
- Social issues (such as children and young people, health inequalities and food); and
- A range of environmental issues (such as climate change, air quality, noise and waste).

Within the London Plan there are a number of key targets for 'major developments', not applicable to this scheme:

- Policy SI 2: Development should be net zero-carbon and should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy; and,
- A minimum on-site reduction of at least 35% over Target Emission Rate identified in Building Regulations 2013 is required.

(*Continued Overleaf*)

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Regional Context: London Plan March 2021 (continued)

The London Plan (March 2021) also sets out the following targets for major developments. This has been followed as guidance for 'best practice':

- Efficient use of natural resources (including water);
- Minimising pollution (including noise, air and urban runoff);
- Minimising the generation of waste and maximising reuse or recycling;
- Avoiding impacts from natural hazards (including flooding);
- Ensuring developments are comfortable and secure for users;
- Securing sustainable procurement of materials, using local supplies where feasible; and
- Promoting and protecting biodiversity and green infrastructure.

Of particular relevance to this report are the following policies required by the Plan:

- Policy D6 – Housing Quality and Standards
- Policy G4 – Open Space
- Policy G5 – Urban Greening
- Policy G6 – Biodiversity and Access to Nature
- Policy SI1 – Improving Air Quality
- Policy SI2 – Minimising Greenhouse Gas Emissions
- Policy SI3 – Energy Infrastructure
- Policy SI4 – Managing Heat Risk
- Policy SI5 – Water Infrastructure
- Policy SI12 – Flood Risk Management
- Policy SI13 – Sustainable Drainage
- Policy T1 – Strategic Approach to Transport
- Policy T3 – Transport Capacity, Connectivity and Safeguarding
- Policy T5 – Cycling
- Policy T6 – Car Parking

Local context: London Borough of Camden's Local Plan 2017

The Camden Local Plan, published in July 2017, sets out the Council's planning policies. It responds to the Borough's unique characteristics and provides a comprehensive local policy framework to deliver Camden's future sustainable development. The Plan is supported by the supplementary planning document 'Camden Planning Guidance 3: Sustainability'.

The Camden Local Plan states a key strategic objective as 'investing in our communities to ensure sustainable neighbourhoods'. This is complimented by further objectives embedded in the Local Plan that define the sustainability vision of the council.

Chapter 8 'Sustainability and climate change' within the Camden Local Plan lists key sustainability objectives for the Borough. The following strategic objectives are relevant to this sustainability statement:

- 8.3 – Developments should reduce carbon dioxide emissions in line with the steps in the energy hierarchy. Developments should support this by ensuring the availability of sustainable transport options, optimising resource efficiency and encouraging sensitive energy use.

- 8.18 – All developments should optimise resource efficiency through waste and energy reduction, minimising materials required, opting for materials with low embodied carbon content and enabling low energy and water demands.

- 8.33 – All developments should adopt appropriate climate change adaptation measures such as green infrastructure and SuDS where feasible.

- 8.53 – Developments should incorporate water efficiency measures, consider the impact of development in areas prone to flooding and avoid harm to the water environment. Residential developments will be expected to meet the requirement of 110 litres per person per day including 5 litres for external water use. Refurbishments will be expected to meet BREEAM water efficiency credits.

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Local context: London Borough of Camden's Local Plan 2017 (continued)

- 8.84 – Construction should adopt sustainable design and construction methods including measures that minimise negative impacts on air quality.

- 8.90 – Developments should include facilities for the storage and collection of waste and recycling.

Further relevant sustainability objectives stated in the Camden Local Plan include the following:

- 4.84 – Developments should incorporate design principles that contribute to community safety and security.

Camden Planning Guidance 3 Sustainability

The Camden Planning Guidance (CPG) 3 Sustainability issued in March 2018 supports the policies in the Camden Local Plan and forms a supplementary planning document (SPD) for planning decisions. The CPG and additional guidance it provides on interpretation of the Local Plan sustainability policies is considered in this sustainability statement.

- 4.3 – All buildings are expected to reduce their carbon emissions by making improvements to the existing building. As a guide, at least 10% of the project cost should be spent on the improvements.

- 8.0 – Waste reduction measures should be incorporated. Primarily, this should involve the re-use of buildings where feasible. All developments should aim for at least 10% of the total value of materials to be derived from recycled and reused sources. Materials used in construction should be sourced responsibly and ensure they are safe to health.

- 10.0 – All developments should incorporate green and brown roofs where feasible.

- 11.0 – All developments are required to prevent or mitigate against flooding and manage drainage and surface water, Developments should not increase the risk of flooding.

Carbon Emission Factors
Energy Assessment
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Emission factors:

The Greater London Authority (GLA) Guidance on Energy Assessments published in October 2018 highlights a critical development regarding carbon emission factors. Grid electricity has significantly decarbonised since the last update of Part L in April 2014 and in July 2018 the Government published updated carbon emission factors (SAP 10.0) demonstrating this. Although SAP 10.0 is not in use yet, the GLA Guidance encourages the use of SAP 10.0 carbon emission factors from January 2019 in areas where there are no opportunities to connect to existing or planned district heat networks. Any applicants proposing to use the SAP 2012 emissions factors is required to provide adequate justification.

SAP 2012 emission factors can be used where:

- The scheme is located within a Heat Network Priority area; and
- There is potential to connect to an existing network using gas-engine CHP or a new network using low-emission CHP; and
- The heat network operator has, or is in the process of developing, a strategy to decarbonise the network and has shared it with the GLA

While the proposed scheme is expected to comply with SAP 2012 for Building Regulation compliance, the assessment presents total emissions using SAP10.0 as it is required for demonstrating performance against planning policy targets. The revised factors are below:

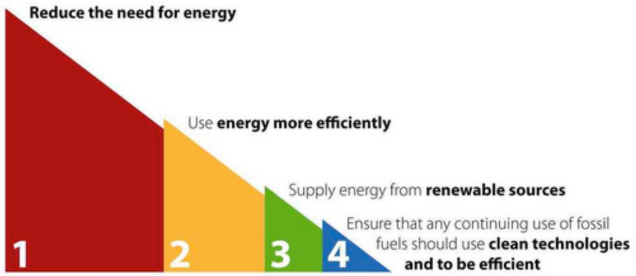
Fuel Type	Carbon Factor (kg CO_2/kWh)	
	SAP 2012	SAP10.0
Natural Gas	0.216	0.210
Grid Electricity	0.519	0.233

The carbon emissions of the scheme have been calculated using Building Regulations methodology for estimating energy performance against Part L 2013 requirements, and the outputs have been manually converted for the SAP 10.0 emission factors using a spreadsheet.

Energy Strategy

An outline energy strategy has been proposed for 14a Hampstead Hill scheme. The strategy has been proposed based on the Building Regulations Part L requirements, in order to meet and improve against the Building Regulations Part L1B CO_2 emissions targets. The energy strategy is detailed in the Energy and CO_2 section of this report.

GLA's Energy Hierarchy: Regulated carbon emissions



This methodology widely used in accordance with meeting the Sustainable Design and the energy hierarchy is widely used in order to achieve significant improvements against the Building Regulations Part L1A CO_2 emissions targets. This approach has been adopted for the scheme, following the principles of 'Lean', 'Clean', and Green', in addressing the planning policy requirements.

GLA's Energy Hierarchy: Regulated CO_2 – Calculated using SAP 2012 CO_2 factors				
	Baseline:	Be lean:	Be clean:	Be green:
CO_2 emissions (tCO_2/yr)	5.36	5.17	–	4.32
CO_2 emissions saving (tCO_2/yr)	–	0.19	–	0.85
Saving from each stage (%)	–	3.6	–	15.8
Total CO_2 emissions saving (tCO_2/yr)		1.04		
19.4% total CO_2 savings over 2013 Building Regulations Part L achieved				

GLA's Energy Hierarchy: Regulated CO_2 – Calculated using SAP 10.0 CO_2 factors				
	Baseline:	Be lean:	Be clean:	Be green:
CO_2 emissions (tCO_2/yr)	4.99	4.35	–	3.97
CO_2 emissions saving (tCO_2/yr)	–	0.64	–	0.38
Saving from each stage (%)	–	12.8	–	7.6
Total CO_2 emissions saving (tCO_2/yr)		1.02		
20.5% total CO_2 savings over 2013 Building Regulations Part L achieved.				

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Establishing CO_2 emissions

As required by the GLA both the regulated and unregulated emissions of the development must be quantified and demonstrated. The total emissions for the scheme are shown below.

CO_2 Emissions – Regulated and Unregulated (tonnes CO_2/yr) – SAP 2012			
	Regulated Emissions	Unregulated Emissions	Total Emissions
Baseline: Part L 2013	5.36	2.96	8.32
Be Lean: Use less energy	5.17	2.96	8.13
Be Clean: Supply energy efficiently	–	–	–
Be Green: Use renewable energy	4.32	2.96	7.28
CO_2 Emissions – Regulated and Unregulated (tonnes CO_2/yr) – SAP 10.0			
	Regulated Emissions	Unregulated Emissions	Total Emissions
Baseline: Part L 2013	4.99	1.33	6.32
Be Lean: Use less energy	4.35	1.33	5.68
Be Clean: Supply energy efficiently	–	–	–
Be Green: Use renewable energy	3.97	1.33	5.30

Building fabric: passive design measures

Element	Minimum Building Regulations U-value W/m^2K	Proposed U-value W/m^2K
Roof	0.20	0.11
Wall	0.30	0.16
Basement wall	0.30	0.13
Basemen floor	0.25	0.13
Exposed floor	0.25	0.13
Windows	2.00	1.3
Rooflights	2.00	1.4
Doors	2.00	1.6
Air permeability (m^3/hm^2 @50 Pa)	10	3

The air permeability target is will require careful attention to two key areas:

- Structural leakage
- Services leakage

Structural leakage occurs at joints in the building fabric and around window and door openings, loft hatches and access openings. There will also be some diffusion through materials such and cracks in masonry walls typically caused by poor perpends in the blockwork or brickwork. Structural leakage is hard to remedy retrospectively therefore good detailing at the design stage is essential.

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Services leakage occurs at penetrations from pipes and cables entering the building. These can be sewerage pipes, water pipes and heating pipes. As well as electricity cables there may also be telecommunication cables. Attention, therefore, needs to be paid to sealing all penetrations during construction.

Thermal Bridging:

The new dwelling will be designed in line with the accredited construction details (ACD) and therefore it has been indicatively modelled with the accredited thermal bridge Psi-values for the following junctions:

- Lintels (E2)
- Sill (E3)
- Jambs (E4)
- Intermediate floor within dwelling (E6)
- Corners (E16)
- Corners inverted (E17)

The default psi-value has been used for the remaining junctions.

Thermal Mass:

Thermal mass of the scheme has been indicatively modelled as 250 kJ/m^{2}K (medium).

Heating

The scheme has been modelled with a gas boiler with an efficiency of 91%. Heat will be provided via radiators and underfloor heating and will be controlled with time and temperature zone programmer and TRVs.

Hot Water

The hot water will be provided by the main heating system. A 300L hot water storage cylinder fully insulated with loss of 1.69kWh/day has also been specified.

Ventilation

Balanced ventilation with heat recovery has been specified with an SFP of 1.05 W/l/s and a heat recovery efficiency of 70%.

Cooling

No cooling has been specified.

Lighting

High efficiency lighting has been specified for the development with a minimum efficacy of 75 lumens/W.

Controls:

The proposed scheme sets out to address demand side response to energy efficiency, including smart meters, to provide more consumption data to inform control which will allow the running of some equipment at a lower capacity during times of peak demand in the future.

Energy demand following energy efficiency measures (MWh/year)

Space Heating	Hot water	Lighting	Auxiliary	Cooling	Unregulated gas	Unregulated electricity
15.2	2.8	0.7	1.7	0	0	3.0

Fabric energy efficiency

Target Fabric Energy Efficiency (MWh/year)	Design Fabric Energy Efficiency (MWh/year)	Improvement (%)
23.80	19.35	19%

Heating infrastructure including CHP

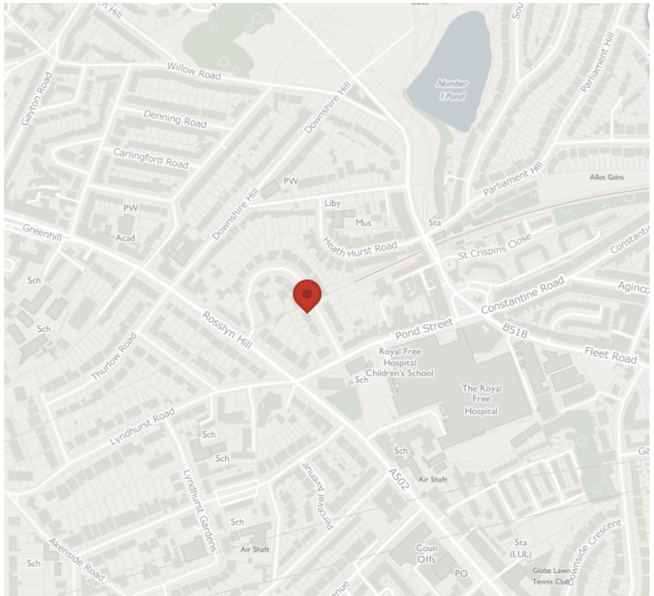
Once demand for energy has been minimised, schemes must demonstrate how their energy systems have been selected in accordance with the order of preference in Policy 5.6B of London Plan and Policy SI3 of Intended to publish London Plan. This has involved a systematic appraisal of the potential to connect to existing or planned heating networks and on site communal and CHP systems.

To comply with London Plan Policy SI 3, developments in Heat Network Priority Areas (HNPAs) should have a communal low-temperature heating system and should select a heat source in accordance with the following heating hierarchy:

a) connect to local existing or planned heat networks
b) use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)
c) use low-emission combined heat and power (only where there is a case for CHP to enable the delivery of an area-wide heat network, meet the development's electricity demand and provide demand response to the local electricity network)
d) use ultra-low NOx gas boilers

Connect to local existing or planned heat network

The illustration below shows the London heat map. Red lines are existing heat networks and orange lines are proposed heat networks. The red circle shows the location of the proposed scheme.



A review of the London Heat Map demonstrates that there are no existing networks present within connectable range of the scheme. Therefore, a connection is not possible.

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Use zero-emission and/or local secondary heat sources

According to the GLA and Intend to Publish London Plan Policy SI3, the exploitation of local energy opportunities to maximise the use of locally available energy sources whilst minimising primary energy demand and carbon emissions is encouraged. Secondary heat includes environmental sources such as air, water and ground; and waste sources such as heat from the sewerage system, sewage treatment plants, the tube network, data centres and chiller systems.

There are no local available waste heat sources for the scheme. The possibilities of capturing waste heat from nearby sources has been undertaken, however the amount of heat available is likely a fraction of the scheme's demand which makes its collection trivial within the context of the scheme.

Use low-emission combined heat and power (CHP)

In accordance with section 9 of the GLA guidance for Energy Planning where connection to an area wide heat network will not be available in the foreseeable future i.e. 5 years following completion, or the development is of such a scale that it could be the catalyst for an area wide heat network, applicants should evaluate the feasibility of on-site CHP

GLA guidance stipulates that small, or purely residential developments of less than 350 dwellings will not be expected to include on-site CHP. CHP systems are best utilised where there is a consistent and high demand for heat. Because of the small electricity supplies and demand of this scheme, a CHP installed to meet the base heat load would typically require the export of electricity to the grid. The administrative burden of managing CHP electricity sales at a small scale without an active energy service companies (ESCOs) is prohibitive for smaller operators of residential developments.

The heat demand profile of this residential scheme is not suitable to CHP as there is not enough demand on site to justify a CHP. Moreover, the fabric improvements from the 'Be Lean' scenario have also reduced the energy demand from space heating and hot water. For CHP systems to be economically viable they need to run for at least 5,000 hours per year. Therefore, a CHP system would be oversized and as a result inefficient.

Use ultra-low NOx gas boilers

Where it is clearly demonstrate that the above heating options (District heating, local secondary heat source and CHP) have been fully investigated and ruled out, then a site-wide heating strategy led by ultra-low NOx gas boilers can be considered.

The scheme will adopt a site wide gas boiler heating network.

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Overheating and cooling

The aim of this section is to reduce the impact of the urban heat island effect in London and encourage the design of spaces to avoid overheating and excessive heat generation, and to mitigate overheating due to the impact of climate change.

Where design measures and the use of natural and/or mechanical ventilation are not enough to guarantee the occupant's comfort, in line with the cooling hierarchy the development's cooling strategy must include details of the active cooling plant being proposed, including efficiencies, and the ability to take advantage of free cooling and/or renewable cooling sources.

Where appropriate, the cooling strategy should investigate the opportunities to improve cooling efficiencies through the use of locally available sources such as ground cooling and river/dock water-cooling.

The Cooling Hierarchy in Policy SI4

Developments should reduce potential overheating and reliance on air conditioning systems and demonstrate this with the Cooling Hierarchy:

1. Reduce the amount of heat entering the building through orientation, shading, high albedo materials, fenestration, insulation, and the provision of green infrastructure
2. Minimise internal heat generation through energy efficient design
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
4. Provide passive ventilation
5. Provide mechanical ventilation
6. Provide active cooling systems

Avoiding overheating: measures taken

The following measures have been taken in accordance with the cooling hierarchy to reduce overheating and the need for cooling:

1. Reduce the amount of heat entering the building through orientation, shading, high albedo materials, fenestration, insulation, and the provision of green infrastructure
   - Light-coloured curtain/roller blinds will be specified to limit solar gain. The shading has also been optimised to avoid substantially reducing daylighting or increasing the requirement for electric lighting.
   - Insulation levels have been maximised and the resulting U-values are lower than the building regulation. The build-ups therefore prevent the penetration of heat as much as practically possible. See the 'Be Lean' section of this report for target U-values.
   - A reduced air permeability rate has been targeted to minimise uncontrolled air infiltration. This will require attention to detailing and sealing. See 'Be Lean' section of this report for details of how this will be achieved.

2. Minimise internal heat generation through energy efficient design
   - Internal heat gains have been minimised where possible. Energy efficient appliances will help reduce internal heat gain and reduce the cooling requirement.
   - Energy efficient lighting will also be specified as per the 'Be Lean' section

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3. Manage the heat within the building through exposed internal thermal mass and high ceilings
    - High thermal mass – exposed building fabric materials such as masonry or concrete have been utilised in the form of concrete floors and dense masonry external walls. These materials act as 'thermal batteries'; they absorb heat gains during the day when the building is occupied and 'store' it for an extended period, thereby helping to stabilise daytime temperatures. At night this heat can be dissipated, which 'resets' the heating cycle. Ventilation will also be used at night to purge the stored heat within the structure.
    - Room heights – high ceilings are traditionally used in hot climates to allow thermal stratification so that occupants can inhabit the lower cooler space, and to decrease the transfer of heat gain through the roof. The proposed building has floor to ceiling heights of more than 2.5m. As the roof will be well insulated to below building regulations, there will be minimal penetration of heat through the roof.

3. Provide passive ventilation
    - Openable windows are specified on all facades of the building.
    - Cross ventilation will be achieved by opening windows on two facades and ensuring there is a clear path for airflow.
    - Night time cooling will also be utilised. This will work in tandem with high thermal mass materials specified. The larger temperature differential that exists between internal and external temperatures at night will allow effective stack ventilation and purging of heat accumulated within the structure during the day.

4. Provide mechanical ventilation
    - MVHR with heat recovery has been specified with an SFP of 1.05 W/l/s and a heat recovery efficiency of 70%.

Overheating risk

The overheating risk considering all the above-described passive measures have been assessed for the scheme:

Areas	Overheating risk from SAP
14a Hampstead Hill	Slight

According to the GLA guidance on preparing energy assessments (April 2020) Section 8, a dynamic modelling in line with CIBSE TM52 and TM59 should be carried out to assess the risk of overheating. However, due to the overheating results of SAP showing that there is no significant risk of overheating, it has been considered that a dynamic modelling is not required.

Active cooling

Air conditioning has not been specified for the scheme, since the overheating analysis demonstrates the there is no significant risk of overheating and the passive design measured are enough to guarantee the occupant's comfort.

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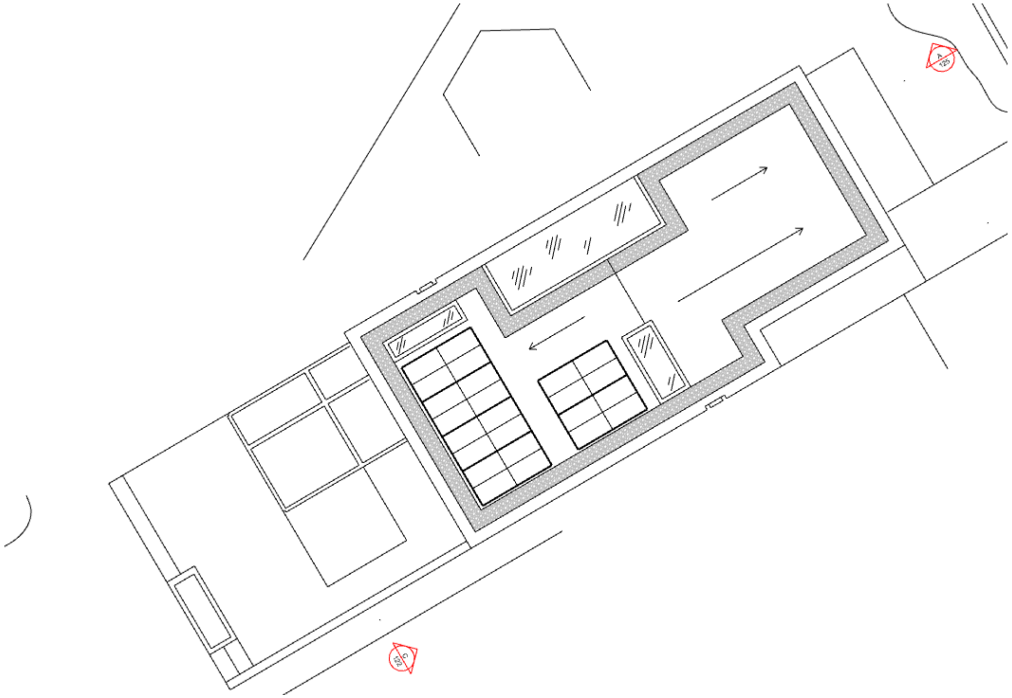
Photovoltaic panels (PV) – Performance

A photovoltaic panel system of 1.98 kWp (6 panels of 330W each) has been specified for the dwelling, a detailed summary of the lifecycle cost, revenue and payback for the photovoltaic panels is presented in this section.

The following drawing shows that there are 45m^2 of available roof that could be used to install photovoltaic modules and lack of shading. PV panels will be placed with 30° tilt, oriented south west, covering 18m^2 of the roof.



The lifecycle of the proposed high efficiency panels is 25 years. To calculate the lifecycle cost of the panels, the maintenance of the system and replacement cost will be included. The total costs for the proposed system's lifetime is shown in the table below.

Capital cost (£)	2,800
Maintenance cost (£)	1,820
Operational cost (£)	900
Total (£)	5,520
Cost of electricity (p/kWh)	14.5
Electricity generation (kWh/yr)	1,630
% of energy used on site	50%
Savings (£)	162
Summary	
Cost Performance Criteria	Value
Extra Cost Over Life Cycle (£)	2,800
Predicted Annual Savings (£)	162
Payback Period (years)	34
Energy and Carbon Performance Criteria	Value
Predicted Annual Energy Saved (kWh/yr)	1,630
Annual Carbon Emissions Reductions (kg CO2/year) using SAP10.0 carbon factors	380
CO_2 Emissions Reduction (%) with SAP10.0	7.6%

Adaptation to Climate Change

Sustainability Statement

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Climate change mitigation

The proposed development will utilise a gas boiler heating system and use MVHR together with natural ventilation. Passive design measures, including openable windows and night-time cooling, are integrated into the design of the development.

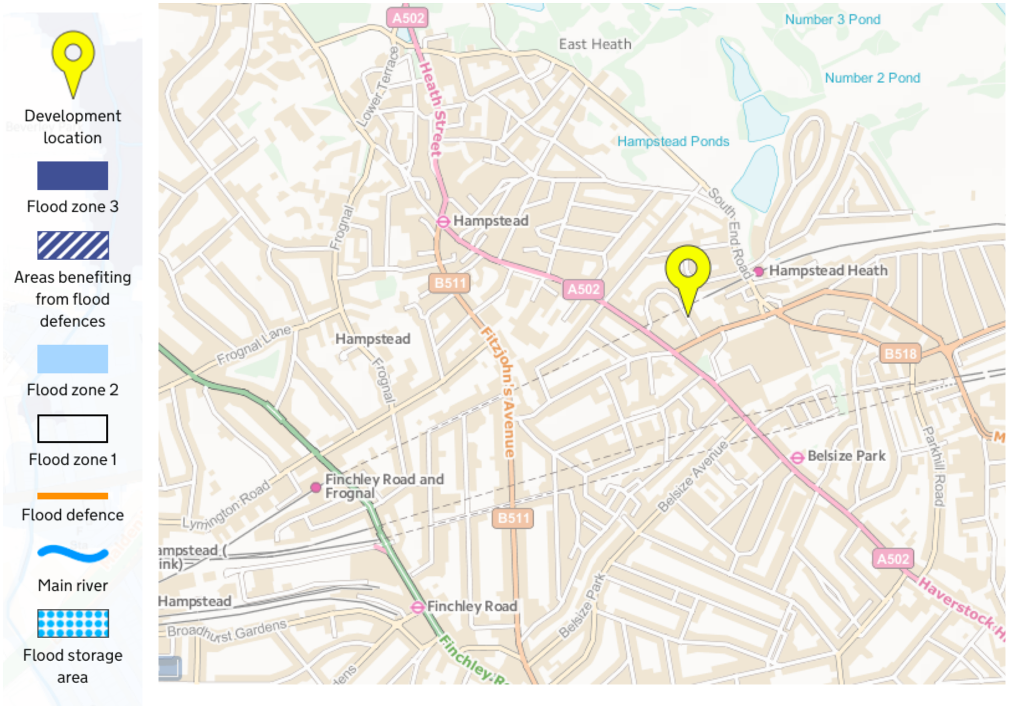
Flood risk and sustainable drainage

14a Hampstead Hill is located within Flood Zone 1 of the Environment Agency's Flood Map for Planning. This is defined as an area with little or no risk to flooding where the annual probability of river, tidal and coastal flooding (with defences where they exist) is <0.1% i.e. less than 1 in 1000 years.

The development will incorporate sustainable drainage systems (SuDS) including attenuation measures to manage the risk of surface water runoff. Mitigation measures will include the specification of a green/brown roof, permeable paving and upgrading soft landscaping and to ensure surface water run-off will not be detrimental to the environment, public wellbeing and the economy.

Flood map

Flood map to show the location of the development within Flood Zone 1:



Waste
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Construction waste management

Resource efficiency will be promoted through effective and appropriate management of demolition and construction site waste.

In line with the waste hierarchy, during the construction phase, the approach will be the following:

- Use reclaimed materials;
- Use materials with higher levels of recycled content; and
- Use new materials.

For any demolition, the following approach will be adopted:

- Prioritise the on site reuse of demolition materials;
- Adopt on site recycling and, where required, use off site recycling; and
- The least preferred option – disposal to landfill.

A site waste management plan will be used which adopts best practice benchmarks for resource efficiency, procedures to minimise non-hazardous and hazardous waste will be confirmed at design stage.

Operational waste

Dedicated internal and external waste storage and recycling facilities are proposed to encourage recycling. The storage space will provide inclusive access and usability. Camden Council offers a weekly food waste collection service, therefore compost waste bins will be provided

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Construction environmental management

Environmental impacts of the construction works will be mitigated as far as possible. This will include the incorporation of the following:

- Monitoring of energy, water and transport to and from site during construction.
- Management of waste on site.
- Following best practice pollution guidance from the Environment Agency.
- Ensuring all site timber is responsibly sourced in line with the UK Government's Timber Procurement Policy.
- Regularly inspecting and wet suppressing materials / soil stockpiles where necessary (including wind shielding or completely enclosing, storing away from site boundaries, and restricted height of stockpiles).
- Covering vehicles carrying dry soil and other dust emitting wastes.
- Shielding of dust-generating construction activities.
- Providing suitable site hoarding.
- Restricting vehicle speeds on haul roads and other unsurfaced areas of the site.

Considerate constructors

The scheme will adopt the principles of the Considerate Constructors Scheme (CCS). The CCS scheme aims to recognise and encourage construction sites that are managed in an environmentally and socially considerate, responsible and accountable manner.

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Water management introduction
The development proposal recognises the need to create a scheme that is efficient and adaptable to future climatic scenarios.

Water conservation
The design team is committed to achieve a reduction in water use for the development over typical performance, equating to a water consumption target of 110 litres per person per day.

Water consumption will be reduced through the use of water efficient components for all specified domestic water-consuming components (including low-flow showerheads and taps, dual flush toilets and low water consuming washing machines and dishwashers).

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Public transport

14a Hampstead Hill site is located approximately within 0.2 miles of two different bus stops serving five different bus routes, providing a frequent service in both peak and off-peak hours. Hampstead Heath and Belsize Park Stations are within 0.4 miles.

Cycling and Car Provision

No dedicated car parking will be provided for residents in line with the NPPF, London Plan recommendations and Policy DP18 although two bike spaces have been provided in accordance with the London Plan and Policy DP18.

Accessibility and security

Creating a secure but fully accessible development is a key part of the proposed development in line with Policy C6. To ensure this is achieved, the design team has proposed a lift for the building and will adopt, where feasible, the key principles of “Secured by Design” within all elements of the scheme.

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Materials and waste introduction

Sustainable material sourcing and waste management will be considered throughout the life of the building to ensure the scheme's environmental footprint is minimised as far as possible. The scheme will also ensure lower embodied carbon through the procurement of more sustainable building materials.

Materials selection and sourcing

The design team has confirmed that efforts will be made to reuse materials where feasible, and that where required, new materials will be responsibly sourced. New construction materials will be selected, where feasible, with a low environmental impact. In addition, the project will aim for new materials to come from a recycled or reused source, e.g. a high-recycled content in steel. Minimum standards apply to new timber, which must be sourced in accordance with the UK Government's Timber Procurement Policy.

In addition, all timber will be FSC / PEFC certified, any concrete will be BES 6001 certified and other metals and plastics will be ISO 14001 certified for both key processes and supply chain / extraction processes where feasible to do so.

The Green Guide for Specification is a reference tool, providing guidance on the relative environmental impacts for a range of different building elemental specifications, based on Life Cycle Assessment and the Environmental Profile Methodology. The design team will reference the Green Guide to Specification to help specify materials with a low environmental impact, where feasible. The design will incorporate at least 5 build-up elements will be A-C rated on the Green Guide.

Insulation specifications will eliminate hydrochlorofluorocarbons (HCFCs) and ozone depleting materials, wherever possible. All insulation specified will have a Global Warming Potential (GWP) of less than 5 and will be responsibly sourced to have a low embodied impact.

Embodied carbon

The development will utilise a number of opportunities to cut embodied carbon, as follows:

- A materials efficiency strategy will be followed throughout the design, procurement and construction stages of the development, to ensure the scheme produces less waste on site. For example, adjustment of some sizes will be made to minimise offcuts of materials.
- Materials will be procured from local suppliers where possible to reduce carbon through transportation.
- Materials and products with a higher recycled content will preferentially be procured where feasible, as these have a low embodied carbon.

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Occupant wellbeing

The development has been designed to ensure the wellbeing of occupants in terms of levels of fresh air, thermal comfort and reduction of overheating, access to natural light and acoustic performance.

The building services strategy has been carefully considered in order to balance the need for energy–smart, low carbon technologies with the need for affordable and controllable ventilation, heating and cooling.

Internal air quality

The design team will specify only low volatile organic compounds (VOC) finishing products, such sealants, glues, and paints. All composite wood products will contain no added urea formaldehyde.

The MVHR system will provide fresh filtered air to the Dwelling.

Daylight

The design has been developed to maximise the use of daylight. The glazing area has been maximised to achieve good daylight levels. The lightwell and courtyard will provide daylight to the basement.

The proposed development will not affect the daylight levels of the neighbouring properties

Inclusive design

The guidance in the Approved Document M (March 2016) will be incorporated to achieve an inclusive built environment that enables users to maximise their individual abilities and enjoy a safe and independent participation. The design team has proposed a lift for the building to ensure this will be achieved.

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Protection of biodiversity

The proposed development will promote the protection of any existing ecological features from damage during site demolition and the completion of the construction works.

The design team is committed to protecting biodiversity on site and will implement the following measures:

- Confirm that all relevant UK and EU legislation relating to protection and enhancement of ecology has been complied with during the design and construction process.
- Ensure that any affected trees and shrubs are cleared out of bird breeding season (March-August). Alternatively, a SQE should check for the presence of active nests prior to the commencement of works.
- Implement bat and bird protection in line with best practice.
- Implement working methods in line with best practice to manage dust and water run-off.
- During the construction phase a Biodiversity Champion will be appointed to monitor and limit environmentally detrimental activities. They will also train the workforce on the project to raise their awareness of environmental impacts during construction.

Ecological enhancement

The design team are committed to help protect and enhance biodiversity on site.

An area of green/ brown roof will be installed, to provide the following ecological and sustainable benefits:

- Provision of habitat to promote species diversity;
- Reduction in urban heat island effect;
- Improvement in air quality;
- Minimisation of heat loss during winter months;
- Protection from solar gain during summer months; and
- Provision of a sustainable urban drainage technique.

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Conclusions

This Sustainability Statement has responded to the London Borough of Camden's local planning policy requirements.

In summary the scheme will adopt the following sustainable features:

- The development will reduce total carbon emissions by 19.4% Building Regulations based on SAP 2012 carbon factors and by 20.5% using the SAP 10 carbon factors.
- MVHR and natural ventilation through opening windows will be used as a passive cooling measure.
- High insulation standards and reduced air permeability will be used as efficient energy measures.
- Photovoltaic Panels system will be used as a renewable energy source
- Minimise embodied carbon through efficient design, procurement of materials from a local source, and/or with a high-recycled content.
- Ensure all materials are responsibly sourced and of low environmental impact.
- Implement a site waste management plan.
- Best-practice guidance for reducing water consumption by specifying efficient water-consuming appliances and sanitaryware (110 litres/person/day throughout the scheme).
- Any features of ecological value on the site will be protected in accordance with best-practice guidance.
- The implementation of health and wellbeing measures such as enhanced indoor air quality and improved thermal comfort.

Appendix A
Sustainability Statement
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SAP files

The emission figures and details of the calculations and methodology used to determine the figures provided within the report can be found in the following pages:

Baseline Residential – TER from the TER SAP worksheet
Be Lean Residential – DER from the Be Lean scenario DER SAP worksheet
Be Green Residential – DER from the Be Green scenario DER SAP worksheet

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Baseline Residential – TER from the TER SAP worksheet

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.12

Property Address: 14a Hampstead Hill

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	99.35	(1a) x	3.05	(2a) =	303.02	(3a)
First floor	80.45	(1b) x	4.07	(2b) =	327.43	(3b)
Second floor	66.66	(1c) x	3.6	(2c) =	239.98	(3c)
Third floor	66.66	(1d) x	3.05	(2d) =	203.31	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	313.12	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	1073.74	(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							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 and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.04	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.29	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.29	(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 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

	0.37	0.36	0.35	0.32	0.31	0.27	0.27	0.27	0.29	0.31	0.32	0.34

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(24d)

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

(25)m=	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(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)	k-value kJ/m²·K	A X k kJ/K	
Doors			0.52	x 1.2	= 0.624			(26)
Windows Type 1			4.57	x1/[1/(1.4)+ 0.04]	= 6.06			(27)
Windows Type 2			2.24	x1/[1/(1.4)+ 0.04]	= 2.97			(27)
Windows Type 3			1.17	x1/[1/(1.4)+ 0.04]	= 1.55			(27)
Windows Type 4			1.57	x1/[1/(1.4)+ 0.04]	= 2.08			(27)
Windows Type 5			0.82	x1/[1/(1.4)+ 0.04]	= 1.09			(27)
Windows Type 6			0.97	x1/[1/(1.4)+ 0.04]	= 1.29			(27)
Windows Type 7			2.43	x1/[1/(1.4)+ 0.04]	= 3.22			(27)
Windows Type 8			1.33	x1/[1/(1.4)+ 0.04]	= 1.76			(27)
Windows Type 9			3.33	x1/[1/(1.4)+ 0.04]	= 4.41			(27)
Windows Type 10			1.31	x1/[1/(1.4)+ 0.04]	= 1.74			(27)
Windows Type 11			7.08	x1/[1/(1.4)+ 0.04]	= 9.39			(27)
Windows Type 12			18.79	x1/[1/(1.4)+ 0.04]	= 24.91			(27)
Windows Type 13			9.89	x1/[1/(1.4)+ 0.04]	= 13.11			(27)

TER WorkSheet: New dwelling design stage

Windows Type 14			6.1	x1/[1/(1.4)+ 0.04] =		8.09			(27)
Rooflights Type 1			7.60175	x1/[1/(1.7) + 0.04] =		12.92298			(27b)
Rooflights Type 2			1.173238	x1/[1/(1.7) + 0.04] =		1.994505			(27b)
Rooflights Type 3			4.03344	x1/[1/(1.7) + 0.04] =		6.856848			(27b)
Rooflights Type 4			0.7358772	x1/[1/(1.7) + 0.04] =		1.250991			(27b)
Floor Type 1			99.35	x	0.13	= 12.9155			(28)
Floor Type 2			1.56	x	0.13	= 0.2028			(28)
Walls Type1	449.95	64.74	385.21	x	0.18	= 69.34			(29)
Walls Type2	141.92	0	141.92	x	0.18	= 25.55			(29)
Roof	100.91	13.54	87.37	x	0.13	= 11.36			(30)
Total area of elements, m²			793.69						(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) = 226.68 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 83957.08 (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 47.18 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 273.86 (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=	200.93	200.01	199.1	194.86	194.06	190.36	190.36	189.67	191.79	194.06	195.67	197.35	(38)

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

(39)m=	474.79	473.87	472.97	468.72	467.92	464.22	464.22	463.54	465.65	467.92	469.53	471.21	

Average = Sum(39)$_{1…12}$ /12= 468.71 (39)

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

(40)m=	1.52	1.51	1.51	1.5	1.49	1.48	1.48	1.48	1.49	1.49	1.5	1.5

Average = Sum(40)$_{1…12}$ /12= 1.5 (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 3.15 (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) + 36 108.99 (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)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	119.89	115.53	111.17	106.81	102.45	98.09	98.09	102.45	106.81	111.17	115.53	119.89

Total = Sum(44)$_{1…12}$ = 1307.86 (44)

TER WorkSheet: New dwelling design stage

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=	177.79	155.5	160.46	139.89	134.23	115.83	107.33	123.17	124.64	145.25	158.55	172.18	

Total = Sum(45)1...12 = 1714.81 (45)

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

(46)m=	26.67	23.32	24.07	20.98	20.13	17.37	16.1	18.47	18.7	21.79	23.78	25.83	(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): 2.11 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 1.14 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 1.14 (55)

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

(56)m=	35.37	31.94	35.37	34.23	35.37	34.23	35.37	35.37	34.23	35.37	34.23	35.37	(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=	35.37	31.94	35.37	34.23	35.37	34.23	35.37	35.37	34.23	35.37	34.23	35.37	(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)

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=	236.42	208.45	219.09	196.63	192.86	172.57	165.96	181.79	181.37	203.88	215.29	230.81	(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=	236.42	208.45	219.09	196.63	192.86	172.57	165.96	181.79	181.37	203.88	215.29	230.81

Output from water heater (annual)1...12 2405.12 (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=	106.02	94.07	100.26	91.9	91.53	83.9	82.59	87.86	86.83	95.2	98.11	104.15	(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=	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	(66)

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

(67)m=	41.79	37.12	30.19	22.86	17.08	14.42	15.58	20.26	27.19	34.52	40.29	42.96	(67)

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

(68)m=	468.8	473.67	461.41	435.31	402.37	371.41	350.72	345.86	358.11	384.21	417.16	448.12	(68)

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

(69)m=	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	(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=	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	(71)

Water heating gains (Table 5)

(72)m=	142.5	139.98	134.75	127.64	123.03	116.53	111.01	118.09	120.6	127.96	136.26	139.99	(72)

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

(73)m=	726.33	724	699.59	659.05	615.72	575.6	550.55	557.43	579.14	619.93	666.95	704.3	(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	4.57	x	11.28	x	0.63	x	0.7	=	15.76	(75)
Northeast 0.9x	0.77	x	2.24	x	11.28	x	0.63	x	0.7	=	7.72	(75)
Northeast 0.9x	0.77	x	1.17	x	11.28	x	0.63	x	0.7	=	4.03	(75)
Northeast 0.9x	0.77	x	1.57	x	11.28	x	0.63	x	0.7	=	5.41	(75)
Northeast 0.9x	0.77	x	0.82	x	11.28	x	0.63	x	0.7	=	2.83	(75)
Northeast 0.9x	0.77	x	6.1	x	11.28	x	0.63	x	0.7	=	21.03	(75)
Northeast 0.9x	0.77	x	4.57	x	22.97	x	0.63	x	0.7	=	32.08	(75)
Northeast 0.9x	0.77	x	2.24	x	22.97	x	0.63	x	0.7	=	15.72	(75)
Northeast 0.9x	0.77	x	1.17	x	22.97	x	0.63	x	0.7	=	8.21	(75)
Northeast 0.9x	0.77	x	1.57	x	22.97	x	0.63	x	0.7	=	11.02	(75)
Northeast 0.9x	0.77	x	0.82	x	22.97	x	0.63	x	0.7	=	5.76	(75)
Northeast 0.9x	0.77	x	6.1	x	22.97	x	0.63	x	0.7	=	42.82	(75)
Northeast 0.9x	0.77	x	4.57	x	41.38	x	0.63	x	0.7	=	57.79	(75)
Northeast 0.9x	0.77	x	2.24	x	41.38	x	0.63	x	0.7	=	28.33	(75)
Northeast 0.9x	0.77	x	1.17	x	41.38	x	0.63	x	0.7	=	14.8	(75)
Northeast 0.9x	0.77	x	1.57	x	41.38	x	0.63	x	0.7	=	19.85	(75)
Northeast 0.9x	0.77	x	0.82	x	41.38	x	0.63	x	0.7	=	10.37	(75)
Northeast 0.9x	0.77	x	6.1	x	41.38	x	0.63	x	0.7	=	77.14	(75)
Northeast 0.9x	0.77	x	4.57	x	67.96	x	0.63	x	0.7	=	94.91	(75)
Northeast 0.9x	0.77	x	2.24	x	67.96	x	0.63	x	0.7	=	46.52	(75)
Northeast 0.9x	0.77	x	1.17	x	67.96	x	0.63	x	0.7	=	24.3	(75)

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Northeast	0.9x	0.77	x	1.57	x	67.96	x	0.63	x	0.7	=	32.61	(75)
Northeast	0.9x	0.77	x	0.82	x	67.96	x	0.63	x	0.7	=	17.03	(75)
Northeast	0.9x	0.77	x	6.1	x	67.96	x	0.63	x	0.7	=	126.69	(75)
Northeast	0.9x	0.77	x	4.57	x	91.35	x	0.63	x	0.7	=	127.58	(75)
Northeast	0.9x	0.77	x	2.24	x	91.35	x	0.63	x	0.7	=	62.53	(75)
Northeast	0.9x	0.77	x	1.17	x	91.35	x	0.63	x	0.7	=	32.66	(75)
Northeast	0.9x	0.77	x	1.57	x	91.35	x	0.63	x	0.7	=	43.83	(75)
Northeast	0.9x	0.77	x	0.82	x	91.35	x	0.63	x	0.7	=	22.89	(75)
Northeast	0.9x	0.77	x	6.1	x	91.35	x	0.63	x	0.7	=	170.29	(75)
Northeast	0.9x	0.77	x	4.57	x	97.38	x	0.63	x	0.7	=	136.01	(75)
Northeast	0.9x	0.77	x	2.24	x	97.38	x	0.63	x	0.7	=	66.67	(75)
Northeast	0.9x	0.77	x	1.17	x	97.38	x	0.63	x	0.7	=	34.82	(75)
Northeast	0.9x	0.77	x	1.57	x	97.38	x	0.63	x	0.7	=	46.73	(75)
Northeast	0.9x	0.77	x	0.82	x	97.38	x	0.63	x	0.7	=	24.4	(75)
Northeast	0.9x	0.77	x	6.1	x	97.38	x	0.63	x	0.7	=	181.55	(75)
Northeast	0.9x	0.77	x	4.57	x	91.1	x	0.63	x	0.7	=	127.24	(75)
Northeast	0.9x	0.77	x	2.24	x	91.1	x	0.63	x	0.7	=	62.37	(75)
Northeast	0.9x	0.77	x	1.17	x	91.1	x	0.63	x	0.7	=	32.57	(75)
Northeast	0.9x	0.77	x	1.57	x	91.1	x	0.63	x	0.7	=	43.71	(75)
Northeast	0.9x	0.77	x	0.82	x	91.1	x	0.63	x	0.7	=	22.83	(75)
Northeast	0.9x	0.77	x	6.1	x	91.1	x	0.63	x	0.7	=	169.83	(75)
Northeast	0.9x	0.77	x	4.57	x	72.63	x	0.63	x	0.7	=	101.43	(75)
Northeast	0.9x	0.77	x	2.24	x	72.63	x	0.63	x	0.7	=	49.72	(75)
Northeast	0.9x	0.77	x	1.17	x	72.63	x	0.63	x	0.7	=	25.97	(75)
Northeast	0.9x	0.77	x	1.57	x	72.63	x	0.63	x	0.7	=	34.85	(75)
Northeast	0.9x	0.77	x	0.82	x	72.63	x	0.63	x	0.7	=	18.2	(75)
Northeast	0.9x	0.77	x	6.1	x	72.63	x	0.63	x	0.7	=	135.39	(75)
Northeast	0.9x	0.77	x	4.57	x	50.42	x	0.63	x	0.7	=	70.42	(75)
Northeast	0.9x	0.77	x	2.24	x	50.42	x	0.63	x	0.7	=	34.52	(75)
Northeast	0.9x	0.77	x	1.17	x	50.42	x	0.63	x	0.7	=	18.03	(75)
Northeast	0.9x	0.77	x	1.57	x	50.42	x	0.63	x	0.7	=	24.19	(75)
Northeast	0.9x	0.77	x	0.82	x	50.42	x	0.63	x	0.7	=	12.64	(75)
Northeast	0.9x	0.77	x	6.1	x	50.42	x	0.63	x	0.7	=	94	(75)
Northeast	0.9x	0.77	x	4.57	x	28.07	x	0.63	x	0.7	=	39.2	(75)
Northeast	0.9x	0.77	x	2.24	x	28.07	x	0.63	x	0.7	=	19.21	(75)
Northeast	0.9x	0.77	x	1.17	x	28.07	x	0.63	x	0.7	=	10.04	(75)
Northeast	0.9x	0.77	x	1.57	x	28.07	x	0.63	x	0.7	=	13.47	(75)
Northeast	0.9x	0.77	x	0.82	x	28.07	x	0.63	x	0.7	=	7.03	(75)
Northeast	0.9x	0.77	x	6.1	x	28.07	x	0.63	x	0.7	=	52.32	(75)
Northeast	0.9x	0.77	x	4.57	x	14.2	x	0.63	x	0.7	=	19.83	(75)
Northeast	0.9x	0.77	x	2.24	x	14.2	x	0.63	x	0.7	=	9.72	(75)

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Northeast	0.9x	0.77	x	1.17	x	14.2	x	0.63	x	0.7	=	5.08	(75)
Northeast	0.9x	0.77	x	1.57	x	14.2	x	0.63	x	0.7	=	6.81	(75)
Northeast	0.9x	0.77	x	0.82	x	14.2	x	0.63	x	0.7	=	3.56	(75)
Northeast	0.9x	0.77	x	6.1	x	14.2	x	0.63	x	0.7	=	26.47	(75)
Northeast	0.9x	0.77	x	4.57	x	9.21	x	0.63	x	0.7	=	12.87	(75)
Northeast	0.9x	0.77	x	2.24	x	9.21	x	0.63	x	0.7	=	6.31	(75)
Northeast	0.9x	0.77	x	1.17	x	9.21	x	0.63	x	0.7	=	3.29	(75)
Northeast	0.9x	0.77	x	1.57	x	9.21	x	0.63	x	0.7	=	4.42	(75)
Northeast	0.9x	0.77	x	0.82	x	9.21	x	0.63	x	0.7	=	2.31	(75)
Northeast	0.9x	0.77	x	6.1	x	9.21	x	0.63	x	0.7	=	17.18	(75)
Southeast	0.9x	0.77	x	1.31	x	36.79	x	0.63	x	0.7	=	44.19	(77)
Southeast	0.9x	0.77	x	18.79	x	36.79	x	0.63	x	0.7	=	211.29	(77)
Southeast	0.9x	0.77	x	1.31	x	62.67	x	0.63	x	0.7	=	75.27	(77)
Southeast	0.9x	0.77	x	18.79	x	62.67	x	0.63	x	0.7	=	359.9	(77)
Southeast	0.9x	0.77	x	1.31	x	85.75	x	0.63	x	0.7	=	102.99	(77)
Southeast	0.9x	0.77	x	18.79	x	85.75	x	0.63	x	0.7	=	492.43	(77)
Southeast	0.9x	0.77	x	1.31	x	106.25	x	0.63	x	0.7	=	127.61	(77)
Southeast	0.9x	0.77	x	18.79	x	106.25	x	0.63	x	0.7	=	610.15	(77)
Southeast	0.9x	0.77	x	1.31	x	119.01	x	0.63	x	0.7	=	142.94	(77)
Southeast	0.9x	0.77	x	18.79	x	119.01	x	0.63	x	0.7	=	683.41	(77)
Southeast	0.9x	0.77	x	1.31	x	118.15	x	0.63	x	0.7	=	141.91	(77)
Southeast	0.9x	0.77	x	18.79	x	118.15	x	0.63	x	0.7	=	678.47	(77)
Southeast	0.9x	0.77	x	1.31	x	113.91	x	0.63	x	0.7	=	136.81	(77)
Southeast	0.9x	0.77	x	18.79	x	113.91	x	0.63	x	0.7	=	654.12	(77)
Southeast	0.9x	0.77	x	1.31	x	104.39	x	0.63	x	0.7	=	125.38	(77)
Southeast	0.9x	0.77	x	18.79	x	104.39	x	0.63	x	0.7	=	599.46	(77)
Southeast	0.9x	0.77	x	1.31	x	92.85	x	0.63	x	0.7	=	111.52	(77)
Southeast	0.9x	0.77	x	18.79	x	92.85	x	0.63	x	0.7	=	533.2	(77)
Southeast	0.9x	0.77	x	1.31	x	69.27	x	0.63	x	0.7	=	83.19	(77)
Southeast	0.9x	0.77	x	18.79	x	69.27	x	0.63	x	0.7	=	397.77	(77)
Southeast	0.9x	0.77	x	1.31	x	44.07	x	0.63	x	0.7	=	52.93	(77)
Southeast	0.9x	0.77	x	18.79	x	44.07	x	0.63	x	0.7	=	253.07	(77)
Southeast	0.9x	0.77	x	1.31	x	31.49	x	0.63	x	0.7	=	37.82	(77)
Southeast	0.9x	0.77	x	18.79	x	31.49	x	0.63	x	0.7	=	180.82	(77)
Southwest	0.9x	0.77	x	0.97	x	36.79		0.63	x	0.7	=	10.91	(79)
Southwest	0.9x	0.77	x	2.43	x	36.79		0.63	x	0.7	=	27.32	(79)
Southwest	0.9x	0.77	x	1.33	x	36.79		0.63	x	0.7	=	14.96	(79)
Southwest	0.9x	0.77	x	3.33	x	36.79		0.63	x	0.7	=	37.44	(79)
Southwest	0.9x	0.77	x	7.08	x	36.79		0.63	x	0.7	=	79.61	(79)
Southwest	0.9x	0.77	x	0.97	x	62.67		0.63	x	0.7	=	18.58	(79)
Southwest	0.9x	0.77	x	2.43	x	62.67		0.63	x	0.7	=	46.54	(79)

Southwest 0.9x	0.77	x	1.33	x	62.67	0.63	x	0.7	=	25.47	(79)
Southwest 0.9x	0.77	x	3.33	x	62.67	0.63	x	0.7	=	63.78	(79)
Southwest 0.9x	0.77	x	7.08	x	62.67	0.63	x	0.7	=	135.61	(79)
Southwest 0.9x	0.77	x	0.97	x	85.75	0.63	x	0.7	=	25.42	(79)
Southwest 0.9x	0.77	x	2.43	x	85.75	0.63	x	0.7	=	63.68	(79)
Southwest 0.9x	0.77	x	1.33	x	85.75	0.63	x	0.7	=	34.86	(79)
Southwest 0.9x	0.77	x	3.33	x	85.75	0.63	x	0.7	=	87.27	(79)
Southwest 0.9x	0.77	x	7.08	x	85.75	0.63	x	0.7	=	185.55	(79)
Southwest 0.9x	0.77	x	0.97	x	106.25	0.63	x	0.7	=	31.5	(79)
Southwest 0.9x	0.77	x	2.43	x	106.25	0.63	x	0.7	=	78.91	(79)
Southwest 0.9x	0.77	x	1.33	x	106.25	0.63	x	0.7	=	43.19	(79)
Southwest 0.9x	0.77	x	3.33	x	106.25	0.63	x	0.7	=	108.13	(79)
Southwest 0.9x	0.77	x	7.08	x	106.25	0.63	x	0.7	=	229.9	(79)
Southwest 0.9x	0.77	x	0.97	x	119.01	0.63	x	0.7	=	35.28	(79)
Southwest 0.9x	0.77	x	2.43	x	119.01	0.63	x	0.7	=	88.38	(79)
Southwest 0.9x	0.77	x	1.33	x	119.01	0.63	x	0.7	=	48.37	(79)
Southwest 0.9x	0.77	x	3.33	x	119.01	0.63	x	0.7	=	121.12	(79)
Southwest 0.9x	0.77	x	7.08	x	119.01	0.63	x	0.7	=	257.51	(79)
Southwest 0.9x	0.77	x	0.97	x	118.15	0.63	x	0.7	=	35.02	(79)
Southwest 0.9x	0.77	x	2.43	x	118.15	0.63	x	0.7	=	87.74	(79)
Southwest 0.9x	0.77	x	1.33	x	118.15	0.63	x	0.7	=	48.02	(79)
Southwest 0.9x	0.77	x	3.33	x	118.15	0.63	x	0.7	=	120.24	(79)
Southwest 0.9x	0.77	x	7.08	x	118.15	0.63	x	0.7	=	255.65	(79)
Southwest 0.9x	0.77	x	0.97	x	113.91	0.63	x	0.7	=	33.77	(79)
Southwest 0.9x	0.77	x	2.43	x	113.91	0.63	x	0.7	=	84.59	(79)
Southwest 0.9x	0.77	x	1.33	x	113.91	0.63	x	0.7	=	46.3	(79)
Southwest 0.9x	0.77	x	3.33	x	113.91	0.63	x	0.7	=	115.92	(79)
Southwest 0.9x	0.77	x	7.08	x	113.91	0.63	x	0.7	=	246.47	(79)
Southwest 0.9x	0.77	x	0.97	x	104.39	0.63	x	0.7	=	30.95	(79)
Southwest 0.9x	0.77	x	2.43	x	104.39	0.63	x	0.7	=	77.52	(79)
Southwest 0.9x	0.77	x	1.33	x	104.39	0.63	x	0.7	=	42.43	(79)
Southwest 0.9x	0.77	x	3.33	x	104.39	0.63	x	0.7	=	106.24	(79)
Southwest 0.9x	0.77	x	7.08	x	104.39	0.63	x	0.7	=	225.87	(79)
Southwest 0.9x	0.77	x	0.97	x	92.85	0.63	x	0.7	=	27.53	(79)
Southwest 0.9x	0.77	x	2.43	x	92.85	0.63	x	0.7	=	68.96	(79)
Southwest 0.9x	0.77	x	1.33	x	92.85	0.63	x	0.7	=	37.74	(79)
Southwest 0.9x	0.77	x	3.33	x	92.85	0.63	x	0.7	=	94.49	(79)
Southwest 0.9x	0.77	x	7.08	x	92.85	0.63	x	0.7	=	200.91	(79)
Southwest 0.9x	0.77	x	0.97	x	69.27	0.63	x	0.7	=	20.53	(79)
Southwest 0.9x	0.77	x	2.43	x	69.27	0.63	x	0.7	=	51.44	(79)
Southwest 0.9x	0.77	x	1.33	x	69.27	0.63	x	0.7	=	28.15	(79)

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Southwest	0.9x	0.77	x	3.33	x	69.27		0.63	x	0.7	=	70.49	(79)
Southwest	0.9x	0.77	x	7.08	x	69.27		0.63	x	0.7	=	149.88	(79)
Southwest	0.9x	0.77	x	0.97	x	44.07		0.63	x	0.7	=	13.06	(79)
Southwest	0.9x	0.77	x	2.43	x	44.07		0.63	x	0.7	=	32.73	(79)
Southwest	0.9x	0.77	x	1.33	x	44.07		0.63	x	0.7	=	17.91	(79)
Southwest	0.9x	0.77	x	3.33	x	44.07		0.63	x	0.7	=	44.85	(79)
Southwest	0.9x	0.77	x	7.08	x	44.07		0.63	x	0.7	=	95.36	(79)
Southwest	0.9x	0.77	x	0.97	x	31.49		0.63	x	0.7	=	9.33	(79)
Southwest	0.9x	0.77	x	2.43	x	31.49		0.63	x	0.7	=	23.38	(79)
Southwest	0.9x	0.77	x	1.33	x	31.49		0.63	x	0.7	=	12.8	(79)
Southwest	0.9x	0.77	x	3.33	x	31.49		0.63	x	0.7	=	32.04	(79)
Southwest	0.9x	0.77	x	7.08	x	31.49		0.63	x	0.7	=	68.13	(79)
Northwest	0.9x	0.77	x	9.89	x	11.28	x	0.63	x	0.7	=	34.1	(81)
Northwest	0.9x	0.77	x	9.89	x	22.97	x	0.63	x	0.7	=	69.42	(81)
Northwest	0.9x	0.77	x	9.89	x	41.38	x	0.63	x	0.7	=	125.07	(81)
Northwest	0.9x	0.77	x	9.89	x	67.96	x	0.63	x	0.7	=	205.4	(81)
Northwest	0.9x	0.77	x	9.89	x	91.35	x	0.63	x	0.7	=	276.09	(81)
Northwest	0.9x	0.77	x	9.89	x	97.38	x	0.63	x	0.7	=	294.35	(81)
Northwest	0.9x	0.77	x	9.89	x	91.1	x	0.63	x	0.7	=	275.35	(81)
Northwest	0.9x	0.77	x	9.89	x	72.63	x	0.63	x	0.7	=	219.52	(81)
Northwest	0.9x	0.77	x	9.89	x	50.42	x	0.63	x	0.7	=	152.4	(81)
Northwest	0.9x	0.77	x	9.89	x	28.07	x	0.63	x	0.7	=	84.83	(81)
Northwest	0.9x	0.77	x	9.89	x	14.2	x	0.63	x	0.7	=	42.91	(81)
Northwest	0.9x	0.77	x	9.89	x	9.21	x	0.63	x	0.7	=	27.85	(81)
Rooflights	0.9x	1	x	7.6	x	26	x	0.63	x	0.7	=	78.45	(82)
Rooflights	0.9x	1	x	1.17	x	26	x	0.63	x	0.7	=	12.11	(82)
Rooflights	0.9x	1	x	4.03	x	26	x	0.63	x	0.7	=	41.62	(82)
Rooflights	0.9x	1	x	0.74	x	26	x	0.63	x	0.7	=	7.59	(82)
Rooflights	0.9x	1	x	7.6	x	54	x	0.63	x	0.7	=	162.93	(82)
Rooflights	0.9x	1	x	1.17	x	54	x	0.63	x	0.7	=	25.15	(82)
Rooflights	0.9x	1	x	4.03	x	54	x	0.63	x	0.7	=	86.45	(82)
Rooflights	0.9x	1	x	0.74	x	54	x	0.63	x	0.7	=	15.77	(82)
Rooflights	0.9x	1	x	7.6	x	96	x	0.63	x	0.7	=	289.64	(82)
Rooflights	0.9x	1	x	1.17	x	96	x	0.63	x	0.7	=	44.7	(82)
Rooflights	0.9x	1	x	4.03	x	96	x	0.63	x	0.7	=	153.68	(82)
Rooflights	0.9x	1	x	0.74	x	96	x	0.63	x	0.7	=	28.04	(82)
Rooflights	0.9x	1	x	7.6	x	150	x	0.63	x	0.7	=	452.57	(82)
Rooflights	0.9x	1	x	1.17	x	150	x	0.63	x	0.7	=	69.85	(82)
Rooflights	0.9x	1	x	4.03	x	150	x	0.63	x	0.7	=	240.13	(82)
Rooflights	0.9x	1	x	0.74	x	150	x	0.63	x	0.7	=	43.81	(82)
Rooflights	0.9x	1	x	7.6	x	192	x	0.63	x	0.7	=	579.29	(82)

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Rooflights 0.9x	1	x	1.17	x	192	x	0.63	x	0.7	=	89.41	(82)
Rooflights 0.9x	1	x	4.03	x	192	x	0.63	x	0.7	=	307.37	(82)
Rooflights 0.9x	1	x	0.74	x	192	x	0.63	x	0.7	=	56.08	(82)
Rooflights 0.9x	1	x	7.6	x	200	x	0.63	x	0.7	=	603.43	(82)
Rooflights 0.9x	1	x	1.17	x	200	x	0.63	x	0.7	=	93.13	(82)
Rooflights 0.9x	1	x	4.03	x	200	x	0.63	x	0.7	=	320.17	(82)
Rooflights 0.9x	1	x	0.74	x	200	x	0.63	x	0.7	=	58.41	(82)
Rooflights 0.9x	1	x	7.6	x	189	x	0.63	x	0.7	=	570.24	(82)
Rooflights 0.9x	1	x	1.17	x	189	x	0.63	x	0.7	=	88.01	(82)
Rooflights 0.9x	1	x	4.03	x	189	x	0.63	x	0.7	=	302.56	(82)
Rooflights 0.9x	1	x	0.74	x	189	x	0.63	x	0.7	=	55.2	(82)
Rooflights 0.9x	1	x	7.6	x	157	x	0.63	x	0.7	=	473.69	(82)
Rooflights 0.9x	1	x	1.17	x	157	x	0.63	x	0.7	=	73.11	(82)
Rooflights 0.9x	1	x	4.03	x	157	x	0.63	x	0.7	=	251.34	(82)
Rooflights 0.9x	1	x	0.74	x	157	x	0.63	x	0.7	=	45.85	(82)
Rooflights 0.9x	1	x	7.6	x	115	x	0.63	x	0.7	=	346.97	(82)
Rooflights 0.9x	1	x	1.17	x	115	x	0.63	x	0.7	=	53.55	(82)
Rooflights 0.9x	1	x	4.03	x	115	x	0.63	x	0.7	=	184.1	(82)
Rooflights 0.9x	1	x	0.74	x	115	x	0.63	x	0.7	=	33.59	(82)
Rooflights 0.9x	1	x	7.6	x	66	x	0.63	x	0.7	=	199.13	(82)
Rooflights 0.9x	1	x	1.17	x	66	x	0.63	x	0.7	=	30.73	(82)
Rooflights 0.9x	1	x	4.03	x	66	x	0.63	x	0.7	=	105.66	(82)
Rooflights 0.9x	1	x	0.74	x	66	x	0.63	x	0.7	=	19.28	(82)
Rooflights 0.9x	1	x	7.6	x	33	x	0.63	x	0.7	=	99.57	(82)
Rooflights 0.9x	1	x	1.17	x	33	x	0.63	x	0.7	=	15.37	(82)
Rooflights 0.9x	1	x	4.03	x	33	x	0.63	x	0.7	=	52.83	(82)
Rooflights 0.9x	1	x	0.74	x	33	x	0.63	x	0.7	=	9.64	(82)
Rooflights 0.9x	1	x	7.6	x	21	x	0.63	x	0.7	=	63.36	(82)
Rooflights 0.9x	1	x	1.17	x	21	x	0.63	x	0.7	=	9.78	(82)
Rooflights 0.9x	1	x	4.03	x	21	x	0.63	x	0.7	=	33.62	(82)
Rooflights 0.9x	1	x	0.74	x	21	x	0.63	x	0.7	=	6.13	(82)

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

(83)m=	656.39	1200.47	1841.62	2583.19	3145.03	3226.73	3067.91	2636.92	2098.74	1382.37	801.69	551.45	(83)

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

(84)m=	1382.72	1924.48	2541.2	3242.24	3760.75	3802.32	3618.46	3194.35	2677.88	2002.3	1468.64	1255.75	(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	1	0.99	0.95	0.86	0.7	0.54	0.62	0.87	0.98	1	1	(86)

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

(87)m=	19.16	19.39	19.78	20.27	20.68	20.91	20.97	20.96	20.75	20.18	19.57	19.12	(87)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(88)m=	19.68	19.68	19.68	19.69	19.69	19.7	19.7	19.7	19.7	19.69	19.69	19.68	(88)

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

(89)m=	1	1	0.98	0.94	0.8	0.59	0.39	0.47	0.79	0.98	1	1	(89)

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

(90)m=	17.24	17.58	18.14	18.85	19.39	19.64	19.69	19.69	19.5	18.74	17.85	17.19	(90)

fLA = Living area ÷ (4) = 0.22 (91)

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

(92)m=	17.66	17.98	18.5	19.16	19.68	19.92	19.97	19.97	19.77	19.06	18.23	17.62	(92)

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

(93)m=	17.66	17.98	18.5	19.16	19.68	19.92	19.97	19.97	19.77	19.06	18.23	17.62	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.98	0.93	0.8	0.61	0.43	0.5	0.8	0.97	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1380.47	1912.94	2486.75	2999.52	3011.4	2305.88	1537.9	1598.25	2139.39	1939.72	1462.73	1254.36	(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=	6343.29	6198.35	5675.95	4811.33	3731.96	2470.09	1566.45	1652.65	2641.68	3957.44	5225.95	6321.67	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	3692.34	2879.8	2372.76	1304.5	536.1	0	0	0	0	1501.18	2709.52	3770.08	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 18766.29 (98)

Space heating requirement in kWh/m²/year 59.93 (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)
Efficiency of main space heating system 1		93.5	(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)													
	3692.34	2879.8	2372.76	1304.5	536.1	0	0	0	0	1501.18	2709.52	3770.08	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	3949.03	3080	2537.71	1395.19	573.37	0	0	0	0	1605.54	2897.88	4032.17	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 20070.89 (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)

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Water heating

Output from water heater (calculated above)

	236.42	208.45	219.09	196.63	192.86	172.57	165.96	181.79	181.37	203.88	215.29	230.81		
Efficiency of water heater													79.8	(216)
(217)m=	89.78	89.69	89.49	88.94	87.4	79.8	79.8	79.8	79.8	89.07	89.62	89.81		(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	263.34	232.42	244.83	221.08	220.66	216.25	207.97	227.81	227.29	228.89	240.24	257.01		
									Total = Sum(219a)$_{1...12}$ =				2787.8	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		20070.89	
Water heating fuel used		2787.8	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		75	(231)
Electricity for lighting		738.1	(232)

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	=	4335.31	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	602.16	(264)
Space and water heating	(261) + (262) + (263) + (264) =			4937.48	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	383.07	(268)
Total CO2, kg/year		sum of (265)…(271) =		5359.48	(272)

TER = 17.12 (273)

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Be Lean Residential – DER from the Be Lean scenario DER SAP worksheet

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.12

Property Address: 14a Hampstead Hill

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	99.35	(1a)	x	3.05	(2a)	=	303.02	(3a)
First floor	80.45	(1b)	x	4.07	(2b)	=	327.43	(3b)
Second floor	66.66	(1c)	x	3.6	(2c)	=	239.98	(3c)
Third floor	66.66	(1d)	x	3.05	(2d)	=	203.31	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	313.12	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	1073.74	(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)

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		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.15	(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 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

0.19	0.19	0.18	0.16	0.16	0.14	0.14	0.14	0.15	0.16	0.17	0.18

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) = 77.35 (23c)

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

(24a)m=	0.3	0.3	0.3	0.28	0.27	0.26	0.26	0.25	0.26	0.27	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	0.3	0.28	0.27	0.26	0.26	0.25	0.26	0.27	0.28	0.29	(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)	k-value kJ/m²·K	A X k kJ/K	
Doors			0.52	x 1.6	= 0.832			(26)
Windows Type 1			6.58	x1/[1/(1.3)+ 0.04]	= 8.13			(27)
Windows Type 2			3.22	x1/[1/(1.3)+ 0.04]	= 3.98			(27)
Windows Type 3			1.68	x1/[1/(1.3)+ 0.04]	= 2.08			(27)
Windows Type 4			2.26	x1/[1/(1.3)+ 0.04]	= 2.79			(27)
Windows Type 5			1.18	x1/[1/(1.3)+ 0.04]	= 1.46			(27)
Windows Type 6			1.4	x1/[1/(1.3)+ 0.04]	= 1.73			(27)
Windows Type 7			3.5	x1/[1/(1.3)+ 0.04]	= 4.33			(27)
Windows Type 8			1.92	x1/[1/(1.3)+ 0.04]	= 2.37			(27)
Windows Type 9			4.8	x1/[1/(1.3)+ 0.04]	= 5.93			(27)
Windows Type 10			1.89	x1/[1/(1.3)+ 0.04]	= 2.34			(27)
Windows Type 11			10.2	x1/[1/(1.3)+ 0.04]	= 12.6			(27)
Windows Type 12			27.06	x1/[1/(1.3)+ 0.04]	= 33.44			(27)
Windows Type 13			14.25	x1/[1/(1.3)+ 0.04]	= 17.61			(27)

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Windows Type 14			8.78	x1/[1/(1.3)+ 0.04] =		10.85			(27)
Rooflights Type 1			10.95	x1/[1/(1.3) + 0.04] =		14.235			(27b)
Rooflights Type 2			1.69	x1/[1/(1.4) + 0.04] =		2.366			(27b)
Rooflights Type 3			5.81	x1/[1/(1.4) + 0.04] =		8.134			(27b)
Rooflights Type 4			1.06	x1/[1/(1.4) + 0.04] =		1.484			(27b)
Floor Type 1			99.35	x	0.13 =	12.9155			(28)
Floor Type 2			1.56	x	0.13 =	0.2028			(28)
Walls Type1	449.95	93.02	356.93	x	0.16 =	57.11			(29)
Walls Type2	141.92	0	141.92	x	0.13 =	18.45			(29)
Roof	100.91	19.51	81.4	x	0.11 =	8.95			(30)
Total area of elements, m²			793.69						(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) =	237.65	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	78530.19	(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		61.23	(36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss	(33) + (36) =	298.88	(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=	107.89	106.57	105.24	98.59	97.26	90.62	90.62	89.29	93.28	97.26	99.92	102.58	(38)

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

(39)m=	406.77	405.45	404.12	397.47	396.14	389.5	389.5	388.17	392.16	396.14	398.8	401.46	

Average = $Sum(39)_{1…12}$ /12= 397.14 (39)

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

(40)m=	1.3	1.29	1.29	1.27	1.27	1.24	1.24	1.24	1.25	1.27	1.27	1.28	

Average = $Sum(40)_{1…12}$ /12= 1.27 (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 — 3.15 (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 — 108.99 (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)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	119.89	115.53	111.17	106.81	102.45	98.09	98.09	102.45	106.81	111.17	115.53	119.89

Total = $Sum(44)_{1…12}$ = 1307.86 (44)

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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=	177.79	155.5	160.46	139.89	134.23	115.83	107.33	123.17	124.64	145.25	158.55	172.18

Total = Sum(45)$_{1...12}$ = 1714.81 (45)

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

(46)m=	26.67	23.32	24.07	20.98	20.13	17.37	16.1	18.47	18.7	21.79	23.78	25.83	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 300 (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): 1.69 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.91 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0.91 (55)

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

(56)m=	28.29	25.55	28.29	27.38	28.29	27.38	28.29	28.29	27.38	28.29	27.38	28.29	(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=	28.29	25.55	28.29	27.38	28.29	27.38	28.29	28.29	27.38	28.29	27.38	28.29	(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)

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=	229.34	202.06	212.01	189.78	185.78	165.72	158.89	174.72	174.53	196.81	208.44	223.73	(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=	229.34	202.06	212.01	189.78	185.78	165.72	158.89	174.72	174.53	196.81	208.44	223.73

Output from water heater (annual)$_{1...12}$ 2321.81 (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=	100.36	88.95	94.59	86.43	85.87	78.43	76.93	82.2	81.35	89.54	92.63	98.49	(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=	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	(66)

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

(67)m=	41.79	37.12	30.19	22.86	17.08	14.42	15.58	20.26	27.19	34.52	40.29	42.96	(67)

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

(68)m=	468.8	473.67	461.41	435.31	402.37	371.41	350.72	345.86	358.11	384.21	417.16	448.12	(68)

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

(69)m=	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	(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=	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	(71)

Water heating gains (Table 5)

(72)m=	134.89	132.37	127.14	120.04	115.42	108.92	103.4	110.48	112.99	120.35	128.65	132.38	(72)

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

(73)m=	718.72	716.4	691.98	651.44	608.11	567.99	542.94	549.83	571.53	612.32	659.34	696.69	(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	6.58	x	11.28	x	0.6	x	0.8	=	24.7	(75)
Northeast 0.9x	0.77	x	3.22	x	11.28	x	0.6	x	0.8	=	12.09	(75)
Northeast 0.9x	0.77	x	1.68	x	11.28	x	0.6	x	0.8	=	6.31	(75)
Northeast 0.9x	0.77	x	2.26	x	11.28	x	0.6	x	0.8	=	8.48	(75)
Northeast 0.9x	0.77	x	1.18	x	11.28	x	0.6	x	0.8	=	4.43	(75)
Northeast 0.9x	0.77	x	8.78	x	11.28	x	0.6	x	0.8	=	32.95	(75)
Northeast 0.9x	0.77	x	6.58	x	22.97	x	0.6	x	0.8	=	50.27	(75)
Northeast 0.9x	0.77	x	3.22	x	22.97	x	0.6	x	0.8	=	24.6	(75)
Northeast 0.9x	0.77	x	1.68	x	22.97	x	0.6	x	0.8	=	12.83	(75)
Northeast 0.9x	0.77	x	2.26	x	22.97	x	0.6	x	0.8	=	17.27	(75)
Northeast 0.9x	0.77	x	1.18	x	22.97	x	0.6	x	0.8	=	9.01	(75)
Northeast 0.9x	0.77	x	8.78	x	22.97	x	0.6	x	0.8	=	67.08	(75)
Northeast 0.9x	0.77	x	6.58	x	41.38	x	0.6	x	0.8	=	90.57	(75)
Northeast 0.9x	0.77	x	3.22	x	41.38	x	0.6	x	0.8	=	44.32	(75)
Northeast 0.9x	0.77	x	1.68	x	41.38	x	0.6	x	0.8	=	23.12	(75)
Northeast 0.9x	0.77	x	2.26	x	41.38	x	0.6	x	0.8	=	31.11	(75)
Northeast 0.9x	0.77	x	1.18	x	41.38	x	0.6	x	0.8	=	16.24	(75)
Northeast 0.9x	0.77	x	8.78	x	41.38	x	0.6	x	0.8	=	120.85	(75)
Northeast 0.9x	0.77	x	6.58	x	67.96	x	0.6	x	0.8	=	148.74	(75)
Northeast 0.9x	0.77	x	3.22	x	67.96	x	0.6	x	0.8	=	72.79	(75)
Northeast 0.9x	0.77	x	1.68	x	67.96	x	0.6	x	0.8	=	37.98	(75)

DER WorkSheet: New dwelling design stage

Northeast 0.9x	0.77	x	2.26	x	67.96	x	0.6	x	0.8	=	51.09	(75)
Northeast 0.9x	0.77	x	1.18	x	67.96	x	0.6	x	0.8	=	26.67	(75)
Northeast 0.9x	0.77	x	8.78	x	67.96	x	0.6	x	0.8	=	198.47	(75)
Northeast 0.9x	0.77	x	6.58	x	91.35	x	0.6	x	0.8	=	199.94	(75)
Northeast 0.9x	0.77	x	3.22	x	91.35	x	0.6	x	0.8	=	97.84	(75)
Northeast 0.9x	0.77	x	1.68	x	91.35	x	0.6	x	0.8	=	51.05	(75)
Northeast 0.9x	0.77	x	2.26	x	91.35	x	0.6	x	0.8	=	68.67	(75)
Northeast 0.9x	0.77	x	1.18	x	91.35	x	0.6	x	0.8	=	35.85	(75)
Northeast 0.9x	0.77	x	8.78	x	91.35	x	0.6	x	0.8	=	266.78	(75)
Northeast 0.9x	0.77	x	6.58	x	97.38	x	0.6	x	0.8	=	213.15	(75)
Northeast 0.9x	0.77	x	3.22	x	97.38	x	0.6	x	0.8	=	104.31	(75)
Northeast 0.9x	0.77	x	1.68	x	97.38	x	0.6	x	0.8	=	54.42	(75)
Northeast 0.9x	0.77	x	2.26	x	97.38	x	0.6	x	0.8	=	73.21	(75)
Northeast 0.9x	0.77	x	1.18	x	97.38	x	0.6	x	0.8	=	38.22	(75)
Northeast 0.9x	0.77	x	8.78	x	97.38	x	0.6	x	0.8	=	284.42	(75)
Northeast 0.9x	0.77	x	6.58	x	91.1	x	0.6	x	0.8	=	199.4	(75)
Northeast 0.9x	0.77	x	3.22	x	91.1	x	0.6	x	0.8	=	97.58	(75)
Northeast 0.9x	0.77	x	1.68	x	91.1	x	0.6	x	0.8	=	50.91	(75)
Northeast 0.9x	0.77	x	2.26	x	91.1	x	0.6	x	0.8	=	68.49	(75)
Northeast 0.9x	0.77	x	1.18	x	91.1	x	0.6	x	0.8	=	35.76	(75)
Northeast 0.9x	0.77	x	8.78	x	91.1	x	0.6	x	0.8	=	266.07	(75)
Northeast 0.9x	0.77	x	6.58	x	72.63	x	0.6	x	0.8	=	158.96	(75)
Northeast 0.9x	0.77	x	3.22	x	72.63	x	0.6	x	0.8	=	77.79	(75)
Northeast 0.9x	0.77	x	1.68	x	72.63	x	0.6	x	0.8	=	40.59	(75)
Northeast 0.9x	0.77	x	2.26	x	72.63	x	0.6	x	0.8	=	54.6	(75)
Northeast 0.9x	0.77	x	1.18	x	72.63	x	0.6	x	0.8	=	28.51	(75)
Northeast 0.9x	0.77	x	8.78	x	72.63	x	0.6	x	0.8	=	212.11	(75)
Northeast 0.9x	0.77	x	6.58	x	50.42	x	0.6	x	0.8	=	110.36	(75)
Northeast 0.9x	0.77	x	3.22	x	50.42	x	0.6	x	0.8	=	54.01	(75)
Northeast 0.9x	0.77	x	1.68	x	50.42	x	0.6	x	0.8	=	28.18	(75)
Northeast 0.9x	0.77	x	2.26	x	50.42	x	0.6	x	0.8	=	37.9	(75)
Northeast 0.9x	0.77	x	1.18	x	50.42	x	0.6	x	0.8	=	19.79	(75)
Northeast 0.9x	0.77	x	8.78	x	50.42	x	0.6	x	0.8	=	147.26	(75)
Northeast 0.9x	0.77	x	6.58	x	28.07	x	0.6	x	0.8	=	61.43	(75)
Northeast 0.9x	0.77	x	3.22	x	28.07	x	0.6	x	0.8	=	30.06	(75)
Northeast 0.9x	0.77	x	1.68	x	28.07	x	0.6	x	0.8	=	15.68	(75)
Northeast 0.9x	0.77	x	2.26	x	28.07	x	0.6	x	0.8	=	21.1	(75)
Northeast 0.9x	0.77	x	1.18	x	28.07	x	0.6	x	0.8	=	11.02	(75)
Northeast 0.9x	0.77	x	8.78	x	28.07	x	0.6	x	0.8	=	81.97	(75)
Northeast 0.9x	0.77	x	6.58	x	14.2	x	0.6	x	0.8	=	31.07	(75)
Northeast 0.9x	0.77	x	3.22	x	14.2	x	0.6	x	0.8	=	15.21	(75)

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Northeast	0.9x	0.77	x	1.68	x	14.2	x	0.6	x	0.8	=	7.93	(75)
Northeast	0.9x	0.77	x	2.26	x	14.2	x	0.6	x	0.8	=	10.67	(75)
Northeast	0.9x	0.77	x	1.18	x	14.2	x	0.6	x	0.8	=	5.57	(75)
Northeast	0.9x	0.77	x	8.78	x	14.2	x	0.6	x	0.8	=	41.46	(75)
Northeast	0.9x	0.77	x	6.58	x	9.21	x	0.6	x	0.8	=	20.17	(75)
Northeast	0.9x	0.77	x	3.22	x	9.21	x	0.6	x	0.8	=	9.87	(75)
Northeast	0.9x	0.77	x	1.68	x	9.21	x	0.6	x	0.8	=	5.15	(75)
Northeast	0.9x	0.77	x	2.26	x	9.21	x	0.6	x	0.8	=	6.93	(75)
Northeast	0.9x	0.77	x	1.18	x	9.21	x	0.6	x	0.8	=	3.62	(75)
Northeast	0.9x	0.77	x	8.78	x	9.21	x	0.6	x	0.8	=	26.91	(75)
Southeast	0.9x	0.77	x	1.89	x	36.79	x	0.6	x	0.8	=	69.4	(77)
Southeast	0.9x	0.77	x	27.06	x	36.79	x	0.6	x	0.8	=	331.19	(77)
Southeast	0.9x	0.77	x	1.89	x	62.67	x	0.6	x	0.8	=	118.21	(77)
Southeast	0.9x	0.77	x	27.06	x	62.67	x	0.6	x	0.8	=	564.14	(77)
Southeast	0.9x	0.77	x	1.89	x	85.75	x	0.6	x	0.8	=	161.74	(77)
Southeast	0.9x	0.77	x	27.06	x	85.75	x	0.6	x	0.8	=	771.88	(77)
Southeast	0.9x	0.77	x	1.89	x	106.25	x	0.6	x	0.8	=	200.4	(77)
Southeast	0.9x	0.77	x	27.06	x	106.25	x	0.6	x	0.8	=	956.4	(77)
Southeast	0.9x	0.77	x	1.89	x	119.01	x	0.6	x	0.8	=	224.46	(77)
Southeast	0.9x	0.77	x	27.06	x	119.01	x	0.6	x	0.8	=	1071.24	(77)
Southeast	0.9x	0.77	x	1.89	x	118.15	x	0.6	x	0.8	=	222.84	(77)
Southeast	0.9x	0.77	x	27.06	x	118.15	x	0.6	x	0.8	=	1063.5	(77)
Southeast	0.9x	0.77	x	1.89	x	113.91	x	0.6	x	0.8	=	214.84	(77)
Southeast	0.9x	0.77	x	27.06	x	113.91	x	0.6	x	0.8	=	1025.32	(77)
Southeast	0.9x	0.77	x	1.89	x	104.39	x	0.6	x	0.8	=	196.89	(77)
Southeast	0.9x	0.77	x	27.06	x	104.39	x	0.6	x	0.8	=	939.64	(77)
Southeast	0.9x	0.77	x	1.89	x	92.85	x	0.6	x	0.8	=	175.13	(77)
Southeast	0.9x	0.77	x	27.06	x	92.85	x	0.6	x	0.8	=	835.78	(77)
Southeast	0.9x	0.77	x	1.89	x	69.27	x	0.6	x	0.8	=	130.64	(77)
Southeast	0.9x	0.77	x	27.06	x	69.27	x	0.6	x	0.8	=	623.49	(77)
Southeast	0.9x	0.77	x	1.89	x	44.07	x	0.6	x	0.8	=	83.12	(77)
Southeast	0.9x	0.77	x	27.06	x	44.07	x	0.6	x	0.8	=	396.69	(77)
Southeast	0.9x	0.77	x	1.89	x	31.49	x	0.6	x	0.8	=	59.39	(77)
Southeast	0.9x	0.77	x	27.06	x	31.49	x	0.6	x	0.8	=	283.43	(77)
Southwest	0.9x	0.77	x	1.4	x	36.79		0.6	x	0.8	=	17.13	(79)
Southwest	0.9x	0.77	x	3.5	x	36.79		0.6	x	0.8	=	42.84	(79)
Southwest	0.9x	0.77	x	1.92	x	36.79		0.6	x	0.8	=	23.5	(79)
Southwest	0.9x	0.77	x	4.8	x	36.79		0.6	x	0.8	=	58.75	(79)
Southwest	0.9x	0.77	x	10.2	x	36.79		0.6	x	0.8	=	124.84	(79)
Southwest	0.9x	0.77	x	1.4	x	62.67		0.6	x	0.8	=	29.19	(79)
Southwest	0.9x	0.77	x	3.5	x	62.67		0.6	x	0.8	=	72.97	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	1.92	x	62.67	0.6	x	0.8	=	40.03	(79)
Southwest	0.9x	0.77	x	4.8	x	62.67	0.6	x	0.8	=	100.07	(79)
Southwest	0.9x	0.77	x	10.2	x	62.67	0.6	x	0.8	=	212.65	(79)
Southwest	0.9x	0.77	x	1.4	x	85.75	0.6	x	0.8	=	39.93	(79)
Southwest	0.9x	0.77	x	3.5	x	85.75	0.6	x	0.8	=	99.84	(79)
Southwest	0.9x	0.77	x	1.92	x	85.75	0.6	x	0.8	=	54.77	(79)
Southwest	0.9x	0.77	x	4.8	x	85.75	0.6	x	0.8	=	136.92	(79)
Southwest	0.9x	0.77	x	10.2	x	85.75	0.6	x	0.8	=	290.95	(79)
Southwest	0.9x	0.77	x	1.4	x	106.25	0.6	x	0.8	=	49.48	(79)
Southwest	0.9x	0.77	x	3.5	x	106.25	0.6	x	0.8	=	123.7	(79)
Southwest	0.9x	0.77	x	1.92	x	106.25	0.6	x	0.8	=	67.86	(79)
Southwest	0.9x	0.77	x	4.8	x	106.25	0.6	x	0.8	=	169.65	(79)
Southwest	0.9x	0.77	x	10.2	x	106.25	0.6	x	0.8	=	360.5	(79)
Southwest	0.9x	0.77	x	1.4	x	119.01	0.6	x	0.8	=	55.42	(79)
Southwest	0.9x	0.77	x	3.5	x	119.01	0.6	x	0.8	=	138.56	(79)
Southwest	0.9x	0.77	x	1.92	x	119.01	0.6	x	0.8	=	76.01	(79)
Southwest	0.9x	0.77	x	4.8	x	119.01	0.6	x	0.8	=	190.02	(79)
Southwest	0.9x	0.77	x	10.2	x	119.01	0.6	x	0.8	=	403.79	(79)
Southwest	0.9x	0.77	x	1.4	x	118.15	0.6	x	0.8	=	55.02	(79)
Southwest	0.9x	0.77	x	3.5	x	118.15	0.6	x	0.8	=	137.55	(79)
Southwest	0.9x	0.77	x	1.92	x	118.15	0.6	x	0.8	=	75.46	(79)
Southwest	0.9x	0.77	x	4.8	x	118.15	0.6	x	0.8	=	188.65	(79)
Southwest	0.9x	0.77	x	10.2	x	118.15	0.6	x	0.8	=	400.87	(79)
Southwest	0.9x	0.77	x	1.4	x	113.91	0.6	x	0.8	=	53.05	(79)
Southwest	0.9x	0.77	x	3.5	x	113.91	0.6	x	0.8	=	132.62	(79)
Southwest	0.9x	0.77	x	1.92	x	113.91	0.6	x	0.8	=	72.75	(79)
Southwest	0.9x	0.77	x	4.8	x	113.91	0.6	x	0.8	=	181.88	(79)
Southwest	0.9x	0.77	x	10.2	x	113.91	0.6	x	0.8	=	386.49	(79)
Southwest	0.9x	0.77	x	1.4	x	104.39	0.6	x	0.8	=	48.61	(79)
Southwest	0.9x	0.77	x	3.5	x	104.39	0.6	x	0.8	=	121.54	(79)
Southwest	0.9x	0.77	x	1.92	x	104.39	0.6	x	0.8	=	66.67	(79)
Southwest	0.9x	0.77	x	4.8	x	104.39	0.6	x	0.8	=	166.68	(79)
Southwest	0.9x	0.77	x	10.2	x	104.39	0.6	x	0.8	=	354.19	(79)
Southwest	0.9x	0.77	x	1.4	x	92.85	0.6	x	0.8	=	43.24	(79)
Southwest	0.9x	0.77	x	3.5	x	92.85	0.6	x	0.8	=	108.1	(79)
Southwest	0.9x	0.77	x	1.92	x	92.85	0.6	x	0.8	=	59.3	(79)
Southwest	0.9x	0.77	x	4.8	x	92.85	0.6	x	0.8	=	148.25	(79)
Southwest	0.9x	0.77	x	10.2	x	92.85	0.6	x	0.8	=	315.04	(79)
Southwest	0.9x	0.77	x	1.4	x	69.27	0.6	x	0.8	=	32.26	(79)
Southwest	0.9x	0.77	x	3.5	x	69.27	0.6	x	0.8	=	80.64	(79)
Southwest	0.9x	0.77	x	1.92	x	69.27	0.6	x	0.8	=	44.24	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	4.8	x	69.27		0.6	x	0.8	=	110.6	(79)
Southwest	0.9x	0.77	x	10.2	x	69.27		0.6	x	0.8	=	235.02	(79)
Southwest	0.9x	0.77	x	1.4	x	44.07		0.6	x	0.8	=	20.52	(79)
Southwest	0.9x	0.77	x	3.5	x	44.07		0.6	x	0.8	=	51.31	(79)
Southwest	0.9x	0.77	x	1.92	x	44.07		0.6	x	0.8	=	28.15	(79)
Southwest	0.9x	0.77	x	4.8	x	44.07		0.6	x	0.8	=	70.37	(79)
Southwest	0.9x	0.77	x	10.2	x	44.07		0.6	x	0.8	=	149.53	(79)
Southwest	0.9x	0.77	x	1.4	x	31.49		0.6	x	0.8	=	14.66	(79)
Southwest	0.9x	0.77	x	3.5	x	31.49		0.6	x	0.8	=	36.66	(79)
Southwest	0.9x	0.77	x	1.92	x	31.49		0.6	x	0.8	=	20.11	(79)
Southwest	0.9x	0.77	x	4.8	x	31.49		0.6	x	0.8	=	50.28	(79)
Southwest	0.9x	0.77	x	10.2	x	31.49		0.6	x	0.8	=	106.84	(79)
Northwest	0.9x	0.77	x	14.25	x	11.28	x	0.6	x	0.8	=	53.48	(81)
Northwest	0.9x	0.77	x	14.25	x	22.97	x	0.6	x	0.8	=	108.87	(81)
Northwest	0.9x	0.77	x	14.25	x	41.38	x	0.6	x	0.8	=	196.14	(81)
Northwest	0.9x	0.77	x	14.25	x	67.96	x	0.6	x	0.8	=	322.12	(81)
Northwest	0.9x	0.77	x	14.25	x	91.35	x	0.6	x	0.8	=	432.99	(81)
Northwest	0.9x	0.77	x	14.25	x	97.38	x	0.6	x	0.8	=	461.61	(81)
Northwest	0.9x	0.77	x	14.25	x	91.1	x	0.6	x	0.8	=	431.83	(81)
Northwest	0.9x	0.77	x	14.25	x	72.63	x	0.6	x	0.8	=	344.26	(81)
Northwest	0.9x	0.77	x	14.25	x	50.42	x	0.6	x	0.8	=	239	(81)
Northwest	0.9x	0.77	x	14.25	x	28.07	x	0.6	x	0.8	=	133.04	(81)
Northwest	0.9x	0.77	x	14.25	x	14.2	x	0.6	x	0.8	=	67.29	(81)
Northwest	0.9x	0.77	x	14.25	x	9.21	x	0.6	x	0.8	=	43.68	(81)
Rooflights	0.9x	1	x	10.95	x	26	x	0.5	x	0.8	=	102.49	(82)
Rooflights	0.9x	1	x	1.69	x	26	x	0.5	x	0.8	=	15.82	(82)
Rooflights	0.9x	1	x	5.81	x	26	x	0.5	x	0.8	=	54.38	(82)
Rooflights	0.9x	1	x	1.06	x	26	x	0.5	x	0.8	=	9.92	(82)
Rooflights	0.9x	1	x	10.95	x	54	x	0.5	x	0.8	=	212.87	(82)
Rooflights	0.9x	1	x	1.69	x	54	x	0.5	x	0.8	=	32.85	(82)
Rooflights	0.9x	1	x	5.81	x	54	x	0.5	x	0.8	=	112.95	(82)
Rooflights	0.9x	1	x	1.06	x	54	x	0.5	x	0.8	=	20.61	(82)
Rooflights	0.9x	1	x	10.95	x	96	x	0.5	x	0.8	=	378.43	(82)
Rooflights	0.9x	1	x	1.69	x	96	x	0.5	x	0.8	=	58.41	(82)
Rooflights	0.9x	1	x	5.81	x	96	x	0.5	x	0.8	=	200.79	(82)
Rooflights	0.9x	1	x	1.06	x	96	x	0.5	x	0.8	=	36.63	(82)
Rooflights	0.9x	1	x	10.95	x	150	x	0.5	x	0.8	=	591.3	(82)
Rooflights	0.9x	1	x	1.69	x	150	x	0.5	x	0.8	=	91.26	(82)
Rooflights	0.9x	1	x	5.81	x	150	x	0.5	x	0.8	=	313.74	(82)
Rooflights	0.9x	1	x	1.06	x	150	x	0.5	x	0.8	=	57.24	(82)
Rooflights	0.9x	1	x	10.95	x	192	x	0.5	x	0.8	=	756.86	(82)

Rooflights 0.9x	1	x	1.69	x	192	x	0.5	x	0.8	=	116.81	(82)
Rooflights 0.9x	1	x	5.81	x	192	x	0.5	x	0.8	=	401.59	(82)
Rooflights 0.9x	1	x	1.06	x	192	x	0.5	x	0.8	=	73.27	(82)
Rooflights 0.9x	1	x	10.95	x	200	x	0.5	x	0.8	=	788.4	(82)
Rooflights 0.9x	1	x	1.69	x	200	x	0.5	x	0.8	=	121.68	(82)
Rooflights 0.9x	1	x	5.81	x	200	x	0.5	x	0.8	=	418.32	(82)
Rooflights 0.9x	1	x	1.06	x	200	x	0.5	x	0.8	=	76.32	(82)
Rooflights 0.9x	1	x	10.95	x	189	x	0.5	x	0.8	=	745.04	(82)
Rooflights 0.9x	1	x	1.69	x	189	x	0.5	x	0.8	=	114.99	(82)
Rooflights 0.9x	1	x	5.81	x	189	x	0.5	x	0.8	=	395.31	(82)
Rooflights 0.9x	1	x	1.06	x	189	x	0.5	x	0.8	=	72.12	(82)
Rooflights 0.9x	1	x	10.95	x	157	x	0.5	x	0.8	=	618.89	(82)
Rooflights 0.9x	1	x	1.69	x	157	x	0.5	x	0.8	=	95.52	(82)
Rooflights 0.9x	1	x	5.81	x	157	x	0.5	x	0.8	=	328.38	(82)
Rooflights 0.9x	1	x	1.06	x	157	x	0.5	x	0.8	=	59.91	(82)
Rooflights 0.9x	1	x	10.95	x	115	x	0.5	x	0.8	=	453.33	(82)
Rooflights 0.9x	1	x	1.69	x	115	x	0.5	x	0.8	=	69.97	(82)
Rooflights 0.9x	1	x	5.81	x	115	x	0.5	x	0.8	=	240.53	(82)
Rooflights 0.9x	1	x	1.06	x	115	x	0.5	x	0.8	=	43.88	(82)
Rooflights 0.9x	1	x	10.95	x	66	x	0.5	x	0.8	=	260.17	(82)
Rooflights 0.9x	1	x	1.69	x	66	x	0.5	x	0.8	=	40.15	(82)
Rooflights 0.9x	1	x	5.81	x	66	x	0.5	x	0.8	=	138.05	(82)
Rooflights 0.9x	1	x	1.06	x	66	x	0.5	x	0.8	=	25.19	(82)
Rooflights 0.9x	1	x	10.95	x	33	x	0.5	x	0.8	=	130.09	(82)
Rooflights 0.9x	1	x	1.69	x	33	x	0.5	x	0.8	=	20.08	(82)
Rooflights 0.9x	1	x	5.81	x	33	x	0.5	x	0.8	=	69.02	(82)
Rooflights 0.9x	1	x	1.06	x	33	x	0.5	x	0.8	=	12.59	(82)
Rooflights 0.9x	1	x	10.95	x	21	x	0.5	x	0.8	=	82.78	(82)
Rooflights 0.9x	1	x	1.69	x	21	x	0.5	x	0.8	=	12.78	(82)
Rooflights 0.9x	1	x	5.81	x	21	x	0.5	x	0.8	=	43.92	(82)
Rooflights 0.9x	1	x	1.06	x	21	x	0.5	x	0.8	=	8.01	(82)

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

(83)m=	992.69	1806.44	2752.64	3839.38	4661.16	4777.96	4544.43	3913.74	3129.05	2074.76	1210.68	835.18	(83)

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

(84)m=	1711.41	2522.84	3444.62	4490.82	5269.27	5345.95	5087.38	4463.57	3700.59	2687.08	1870.02	1531.87	(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	0.99	0.96	0.85	0.65	0.46	0.34	0.4	0.68	0.95	1	1	(86)

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

(87)m=	19.83	20.06	20.38	20.72	20.89	20.93	20.94	20.94	20.9	20.6	20.13	19.8	(87)

DER WorkSheet: New dwelling design stage

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

(88)m=	19.84	19.84	19.85	19.86	19.87	19.89	19.89	19.89	19.88	19.87	19.86	19.85	(88)

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

(89)m=	1	0.99	0.95	0.81	0.59	0.38	0.25	0.3	0.59	0.92	0.99	1	(89)

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

(90)m=	18.27	18.61	19.08	19.55	19.74	19.8	19.8	19.8	19.76	19.4	18.73	18.24	(90)

fLA = Living area ÷ (4) = 0.22 (91)

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

(92)m=	18.62	18.93	19.37	19.81	19.99	20.05	20.05	20.05	20.01	19.66	19.04	18.58	(92)

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

(93)m=	18.62	18.93	19.37	19.81	19.99	20.05	20.05	20.05	20.01	19.66	19.04	18.58	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.94	0.81	0.6	0.39	0.26	0.32	0.6	0.92	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1706.89	2488.46	3249.17	3628.88	3137.7	2105.04	1342.38	1413.79	2215.16	2469.66	1855.03	1529.39	(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=	5823.33	5689.08	5199.38	4334.82	3284.6	2121.41	1344.22	1418.04	2318.76	3590.08	4762.43	5773.47	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	3062.63	2150.82	1450.96	508.28	109.29	0	0	0	0	833.59	2093.33	3157.6	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 13366.49 (98)

Space heating requirement in kWh/m²/year 42.69 (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)
Efficiency of main space heating system 1		88.1	(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)													
	3062.63	2150.82	1450.96	508.28	109.29	0	0	0	0	833.59	2093.33	3157.6	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	3476.31	2441.34	1646.94	576.93	124.05	0	0	0	0	946.19	2376.08	3584.11	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 15171.96 (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)

DER WorkSheet: New dwelling design stage

Water heating

Output from water heater (calculated above)

	229.34	202.06	212.01	189.78	185.78	165.72	158.89	174.72	174.53	196.81	208.44	223.73	
Efficiency of water heater												78	(216)
(217)m=	87.31	87.13	86.67	85.1	81.46	78	78	78	78	85.97	87.08	87.35	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	262.67	231.9	244.62	223	228.07	212.46	203.7	224	223.75	228.91	239.37	256.13	
Total = $Sum(219a)_{1...12}$ =												2778.59	(219)

Annual totals		kWh/year	kWh/year	
Space heating fuel used, main system 1			15171.96	
Water heating fuel used			2778.59	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		1719.32		(230a)
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		1749.32	(231)
Electricity for lighting			738.1	(232)

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	=	3277.14	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	600.17	(264)
Space and water heating	(261) + (262) + (263) + (264) =			3877.32	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	907.9	(267)
Electricity for lighting	(232) x	0.519	=	383.07	(268)
Total CO2, kg/year		sum of (265)…(271) =		5168.29	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		16.51	(273)
EI rating (section 14)				81	(274)

Appendix A
Sustainability Statement
14a Hampstead Hill

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Be Green Residential – DER from the Be Green scenario DER SAP worksheet

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.12

Property Address: Green

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	99.35	(1a)	x	3.05	(2a)	=	303.02	(3a)
First floor	80.45	(1b)	x	4.07	(2b)	=	327.43	(3b)
Second floor	66.66	(1c)	x	3.6	(2c)	=	239.98	(3c)
Third floor	66.66	(1d)	x	3.05	(2d)	=	203.31	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	313.12	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	1073.74	(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)

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		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.15	(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 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

	0.19	0.19	0.18	0.16	0.16	0.14	0.14	0.14	0.15	0.16	0.17	0.18

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) = 77.35 (23c)

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

(24a)m=	0.3	0.3	0.3	0.28	0.27	0.26	0.26	0.25	0.26	0.27	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	0.3	0.28	0.27	0.26	0.26	0.25	0.26	0.27	0.28	0.29	(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)	k-value kJ/m²·K	A X k kJ/K	
Doors			0.52	x	1.6	=	0.832			(26)
Windows Type 1			6.58	x1/[1/(1.3)+ 0.04]		=	8.13			(27)
Windows Type 2			3.22	x1/[1/(1.3)+ 0.04]		=	3.98			(27)
Windows Type 3			1.68	x1/[1/(1.3)+ 0.04]		=	2.08			(27)
Windows Type 4			2.26	x1/[1/(1.3)+ 0.04]		=	2.79			(27)
Windows Type 5			1.18	x1/[1/(1.3)+ 0.04]		=	1.46			(27)
Windows Type 6			1.4	x1/[1/(1.3)+ 0.04]		=	1.73			(27)
Windows Type 7			3.5	x1/[1/(1.3)+ 0.04]		=	4.33			(27)
Windows Type 8			1.92	x1/[1/(1.3)+ 0.04]		=	2.37			(27)
Windows Type 9			4.8	x1/[1/(1.3)+ 0.04]		=	5.93			(27)
Windows Type 10			1.89	x1/[1/(1.3)+ 0.04]		=	2.34			(27)
Windows Type 11			10.2	x1/[1/(1.3)+ 0.04]		=	12.6			(27)
Windows Type 12			27.06	x1/[1/(1.3)+ 0.04]		=	33.44			(27)
Windows Type 13			14.25	x1/[1/(1.3)+ 0.04]		=	17.61			(27)

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Windows Type 14			8.78	x1/[1/(1.3)+ 0.04] =		10.85				(27)
Rooflights Type 1			10.9532	x1/[1/(1.3) + 0.04] =		14.23916				(27b)
Rooflights Type 2			1.69	x1/[1/(1.4) + 0.04] =		2.366				(27b)
Rooflights Type 3			5.81	x1/[1/(1.4) + 0.04] =		8.134				(27b)
Rooflights Type 4			1.06	x1/[1/(1.4) + 0.04] =		1.484				(27b)
Floor Type 1			99.35	x	0.13	= 12.9155				(28)
Floor Type 2			1.56	x	0.13	= 0.2028				(28)
Walls Type1	449.95	93.02	356.93	x	0.16	= 57.11				(29)
Walls Type2	141.92	0	141.92	x	0.13	= 18.45				(29)
Roof	100.91	19.51	81.4	x	0.11	= 8.95				(30)
Total area of elements, m²			793.69							(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) =	237.65	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	78530.16	(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		61.23	(36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss	(33) + (36) =	298.88	(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=	107.89	106.57	105.24	98.59	97.26	90.62	90.62	89.29	93.28	97.26	99.92	102.58	(38)

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

(39)m=	406.78	405.45	404.12	397.48	396.15	389.5	389.5	388.18	392.16	396.15	398.81	401.46	

Average = $Sum(39)_{1…12}$ /12= 397.14 (39)

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

(40)m=	1.3	1.29	1.29	1.27	1.27	1.24	1.24	1.24	1.25	1.27	1.27	1.28

Average = $Sum(40)_{1…12}$ /12= 1.27 (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 3.15 (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) + 36 108.99 (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)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	119.89	115.53	111.17	106.81	102.45	98.09	98.09	102.45	106.81	111.17	115.53	119.89

Total = $Sum(44)_{1…12}$ = 1307.86 (44)

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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=	177.79	155.5	160.46	139.89	134.23	115.83	107.33	123.17	124.64	145.25	158.55	172.18

Total = Sum(45)1...12 = 1714.81 (45)

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

(46)m=	26.67	23.32	24.07	20.98	20.13	17.37	16.1	18.47	18.7	21.79	23.78	25.83	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 300 (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): 1.69 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.91 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0.91 (55)

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

(56)m=	28.29	25.55	28.29	27.38	28.29	27.38	28.29	28.29	27.38	28.29	27.38	28.29	(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=	28.29	25.55	28.29	27.38	28.29	27.38	28.29	28.29	27.38	28.29	27.38	28.29	(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)

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=	229.34	202.06	212.01	189.78	185.78	165.72	158.89	174.72	174.53	196.81	208.44	223.73	(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=	229.34	202.06	212.01	189.78	185.78	165.72	158.89	174.72	174.53	196.81	208.44	223.73

Output from water heater (annual)1...12 2321.81 (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=	100.36	88.95	94.59	86.43	85.87	78.43	76.93	82.2	81.35	89.54	92.63	98.49	(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=	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	157.45	(66)

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

(67)m=	41.79	37.12	30.19	22.86	17.08	14.42	15.58	20.26	27.19	34.52	40.29	42.96	(67)

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

(68)m=	468.8	473.67	461.41	435.31	402.37	371.41	350.72	345.86	358.11	384.21	417.16	448.12	(68)

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

(69)m=	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	(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=	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	-125.96	(71)

Water heating gains (Table 5)

(72)m=	134.89	132.37	127.14	120.04	115.42	108.92	103.4	110.48	112.99	120.35	128.65	132.38	(72)

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

(73)m=	718.72	716.4	691.98	651.44	608.11	567.99	542.94	549.83	571.53	612.32	659.34	696.69	(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	6.58	x	11.28	x	0.6	x	0.8	=	24.7	(75)
Northeast 0.9x	0.77	x	3.22	x	11.28	x	0.6	x	0.8	=	12.09	(75)
Northeast 0.9x	0.77	x	1.68	x	11.28	x	0.6	x	0.8	=	6.31	(75)
Northeast 0.9x	0.77	x	2.26	x	11.28	x	0.6	x	0.8	=	8.48	(75)
Northeast 0.9x	0.77	x	1.18	x	11.28	x	0.6	x	0.8	=	4.43	(75)
Northeast 0.9x	0.77	x	8.78	x	11.28	x	0.6	x	0.8	=	32.95	(75)
Northeast 0.9x	0.77	x	6.58	x	22.97	x	0.6	x	0.8	=	50.27	(75)
Northeast 0.9x	0.77	x	3.22	x	22.97	x	0.6	x	0.8	=	24.6	(75)
Northeast 0.9x	0.77	x	1.68	x	22.97	x	0.6	x	0.8	=	12.83	(75)
Northeast 0.9x	0.77	x	2.26	x	22.97	x	0.6	x	0.8	=	17.27	(75)
Northeast 0.9x	0.77	x	1.18	x	22.97	x	0.6	x	0.8	=	9.01	(75)
Northeast 0.9x	0.77	x	8.78	x	22.97	x	0.6	x	0.8	=	67.08	(75)
Northeast 0.9x	0.77	x	6.58	x	41.38	x	0.6	x	0.8	=	90.57	(75)
Northeast 0.9x	0.77	x	3.22	x	41.38	x	0.6	x	0.8	=	44.32	(75)
Northeast 0.9x	0.77	x	1.68	x	41.38	x	0.6	x	0.8	=	23.12	(75)
Northeast 0.9x	0.77	x	2.26	x	41.38	x	0.6	x	0.8	=	31.11	(75)
Northeast 0.9x	0.77	x	1.18	x	41.38	x	0.6	x	0.8	=	16.24	(75)
Northeast 0.9x	0.77	x	8.78	x	41.38	x	0.6	x	0.8	=	120.85	(75)
Northeast 0.9x	0.77	x	6.58	x	67.96	x	0.6	x	0.8	=	148.74	(75)
Northeast 0.9x	0.77	x	3.22	x	67.96	x	0.6	x	0.8	=	72.79	(75)
Northeast 0.9x	0.77	x	1.68	x	67.96	x	0.6	x	0.8	=	37.98	(75)

DER WorkSheet: New dwelling design stage

Northeast 0.9x	0.77	x	2.26	x	67.96	x	0.6	x	0.8	=	51.09	(75)
Northeast 0.9x	0.77	x	1.18	x	67.96	x	0.6	x	0.8	=	26.67	(75)
Northeast 0.9x	0.77	x	8.78	x	67.96	x	0.6	x	0.8	=	198.47	(75)
Northeast 0.9x	0.77	x	6.58	x	91.35	x	0.6	x	0.8	=	199.94	(75)
Northeast 0.9x	0.77	x	3.22	x	91.35	x	0.6	x	0.8	=	97.84	(75)
Northeast 0.9x	0.77	x	1.68	x	91.35	x	0.6	x	0.8	=	51.05	(75)
Northeast 0.9x	0.77	x	2.26	x	91.35	x	0.6	x	0.8	=	68.67	(75)
Northeast 0.9x	0.77	x	1.18	x	91.35	x	0.6	x	0.8	=	35.85	(75)
Northeast 0.9x	0.77	x	8.78	x	91.35	x	0.6	x	0.8	=	266.78	(75)
Northeast 0.9x	0.77	x	6.58	x	97.38	x	0.6	x	0.8	=	213.15	(75)
Northeast 0.9x	0.77	x	3.22	x	97.38	x	0.6	x	0.8	=	104.31	(75)
Northeast 0.9x	0.77	x	1.68	x	97.38	x	0.6	x	0.8	=	54.42	(75)
Northeast 0.9x	0.77	x	2.26	x	97.38	x	0.6	x	0.8	=	73.21	(75)
Northeast 0.9x	0.77	x	1.18	x	97.38	x	0.6	x	0.8	=	38.22	(75)
Northeast 0.9x	0.77	x	8.78	x	97.38	x	0.6	x	0.8	=	284.42	(75)
Northeast 0.9x	0.77	x	6.58	x	91.1	x	0.6	x	0.8	=	199.4	(75)
Northeast 0.9x	0.77	x	3.22	x	91.1	x	0.6	x	0.8	=	97.58	(75)
Northeast 0.9x	0.77	x	1.68	x	91.1	x	0.6	x	0.8	=	50.91	(75)
Northeast 0.9x	0.77	x	2.26	x	91.1	x	0.6	x	0.8	=	68.49	(75)
Northeast 0.9x	0.77	x	1.18	x	91.1	x	0.6	x	0.8	=	35.76	(75)
Northeast 0.9x	0.77	x	8.78	x	91.1	x	0.6	x	0.8	=	266.07	(75)
Northeast 0.9x	0.77	x	6.58	x	72.63	x	0.6	x	0.8	=	158.96	(75)
Northeast 0.9x	0.77	x	3.22	x	72.63	x	0.6	x	0.8	=	77.79	(75)
Northeast 0.9x	0.77	x	1.68	x	72.63	x	0.6	x	0.8	=	40.59	(75)
Northeast 0.9x	0.77	x	2.26	x	72.63	x	0.6	x	0.8	=	54.6	(75)
Northeast 0.9x	0.77	x	1.18	x	72.63	x	0.6	x	0.8	=	28.51	(75)
Northeast 0.9x	0.77	x	8.78	x	72.63	x	0.6	x	0.8	=	212.11	(75)
Northeast 0.9x	0.77	x	6.58	x	50.42	x	0.6	x	0.8	=	110.36	(75)
Northeast 0.9x	0.77	x	3.22	x	50.42	x	0.6	x	0.8	=	54.01	(75)
Northeast 0.9x	0.77	x	1.68	x	50.42	x	0.6	x	0.8	=	28.18	(75)
Northeast 0.9x	0.77	x	2.26	x	50.42	x	0.6	x	0.8	=	37.9	(75)
Northeast 0.9x	0.77	x	1.18	x	50.42	x	0.6	x	0.8	=	19.79	(75)
Northeast 0.9x	0.77	x	8.78	x	50.42	x	0.6	x	0.8	=	147.26	(75)
Northeast 0.9x	0.77	x	6.58	x	28.07	x	0.6	x	0.8	=	61.43	(75)
Northeast 0.9x	0.77	x	3.22	x	28.07	x	0.6	x	0.8	=	30.06	(75)
Northeast 0.9x	0.77	x	1.68	x	28.07	x	0.6	x	0.8	=	15.68	(75)
Northeast 0.9x	0.77	x	2.26	x	28.07	x	0.6	x	0.8	=	21.1	(75)
Northeast 0.9x	0.77	x	1.18	x	28.07	x	0.6	x	0.8	=	11.02	(75)
Northeast 0.9x	0.77	x	8.78	x	28.07	x	0.6	x	0.8	=	81.97	(75)
Northeast 0.9x	0.77	x	6.58	x	14.2	x	0.6	x	0.8	=	31.07	(75)
Northeast 0.9x	0.77	x	3.22	x	14.2	x	0.6	x	0.8	=	15.21	(75)

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Northeast	0.9x	0.77	x	1.68	x	14.2	x	0.6	x	0.8	=	7.93	(75)
Northeast	0.9x	0.77	x	2.26	x	14.2	x	0.6	x	0.8	=	10.67	(75)
Northeast	0.9x	0.77	x	1.18	x	14.2	x	0.6	x	0.8	=	5.57	(75)
Northeast	0.9x	0.77	x	8.78	x	14.2	x	0.6	x	0.8	=	41.46	(75)
Northeast	0.9x	0.77	x	6.58	x	9.21	x	0.6	x	0.8	=	20.17	(75)
Northeast	0.9x	0.77	x	3.22	x	9.21	x	0.6	x	0.8	=	9.87	(75)
Northeast	0.9x	0.77	x	1.68	x	9.21	x	0.6	x	0.8	=	5.15	(75)
Northeast	0.9x	0.77	x	2.26	x	9.21	x	0.6	x	0.8	=	6.93	(75)
Northeast	0.9x	0.77	x	1.18	x	9.21	x	0.6	x	0.8	=	3.62	(75)
Northeast	0.9x	0.77	x	8.78	x	9.21	x	0.6	x	0.8	=	26.91	(75)
Southeast	0.9x	0.77	x	1.89	x	36.79	x	0.6	x	0.8	=	69.4	(77)
Southeast	0.9x	0.77	x	27.06	x	36.79	x	0.6	x	0.8	=	331.19	(77)
Southeast	0.9x	0.77	x	1.89	x	62.67	x	0.6	x	0.8	=	118.21	(77)
Southeast	0.9x	0.77	x	27.06	x	62.67	x	0.6	x	0.8	=	564.14	(77)
Southeast	0.9x	0.77	x	1.89	x	85.75	x	0.6	x	0.8	=	161.74	(77)
Southeast	0.9x	0.77	x	27.06	x	85.75	x	0.6	x	0.8	=	771.88	(77)
Southeast	0.9x	0.77	x	1.89	x	106.25	x	0.6	x	0.8	=	200.4	(77)
Southeast	0.9x	0.77	x	27.06	x	106.25	x	0.6	x	0.8	=	956.4	(77)
Southeast	0.9x	0.77	x	1.89	x	119.01	x	0.6	x	0.8	=	224.46	(77)
Southeast	0.9x	0.77	x	27.06	x	119.01	x	0.6	x	0.8	=	1071.24	(77)
Southeast	0.9x	0.77	x	1.89	x	118.15	x	0.6	x	0.8	=	222.84	(77)
Southeast	0.9x	0.77	x	27.06	x	118.15	x	0.6	x	0.8	=	1063.5	(77)
Southeast	0.9x	0.77	x	1.89	x	113.91	x	0.6	x	0.8	=	214.84	(77)
Southeast	0.9x	0.77	x	27.06	x	113.91	x	0.6	x	0.8	=	1025.32	(77)
Southeast	0.9x	0.77	x	1.89	x	104.39	x	0.6	x	0.8	=	196.89	(77)
Southeast	0.9x	0.77	x	27.06	x	104.39	x	0.6	x	0.8	=	939.64	(77)
Southeast	0.9x	0.77	x	1.89	x	92.85	x	0.6	x	0.8	=	175.13	(77)
Southeast	0.9x	0.77	x	27.06	x	92.85	x	0.6	x	0.8	=	835.78	(77)
Southeast	0.9x	0.77	x	1.89	x	69.27	x	0.6	x	0.8	=	130.64	(77)
Southeast	0.9x	0.77	x	27.06	x	69.27	x	0.6	x	0.8	=	623.49	(77)
Southeast	0.9x	0.77	x	1.89	x	44.07	x	0.6	x	0.8	=	83.12	(77)
Southeast	0.9x	0.77	x	27.06	x	44.07	x	0.6	x	0.8	=	396.69	(77)
Southeast	0.9x	0.77	x	1.89	x	31.49	x	0.6	x	0.8	=	59.39	(77)
Southeast	0.9x	0.77	x	27.06	x	31.49	x	0.6	x	0.8	=	283.43	(77)
Southwest	0.9x	0.77	x	1.4	x	36.79		0.6	x	0.8	=	17.13	(79)
Southwest	0.9x	0.77	x	3.5	x	36.79		0.6	x	0.8	=	42.84	(79)
Southwest	0.9x	0.77	x	1.92	x	36.79		0.6	x	0.8	=	23.5	(79)
Southwest	0.9x	0.77	x	4.8	x	36.79		0.6	x	0.8	=	58.75	(79)
Southwest	0.9x	0.77	x	10.2	x	36.79		0.6	x	0.8	=	124.84	(79)
Southwest	0.9x	0.77	x	1.4	x	62.67		0.6	x	0.8	=	29.19	(79)
Southwest	0.9x	0.77	x	3.5	x	62.67		0.6	x	0.8	=	72.97	(79)

Southwest	0.9x	0.77	x	1.92	x	62.67	0.6	x	0.8	=	40.03	(79)
Southwest	0.9x	0.77	x	4.8	x	62.67	0.6	x	0.8	=	100.07	(79)
Southwest	0.9x	0.77	x	10.2	x	62.67	0.6	x	0.8	=	212.65	(79)
Southwest	0.9x	0.77	x	1.4	x	85.75	0.6	x	0.8	=	39.93	(79)
Southwest	0.9x	0.77	x	3.5	x	85.75	0.6	x	0.8	=	99.84	(79)
Southwest	0.9x	0.77	x	1.92	x	85.75	0.6	x	0.8	=	54.77	(79)
Southwest	0.9x	0.77	x	4.8	x	85.75	0.6	x	0.8	=	136.92	(79)
Southwest	0.9x	0.77	x	10.2	x	85.75	0.6	x	0.8	=	290.95	(79)
Southwest	0.9x	0.77	x	1.4	x	106.25	0.6	x	0.8	=	49.48	(79)
Southwest	0.9x	0.77	x	3.5	x	106.25	0.6	x	0.8	=	123.7	(79)
Southwest	0.9x	0.77	x	1.92	x	106.25	0.6	x	0.8	=	67.86	(79)
Southwest	0.9x	0.77	x	4.8	x	106.25	0.6	x	0.8	=	169.65	(79)
Southwest	0.9x	0.77	x	10.2	x	106.25	0.6	x	0.8	=	360.5	(79)
Southwest	0.9x	0.77	x	1.4	x	119.01	0.6	x	0.8	=	55.42	(79)
Southwest	0.9x	0.77	x	3.5	x	119.01	0.6	x	0.8	=	138.56	(79)
Southwest	0.9x	0.77	x	1.92	x	119.01	0.6	x	0.8	=	76.01	(79)
Southwest	0.9x	0.77	x	4.8	x	119.01	0.6	x	0.8	=	190.02	(79)
Southwest	0.9x	0.77	x	10.2	x	119.01	0.6	x	0.8	=	403.79	(79)
Southwest	0.9x	0.77	x	1.4	x	118.15	0.6	x	0.8	=	55.02	(79)
Southwest	0.9x	0.77	x	3.5	x	118.15	0.6	x	0.8	=	137.55	(79)
Southwest	0.9x	0.77	x	1.92	x	118.15	0.6	x	0.8	=	75.46	(79)
Southwest	0.9x	0.77	x	4.8	x	118.15	0.6	x	0.8	=	188.65	(79)
Southwest	0.9x	0.77	x	10.2	x	118.15	0.6	x	0.8	=	400.87	(79)
Southwest	0.9x	0.77	x	1.4	x	113.91	0.6	x	0.8	=	53.05	(79)
Southwest	0.9x	0.77	x	3.5	x	113.91	0.6	x	0.8	=	132.62	(79)
Southwest	0.9x	0.77	x	1.92	x	113.91	0.6	x	0.8	=	72.75	(79)
Southwest	0.9x	0.77	x	4.8	x	113.91	0.6	x	0.8	=	181.88	(79)
Southwest	0.9x	0.77	x	10.2	x	113.91	0.6	x	0.8	=	386.49	(79)
Southwest	0.9x	0.77	x	1.4	x	104.39	0.6	x	0.8	=	48.61	(79)
Southwest	0.9x	0.77	x	3.5	x	104.39	0.6	x	0.8	=	121.54	(79)
Southwest	0.9x	0.77	x	1.92	x	104.39	0.6	x	0.8	=	66.67	(79)
Southwest	0.9x	0.77	x	4.8	x	104.39	0.6	x	0.8	=	166.68	(79)
Southwest	0.9x	0.77	x	10.2	x	104.39	0.6	x	0.8	=	354.19	(79)
Southwest	0.9x	0.77	x	1.4	x	92.85	0.6	x	0.8	=	43.24	(79)
Southwest	0.9x	0.77	x	3.5	x	92.85	0.6	x	0.8	=	108.1	(79)
Southwest	0.9x	0.77	x	1.92	x	92.85	0.6	x	0.8	=	59.3	(79)
Southwest	0.9x	0.77	x	4.8	x	92.85	0.6	x	0.8	=	148.25	(79)
Southwest	0.9x	0.77	x	10.2	x	92.85	0.6	x	0.8	=	315.04	(79)
Southwest	0.9x	0.77	x	1.4	x	69.27	0.6	x	0.8	=	32.26	(79)
Southwest	0.9x	0.77	x	3.5	x	69.27	0.6	x	0.8	=	80.64	(79)
Southwest	0.9x	0.77	x	1.92	x	69.27	0.6	x	0.8	=	44.24	(79)

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Southwest	0.9x	0.77	x	4.8	x	69.27		0.6	x	0.8	=	110.6	(79)
Southwest	0.9x	0.77	x	10.2	x	69.27		0.6	x	0.8	=	235.02	(79)
Southwest	0.9x	0.77	x	1.4	x	44.07		0.6	x	0.8	=	20.52	(79)
Southwest	0.9x	0.77	x	3.5	x	44.07		0.6	x	0.8	=	51.31	(79)
Southwest	0.9x	0.77	x	1.92	x	44.07		0.6	x	0.8	=	28.15	(79)
Southwest	0.9x	0.77	x	4.8	x	44.07		0.6	x	0.8	=	70.37	(79)
Southwest	0.9x	0.77	x	10.2	x	44.07		0.6	x	0.8	=	149.53	(79)
Southwest	0.9x	0.77	x	1.4	x	31.49		0.6	x	0.8	=	14.66	(79)
Southwest	0.9x	0.77	x	3.5	x	31.49		0.6	x	0.8	=	36.66	(79)
Southwest	0.9x	0.77	x	1.92	x	31.49		0.6	x	0.8	=	20.11	(79)
Southwest	0.9x	0.77	x	4.8	x	31.49		0.6	x	0.8	=	50.28	(79)
Southwest	0.9x	0.77	x	10.2	x	31.49		0.6	x	0.8	=	106.84	(79)
Northwest	0.9x	0.77	x	14.25	x	11.28	x	0.6	x	0.8	=	53.48	(81)
Northwest	0.9x	0.77	x	14.25	x	22.97	x	0.6	x	0.8	=	108.87	(81)
Northwest	0.9x	0.77	x	14.25	x	41.38	x	0.6	x	0.8	=	196.14	(81)
Northwest	0.9x	0.77	x	14.25	x	67.96	x	0.6	x	0.8	=	322.12	(81)
Northwest	0.9x	0.77	x	14.25	x	91.35	x	0.6	x	0.8	=	432.99	(81)
Northwest	0.9x	0.77	x	14.25	x	97.38	x	0.6	x	0.8	=	461.61	(81)
Northwest	0.9x	0.77	x	14.25	x	91.1	x	0.6	x	0.8	=	431.83	(81)
Northwest	0.9x	0.77	x	14.25	x	72.63	x	0.6	x	0.8	=	344.26	(81)
Northwest	0.9x	0.77	x	14.25	x	50.42	x	0.6	x	0.8	=	239	(81)
Northwest	0.9x	0.77	x	14.25	x	28.07	x	0.6	x	0.8	=	133.04	(81)
Northwest	0.9x	0.77	x	14.25	x	14.2	x	0.6	x	0.8	=	67.29	(81)
Northwest	0.9x	0.77	x	14.25	x	9.21	x	0.6	x	0.8	=	43.68	(81)
Rooflights	0.9x	1	x	10.95	x	26	x	0.5	x	0.8	=	102.52	(82)
Rooflights	0.9x	1	x	1.69	x	26	x	0.5	x	0.8	=	15.82	(82)
Rooflights	0.9x	1	x	5.81	x	26	x	0.5	x	0.8	=	54.38	(82)
Rooflights	0.9x	1	x	1.06	x	26	x	0.5	x	0.8	=	9.92	(82)
Rooflights	0.9x	1	x	10.95	x	54	x	0.5	x	0.8	=	212.93	(82)
Rooflights	0.9x	1	x	1.69	x	54	x	0.5	x	0.8	=	32.85	(82)
Rooflights	0.9x	1	x	5.81	x	54	x	0.5	x	0.8	=	112.95	(82)
Rooflights	0.9x	1	x	1.06	x	54	x	0.5	x	0.8	=	20.61	(82)
Rooflights	0.9x	1	x	10.95	x	96	x	0.5	x	0.8	=	378.54	(82)
Rooflights	0.9x	1	x	1.69	x	96	x	0.5	x	0.8	=	58.41	(82)
Rooflights	0.9x	1	x	5.81	x	96	x	0.5	x	0.8	=	200.79	(82)
Rooflights	0.9x	1	x	1.06	x	96	x	0.5	x	0.8	=	36.63	(82)
Rooflights	0.9x	1	x	10.95	x	150	x	0.5	x	0.8	=	591.47	(82)
Rooflights	0.9x	1	x	1.69	x	150	x	0.5	x	0.8	=	91.26	(82)
Rooflights	0.9x	1	x	5.81	x	150	x	0.5	x	0.8	=	313.74	(82)
Rooflights	0.9x	1	x	1.06	x	150	x	0.5	x	0.8	=	57.24	(82)
Rooflights	0.9x	1	x	10.95	x	192	x	0.5	x	0.8	=	757.09	(82)

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Rooflights 0.9x	1	x	1.69	x	192	x	0.5	x	0.8	=	116.81	(82)
Rooflights 0.9x	1	x	5.81	x	192	x	0.5	x	0.8	=	401.59	(82)
Rooflights 0.9x	1	x	1.06	x	192	x	0.5	x	0.8	=	73.27	(82)
Rooflights 0.9x	1	x	10.95	x	200	x	0.5	x	0.8	=	788.63	(82)
Rooflights 0.9x	1	x	1.69	x	200	x	0.5	x	0.8	=	121.68	(82)
Rooflights 0.9x	1	x	5.81	x	200	x	0.5	x	0.8	=	418.32	(82)
Rooflights 0.9x	1	x	1.06	x	200	x	0.5	x	0.8	=	76.32	(82)
Rooflights 0.9x	1	x	10.95	x	189	x	0.5	x	0.8	=	745.26	(82)
Rooflights 0.9x	1	x	1.69	x	189	x	0.5	x	0.8	=	114.99	(82)
Rooflights 0.9x	1	x	5.81	x	189	x	0.5	x	0.8	=	395.31	(82)
Rooflights 0.9x	1	x	1.06	x	189	x	0.5	x	0.8	=	72.12	(82)
Rooflights 0.9x	1	x	10.95	x	157	x	0.5	x	0.8	=	619.07	(82)
Rooflights 0.9x	1	x	1.69	x	157	x	0.5	x	0.8	=	95.52	(82)
Rooflights 0.9x	1	x	5.81	x	157	x	0.5	x	0.8	=	328.38	(82)
Rooflights 0.9x	1	x	1.06	x	157	x	0.5	x	0.8	=	59.91	(82)
Rooflights 0.9x	1	x	10.95	x	115	x	0.5	x	0.8	=	453.46	(82)
Rooflights 0.9x	1	x	1.69	x	115	x	0.5	x	0.8	=	69.97	(82)
Rooflights 0.9x	1	x	5.81	x	115	x	0.5	x	0.8	=	240.53	(82)
Rooflights 0.9x	1	x	1.06	x	115	x	0.5	x	0.8	=	43.88	(82)
Rooflights 0.9x	1	x	10.95	x	66	x	0.5	x	0.8	=	260.25	(82)
Rooflights 0.9x	1	x	1.69	x	66	x	0.5	x	0.8	=	40.15	(82)
Rooflights 0.9x	1	x	5.81	x	66	x	0.5	x	0.8	=	138.05	(82)
Rooflights 0.9x	1	x	1.06	x	66	x	0.5	x	0.8	=	25.19	(82)
Rooflights 0.9x	1	x	10.95	x	33	x	0.5	x	0.8	=	130.12	(82)
Rooflights 0.9x	1	x	1.69	x	33	x	0.5	x	0.8	=	20.08	(82)
Rooflights 0.9x	1	x	5.81	x	33	x	0.5	x	0.8	=	69.02	(82)
Rooflights 0.9x	1	x	1.06	x	33	x	0.5	x	0.8	=	12.59	(82)
Rooflights 0.9x	1	x	10.95	x	21	x	0.5	x	0.8	=	82.81	(82)
Rooflights 0.9x	1	x	1.69	x	21	x	0.5	x	0.8	=	12.78	(82)
Rooflights 0.9x	1	x	5.81	x	21	x	0.5	x	0.8	=	43.92	(82)
Rooflights 0.9x	1	x	1.06	x	21	x	0.5	x	0.8	=	8.01	(82)

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

(83)m=	992.72	1806.5	2752.75	3839.56	4661.38	4778.19	4544.65	3913.92	3129.19	2074.84	1210.72	835.2	(83)

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

(84)m=	1711.44	2522.9	3444.73	4490.99	5269.49	5346.18	5087.59	4463.75	3700.72	2687.16	1870.06	1531.89	(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	0.99	0.96	0.85	0.65	0.46	0.34	0.4	0.68	0.95	1	1	(86)

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

(87)m=	19.83	20.06	20.38	20.72	20.89	20.93	20.94	20.94	20.9	20.6	20.13	19.8	(87)

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

(88)m=	19.84	19.84	19.85	19.86	19.87	19.89	19.89	19.89	19.88	19.87	19.86	19.85	(88)

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

(89)m=	1	0.99	0.95	0.81	0.59	0.38	0.25	0.3	0.59	0.92	0.99	1	(89)

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

(90)m=	18.27	18.61	19.08	19.55	19.74	19.8	19.8	19.8	19.76	19.4	18.73	18.24	(90)

fLA = Living area ÷ (4) = 0.22 (91)

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

(92)m=	18.62	18.93	19.37	19.81	19.99	20.05	20.05	20.05	20.01	19.66	19.04	18.58	(92)

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

(93)m=	18.62	18.93	19.37	19.81	19.99	20.05	20.05	20.05	20.01	19.66	19.04	18.58	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.94	0.81	0.6	0.39	0.26	0.32	0.6	0.92	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1706.91	2488.52	3249.25	3628.96	3137.74	2105.06	1342.39	1413.8	2215.18	2469.72	1855.06	1529.41	(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=	5823.37	5689.13	5199.43	4334.86	3284.63	2121.43	1344.23	1418.05	2318.78	3590.11	4762.47	5773.51	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	3062.65	2150.81	1450.93	508.25	109.28	0	0	0	0	833.58	2093.33	3157.61	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 13366.44 (98)

Space heating requirement in kWh/m²/year 42.69 (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)
Efficiency of main space heating system 1		88.1	(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)													
	3062.65	2150.81	1450.93	508.25	109.28	0	0	0	0	833.58	2093.33	3157.61	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	3476.33	2441.33	1646.91	576.9	124.04	0	0	0	0	946.17	2376.09	3584.12	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 15171.89 (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)

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Water heating

Output from water heater (calculated above)

	229.34	202.06	212.01	189.78	185.78	165.72	158.89	174.72	174.53	196.81	208.44	223.73	
Efficiency of water heater												78	(216)
(217)m=	87.31	87.13	86.67	85.1	81.46	78	78	78	78	85.97	87.08	87.35	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	262.67	231.9	244.62	223	228.07	212.46	203.7	224	223.75	228.91	239.37	256.13	
Total = $Sum(219a)_{1...12}$ =												2778.59	(219)

Annual totals		kWh/year	kWh/year	
Space heating fuel used, main system 1			15171.89	
Water heating fuel used			2778.59	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		1719.32		(230a)
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		1749.32	(231)
Electricity for lighting			738.1	(232)
Electricity generated by PVs			-1630.23	(233)

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	=	3277.13	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	600.17	(264)
Space and water heating	(261) + (262) + (263) + (264) =			3877.3	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	907.9	(267)
Electricity for lighting	(232) x	0.519	=	383.07	(268)
Energy saving/generation technologies Item 1		0.519	=	-846.09	(269)
Total CO2, kg/year		sum of (265)…(271) =		4322.19	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		13.8	(273)
El rating (section 14)				84	(274)