Energy Strategy Report

151-153 Camden High Street, London, NW1 7JY

October 2019

Ref: 19-5251

Quality Standards Control

The signatories below verify that this document has been prepared in accordance with our quality control requirements. These procedures do not affect the content and views expressed by the originator.

Revision	*Initial*	*Rev A*	*Rev B*	*Rev C*
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1. Executive Summary

This Energy Statement demonstrates the predicted energy performance and carbon dioxide emissions of the proposed development at **151-153 Camden High Street, London, NW1 7JY,** based on the information provided by the design team. The development will comprise of **a refurbishment a 2-storey apartment and erection of 2nd floor rear extension and roof extension residential building.**

Policy Requirements

The Council requires new developments to incorporate sustainable design and construction measures. The table below summarises the local policy requirements for the proposed development.

Policies	Requirements	Compliance Check
Local Plan Policy CC1	All new residential development will also be required to demonstrate a 19% CO2 reduction below Part L 2013 Building Regulations and 20% carbon reduction via on-site renewable technologies	The development achieved a carbon reduction of 75.43% over Part L 2013 baseline via energy efficient measures. The development achieved an overall carbon reduction of 21.39% via PV.
Local Plan Policy CC2	BREEAM domestic refurbishment 'Excellent' for conversions and extensions of 500 sqm of residential floorspace or above or five or more dwellings.	Since the development consists of 2 dwellings of a total of 193.09 sqm, BREEAM 'Excellent' was not targeted.

Table 1 Policy Requirements

Methodology and Strategies

The methodology used to determine the CO_2 emissions is in accordance with the London Plan's three-step Energy Hierarchy (Policy 5.2). The below table shows the Energy Hierarchy and suggested strategies for the proposed development.

Stages	Strategies
BE LEAN Energy efficient design	• U-values better and air permeability better than Building Regulations Part L; • High efficiency electric boiler for heating and hot water. • Low energy (LED) type lighting; • Natural ventilation
BE CLEAN District heat networks or communal heating systems	As there are no current or proposed district heat networks and the size of the development is not suitable for CHP this stage of the hierarchy is not feasible for this scheme. Details can be found in section 8.1.
BE GREEN On-site renewable technologies	• PV panels of 4.725 kWp on the roof (approximate 15 panels with 315 w/p are required). Details are in Section **Error! Reference source not found.**.

Table 2 Energy Hierarchy and suggested strategies

Assessment Results

After the application of all strategies based on the Energy Hierarchy, the regulated carbon dioxide emissions have been reduced as follows;

Energy Hierarchy		**Regulated Carbon Emissions** (Tonnes CO_2/yr)
BASELINE	TER set by Building Regulations 2013 Part L	27.90
BE LEAN	After energy demand reduction	8.72
BE CLEAN	After CHP/ Communal Heating	8.72
BE GREEN	After renewable energy	6.85

Table 3 Carbon Emissions after each stage of the proposed strategy

This carbon savings from each stage can be calculated based on the results above. The table below summarises the total cumulative savings:

Energy Hierarchy		Regulated Carbon Savings	
		Tonnes CO_2/yr	%
BE LEAN	After energy demand reduction	19.18	68.75 %
BE CLEAN	After heat network/ CHP	0	0
BE GREEN	After renewable energy	1.87	21.39%
Total Cumulative Savings		**21.05**	**75.43%**
Total Target Savings		5.30	19 %

Table 4 Carbon dioxide Emissions after each stage of the Energy Hierarchy

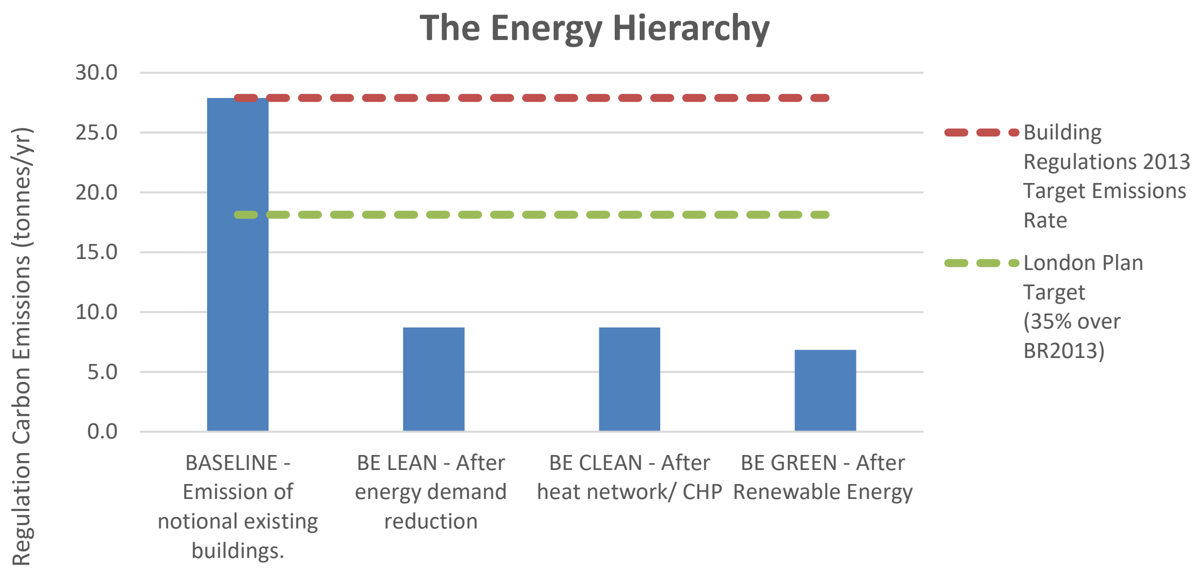


Figure 1 The Energy Hierarchy

2. Introduction

This Energy Statement will be included as part of the planning application that addresses the environmental impact of the development. This report focuses on the energy strategy for the proposed scheme and how energy consumption and carbon emissions will be minimised and to meet the targeted carbon emissions in accordance with the London Plan and Local planning policy.

The development is to be located in the **London Borough of Camden** and it is in close proximity to Camden town underground Station (approximately 150 meters to the North) and Camden road station (approximately 500 meters to the North East). The proposal is **a refurbishment a 2-storey apartment and erection of 2nd floor rear extension and roof extension residential building at 151-153 Camden High Street, London, NW1 7JY.**

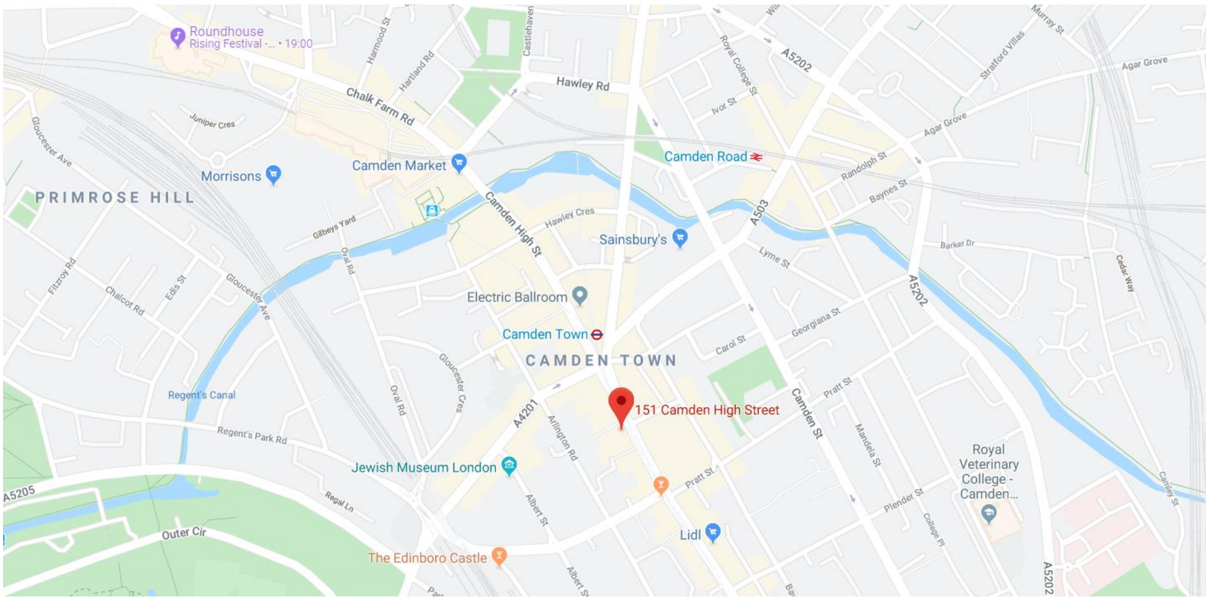


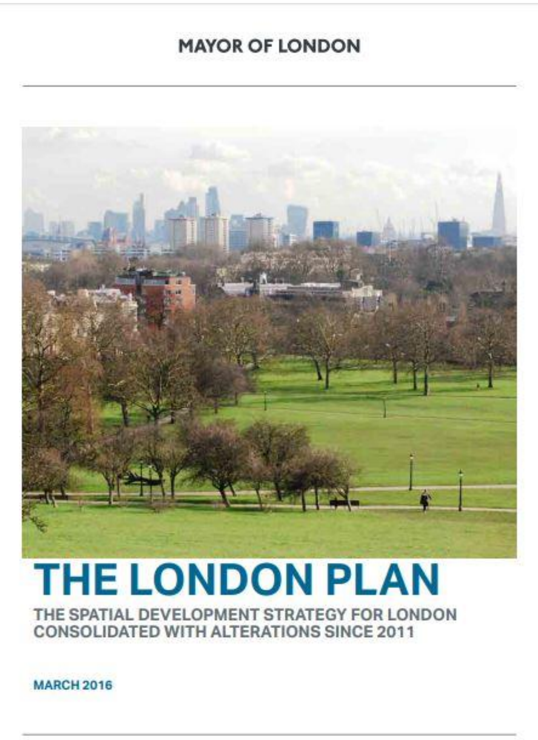
Figure 2 Site Location

3. Planning Policy

National Planning Policy Framework (February 2019)

The National Planning Policy Framework is a key part of our reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth.

The London Plan (March 2016)



Policy 5.2, 5.4, 5.5, 5.6, & 5.7

According to Policy 5.2 all major new developments should show carbon emissions reduction through the Mayor's energy hierarchy (Be Lean, Be Clean and Be Green), unless it can be demonstrated that such provision is not feasible. From October 2016 Zero Carbon Standard apply to all new major residential development (10 or more units). This means that at least 35% of carbon reductions against a Building Regulations Part L 2013 must be achieved on-site, with the remaining emissions, up to 100%, to be offset through a contribution to the Council's Carbon Offset Fund. For the non-residential development, must achieve a 35% reduction in CO_2 emissions against a Building Regulations Part L 2013 baseline.
For retrofitting developments, it will be a challenge to meet these targets. However, available reductions in carbon emissions should be demonstrated along with water saving measures as per Policy 5.4.
Furthermore, intent must be shown for connecting to a Decentralised Energy Network and utilizing a Combined Heat & Power according to Policy 5.5 and 5.6. The Mayor and boroughs should in their DPDs adopt a presumption that developments will achieve a reduction in carbon dioxide emissions of 20% from onsite renewable energy generation according to paragraph 5.42 of Policy 5.7

London Borough of Camden

<u>Core Strategy</u> <u>(Adopted in 2010)</u>

Policy CS13 – Tackling climate change through promoting higher environmental standards

Reducing the effects of and adapting to climate change

The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:

a) Ensuring patterns of land use that minimize the need to travel by car and hep support local energy networks;
b) Promoting the efficient use of land and buildings;
c) Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all the elements of the following energy hierarchy:
    - Ensuring developments use less energy,
    - Making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;
    - Generating renewable energy on-site; and
d) Ensuring buildings and spaces are designed to cope with, and minimize the effects of, climate change.

The Council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reductions in carbon dioxide emissions.

Local Plan (Adopted July 2017)

Policy CC1 – Climate change mitigation

The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation.
We will:

a. Promote zero development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy;
b. Require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met;
c. Ensure that the location of development and mix of land uses minimise the need to travel by car and help to support decentralised energy networks;
d. Support and encourage sensitive energy efficiency improvements to existing building;
e. Require all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building; and
f. Expect all developments to optimise resource efficiency.

For decentralised energy networks, we will promote decentralised energy by:

g. Working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them;
h. Protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes; and
i. Requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network.

To ensure that the Council can monitor the effectiveness of renewable and low carbon technologies, major developments will be required to install appropriate monitoring equipment.

The energy hierarchy

The Council's Sustainability Plan 'Green Action for Change' commits the Council to seek low and where possible zero carbon buildings. New developments in Camden will be expected to be designed to minimise energy use and CO2 emissions in operation through the application of the energy hierarchy. It is understood that some sustainable design measures may be challenging for listed buildings and some conservation areas and we would advise developers to engage early with the Council to develop innovative solutions.

The energy hierarchy is a sequence of steps that minimise the energy consumption of a building. Buildings designed in line with the energy hierarchy prioritise lower cost passive design measures, such as improved fabric performance over higher cost active systems such as renewable energy technologies.

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

Policy CC2 – Adapting to climate change

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

All development should adopt appropriate climate change adaptation.

a. The protection of existing green spaces and promoting new appropriate green infrastructure;
b. Not increasing, and wherever possible reducing, surface water run-off through increasing permeable surfaces and use of Sustainable Drainage Systems;
c. Incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and
d. Measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

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

Sustainable design and constructions measures

The Council will promote and measure sustainable design and construction by:

e. Ensuring development schemes demonstrate how adaptation measures and sustainable development principles have been incorporated into the design and proposed implementation;
f. Encourage new build residential development to use the Home Quality Mark and Passivhaus design standards;
g. Encouraging conversions and extensions of 500 sqm of residential floorspace or above or five or more dwellings to achieve "excellent" in BREEAM Domestic refurbishment; and
h. Expecting non-domestic developments of 500 sqm of floorspace or above to achieve "excellent" in BREEAM assessments and encouraging zero carbon in new development from 2019.

Policy CC3 – Water and flooding

The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible.

We will require development to:

a. Incorporate water efficiency measures;
b. Avoid harm to the water environment and improve water quality;
c. Consider the impact of development in areas at risk of flooding (including drainage);
d. Incorporate flood resilient measures in areas prone to flooding;
e. Utilize Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible; and
f. Not locate vulnerable development in flood-prone areas.

Where an assessment of flood risk is required, developments should consider surface water flooding in detail and groundwater flooding where applicable.

The Council will protect the borough's existing drinking water and foul water infrastructure, including the reservoirs at Barrow Hill, Hampstead Heath, Highgate and Kidderpore.

4. Assessment Methodology

Mayor's Energy Hierarchy

The energy hierarchy is a classification of different methods to improve energy performance in a parallel sequence. This includes primarily a focus on reducing energy use by avoiding unnecessary use, to then improving the efficiency of energy systems to minimise loss, this is followed by exploiting renewable energy sources and then low carbon energy solutions for energy needs and finally, any remaining demand can be catered for by conventional fuel sources.

The Mayor's Energy Strategy adopts a set of principles to guide design development and decisions regarding energy, balanced with the need to optimise environmental and economic benefits. These guiding principles have been reordered since the publication of the Mayor's Energy Strategy in Feb 2004 and the adopted replacement London Plan 2011 with further alterations in 2015 stating that the following hierarchy should be used to assess applications:

- **BE LEAN** – By using less energy and taking into account the further energy efficiency measure in comparison to the baseline building.
- **BE CLEAN** – By supplying energy efficiently. The clean building looks at further carbon dioxide emission savings over the lean building by taking into consideration the use of decentralise energy via CHP.
- **BE GREEN** – By integrating renewable energy into the scheme which can further reduce the carbon dioxide emission rate.

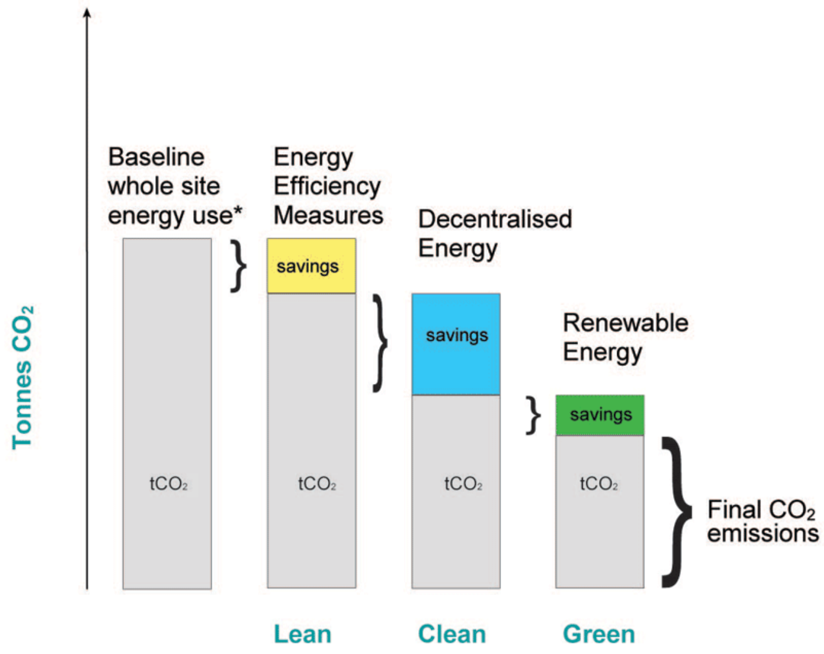


Figure 3 The Energy Hierarchy

Software and Input data

The Government approved software, i.e. **FSAP 2012**, have been utilised to carry out **Standard Assessment Procedure (SAP)** calculations.

Syntegra received the architectural drawings and relevant documents, and they were used to undertake the energy assessments. The document reference is listed in table below.

No.	Document Name	Format	Received Date
1	PLANNING	dwg	08-04-2019

Table 5 The document list

5. Baseline – Target Emission Rate

In regard to the conversion/ refurbishment area, the CO_2 emissions for the development are calculated based on the notional existing building conditions in accordance with GLA Guidance on preparing energy assessments (March 2016). The inputs were gathered during the site survey or assumed by the Reduced Data SAP (RdSAP) when the data was not available. To make a parallel comparison with the proposed building, the existing building was assumed as if it has same functions and geometry with the proposed building. The existing building conditions are summarised in the table below.

		Existing Specifications (Age band A set by RdSAP 2012)
U-value (W/m^2 K)	**Wall**	2.1 (solid brick as built)
	Window	4.8 (single glazing before 2002)
	Floor	1.2 (as built/ insulation unknown)
	Roof	2.3 (Pitched, slates or tiles, insulation at rafters)
	Door	3.0
Air Permeability ($m^3/h.m^2$ at 50 Pa)		35
Heating System		Direct acting electric boiler for radiator heating (SAP default efficiency - 100%)
Hot Water System		From main heating system boiler 110 litres, 12 mm loose jacket
Lighting		0% Low Energy Lights
Ventilation		Natural ventilation with no extract fans in wet rooms

Table 6 Existing Specifications used for energy assessment

The baseline regulated energy demand for the development is presented in the table below:

BASELINE

BASELINE	**Regulated CO_2 Emissions** (Tonnes CO_2/yr)
151-153 Camden High Street	27.90

Table 7 Regulated Carbon Emissions at Baseline

6. BE LEAN – Energy Efficient Design

This section outlines the energy efficient measures taken in order to minimise the building's energy demand and therefore reduce energy use and CO_2 emissions further than the Baseline requirements (Building Regulations 2013 Part L compliance).

Passive Design Measures

- **Enhanced Building Elements**

At the 'BE LEAN' stage of the energy hierarchy, energy efficient building elements have been incorporated into the build. The heat loss of different building element is dependent upon their U-value, air tightness, and thermal bridging y-values. Therefore, better U-values and air permeability than the minimum values set in the Part L 2013 have been suggested in this development. Please see the table below more specifically:

		Part L2b min. required values	Proposed building values
U-value ($W/m^2 K$)	Wall	New element - 0.28 Upgrade element – 0.3-0.55	New wall – 0.28
	Window unit	1.6	New window - 1.6 Replaced window – 1.6
	Floor	New element - 0.22 Upgrade element –0.25	New floor - 0.15 Retained ground floor – 0.25
	Roof	0.16 – 0.18	New roof - 0.18
	Door	1.8 - 3.5	New door – 1.2
Air Permeability ($m^3/h.m^2$ at 50 Pa)		-	4.5

Table 8 Proposed Building Elements

- **Orientation & Natural Daylighting**

Passive solar gain reduces the amount of energy required for space heating during the winter months. The building is typically positioned to have South-West outdoor area with North-East aspects which align with the roads and also maximise the passive solar gains into the building throughout the day. Moreover, the internal layout of the development has been designed to improve daylighting in all habitable spaces, as a way of improving the health and wellbeing of occupants.

- **Natural Ventilation**

A natural ventilation strategy will be adopted with extract fans in wet rooms; toilets, bathrooms, kitchens and utility rooms. Therefore, higher energy consumption and CO_2 emissions due to mechanical ventilation is avoided.

- **Water Efficiency**

In accordance with London Plan policy 5.15, the development will be based upon the specification of water efficient fittings including low volume dual flush WCs, and low flow taps/ showers/ bath. These measures will result in the internal water consumption rate of **105 litres/person/day** or less, excluding an allowance 5 litres per person per day for external water consumption. The design stage water use calculations is below.

Installation Type	Unit of Measure	Capacity/ flow rate (1)	Use factor (2)	Fixed use (litres/head/ day) (3)	Total Consumption Litres/head/day (1)x(2)+(3) =(4)
WC (dual flush)	Full Flush Volume (litres)	**6**	1.46	0	**8.76**
	Part flush Volume (litres)	**4**	2.96	0	**11.85**
Taps (excluding kitchen/ utility room taps)	Flow rate (litres/minute)	**6.5**	1.58	1.58	**11.85**
Bath (where shower also present)	Capacity to overflow (litres)	**120**	0.11	0	**13.20**
Shower (where bath also present)	Flow rate (litres/minute)	**7.5**	4.37	0	**32.78**
Kitchen / utility room sink taps	Flow rate (litres/minute)	**6.5**	0.44	10.36	**13.22**
Washing machine	Litres/kg dry load	**9**	2.1	0	**18.90**
Dishwasher	Litres/place setting	**1.2**	3.6	0	**4.32**
Waste disposal unit	Litres/use	**If present = 1 If absent = 0**	3.08	0.00	**0**
Water Softener	Litres/person/day	-	1.00	0.00	-
(5)	**Total calculated use (litres/person/day) = Sum column 4**				**114.9**
(6)	**Contribution from greywater (litres/person/day)**				**0**
(7)	**Contribution from rainwater (litres/person/day)**				**0**
(8)	**Normalisation Factor**				**0.91**
Total water consumption (litres/person/day)					**104.5**
	External water use				**5**

Table 9 Design stage water use calculations

- **Solar Shading**

Each dwelling will incorporate internal blinds or curtains to reduce the solar heat coming into the dwelling, and thus can avoid installing cooling systems for summer.

Active Design Measures

- **Heating, Cooling and Hot Water System**

The space heating and hot water are provided by energy efficient systems as summarised in the table below. At Be Lean stage, **direct acting electric boiler (100% efficiency) have been examined for radiator heating and hot water.** Detailed specifications are in the table below:

Systems	General Specification	Controls/ Other inputs	
Heating	Direct acting electric boiler for radiator heating (efficiency of 100%)	• Controls – Time and temperature zone control by suitable arrangement of plumbing and electrical services • Pump is in heated space • Boiler interlock – Yes	
Hot water	From main heating system	Flat 1 • Cylinder – 125 • Loss factor – 1.19 kWh/day Flat 2 • Cylinder – 145 • Loss factor – 1.32 kWh/day	• Cylinder in heated space • Cylinderstat • Water heating timed separately

Table 10 Heating, cooling and Hot water systems

All suggested specifications above are provisional at this early design stage, and therefore have to be reviewed with mechanical engineers and contractors in the course of design development.

The following table demonstrates the reduction in CO2 emissions from the energy efficiency measures mentioned above. It can be seen that the carbon reduction of ***<u>68.75%</u>*** can be achieved against the existing building conditions.

BE LEAN STAGE

Regulated CO_2 Emissions (Tonnes CO_2/yr)		Carbon Reduction (%)
BASELINE	BE LEAN	
27.90	8.72	68.75%

Table 11 Regulated Carbon Emissions

7. BE CLEAN – CHP & Decentralised Energy Networks

The Energy Hierarchy encourages the use of a CHP system and the connection to District Heating system to reduce CO_2 emissions further.

Decentralised Energy Network

The Mayor's Energy Strategy favours community heating systems because they offer:

- Potential economies of scale in respect of efficiency and therefore reduced carbon emissions; and
- Greater potential for future replacement with Low or Zero Carbon (LZC) technologies.

The feasibility of connecting into an existing heating network or providing the building with its own combined heat and power plant has been assessed alongside the **London Heat Map Study for the London Borough of Camden** as part of this assessment. The study identifies that the site is located near the existing district heating networks. This is demonstrated clearly from the London Heat Map (http://www.londonheatmap.org.uk) snapshot below.

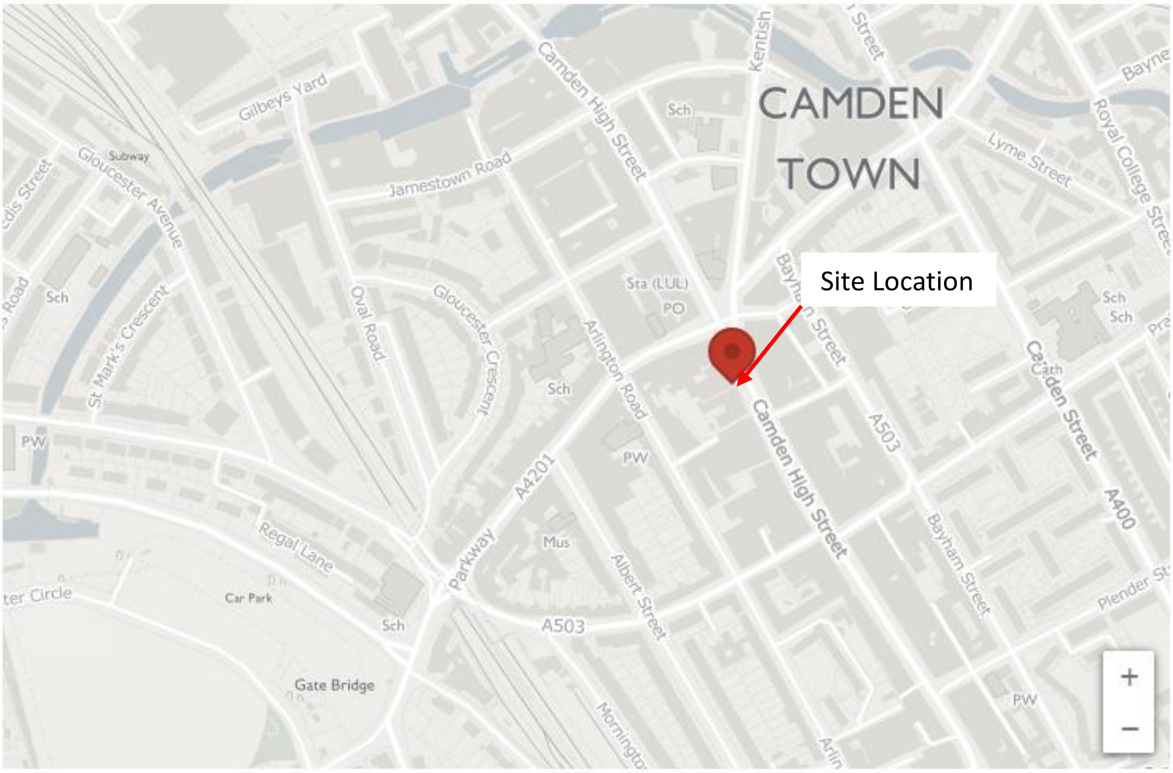


Figure 4 London Heat Map near the site

Moreover, the London heat map below identifies existing and potential DH networks in more broaden area, and it could not find any existing (in red) and potential (in yellow) DH networks within 500m radius from the property. The costs involved in extending the DH networks would outweigh the advantages in this development. **Therefore, utilisation of the DH network has not been a feasible option for this development.**

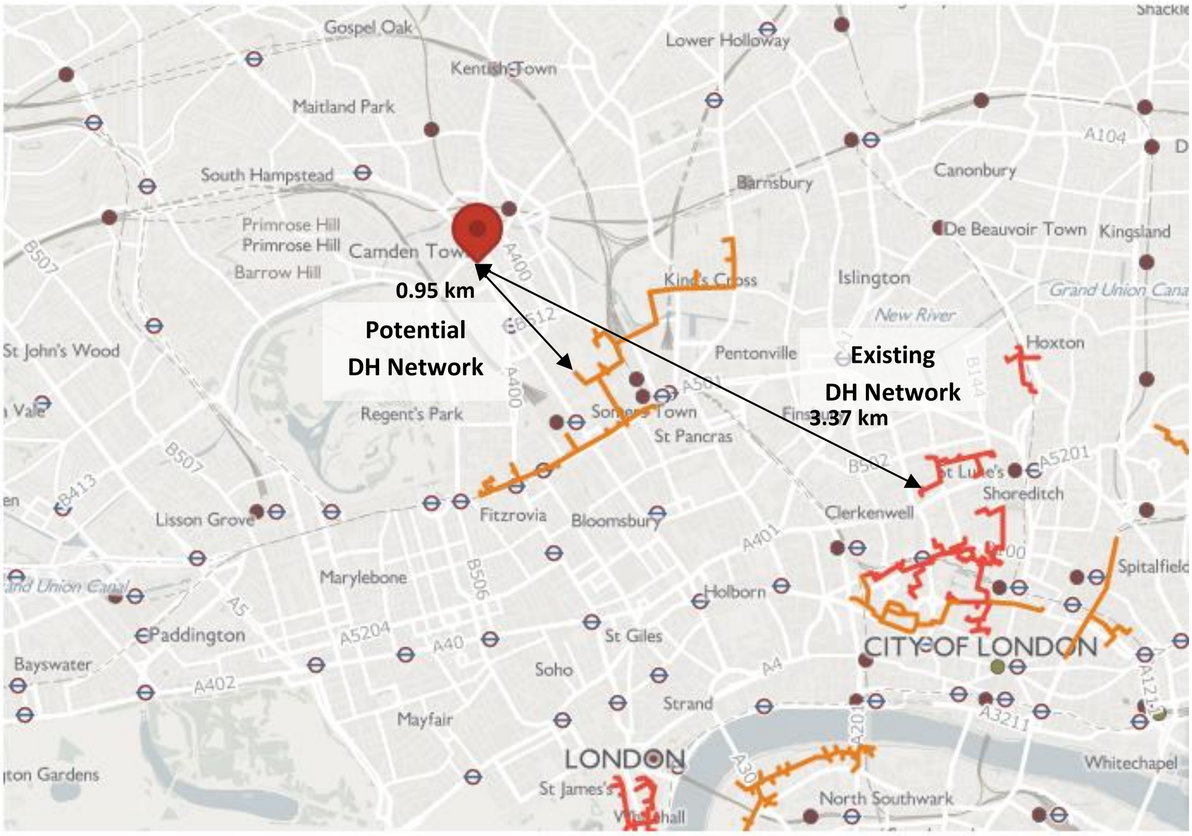


Figure 5 Existing and Potential DH Network near the site

CHP

The Energy Hierarchy identifies the combined heat and power (CHP) as a method of producing heat and electricity with much lower emissions than separate heat and power. Also, it encourages the creation of district heating systems supplied by CHP. The implementation of a CHP strategy should be decided according to good practice design. Key factors for the efficient implementation of the CHP system are:

- Development with high heating load for the majority of the year.
- CHP operation based on maximum heat load for minimum 10 hours per day.
- CHP operation at maximum capacity of 90% of its operating period.

To ensure that CHP is financially viable it is essential that the unit is selected to meet the base heat load and that this load is maintained over a large proportion of the day (a figure of 14 – 17 hours per day is often quoted subject to the load profiles and gas and electricity prices) to ensure that the additional costs (maintenance) associated with running a CHP unit can be recovered. This need to run the CHP plant, as far as possible continuously makes the building load profile of prime importance when reviewing the viability of such solutions and in particular the summer time heat load profile. To enable the CHP plant to run continuously when it is operating, a thermal store is often used so that excess CHP capacity can be used to generate hot water for use at a later time.

The feasibility of installing CHP has been assessed for this development. **Since this development has only two residential units that would not require high hot water loads, installing the CHP system would not be beneficial given the cost. Hence the CHP system has not been considered for this small development at Be Clean stage.**

BE CLEAN stage

Regulated CO_2 Emissions (Tonnes CO_2/yr)	**BE LEAN**	**BE CLEAN**	**CARBON REDUCTION (%)**
151-153 Camden High Street	8.72	8.72	0

Table 12 Regulated Carbon Emissions at Be Clean Stage

- **Wind Power**

Wind turbines need extensive planning requirements and they are only feasible at consistent wind speed. Moreover, since the development is located in an urban area, the site does not have sufficient wind speed to operate wind turbine at the height of 10meters as shown below (http://www.renew-reuse-recycle.com/noabl.pl?n=503). Hence this option has been discounted.

Estimated average windspeeds around NW1 7..

Wind speed at 10m above ground level (m/s)		
5	4.9	4.8
4.9	**4.8**	4.8
5	4.9	4.8

Wind speed at 25m above ground level (m/s)		
5.8	5.6	5.6
5.7	**5.6**	5.6
5.8	5.7	5.6

Wind speed at 45m above ground level (m/s)		
6.3	6.1	6.1
6.2	**6.1**	6.1
6.2	6.2	6.1

Squares surrounding the central square correspond to wind speeds for surrounding grid squares. Power generated is related to windspeed by a cubic ratio. This means that if you halve the windspeed, the power goes down by a factor of 8 (which is 2 x 2 x 2). A quarter of the windspeed gives you a 64^{th} of the power (4 x 4 x 4). As a rough guide, if your turbine is rated at producing 1KW at 12m/s, it will produce 125W at 6m/s and 15W at 3m/s.

Please note that the NOABL windspeed dataset used here is a model of windspeeds across the country, assuming completely flat terrain. It is not a database of measured windspeeds. Other factors such as hills, houses, trees and other obstructions in the vicinity need to be considered as well as they can have a significant effect. If you are thinking about installing a wind turbine, you should perform your own windspeed measurements using an anemometer to determine what the actual figures are.

8. BE GREEN – Renewable Energy

In this section the viable renewable energy technologies that could reduce the development's CO_2 emissions are examined. In determining the appropriate renewable technology for the site, the following factors were considered;

- Renewable energy resource or fuel availability of the LZC technology on the site.
- Space limitations due to building design and urban location of the site.
- Capital, operating and maintenance cost.
- Planning Permission
- Implementation with regards the overall M&E design strategy for building type
- Available Grants

The table below summarises the various low zero carbon technologies considered for the projects, and we have identified that **Air Source Heat Pumps (ASHP)** would be the most appropriate option in this development.

Technology	Local Planning Requirements	Carbon Payback	Grants/ Funding	Feasibility
Air Source Heat Pumps (ASHP)	Noise Issues from External units	High	Renewable Heat Incentive (RHI)	**LOW**
Photovoltaic (PV)	Spatial and Shadowing	Medium	-	**HIGH**
Solar Thermal	Spatial and Shadowing	Low	Renewable Heat Incentive (RHI)	**MEDIUM**
Ground Source Heat Pumps (GSHP)	Spatial issues for Bore Holes and noise	Medium	Renewable Heat Incentive (RHI)	**MEDIUM**
Biomass	Spatial requirement for fuel storage and biomass odour	High	Renewable Heat Incentive (RHI)	**LOW**
Wind Power	Extensive planning requirements for noise and local biodiversity	Low	-	**LOW**
Hydro Power	Extensive planning requirements for noise and water quality	None	-	**ZERO**

Table 13 Feasibility Study of LZC Technologies

Non-feasible Technology

- **Air Source Heat Pumps (ASHP)**

ASHP can meet the space heating demands on site efficiently in comparison with gas boilers. Although this low carbon technology consumes electricity to operate due to higher efficiency the heat output is much greater. However, the efficiency of heat pumps is very much dependent on the temperature difference between the heat source and the space required to be heated. As a result, ASHPs tend to have a lower COP than GSHPs. This is due to the varying levels of air temperature throughout the year when compared to the relatively stable ground temperature. Moreover, any noise associated with the external units could potentially be an issue at night due to the proximity of the neighbouring residential buildings. Therefore, the use of ASHP is not a suitable option for this development.

- **Ground Source Heat Pumps (GSHP)**

Ground source heat pump would be a feasible option to meet the space heating requirements, however, it requires ground space for bore holes to extract the ground heat to be utilised for space heating requirements. In this case there is no available ground space for a borehole or trench system, the ground source loop would have to be incorporated within the foundation piles of the structure, which would result in additional cost. Hence, this option is not suitable for this development.

- **Solar Thermal**

The use of solar thermal for this development would be limited to domestic hot water only. The use of solar thermal for space heating would not be practical as it is not required when solar thermal is at its most effective during the summer months. Therefore, this system would require additional plumbing and space for hot water storage, incurring additional financial cost. Moreover, the amount of carbon offset from the system is generally lower than other technologies. Therefore, this technology is deemed to be unsuitable for this development.

- **Hydro power**

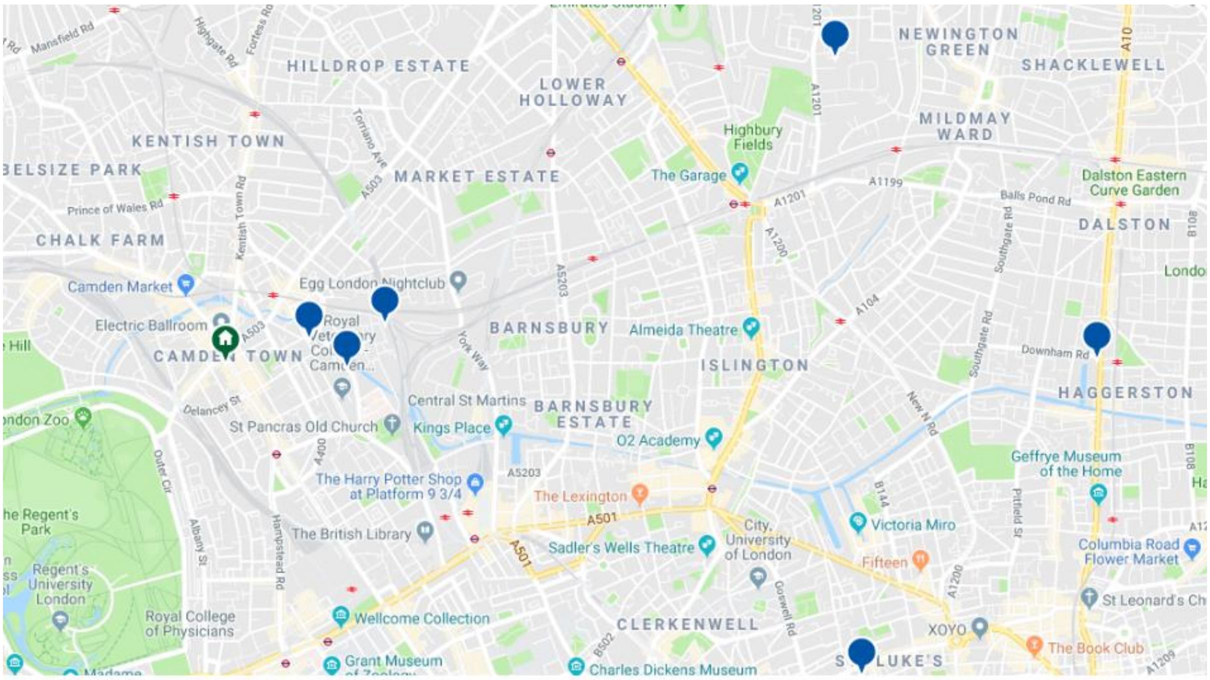
There is no river or lake within the development site boundaries. Therefore, small scale hydro-electric will not be studied any further because of the location and the spatial limitations of the development.

- **Biomass**

A biomass system designed for this development would be fueled by wood pellets which have a high energy content. However, a biomass system would not be an appropriate technology for the site for the following reasons:

i. The burning of wood pellets releases substantially more NOx emissions when compared to similar gas boilers. As the development is situated within an urban area, the installation of a biomass boiler would further impact on the air quality in this area.
ii. the lack of spaces for pellet boiler and storage on the site.
iii. Pellets would need to be transported from local pellet suppliers, which causes carbon emissions to the air.

However, if the biomass system is considered at detailed design stage, local suppliers can be found near the site as shown in the map below (http://biomass-suppliers-list.service.gov.uk).



Company name	Postcode	Contact	Fuel Supplied
Wolseley UK Ltd	NW1 0BY	www.plumbcenter.co.uk FFP.Camden@wolseley.co.uk	Pellets
Travis Perkins Trading Co. Ltd	NW1 0PT	www.travisperkins.co.uk sean.mahon@travisperkins.co.uk	Pellets
Wolseley UK Ltd	N1C 4PD	www.pipecenter.co.uk k94.kingscross@wolseley.co.uk	Pellets
Travis Perkins Trading Co. Ltd	N19 5UN	www.travisperkins.co.uk toby.duncan@travisperkins.co.uk	Pellets
Travis Perkins Trading Co. Ltd	W2 6NA	www.travisperkins.co.uk liam.clancy@travisperkins.co.uk	Pellets
Travis Perkins Trading Co. Ltd	NW6 1SD	www.travisperkins.co.uk johnny.farmer@travisperkins.co.uk	Pellets
Wolseley UK Ltd	N5 2PW	www.plumbcenter.co.uk YM.Highbury@wolseley.co.uk	Pellets
Travis Perkins Trading Co. Ltd	EC1Y 0TY	www.travisperkins.co.uk keith.gittins@travisperkins.co.uk	Pellets
Travis Perkins Trading Co. Ltd	EC1Y 0TY	www.travisperkins.co.uk kenneth.walker@travisperkins.co.uk	Pellets
Travis Perkins Trading Co. Ltd	E8 4DL	www.travisperkins.co.uk daniel.marsden@travisperkins.co.uk	Pellets

Proposed Technology

- **Photovoltaic (PV)**

Based on the feasibility study above, PV would be the most suitable renewable Technology for the following reasons:

I. The installation of PV is much simpler when compared to other renewable technologies
II. There is sufficient roof space available to install enough PV modules to have a significant impact on carbon emissions of the development
III. PV panels sited on the roof within an urban area are less visually intrusive when compared to wind turbines

The PV system capacity for the whole development depends upon the selection of the heating system. Therefore, the amount of PV relating to the proposed heating system option is outlined below:

Direct acting electric Boilers + 4.725 kWp

The tables below illustrate the indicative PV panel's detail, should it be feasible to implement:

Orientation	South - West	**Overshading**	Less than 20 percent
Panel Tilt	0-10°	**Power Output**	315 W per panel
Annual Output	Approximately 1796.7 kWh	**PV Area**	1.65 m^2 per panel
Numbers of Panels	15 panels in total		

Table 14 Suggested PV details

The proposed PV panels are subject to further consideration at detailed design stage. In order to qualify both the installer and the equipment, the system must be certified under the Microgeneration Certification Scheme (MCS).

Given the proposed LZC technologies on the site (**PVs**), the overall CO2 reduction at BE GREEN stage can be calculated as shown below. And, it can be seen that the development can achieve the CO_2 emissions reduction of ***21.39%*** in the residential units over Building Regulations Part L 2013

BE GREEN stage

Regulated CO_2 Emissions (Tonnes CO_2/yr)	**BE LEAN**	**BE CLEAN**	**CARBON REDUCTION (%)**
2-6 Camden High Street	8.72	6.85	21.39

Table 15 Regulated Carbon Reduction at Be Green Stage

9. Conclusion

This report assesses the predicted energy performance and carbon dioxide emissions of the proposed development at **151-153 Camden High Street, London, NW1 7JY**, based on the information provided by the design team.

In line with the London Plan's three step energy hierarchy the regulated CO2 emissions for this development have been reduced by **73.96%** over Building Regulation 2013 with **23.10%** from renewable energy, once all measures in the table below are taken into account.

Stages	Strategies
BE LEAN Energy efficient design	• U-values better and air permeability better than Building Regulations Part L; • High efficiency electric boiler for heating and hot water. • Low energy (LED) type lighting; • Natural ventilation
BE CLEAN District heat networks or communal heating systems	As there are no current or proposed district heat networks and the size of the development is not suitable for CHP this stage of the hierarchy is not feasible for this scheme. Details can be found in section 8.1.
BE GREEN On-site renewable technologies	• PV panels of 4.725 kWp on the roof (approximate 15 panels with 315 w/p are required). Details are in Section **Error! Reference source not found.**.

Table 16 Energy Hierarchy and suggested strategies

This carbon savings from each stage can be calculated based on the results above. The chart below summarises the total cumulative savings:

Energy Hierarchy		Regulated Carbon Savings	
		Tonnes CO_2/yr	%
BE LEAN	After energy demand reduction	19.18	68.75%
BE CLEAN	After heat network/ CHP	0	0
BE GREEN	After renewable energy	1.87	21.39%
Total Cumulative Savings		**21.05**	**75.43%**
Total Target Savings		5.30	19 %

Table 17 Carbon dioxide Emissions after each stage of the Energy Hierarchy

10. Appendix A – Sap Reports

SAP Existing

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Su Lee	**Stroma Number:**	STRO031315
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: Flat 1- Existing

Address : 151-153, Camden High Street, LONDON, NW1 7JY

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	74.67	(1a) x	2.75	(2a) =	205.34	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	74.67	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	205.34	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.1	(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		35	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	1.85	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	1.57	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

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

DER WorkSheet: New dwelling design stage

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

2	1.96	1.92	1.73	1.69	1.49	1.49	1.45	1.57	1.69	1.77	1.85

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=	2	1.96	1.92	1.73	1.69	1.49	1.49	1.45	1.57	1.69	1.77	1.85	(24d)

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

(25)m=	2	1.96	1.92	1.73	1.69	1.49	1.49	1.45	1.57	1.69	1.77	1.85	(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			2.12	x	3	=	6.36			(26)
Windows Type 1			0.91	x1/[1/(4.8)+ 0.04]		=	3.66			(27)
Windows Type 2			1.53	x1/[1/(4.8)+ 0.04]		=	6.16			(27)
Windows Type 3			4.42	x1/[1/(4.8)+ 0.04]		=	17.8			(27)
Windows Type 4			4.01	x1/[1/(4.8)+ 0.04]		=	16.15			(27)
Floor			74.67	x	1.2	=	89.604			(28)
Walls Type1	28.68	6.86	21.82	x	2.1	=	45.83			(29)
Walls Type2	30.91	8.02	22.89	x	2.1	=	48.07			(29)
Walls Type3	12.24	2.12	10.12	x	2.1	=	21.25			(29)
Roof	6.42	0	6.42	x	2.3	=	14.77			(30)
Total area of elements, m²			152.92							(31)
Party wall			28.6	x	0	=	0			(32)
Party wall			16.44	x	0	=	0			(32)

** 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) =	285.79	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	0	(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	22.94	(36)

DER WorkSheet: New dwelling design stage

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

Total fabric heat loss (33) + (36) = 308.73 (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=	135.67	133.01	130.35	117.05	114.39	101.09	101.09	98.43	106.41	114.39	119.71	125.03	(38)

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

(39)m=	444.4	441.74	439.08	425.78	423.12	409.82	409.82	407.16	415.14	423.12	428.44	433.76	

Average = Sum(39)$_{1...12}$ /12= 425.12 (39)

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

(40)m=	5.95	5.92	5.88	5.7	5.67	5.49	5.49	5.45	5.56	5.67	5.74	5.81	

Average = Sum(40)$_{1...12}$ /12= 5.69 (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 2.35 (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 94.85 (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=	104.33	100.54	96.75	92.95	89.16	85.36	85.36	89.16	92.95	96.75	100.54	104.33	

Total = Sum(44)$_{1...12}$ = 1138.19 (44)

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

(45)m=	154.72	135.32	139.64	121.74	116.81	100.8	93.41	107.19	108.47	126.41	137.98	149.84	

Total = Sum(45)$_{1...12}$ = 1492.35 (45)

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

(46)m=	23.21	20.3	20.95	18.26	17.52	15.12	14.01	16.08	16.27	18.96	20.7	22.48	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 110 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.08 (51)

If community heating see section 4.3

Volume factor from Table 2a 1.03 (52)

Temperature factor from Table 2b 0.78 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 6.71 (54)

Enter (50) or (54) in (55) 6.71 (55)

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

(56)m=	208.01	187.88	208.01	201.3	208.01	201.3	208.01	208.01	201.3	208.01	201.3	208.01	(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=	208.01	187.88	208.01	201.3	208.01	201.3	208.01	208.01	201.3	208.01	201.3	208.01	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	362.73	323.2	347.65	323.04	324.82	302.1	301.41	315.19	309.76	334.41	339.28	357.85	(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=	362.73	323.2	347.65	323.04	324.82	302.1	301.41	315.19	309.76	334.41	339.28	357.85

Output from water heater (annual)$_{1...12}$ | 3941.44 | (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=	217.85	195.3	212.83	201.52	205.25	194.55	197.46	202.04	197.1	208.44	206.92	216.23	(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=	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	(66)

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

(67)m=	31.75	28.2	22.93	17.36	12.98	10.96	11.84	15.39	20.66	26.23	30.61	32.63	(67)

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

(68)m=	207.94	210.1	204.66	193.09	178.47	164.74	155.57	153.41	158.85	170.42	185.03	198.77	(68)

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

(69)m=	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

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

(71)m=	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	(71)

Water heating gains (Table 5)

(72)m=	292.81	290.62	286.07	279.88	275.87	270.21	265.41	271.56	273.75	280.15	287.38	290.63	(72)

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

(73)m=	600.81	597.23	581.97	558.64	535.63	514.22	501.12	508.67	521.56	545.11	571.34	590.34	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	4.01	x	11.28	x	0.76	x	0.7	=	33.36	(75)
Northeast	0.9x	0.77	x	4.01	x	22.97	x	0.76	x	0.7	=	67.91	(75)
Northeast	0.9x	0.77	x	4.01	x	41.38	x	0.76	x	0.7	=	122.35	(75)
Northeast	0.9x	0.77	x	4.01	x	67.96	x	0.76	x	0.7	=	200.93	(75)
Northeast	0.9x	0.77	x	4.01	x	91.35	x	0.76	x	0.7	=	270.09	(75)
Northeast	0.9x	0.77	x	4.01	x	97.38	x	0.76	x	0.7	=	287.94	(75)
Northeast	0.9x	0.77	x	4.01	x	91.1	x	0.76	x	0.7	=	269.37	(75)
Northeast	0.9x	0.77	x	4.01	x	72.63	x	0.76	x	0.7	=	214.74	(75)
Northeast	0.9x	0.77	x	4.01	x	50.42	x	0.76	x	0.7	=	149.08	(75)
Northeast	0.9x	0.77	x	4.01	x	28.07	x	0.76	x	0.7	=	82.99	(75)
Northeast	0.9x	0.77	x	4.01	x	14.2	x	0.76	x	0.7	=	41.98	(75)
Northeast	0.9x	0.77	x	4.01	x	9.21	x	0.76	x	0.7	=	27.24	(75)
Southwest	0.9x	0.77	x	0.91	x	36.79		0.76	x	0.7	=	12.34	(79)
Southwest	0.9x	0.77	x	1.53	x	36.79		0.76	x	0.7	=	20.75	(79)
Southwest	0.9x	0.77	x	4.42	x	36.79		0.76	x	0.7	=	59.96	(79)
Southwest	0.9x	0.77	x	0.91	x	62.67		0.76	x	0.7	=	21.03	(79)
Southwest	0.9x	0.77	x	1.53	x	62.67		0.76	x	0.7	=	35.35	(79)
Southwest	0.9x	0.77	x	4.42	x	62.67		0.76	x	0.7	=	102.13	(79)
Southwest	0.9x	0.77	x	0.91	x	85.75		0.76	x	0.7	=	28.77	(79)
Southwest	0.9x	0.77	x	1.53	x	85.75		0.76	x	0.7	=	48.37	(79)
Southwest	0.9x	0.77	x	4.42	x	85.75		0.76	x	0.7	=	139.74	(79)
Southwest	0.9x	0.77	x	0.91	x	106.25		0.76	x	0.7	=	35.65	(79)
Southwest	0.9x	0.77	x	1.53	x	106.25		0.76	x	0.7	=	59.93	(79)
Southwest	0.9x	0.77	x	4.42	x	106.25		0.76	x	0.7	=	173.14	(79)
Southwest	0.9x	0.77	x	0.91	x	119.01		0.76	x	0.7	=	39.93	(79)
Southwest	0.9x	0.77	x	1.53	x	119.01		0.76	x	0.7	=	67.13	(79)
Southwest	0.9x	0.77	x	4.42	x	119.01		0.76	x	0.7	=	193.93	(79)
Southwest	0.9x	0.77	x	0.91	x	118.15		0.76	x	0.7	=	39.64	(79)
Southwest	0.9x	0.77	x	1.53	x	118.15		0.76	x	0.7	=	66.65	(79)
Southwest	0.9x	0.77	x	4.42	x	118.15		0.76	x	0.7	=	192.53	(79)
Southwest	0.9x	0.77	x	0.91	x	113.91		0.76	x	0.7	=	38.22	(79)
Southwest	0.9x	0.77	x	1.53	x	113.91		0.76	x	0.7	=	64.25	(79)
Southwest	0.9x	0.77	x	4.42	x	113.91		0.76	x	0.7	=	185.62	(79)
Southwest	0.9x	0.77	x	0.91	x	104.39		0.76	x	0.7	=	35.02	(79)
Southwest	0.9x	0.77	x	1.53	x	104.39		0.76	x	0.7	=	58.88	(79)
Southwest	0.9x	0.77	x	4.42	x	104.39		0.76	x	0.7	=	170.11	(79)
Southwest	0.9x	0.77	x	0.91	x	92.85		0.76	x	0.7	=	31.15	(79)
Southwest	0.9x	0.77	x	1.53	x	92.85		0.76	x	0.7	=	52.38	(79)
Southwest	0.9x	0.77	x	4.42	x	92.85		0.76	x	0.7	=	151.31	(79)

Southwest 0.9x	0.77	x	0.91	x	69.27		0.76	x	0.7	=	23.24	(79)
Southwest 0.9x	0.77	x	1.53	x	69.27		0.76	x	0.7	=	39.07	(79)
Southwest 0.9x	0.77	x	4.42	x	69.27		0.76	x	0.7	=	112.87	(79)
Southwest 0.9x	0.77	x	0.91	x	44.07		0.76	x	0.7	=	14.79	(79)
Southwest 0.9x	0.77	x	1.53	x	44.07		0.76	x	0.7	=	24.86	(79)
Southwest 0.9x	0.77	x	4.42	x	44.07		0.76	x	0.7	=	71.82	(79)
Southwest 0.9x	0.77	x	0.91	x	31.49		0.76	x	0.7	=	10.56	(79)
Southwest 0.9x	0.77	x	1.53	x	31.49		0.76	x	0.7	=	17.76	(79)
Southwest 0.9x	0.77	x	4.42	x	31.49		0.76	x	0.7	=	51.31	(79)

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

(83)m=	126.42	226.42	339.23	469.65	571.08	586.76	557.46	478.76	383.92	258.17	153.44	106.88	(83)

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

(84)m=	727.23	823.64	921.2	1028.29	1106.71	1100.98	1058.58	987.43	905.48	803.29	724.77	697.22	(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=	0.99	0.98	0.97	0.96	0.93	0.87	0.8	0.83	0.91	0.96	0.98	0.99	(86)

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

(87)m=	16.55	16.8	17.34	18.16	19.01	19.84	20.33	20.26	19.59	18.52	17.44	16.56	(87)

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

(88)m=	18	18	18	18.01	18.01	18.02	18.02	18.02	18.02	18.01	18.01	18	(88)

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

(89)m=	0.98	0.97	0.96	0.93	0.87	0.72	0.45	0.52	0.81	0.94	0.97	0.98	(89)

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

(90)m=	14.44	14.68	15.22	16.02	16.84	17.6	17.95	17.92	17.4	16.38	15.31	14.43	(90)

fLA = Living area ÷ (4) = 0.45 (91)

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

(92)m=	15.39	15.64	16.18	16.99	17.82	18.61	19.02	18.98	18.39	17.35	16.27	15.39	(92)

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

(93)m=	15.39	15.64	16.18	16.99	17.82	18.61	19.02	18.98	18.39	17.35	16.27	15.39	(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=	0.97	0.96	0.95	0.92	0.87	0.77	0.63	0.67	0.83	0.93	0.96	0.97	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	706.49	793.39	873.59	944.74	957.93	845.6	664.4	659.89	754.34	743.95	696.66	678.87	(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=	4929.46	4744.38	4249.5	3442.45	2589.8	1643.59	993.64	1048.46	1780.39	2853.96	3930.07	4854.2	(97)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(98)m=	3141.89	2655.06	2511.67	1798.36	1214.11	0	0	0	0	1569.84	2328.05	3106.44		

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 18325.44 (98)

Space heating requirement in kWh/m²/year 245.42 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		100	(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)	3141.89	2655.06	2511.67	1798.36	1214.11	0	0	0	0	1569.84	2328.05	3106.44	
(211)m = {[(98)m x (204)] } x 100 ÷ (206) (211)	3141.89	2655.06	2511.67	1798.36	1214.11	0	0	0	0	1569.84	2328.05	3106.44	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 18325.44 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10....12}$= 0 (215)

Water heating

Output from water heater (calculated above)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	362.73	323.2	347.65	323.04	324.82	302.1	301.41	315.19	309.76	334.41	339.28	357.85

Efficiency of water heater 100 (216)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(217)m=	100	100	100	100	100	100	100	100	100	100	100	100	(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(219)m=	362.73	323.2	347.65	323.04	324.82	302.1	301.41	315.19	309.76	334.41	339.28	357.85

Total = Sum(219a)$_{1...12}$ = 3941.44 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			18325.44	
Water heating fuel used			3941.44	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		120		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		120	(231)
Electricity for lighting			560.7	(232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year

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Space heating (main system 1)	(211) x	0.519	=	9510.9	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.519	=	2045.61	(264)
Space and water heating	(261) + (262) + (263) + (264) =			11556.51	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	62.28	(267)
Electricity for lighting	(232) x	0.519	=	291	(268)
Total CO2, kg/year		sum of (265)…(271) =		11909.79	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		159.5	(273)
EI rating (section 14)				10	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Su Lee	**Stroma Number:**	STRO031315
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: Flat 2- Existing

Address : 151-153, Camden High Street, LONDON, NW1 7JY

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	70.26	(1a)	x	3.04	(2a)	=	213.59	(3a)
First floor	48.16	(1b)	x	2.39	(2b)	=	115.1	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	118.42	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	328.69	(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) =	0.12	(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		35	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	1.87	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	1.59	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

2.03	1.99	1.95	1.75	1.71	1.51	1.51	1.47	1.59	1.71	1.79	1.87

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=	2.03	1.99	1.95	1.75	1.71	1.51	1.51	1.47	1.59	1.71	1.79	1.87	(24d)

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

(25)m=	2.03	1.99	1.95	1.75	1.71	1.51	1.51	1.47	1.59	1.71	1.79	1.87	(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			2.1	x	3	=	6.3			(26)
Windows Type 1			1.43	x1/[1/(4.8)+ 0.04]		=	5.76			(27)
Windows Type 2			1.43	x1/[1/(4.8)+ 0.04]		=	5.76			(27)
Windows Type 3			0.91	x1/[1/(4.8)+ 0.04]		=	3.66			(27)
Windows Type 4			3.1	x1/[1/(4.8)+ 0.04]		=	12.48			(27)
Windows Type 5			1.43	x1/[1/(4.8)+ 0.04]		=	5.76			(27)
Windows Type 6			4.01	x1/[1/(4.8)+ 0.04]		=	16.15			(27)
Floor Type 1			70.26	x	1.2	=	84.312			(28)
Floor Type 2			48.16	x	1.2	=	57.792			(28)
Walls Type1	14.11	16.32	-2.21	x	2.1	=	-4.65			(29)
Walls Type2	27.48	8.02	19.46	x	2.1	=	40.87			(29)
Walls Type3	6.75	0	6.75	x	0.73	=	4.9			(29)
Walls Type4	6.75	0	6.75	x	0.73	=	4.9			(29)
Walls Type5	10.37	2.1	8.27	x	0.73	=	6.01			(29)
Walls Type6	19.84	4.29	15.55	x	2.1	=	32.65			(29)
Walls Type7	20.62	4.29	16.33	x	2.1	=	34.29			(29)
Walls Type8	2.14	0	2.14	x	2.1	=	4.49			(29)

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Walls Type9	2.14	0	2.14	x	2.1	=	4.49		(29)
Walls Type10	8.18	0	8.18	x	2.1	=	17.17		(29)
Roof	49.71	0	49.71	x	2.3	=	114.33		(30)
Total area of elements, m²			286.5						(31)
Party wall			38.91	x	0	=	0		(32)
Party wall			21.31	x	0	=	0		(32)
Party wall			2.13	x	0	=	0		(32)
Party wall			13.46	x	0	=	0		(32)
Party wall			13.45	x	0	=	0		(32)

** 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) =	540.45	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	0	(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		42.98	(36)

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

Total fabric heat loss	(33) + (36) =	583.42	(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=	220.02	215.71	211.39	189.82	185.51	163.94	163.94	159.62	172.57	185.51	194.14	202.77	(38)

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

(39)m=	803.44	799.13	794.82	773.24	768.93	747.36	747.36	743.05	755.99	768.93	777.56	786.19	

Average = Sum(39)$_{1…12}$ /12= 772.17 (39)

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

(40)m=	6.78	6.75	6.71	6.53	6.49	6.31	6.31	6.27	6.38	6.49	6.57	6.64	

Average = Sum(40)$_{1…12}$ /12= 6.52 (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 2.86 (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) + 36 107.42 (43)

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

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

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

(44)m=	118.17	113.87	109.57	105.28	100.98	96.68	96.68	100.98	105.28	109.57	113.87	118.17

Total = Sum(44)$_{1…12}$ = 1289.1 (44)

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

(45)m=	175.24	153.27	158.16	137.88	132.3	114.17	105.79	121.4	122.85	143.17	156.28	169.71

Total = Sum(45)$_{1…12}$ = 1690.21 (45)

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

(46)m=	26.29	22.99	23.72	20.68	19.85	17.13	15.87	18.21	18.43	21.48	23.44	25.46	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 110 | (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b | 0 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 110 | (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.08 | (51)

If community heating see section 4.3

Volume factor from Table 2a | 1.03 | (52)

Temperature factor from Table 2b | 0.78 | (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = | 6.71 | (54)

Enter (50) or (54) in (55) | 6.71 | (55)

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

(56)m=	208.01	187.88	208.01	201.3	208.01	201.3	208.01	208.01	201.3	208.01	201.3	208.01	(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=	208.01	187.88	208.01	201.3	208.01	201.3	208.01	208.01	201.3	208.01	201.3	208.01	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	383.24	341.14	366.16	339.18	340.31	315.46	313.8	329.4	324.14	351.17	357.58	377.71	(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=	383.24	341.14	366.16	339.18	340.31	315.46	313.8	329.4	324.14	351.17	357.58	377.71

Output from water heater (annual)₁…₁₂ | 4139.31 | (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=	224.67	201.26	218.99	206.88	210.39	199	201.58	206.77	201.88	214.01	213	222.83	(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=	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	(66)

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

(67)m=	42.91	38.11	31	23.47	17.54	14.81	16	20.8	27.92	35.45	41.37	44.1	(67)

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

(68)m=	283.14	286.08	278.68	262.91	243.02	224.32	211.82	208.89	216.29	232.05	251.95	270.65	(68)

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

(69)m=	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

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

(71)m=	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	(71)

Water heating gains (Table 5)

(72)m=	301.98	299.5	294.34	287.34	282.79	276.38	270.94	277.92	280.39	287.64	295.83	299.51	(72)

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

(73)m=	703.89	699.54	679.87	649.57	619.2	591.37	574.62	583.46	600.46	631	665.01	690.11	(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	1.43	x	11.28	x	0.76	x	0.7	=	17.85	(75)
Northeast 0.9x	0.77	x	4.01	x	11.28	x	0.76	x	0.7	=	33.36	(75)
Northeast 0.9x	0.77	x	1.43	x	22.97	x	0.76	x	0.7	=	36.32	(75)
Northeast 0.9x	0.77	x	4.01	x	22.97	x	0.76	x	0.7	=	67.91	(75)
Northeast 0.9x	0.77	x	1.43	x	41.38	x	0.76	x	0.7	=	65.45	(75)
Northeast 0.9x	0.77	x	4.01	x	41.38	x	0.76	x	0.7	=	122.35	(75)
Northeast 0.9x	0.77	x	1.43	x	67.96	x	0.76	x	0.7	=	107.48	(75)
Northeast 0.9x	0.77	x	4.01	x	67.96	x	0.76	x	0.7	=	200.93	(75)
Northeast 0.9x	0.77	x	1.43	x	91.35	x	0.76	x	0.7	=	144.47	(75)
Northeast 0.9x	0.77	x	4.01	x	91.35	x	0.76	x	0.7	=	270.09	(75)
Northeast 0.9x	0.77	x	1.43	x	97.38	x	0.76	x	0.7	=	154.03	(75)
Northeast 0.9x	0.77	x	4.01	x	97.38	x	0.76	x	0.7	=	287.94	(75)
Northeast 0.9x	0.77	x	1.43	x	91.1	x	0.76	x	0.7	=	144.09	(75)
Northeast 0.9x	0.77	x	4.01	x	91.1	x	0.76	x	0.7	=	269.37	(75)
Northeast 0.9x	0.77	x	1.43	x	72.63	x	0.76	x	0.7	=	114.87	(75)
Northeast 0.9x	0.77	x	4.01	x	72.63	x	0.76	x	0.7	=	214.74	(75)
Northeast 0.9x	0.77	x	1.43	x	50.42	x	0.76	x	0.7	=	79.75	(75)
Northeast 0.9x	0.77	x	4.01	x	50.42	x	0.76	x	0.7	=	149.08	(75)
Northeast 0.9x	0.77	x	1.43	x	28.07	x	0.76	x	0.7	=	44.39	(75)
Northeast 0.9x	0.77	x	4.01	x	28.07	x	0.76	x	0.7	=	82.99	(75)
Northeast 0.9x	0.77	x	1.43	x	14.2	x	0.76	x	0.7	=	22.45	(75)
Northeast 0.9x	0.77	x	4.01	x	14.2	x	0.76	x	0.7	=	41.98	(75)
Northeast 0.9x	0.77	x	1.43	x	9.21	x	0.76	x	0.7	=	14.57	(75)
Northeast 0.9x	0.77	x	4.01	x	9.21	x	0.76	x	0.7	=	27.24	(75)

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Southwest	0.9x	0.77	x	1.43	x	36.79	0.76	x	0.7	=	58.19	(79)
Southwest	0.9x	0.77	x	0.91	x	36.79	0.76	x	0.7	=	37.03	(79)
Southwest	0.9x	0.77	x	3.1	x	36.79	0.76	x	0.7	=	126.15	(79)
Southwest	0.9x	0.77	x	1.43	x	36.79	0.76	x	0.7	=	58.19	(79)
Southwest	0.9x	0.77	x	1.43	x	62.67	0.76	x	0.7	=	99.13	(79)
Southwest	0.9x	0.77	x	0.91	x	62.67	0.76	x	0.7	=	63.08	(79)
Southwest	0.9x	0.77	x	3.1	x	62.67	0.76	x	0.7	=	214.89	(79)
Southwest	0.9x	0.77	x	1.43	x	62.67	0.76	x	0.7	=	99.13	(79)
Southwest	0.9x	0.77	x	1.43	x	85.75	0.76	x	0.7	=	135.63	(79)
Southwest	0.9x	0.77	x	0.91	x	85.75	0.76	x	0.7	=	86.31	(79)
Southwest	0.9x	0.77	x	3.1	x	85.75	0.76	x	0.7	=	294.02	(79)
Southwest	0.9x	0.77	x	1.43	x	85.75	0.76	x	0.7	=	135.63	(79)
Southwest	0.9x	0.77	x	1.43	x	106.25	0.76	x	0.7	=	168.05	(79)
Southwest	0.9x	0.77	x	0.91	x	106.25	0.76	x	0.7	=	106.94	(79)
Southwest	0.9x	0.77	x	3.1	x	106.25	0.76	x	0.7	=	364.3	(79)
Southwest	0.9x	0.77	x	1.43	x	106.25	0.76	x	0.7	=	168.05	(79)
Southwest	0.9x	0.77	x	1.43	x	119.01	0.76	x	0.7	=	188.23	(79)
Southwest	0.9x	0.77	x	0.91	x	119.01	0.76	x	0.7	=	119.78	(79)
Southwest	0.9x	0.77	x	3.1	x	119.01	0.76	x	0.7	=	408.05	(79)
Southwest	0.9x	0.77	x	1.43	x	119.01	0.76	x	0.7	=	188.23	(79)
Southwest	0.9x	0.77	x	1.43	x	118.15	0.76	x	0.7	=	186.87	(79)
Southwest	0.9x	0.77	x	0.91	x	118.15	0.76	x	0.7	=	118.92	(79)
Southwest	0.9x	0.77	x	3.1	x	118.15	0.76	x	0.7	=	405.1	(79)
Southwest	0.9x	0.77	x	1.43	x	118.15	0.76	x	0.7	=	186.87	(79)
Southwest	0.9x	0.77	x	1.43	x	113.91	0.76	x	0.7	=	180.16	(79)
Southwest	0.9x	0.77	x	0.91	x	113.91	0.76	x	0.7	=	114.65	(79)
Southwest	0.9x	0.77	x	3.1	x	113.91	0.76	x	0.7	=	390.56	(79)
Southwest	0.9x	0.77	x	1.43	x	113.91	0.76	x	0.7	=	180.16	(79)
Southwest	0.9x	0.77	x	1.43	x	104.39	0.76	x	0.7	=	165.11	(79)
Southwest	0.9x	0.77	x	0.91	x	104.39	0.76	x	0.7	=	105.07	(79)
Southwest	0.9x	0.77	x	3.1	x	104.39	0.76	x	0.7	=	357.92	(79)
Southwest	0.9x	0.77	x	1.43	x	104.39	0.76	x	0.7	=	165.11	(79)
Southwest	0.9x	0.77	x	1.43	x	92.85	0.76	x	0.7	=	146.86	(79)
Southwest	0.9x	0.77	x	0.91	x	92.85	0.76	x	0.7	=	93.45	(79)
Southwest	0.9x	0.77	x	3.1	x	92.85	0.76	x	0.7	=	318.36	(79)
Southwest	0.9x	0.77	x	1.43	x	92.85	0.76	x	0.7	=	146.86	(79)
Southwest	0.9x	0.77	x	1.43	x	69.27	0.76	x	0.7	=	109.55	(79)
Southwest	0.9x	0.77	x	0.91	x	69.27	0.76	x	0.7	=	69.72	(79)
Southwest	0.9x	0.77	x	3.1	x	69.27	0.76	x	0.7	=	237.5	(79)
Southwest	0.9x	0.77	x	1.43	x	69.27	0.76	x	0.7	=	109.55	(79)
Southwest	0.9x	0.77	x	1.43	x	44.07	0.76	x	0.7	=	69.7	(79)

Southwest	0.9x	0.77	x	0.91	x	44.07	0.76	x	0.7	=	44.36	(79)
Southwest	0.9x	0.77	x	3.1	x	44.07	0.76	x	0.7	=	151.1	(79)
Southwest	0.9x	0.77	x	1.43	x	44.07	0.76	x	0.7	=	69.7	(79)
Southwest	0.9x	0.77	x	1.43	x	31.49	0.76	x	0.7	=	49.8	(79)
Southwest	0.9x	0.77	x	0.91	x	31.49	0.76	x	0.7	=	31.69	(79)
Southwest	0.9x	0.77	x	3.1	x	31.49	0.76	x	0.7	=	107.96	(79)
Southwest	0.9x	0.77	x	1.43	x	31.49	0.76	x	0.7	=	49.8	(79)

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

(83)m=	330.78	580.45	839.38	1115.75	1318.86	1339.72	1278.98	1122.81	934.36	653.7	399.3	281.08	(83)

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

(84)m=	1034.67	1280	1519.25	1765.33	1938.06	1931.09	1853.6	1706.27	1534.81	1284.7	1064.31	971.19	(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=	0.99	0.98	0.97	0.95	0.92	0.86	0.8	0.82	0.91	0.96	0.98	0.99	(86)

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

(87)m=	16.26	16.54	17.13	17.98	18.88	19.75	20.27	20.19	19.48	18.33	17.18	16.24	(87)

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

(88)m=	18	18	18	18	18	18	18	18	18	18	18	18	(88)

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

(89)m=	0.98	0.97	0.96	0.93	0.86	0.72	0.45	0.52	0.81	0.94	0.97	0.98	(89)

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

(90)m=	14.18	14.46	15.04	15.88	16.75	17.54	17.91	17.88	17.32	16.23	15.09	14.16	(90)

fLA = Living area ÷ (4) = 0.15 (91)

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

(92)m=	14.49	14.77	15.35	16.19	17.07	17.87	18.27	18.22	17.64	16.55	15.4	14.47	(92)

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

(93)m=	14.49	14.77	15.35	16.19	17.07	17.87	18.27	18.22	17.64	16.55	15.4	14.47	(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=	0.97	0.96	0.94	0.9	0.83	0.71	0.51	0.56	0.79	0.92	0.96	0.98	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1006.71	1229.64	1428.4	1591.25	1615	1363.04	936.21	955.37	1213.76	1176.25	1022.87	947.64	(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=	8186.31	7887.68	7034.77	5640.03	4128.35	2441.43	1245.89	1354.26	2679.39	4572.04	6454.82	8073.53	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	5341.62	4474.2	4171.14	2915.13	1869.93	0	0	0	0	2526.47	3911.01	5301.66	

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	Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =	30511.16	(98)
Space heating requirement in kWh/m²/year		257.65	(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		100	(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)	5341.62	4474.2	4171.14	2915.13	1869.93	0	0	0	0	2526.47	3911.01	5301.66		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	5341.62	4474.2	4171.14	2915.13	1869.93	0	0	0	0	2526.47	3911.01	5301.66		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													30511.16	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208) (215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	383.24	341.14	366.16	339.18	340.31	315.46	313.8	329.4	324.14	351.17	357.58	377.71		
Efficiency of water heater													100	(216)
(217)m=	100	100	100	100	100	100	100	100	100	100	100	100		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	383.24	341.14	366.16	339.18	340.31	315.46	313.8	329.4	324.14	351.17	357.58	377.71		
Total = Sum(219a)$_{1...12}$ =													4139.31	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			30511.16	
Water heating fuel used			4139.31	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		120		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		120	(231)
Electricity for lighting			757.84	(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	0.519	=	15835.29	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)

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Water heating	(219) x	0.216	=	894.09	(264)
Space and water heating	(261) + (262) + (263) + (264) =			16729.38	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	62.28	(267)
Electricity for lighting	(232) x	0.519	=	393.32	(268)
Total CO2, kg/year		sum of (265)…(271) =		17184.98	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		145.12	(273)
EI rating (section 14)				8	(274)

SAP Proposed

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Su Lee	**Stroma Number:**	STRO031315
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: Flat 1- Proposed

Address : 151-153, Camden High Street, LONDON, NW1 7JY

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	74.67	(1a) x	2.75	(2a) =	205.34	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	74.67	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	205.34	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans =	(6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.1	(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		4.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.32	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.27	(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

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

0.35	0.34	0.34	0.3	0.29	0.26	0.26	0.25	0.27	0.29	0.31	0.32

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=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

(25)m=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.12	x	1.2	=	2.544			(26)
Windows Type 1			0.91	x1/[1/(1.2)+ 0.04]		=	1.04			(27)
Windows Type 2			1.53	x1/[1/(1.2)+ 0.04]		=	1.75			(27)
Windows Type 3			4.42	x1/[1/(1.2)+ 0.04]		=	5.06			(27)
Windows Type 4			4.01	x1/[1/(1.2)+ 0.04]		=	4.59			(27)
Floor			74.67	x	0.22	=	16.4274			(28)
Walls Type1	28.68	6.86	21.82	x	0.55	=	12			(29)
Walls Type2	30.91	8.02	22.89	x	0.55	=	12.59			(29)
Walls Type3	12.24	2.12	10.12	x	0.55	=	5.56			(29)
Roof	6.42	0	6.42	x	0.18	=	1.16			(30)
Total area of elements, m²			152.92							(31)
Party wall			28.6	x	0	=	0			(32)
Party wall			16.44	x	0	=	0			(32)

** 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) = 67.32 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 0 (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 22.94 (36)

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

Total fabric heat loss (33) + (36) = 90.26 (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=	38.02	37.86	37.7	36.96	36.82	36.18	36.18	36.06	36.43	36.82	37.1	37.39	(38)

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

(39)m=	128.28	128.12	127.96	127.22	127.08	126.44	126.44	126.32	126.69	127.08	127.36	127.65	

Average = $Sum(39)_{1...12}$ /12= 127.22 (39)

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

(40)m=	1.72	1.72	1.71	1.7	1.7	1.69	1.69	1.69	1.7	1.7	1.71	1.71	

Average = $Sum(40)_{1...12}$ /12= 1.7 (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 2.35 (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 90.11 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m=	99.12	95.51	91.91	88.3	84.7	81.1	81.1	84.7	88.3	91.91	95.51	99.12

Total = $Sum(44)_{1...12}$ = 1081.28 (44)

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

(45)m=	146.99	128.56	132.66	115.66	110.97	95.76	88.74	101.83	103.04	120.09	131.09	142.35

Total = $Sum(45)_{1...12}$ = 1417.73 (45)

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

(46)m=	22.05	19.28	19.9	17.35	16.65	14.36	13.31	15.27	15.46	18.01	19.66	21.35	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 125 (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): 1.19 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.64 (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) 0.64 (55)

DER WorkSheet: New dwelling design stage

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

(56)m=	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92	(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=	19.92	17.99	19.92	19.28	19.92	19.28	19.92	19.92	19.28	19.92	19.28	19.92	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	166.91	146.55	152.58	134.93	130.89	115.04	108.66	121.75	122.32	140.01	150.36	162.27	(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=	166.91	146.55	152.58	134.93	130.89	115.04	108.66	121.75	122.32	140.01	150.36	162.27

Output from water heater (annual)$_{1...12}$ | 1652.28 | (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=	64.81	57.14	60.05	53.88	52.84	47.26	45.44	49.79	49.68	55.87	59.01	63.27	(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=	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	117.7	(66)

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

(67)m=	18.68	16.59	13.49	10.21	7.63	6.45	6.96	9.05	12.15	15.43	18.01	19.2	(67)

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

(68)m=	207.94	210.1	204.66	193.09	178.47	164.74	155.57	153.41	158.85	170.42	185.03	198.77	(68)

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

(69)m=	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	34.77	(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=	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	-94.16	(71)

Water heating gains (Table 5)

(72)m=	87.11	85.03	80.71	74.83	71.02	65.64	61.08	66.93	69.01	75.09	81.96	85.04	(72)

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

(73)m=	375.04	373.03	360.17	339.44	318.43	298.14	284.92	290.7	301.31	322.25	346.31	364.31	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	4.01	x	11.28	x	0.76	x	0.7	=	33.36	(75)
Northeast 0.9x	0.77	x	4.01	x	22.97	x	0.76	x	0.7	=	67.91	(75)
Northeast 0.9x	0.77	x	4.01	x	41.38	x	0.76	x	0.7	=	122.35	(75)
Northeast 0.9x	0.77	x	4.01	x	67.96	x	0.76	x	0.7	=	200.93	(75)
Northeast 0.9x	0.77	x	4.01	x	91.35	x	0.76	x	0.7	=	270.09	(75)
Northeast 0.9x	0.77	x	4.01	x	97.38	x	0.76	x	0.7	=	287.94	(75)
Northeast 0.9x	0.77	x	4.01	x	91.1	x	0.76	x	0.7	=	269.37	(75)
Northeast 0.9x	0.77	x	4.01	x	72.63	x	0.76	x	0.7	=	214.74	(75)
Northeast 0.9x	0.77	x	4.01	x	50.42	x	0.76	x	0.7	=	149.08	(75)
Northeast 0.9x	0.77	x	4.01	x	28.07	x	0.76	x	0.7	=	82.99	(75)
Northeast 0.9x	0.77	x	4.01	x	14.2	x	0.76	x	0.7	=	41.98	(75)
Northeast 0.9x	0.77	x	4.01	x	9.21	x	0.76	x	0.7	=	27.24	(75)
Southwest 0.9x	0.77	x	0.91	x	36.79		0.76	x	0.7	=	12.34	(79)
Southwest 0.9x	0.77	x	1.53	x	36.79		0.76	x	0.7	=	20.75	(79)
Southwest 0.9x	0.77	x	4.42	x	36.79		0.76	x	0.7	=	59.96	(79)
Southwest 0.9x	0.77	x	0.91	x	62.67		0.76	x	0.7	=	21.03	(79)
Southwest 0.9x	0.77	x	1.53	x	62.67		0.76	x	0.7	=	35.35	(79)
Southwest 0.9x	0.77	x	4.42	x	62.67		0.76	x	0.7	=	102.13	(79)
Southwest 0.9x	0.77	x	0.91	x	85.75		0.76	x	0.7	=	28.77	(79)
Southwest 0.9x	0.77	x	1.53	x	85.75		0.76	x	0.7	=	48.37	(79)
Southwest 0.9x	0.77	x	4.42	x	85.75		0.76	x	0.7	=	139.74	(79)
Southwest 0.9x	0.77	x	0.91	x	106.25		0.76	x	0.7	=	35.65	(79)
Southwest 0.9x	0.77	x	1.53	x	106.25		0.76	x	0.7	=	59.93	(79)
Southwest 0.9x	0.77	x	4.42	x	106.25		0.76	x	0.7	=	173.14	(79)
Southwest 0.9x	0.77	x	0.91	x	119.01		0.76	x	0.7	=	39.93	(79)
Southwest 0.9x	0.77	x	1.53	x	119.01		0.76	x	0.7	=	67.13	(79)
Southwest 0.9x	0.77	x	4.42	x	119.01		0.76	x	0.7	=	193.93	(79)
Southwest 0.9x	0.77	x	0.91	x	118.15		0.76	x	0.7	=	39.64	(79)
Southwest 0.9x	0.77	x	1.53	x	118.15		0.76	x	0.7	=	66.65	(79)
Southwest 0.9x	0.77	x	4.42	x	118.15		0.76	x	0.7	=	192.53	(79)
Southwest 0.9x	0.77	x	0.91	x	113.91		0.76	x	0.7	=	38.22	(79)
Southwest 0.9x	0.77	x	1.53	x	113.91		0.76	x	0.7	=	64.25	(79)
Southwest 0.9x	0.77	x	4.42	x	113.91		0.76	x	0.7	=	185.62	(79)
Southwest 0.9x	0.77	x	0.91	x	104.39		0.76	x	0.7	=	35.02	(79)
Southwest 0.9x	0.77	x	1.53	x	104.39		0.76	x	0.7	=	58.88	(79)
Southwest 0.9x	0.77	x	4.42	x	104.39		0.76	x	0.7	=	170.11	(79)
Southwest 0.9x	0.77	x	0.91	x	92.85		0.76	x	0.7	=	31.15	(79)
Southwest 0.9x	0.77	x	1.53	x	92.85		0.76	x	0.7	=	52.38	(79)
Southwest 0.9x	0.77	x	4.42	x	92.85		0.76	x	0.7	=	151.31	(79)

Southwest 0.9x	0.77	x	0.91	x	69.27	0.76	x	0.7	=	23.24	(79)
Southwest 0.9x	0.77	x	1.53	x	69.27	0.76	x	0.7	=	39.07	(79)
Southwest 0.9x	0.77	x	4.42	x	69.27	0.76	x	0.7	=	112.87	(79)
Southwest 0.9x	0.77	x	0.91	x	44.07	0.76	x	0.7	=	14.79	(79)
Southwest 0.9x	0.77	x	1.53	x	44.07	0.76	x	0.7	=	24.86	(79)
Southwest 0.9x	0.77	x	4.42	x	44.07	0.76	x	0.7	=	71.82	(79)
Southwest 0.9x	0.77	x	0.91	x	31.49	0.76	x	0.7	=	10.56	(79)
Southwest 0.9x	0.77	x	1.53	x	31.49	0.76	x	0.7	=	17.76	(79)
Southwest 0.9x	0.77	x	4.42	x	31.49	0.76	x	0.7	=	51.31	(79)

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

(83)m=	126.42	226.42	339.23	469.65	571.08	586.76	557.46	478.76	383.92	258.17	153.44	106.88	(83)

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

(84)m=	501.46	599.44	699.4	809.09	889.52	884.9	842.37	769.46	685.23	580.42	499.74	471.19	(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	0.98	0.95	0.88	0.75	0.61	0.67	0.87	0.97	0.99	1	(86)

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

(87)m=	19.13	19.33	19.67	20.12	20.55	20.84	20.95	20.92	20.68	20.14	19.55	19.09	(87)

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

(88)m=	19.53	19.53	19.53	19.54	19.54	19.55	19.55	19.55	19.54	19.54	19.54	19.53	(88)

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

(89)m=	1	0.99	0.98	0.93	0.83	0.64	0.43	0.49	0.79	0.96	0.99	1	(89)

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

(90)m=	17.1	17.39	17.89	18.54	19.11	19.44	19.53	19.52	19.3	18.57	17.72	17.05	(90)

fLA = Living area ÷ (4) = 0.45 (91)

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

(92)m=	18.02	18.26	18.69	19.25	19.76	20.07	20.17	20.15	19.92	19.28	18.54	17.97	(92)

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

(93)m=	17.87	18.11	18.54	19.1	19.61	19.92	20.02	20	19.77	19.13	18.39	17.82	(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=	0.99	0.99	0.97	0.93	0.83	0.67	0.49	0.55	0.81	0.95	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	497.85	591.05	678.35	750.19	741.29	593	414.05	426.53	552.89	552.53	493.27	468.47	(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=	1740.11	1692.97	1540.67	1298.18	1004.94	672.73	432.25	455	718.62	1083.45	1438.04	1738.39	(97)

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

(98)m=	924.24	740.49	641.56	394.55	196.15	0	0	0	0	395.01	680.24	944.82

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4917.07 (98)

Space heating requirement in kWh/m²/year 65.85 (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 1 100 (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)	924.24	740.49	641.56	394.55	196.15	0	0	0	0	395.01	680.24	944.82		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	924.24	740.49	641.56	394.55	196.15	0	0	0	0	395.01	680.24	944.82		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													4917.07	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208) (215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	166.91	146.55	152.58	134.93	130.89	115.04	108.66	121.75	122.32	140.01	150.36	162.27		
Efficiency of water heater													100	(216)
(217)m=	100	100	100	100	100	100	100	100	100	100	100	100		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	166.91	146.55	152.58	134.93	130.89	115.04	108.66	121.75	122.32	140.01	150.36	162.27		
Total = Sum(219a)$_{1...12}$ =													1652.28	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			4917.07	
Water heating fuel used			1652.28	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			329.82	(232)
Electricity generated by PVs			-1389.58	(233)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year

DER WorkSheet: New dwelling design stage

Space heating (main system 1)	(211) x	0.519	=	2551.96	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.519	=	857.53	(264)
Space and water heating	(261) + (262) + (263) + (264) =			3409.49	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	171.18	(268)
Energy saving/generation technologies Item 1		0.519	=	-721.19	(269)
Total CO2, kg/year	sum of (265)…(271) =			2875.05	(272)
Dwelling CO2 Emission Rate	(272) ÷ (4) =			38.5	(273)
EI rating (section 14)				68	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Su Lee	**Stroma Number:**	STRO031315
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: Flat 2- Proposed

Address : 151-153, Camden High Street, LONDON, NW1 7JY

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	70.26	(1a)	x	3.04	(2a)	=	213.59	(3a)
First floor	48.16	(1b)	x	2.39	(2b)	=	115.1	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	118.42	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	328.69	(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) =	0.12	(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		4.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.35	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.29	(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

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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

0.38	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.35

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	0.57	0.57	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	0.57	0.57	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			2.1	x	1.2	=	2.52			(26)
Windows Type 1			1.43	x1/[1/(1.6)+ 0.04]		=	2.15			(27)
Windows Type 2			1.43	x1/[1/(1.6)+ 0.04]		=	2.15			(27)
Windows Type 3			0.91	x1/[1/(1.6)+ 0.04]		=	1.37			(27)
Windows Type 4			3.1	x1/[1/(1.6)+ 0.04]		=	4.66			(27)
Windows Type 5			1.43	x1/[1/(1.6)+ 0.04]		=	2.15			(27)
Windows Type 6			4.01	x1/[1/(1.6)+ 0.04]		=	6.03			(27)
Floor Type 1			70.26	x	0.25	=	17.565			(28)
Floor Type 2			48.16	x	0.15	=	7.224			(28)
Walls Type1	14.11	16.32	-2.21	x	0.28	=	-0.62			(29)
Walls Type2	27.48	8.02	19.46	x	0.28	=	5.45			(29)
Walls Type3	6.75	0	6.75	x	0.13	=	0.89			(29)
Walls Type4	6.75	0	6.75	x	0.13	=	0.89			(29)
Walls Type5	10.37	2.1	8.27	x	0.13	=	1.09			(29)
Walls Type6	19.84	4.29	15.55	x	0.15	=	2.33			(29)
Walls Type7	20.62	4.29	16.33	x	0.15	=	2.45			(29)
Walls Type8	2.14	0	2.14	x	0.15	=	0.32			(29)

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Walls Type9	2.14	0	2.14	x	0.15	=	0.32			(29)
Walls Type10	8.18	0	8.18	x	0.15	=	1.23			(29)
Roof	49.71	0	49.71	x	0.18	=	8.95			(30)
Total area of elements, m²			286.5							(31)
Party wall			38.91	x	0	=	0			(32)
Party wall			21.31	x	0	=	0			(32)
Party wall			2.13	x	0	=	0			(32)
Party wall			13.46	x	0	=	0			(32)
Party wall			13.45	x	0	=	0			(32)

** 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) =	100.12	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	0	(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		42.98	(36)

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

Total fabric heat loss	(33) + (36) =	143.09	(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=	61.89	61.59	61.3	59.93	59.68	58.48	58.48	58.26	58.94	59.68	60.2	60.74	(38)

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

(39)m=	204.98	204.69	204.39	203.03	202.77	201.58	201.58	201.36	202.04	202.77	203.29	203.83

Average = Sum(39)$_{1…12}$ /12= 203.02 (39)

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

(40)m=	1.73	1.73	1.73	1.71	1.71	1.7	1.7	1.7	1.71	1.71	1.72	1.72

Average = Sum(40)$_{1…12}$ /12= 1.71 (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 2.86 (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) + 36 102.05 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m=	112.26	108.18	104.09	100.01	95.93	91.85	91.85	95.93	100.01	104.09	108.18	112.26

Total = Sum(44)$_{1…12}$ = 1224.64 (44)

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

(45)m=	166.48	145.6	150.25	130.99	125.69	108.46	100.5	115.33	116.71	136.01	148.47	161.22

Total = Sum(45)$_{1…12}$ = 1605.7 (45)

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

(46)m=	24.97	21.84	22.54	19.65	18.85	16.27	15.08	17.3	17.51	20.4	22.27	24.18	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 145 | (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): | 1.32 | (48)

Temperature factor from Table 2b | 0.54 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 0.71 | (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) | 0.71 | (55)

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

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	188.57	165.56	172.34	152.37	147.78	129.84	122.6	137.43	138.09	158.11	169.85	183.32	(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=	188.57	165.56	172.34	152.37	147.78	129.84	122.6	137.43	138.09	158.11	169.85	183.32

Output from water heater (annual)$_{1...12}$ | 1865.87 | (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=	73.03	64.38	67.63	60.66	59.47	53.17	51.09	56.02	55.91	62.9	66.47	71.28	(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=	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	142.85	(66)

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

(67)m=	25.24	22.42	18.23	13.8	10.32	8.71	9.41	12.24	16.42	20.85	24.34	25.94	(67)

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

(68)m=	283.14	286.08	278.68	262.91	243.02	224.32	211.82	208.89	216.29	232.05	251.95	270.65	(68)

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

(69)m=	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	(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=	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	-114.28	(71)

Water heating gains (Table 5)

(72)m=	98.16	95.8	90.91	84.25	79.93	73.85	68.68	75.3	77.66	84.54	92.32	95.81	(72)

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

(73)m=	475.4	473.16	456.67	429.82	402.12	375.73	358.77	365.28	379.22	406.3	437.46	461.26	(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	1.43	x	11.28	x	0.76	x	0.7	=	17.85	(75)
Northeast 0.9x	0.77	x	4.01	x	11.28	x	0.76	x	0.7	=	33.36	(75)
Northeast 0.9x	0.77	x	1.43	x	22.97	x	0.76	x	0.7	=	36.32	(75)
Northeast 0.9x	0.77	x	4.01	x	22.97	x	0.76	x	0.7	=	67.91	(75)
Northeast 0.9x	0.77	x	1.43	x	41.38	x	0.76	x	0.7	=	65.45	(75)
Northeast 0.9x	0.77	x	4.01	x	41.38	x	0.76	x	0.7	=	122.35	(75)
Northeast 0.9x	0.77	x	1.43	x	67.96	x	0.76	x	0.7	=	107.48	(75)
Northeast 0.9x	0.77	x	4.01	x	67.96	x	0.76	x	0.7	=	200.93	(75)
Northeast 0.9x	0.77	x	1.43	x	91.35	x	0.76	x	0.7	=	144.47	(75)
Northeast 0.9x	0.77	x	4.01	x	91.35	x	0.76	x	0.7	=	270.09	(75)
Northeast 0.9x	0.77	x	1.43	x	97.38	x	0.76	x	0.7	=	154.03	(75)
Northeast 0.9x	0.77	x	4.01	x	97.38	x	0.76	x	0.7	=	287.94	(75)
Northeast 0.9x	0.77	x	1.43	x	91.1	x	0.76	x	0.7	=	144.09	(75)
Northeast 0.9x	0.77	x	4.01	x	91.1	x	0.76	x	0.7	=	269.37	(75)
Northeast 0.9x	0.77	x	1.43	x	72.63	x	0.76	x	0.7	=	114.87	(75)
Northeast 0.9x	0.77	x	4.01	x	72.63	x	0.76	x	0.7	=	214.74	(75)
Northeast 0.9x	0.77	x	1.43	x	50.42	x	0.76	x	0.7	=	79.75	(75)
Northeast 0.9x	0.77	x	4.01	x	50.42	x	0.76	x	0.7	=	149.08	(75)
Northeast 0.9x	0.77	x	1.43	x	28.07	x	0.76	x	0.7	=	44.39	(75)
Northeast 0.9x	0.77	x	4.01	x	28.07	x	0.76	x	0.7	=	82.99	(75)
Northeast 0.9x	0.77	x	1.43	x	14.2	x	0.76	x	0.7	=	22.45	(75)
Northeast 0.9x	0.77	x	4.01	x	14.2	x	0.76	x	0.7	=	41.98	(75)
Northeast 0.9x	0.77	x	1.43	x	9.21	x	0.76	x	0.7	=	14.57	(75)
Northeast 0.9x	0.77	x	4.01	x	9.21	x	0.76	x	0.7	=	27.24	(75)

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Southwest	0.9x	0.77	x	1.43	x	36.79	0.76	x	0.7	=	58.19	(79)
Southwest	0.9x	0.77	x	0.91	x	36.79	0.76	x	0.7	=	37.03	(79)
Southwest	0.9x	0.77	x	3.1	x	36.79	0.76	x	0.7	=	126.15	(79)
Southwest	0.9x	0.77	x	1.43	x	36.79	0.76	x	0.7	=	58.19	(79)
Southwest	0.9x	0.77	x	1.43	x	62.67	0.76	x	0.7	=	99.13	(79)
Southwest	0.9x	0.77	x	0.91	x	62.67	0.76	x	0.7	=	63.08	(79)
Southwest	0.9x	0.77	x	3.1	x	62.67	0.76	x	0.7	=	214.89	(79)
Southwest	0.9x	0.77	x	1.43	x	62.67	0.76	x	0.7	=	99.13	(79)
Southwest	0.9x	0.77	x	1.43	x	85.75	0.76	x	0.7	=	135.63	(79)
Southwest	0.9x	0.77	x	0.91	x	85.75	0.76	x	0.7	=	86.31	(79)
Southwest	0.9x	0.77	x	3.1	x	85.75	0.76	x	0.7	=	294.02	(79)
Southwest	0.9x	0.77	x	1.43	x	85.75	0.76	x	0.7	=	135.63	(79)
Southwest	0.9x	0.77	x	1.43	x	106.25	0.76	x	0.7	=	168.05	(79)
Southwest	0.9x	0.77	x	0.91	x	106.25	0.76	x	0.7	=	106.94	(79)
Southwest	0.9x	0.77	x	3.1	x	106.25	0.76	x	0.7	=	364.3	(79)
Southwest	0.9x	0.77	x	1.43	x	106.25	0.76	x	0.7	=	168.05	(79)
Southwest	0.9x	0.77	x	1.43	x	119.01	0.76	x	0.7	=	188.23	(79)
Southwest	0.9x	0.77	x	0.91	x	119.01	0.76	x	0.7	=	119.78	(79)
Southwest	0.9x	0.77	x	3.1	x	119.01	0.76	x	0.7	=	408.05	(79)
Southwest	0.9x	0.77	x	1.43	x	119.01	0.76	x	0.7	=	188.23	(79)
Southwest	0.9x	0.77	x	1.43	x	118.15	0.76	x	0.7	=	186.87	(79)
Southwest	0.9x	0.77	x	0.91	x	118.15	0.76	x	0.7	=	118.92	(79)
Southwest	0.9x	0.77	x	3.1	x	118.15	0.76	x	0.7	=	405.1	(79)
Southwest	0.9x	0.77	x	1.43	x	118.15	0.76	x	0.7	=	186.87	(79)
Southwest	0.9x	0.77	x	1.43	x	113.91	0.76	x	0.7	=	180.16	(79)
Southwest	0.9x	0.77	x	0.91	x	113.91	0.76	x	0.7	=	114.65	(79)
Southwest	0.9x	0.77	x	3.1	x	113.91	0.76	x	0.7	=	390.56	(79)
Southwest	0.9x	0.77	x	1.43	x	113.91	0.76	x	0.7	=	180.16	(79)
Southwest	0.9x	0.77	x	1.43	x	104.39	0.76	x	0.7	=	165.11	(79)
Southwest	0.9x	0.77	x	0.91	x	104.39	0.76	x	0.7	=	105.07	(79)
Southwest	0.9x	0.77	x	3.1	x	104.39	0.76	x	0.7	=	357.92	(79)
Southwest	0.9x	0.77	x	1.43	x	104.39	0.76	x	0.7	=	165.11	(79)
Southwest	0.9x	0.77	x	1.43	x	92.85	0.76	x	0.7	=	146.86	(79)
Southwest	0.9x	0.77	x	0.91	x	92.85	0.76	x	0.7	=	93.45	(79)
Southwest	0.9x	0.77	x	3.1	x	92.85	0.76	x	0.7	=	318.36	(79)
Southwest	0.9x	0.77	x	1.43	x	92.85	0.76	x	0.7	=	146.86	(79)
Southwest	0.9x	0.77	x	1.43	x	69.27	0.76	x	0.7	=	109.55	(79)
Southwest	0.9x	0.77	x	0.91	x	69.27	0.76	x	0.7	=	69.72	(79)
Southwest	0.9x	0.77	x	3.1	x	69.27	0.76	x	0.7	=	237.5	(79)
Southwest	0.9x	0.77	x	1.43	x	69.27	0.76	x	0.7	=	109.55	(79)
Southwest	0.9x	0.77	x	1.43	x	44.07	0.76	x	0.7	=	69.7	(79)

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Southwest	0.9x	0.77	x	0.91	x	44.07	0.76	x	0.7	=	44.36	(79)
Southwest	0.9x	0.77	x	3.1	x	44.07	0.76	x	0.7	=	151.1	(79)
Southwest	0.9x	0.77	x	1.43	x	44.07	0.76	x	0.7	=	69.7	(79)
Southwest	0.9x	0.77	x	1.43	x	31.49	0.76	x	0.7	=	49.8	(79)
Southwest	0.9x	0.77	x	0.91	x	31.49	0.76	x	0.7	=	31.69	(79)
Southwest	0.9x	0.77	x	3.1	x	31.49	0.76	x	0.7	=	107.96	(79)
Southwest	0.9x	0.77	x	1.43	x	31.49	0.76	x	0.7	=	49.8	(79)

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

(83)m=	330.78	580.45	839.38	1115.75	1318.86	1339.72	1278.98	1122.81	934.36	653.7	399.3	281.08	(83)

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

(84)m=	806.18	1053.61	1296.05	1545.58	1720.98	1715.45	1637.75	1488.09	1313.58	1060.01	836.76	742.34	(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	0.97	0.92	0.82	0.66	0.51	0.58	0.81	0.96	0.99	1	(86)

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

(87)m=	19.12	19.38	19.78	20.26	20.66	20.89	20.97	20.95	20.76	20.21	19.57	19.07	(87)

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

(88)m=	19.52	19.52	19.52	19.53	19.53	19.54	19.54	19.54	19.54	19.53	19.53	19.53	(88)

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

(89)m=	0.99	0.99	0.96	0.9	0.75	0.55	0.36	0.41	0.71	0.94	0.99	1	(89)

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

(90)m=	17.08	17.47	18.04	18.72	19.23	19.48	19.53	19.52	19.37	18.67	17.74	17.02	(90)

fLA = Living area ÷ (4) = | 0.15 | (91)

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

(92)m=	17.39	17.75	18.3	18.95	19.44	19.69	19.75	19.74	19.57	18.9	18.01	17.32	(92)

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

(93)m=	17.24	17.6	18.15	18.8	19.29	19.54	19.6	19.59	19.42	18.75	17.86	17.17	(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=	0.99	0.98	0.95	0.88	0.74	0.55	0.36	0.42	0.7	0.92	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	799.1	1030.69	1229.24	1354.96	1276.09	935.68	594.43	625.7	923.65	976.31	821.8	737.41	(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=	2652.36	2600.41	2380.46	2009.35	1539.42	995.43	603.83	641.97	1075.73	1653.08	2188.02	2644.67	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1378.83	1054.85	856.51	471.16	195.92	0	0	0	0	503.51	983.67	1419	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 6863.46 (98)

Space heating requirement in kWh/m²/year 57.96 (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 1 100 (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)	1378.83	1054.85	856.51	471.16	195.92	0	0	0	0	503.51	983.67	1419	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1378.83	1054.85	856.51	471.16	195.92	0	0	0	0	503.51	983.67	1419	(211)

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 6863.46 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10...12}$= 0 (215)

Water heating

Output from water heater (calculated above)

	188.57	165.56	172.34	152.37	147.78	129.84	122.6	137.43	138.09	158.11	169.85	183.32

Efficiency of water heater 100 (216)

(217)m=	100	100	100	100	100	100	100	100	100	100	100	100	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	188.57	165.56	172.34	152.37	147.78	129.84	122.6	137.43	138.09	158.11	169.85	183.32

Total = Sum(219a)$_{1...12}$ = 1865.87 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		6863.46	
Water heating fuel used		1865.87	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
Total electricity for the above, kWh/year (sum of (230a)…(230g) =)		30	(231)
Electricity for lighting		445.79	(232)
Electricity generated by PVs		-2203.75	(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	0.519	=	3562.14	(261)

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Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.519	=	968.39	(264)
Space and water heating	(261) + (262) + (263) + (264) =			4530.52	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	231.36	(268)
Energy saving/generation technologies					
Item 1		0.519	=	-1143.75	(269)
Total CO2, kg/year		sum of (265)…(271) =		3633.71	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		30.68	(273)
EI rating (section 14)				70	(274)