AJ ENERGY CONSULTANTS LIMITED

13 Murray Mews, London NW1 9RJ

Energy Assessment

February 2017

CUTTING THE COST OF CARBON

www.ajenergy.com

[page left intentionally blank]

1 Issue Register

Revision	Reason for Issue	Date of Issue	Issued By
1.0	For information	27/02/17	J Simpson CEng MCIBSE

2 Contents

3 Executive Summary

This document responds to planning policy in respect of energy consumption and carbon dioxide emissions. The methodology used herein is consistent with the latest Greater London Authority (GLA) guidance and Part L of the Building Regulations.

There are no installed district heating schemes in the immediate vicinity of the site, and therefore it is not considered feasible to connect the Proposed Development to a district heating scheme. Combined heat and power (CHP) has been assessed in terms of feasibility. There is no economic or sustainable justification for over-sizing the CHP plant, and therefore the CHP unit size needs to be carefully matched to the demands of the development. The smallest commercially available CHP unit is too large for the scheme due to the limited number of residential dwellings, and therefore CHP is not considered to be viable for the Proposed Development.

The Proposed Development features significantly improved insulation and air tightness standards, when compared against the compliance requirements of Part L 2013 of the Building Regulations. In addition, energy efficient lighting is to be provided throughout the dwelling in excess of the Part L1 2013 requirements, with high efficiency gas boiler and heating controls. The proposed energy efficiency measures would reduce the annual carbon dioxide emissions of the site by 259 $kgCO_2$, which equates to a reduction of 11.1% against the gas baseline TER 2013.

A feasibility study of the currently available low and zero carbon technologies has been undertaken, with photovoltaic panels proposed for the development at roof level, to generate electricity for the site. It has been estimated that the proposed photovoltaic system would reduce the annual carbon dioxide emissions of the site by 592 $kgCO_2$, which equates to a reduction of 25.5%.

The incorporation of the energy efficiency measures and photovoltaic panels equates to a reduction of 36.6% against the Building Regulations compliant TER 2013 for the scheme. Further energy reductions are not considered to be feasible due to the limited benefit of increasing the enhanced insulation and air tightness standards already proposed.

A summary of the reduction in emissions is shown in Tables 1 and 2 below, and graphically in Figure 1 below.

Stage	Regulated carbon dioxide emissions (heating, cooling, hot water, lighting, fans & pumps) ($kgCO_2/yr$)	Unregulated carbon dioxide emissions (cooking, appliances, communal lighting & power) ($kgCO_2/yr$)
Building Regulations Compliance (TER 2013)	2,326	1,983
Energy Efficiency Measures ('Be Lean')	2,067	1,983
Proposed Development with PVs ('Be Green')	1,475	1,983

Table 1 – Carbon dioxide emissions after each stage of the Energy Hierarchy for SAP 2012

Stage	Regulated carbon dioxide savings	
	(kgCO2 per annum)	(%)
Savings from energy demand reduction	259	11.1
Savings from PVs	592	25.5
Total Cumulative Savings	**851**	**36.6**

Table 2 – Regulated carbon dioxide savings from each stage of the Energy Hierarchy for SAP 2012

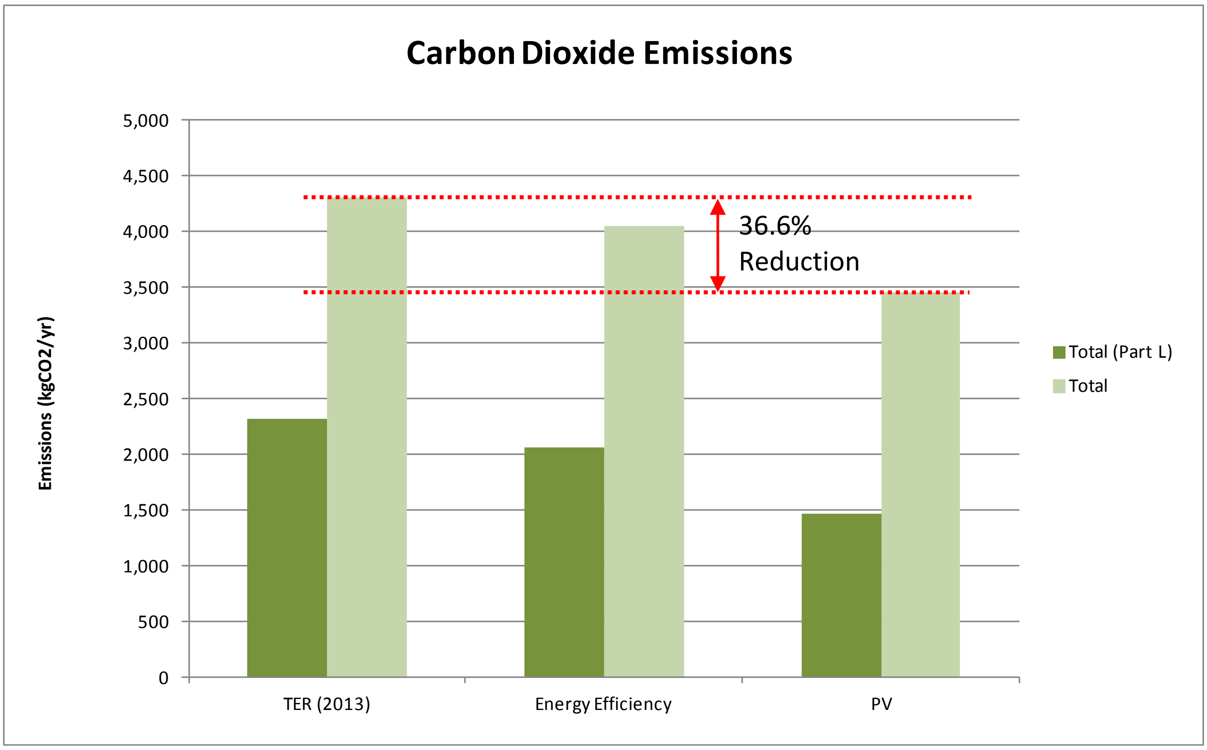


Figure 1 – Summary of carbon dioxide emissions

4 Introduction

4.1 Proposed Development

The Proposed Development comprises the construction of a new build 3-bedroom dwelling at the site.

4.2 Planning Policy Context

4.2.1 National

The following description is taken from the LRT

“Increased development of renewable energy resources is vital to facilitating the delivery of the Government’s commitments on both climate change and renewable energy. The Government’s Energy Policy, including its policy on renewable energy, is set out in the Energy White Paper. This aims to put the UK on a path to cut its carbon dioxide emissions by some 60% by 2050, with real progress by 2020, and to maintain reliable and competitive energy supplies. As part of the strategy for achieving these reductions the White Paper sets out:

- The Government’s target to generate 10% of UK electricity from renewable energy sources by 2010
- The Government’s aspiration to double that figure to 20% by 2020 and suggests that still more renewable energy will be needed beyond that date.

“The Energy White Paper indicated that the Government would be looking to work with regional and local bodies to deliver its objectives, including establishing regional targets for renewable energy generation. Regional Planning Guidance should include the target for renewable energy generation for its respective region, derived from assessments of the region’s renewable energy resource potential.”

The *National Planning Policy Framework* sets out the Government’s national policy for renewable energy. It states that “to help increase the use and supply of renewable and low carbon energy, local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low carbon sources.”

4.2.2 Regional

The London Plan is the overall strategic plan for London, and it sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031. It forms part of the development plan for Greater London. The London Plan 2011 was published on 22 July 2011.

Policy 5.2 (Minimising Carbon Dioxide Emissions) states that:

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

1 – Be lean: use less energy

2 – Be clean: supply energy efficiently
3 – Be green: use renewable energy

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

Year	Improvement on 2010 Building Regulations	
	Residential buildings	**Non-domestic buildings**
2010 – 2013	25 per cent	25 per cent
2013 – 2016	40 per cent	40 per cent
2016 – 2019	Zero carbon	As per building regulations requirements
2019 – 2031		Zero carbon

Table 3 – Proposed carbon dioxide reduction targets under the 2011 London Plan

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

As a minimum, energy assessments should include the following:

a) Calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations at each stage of the energy hierarchy
b) Proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services
c) Proposals to further reduce carbon dioxide emissions through the use of decentralized energy where feasible, such as district heating and cooling and combined heat and power (CHP)
d) Proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.”

Policy 5.7 (Renewable Energy) states that:

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

Within the framework of the energy hierarchy, major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.”

Following the update to Part L of the Building Regulations in April 2014, the carbon dioxide reduction targets have been revised to reflect the changes in software and Building Regulations compliance targets. The GLA have confirmed in their policy update that the current requirement is for a 35% reduction in carbon dioxide emissions against the Part L 2013 TER requirements.

4.2.3 Local

The Core Strategy sets out the key elements of the vision for the Borough of Camden, and is a central part of the Local Development Framework (LDF). Core Policy CS13 on 'tackling climate change through promoting higher environmental standards' states that:

'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 minimise the need to travel by car and help 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 of the elements of the following energy hierarchy:*
    1. *ensuring developments use less energy,*
    2. *making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralized energy networks;*
    3. *generating renewable energy on-site; and*
- *d) ensuring buildings and spaces are designed to cope with, and minimise 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 energy generation
The Council will promote local energy generation and networks by:

- *e) working with our partners and developers to implement local energy networks in the parts of Camden most likely to support them, i.e. in the vicinity of:*
  – housing estates with community heating or the potential for community heating and other uses with large heating loads;
  – the growth areas of King's Cross; Euston; Tottenham Court Road; West Hampstead Interchange and Holborn;
  – schools to be redeveloped as part of Building Schools for the Future programme;
  – existing or approved combined heat and power/local energy networks (see Map 4);
  and other locations where land ownership would facilitate their implementation.

- *f) protecting existing local energy networks where possible (e.g. at Gower Street and Bloomsbury) and safeguarding potential network routes (e.g. Euston Road);*

Water and surface water flooding
We will make Camden a water efficient borough and minimise the potential for surface water flooding by:

- *g) protecting our existing drinking water and foul water infrastructure, including Barrow Hill Reservoir, Hampstead Heath Reservoir, Highgate Reservoir and Kidderpore Reservoir;*
- *h) making sure development incorporates efficient water and foul water infrastructure;*

i) requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and downstream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross (see Map 5).

Camden's carbon reduction measures

The Council will take a lead in tackling climate change by:

j) taking measures to reduce its own carbon emissions;
k) trialling new energy efficient technologies, where feasible; and
l) raising awareness on mitigation and adaptation measures.'

Policy DP22 on 'promoting sustainable design and construction' states that:

"The Council will require development to incorporate sustainable design and construction measures. Schemes must:

a) demonstrate how sustainable development principles, including the relevant measures set out in paragraph 22.5 below, have been incorporated into the design and proposed implementation; and
b) incorporate green or brown roofs and green walls wherever suitable.

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

c) expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016.;
d) expecting developments (except new build) of 500 sq m of residential floorspace or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;
e) expecting non-domestic developments of 500sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:

f) summer shading and planting;
g) limiting run-off;
h) reducing water consumption;
i) reducing air pollution; and
j) not locating vulnerable uses in basements in flood-prone areas.'

Following the Government's Ministerial Statement released on 25 March 2015 in response to the Housing Standards Review Consultation, a number of changes have been introduced to technical housing standards in England, including the withdrawal of the Code for Sustainable Homes as a national standard.

5 Methodology

This report draws on the information and approach set out in the GLA's latest Energy Planning guidance. The currency used for emissions is carbon dioxide, rather than the carbon equivalent, for consistency with Part L of the Building Regulations.

A Part L analysis is conducted to calculate carbon dioxide emissions for the following end uses: heating; hot water; cooling; fans, pumps and controls; and lighting. Various energy-saving measures are considered in terms of technical and economic feasibility and their effect on carbon dioxide emissions. A package of energy-saving measures is proposed that meets the Part L standard, without reliance on the contribution of CHP or renewables. Unregulated energy end uses, such as appliances, are added using the SBEM or SAP software.

CHP is then considered in terms of technical and economic feasibility and its effect on carbon dioxide emissions. The strategic issues relating to each technology are also considered in the context of the Proposed Development, and two or three preferred options are short-listed. These are then considered in more detail in terms of technical and economic feasibility and its effect on carbon dioxide emissions.

Calculations are presented in summary form in subsequent sections, with detailed calculations in Appendix A.

Figure 2 below provides a summary of the methodology in the form of a flow diagram.

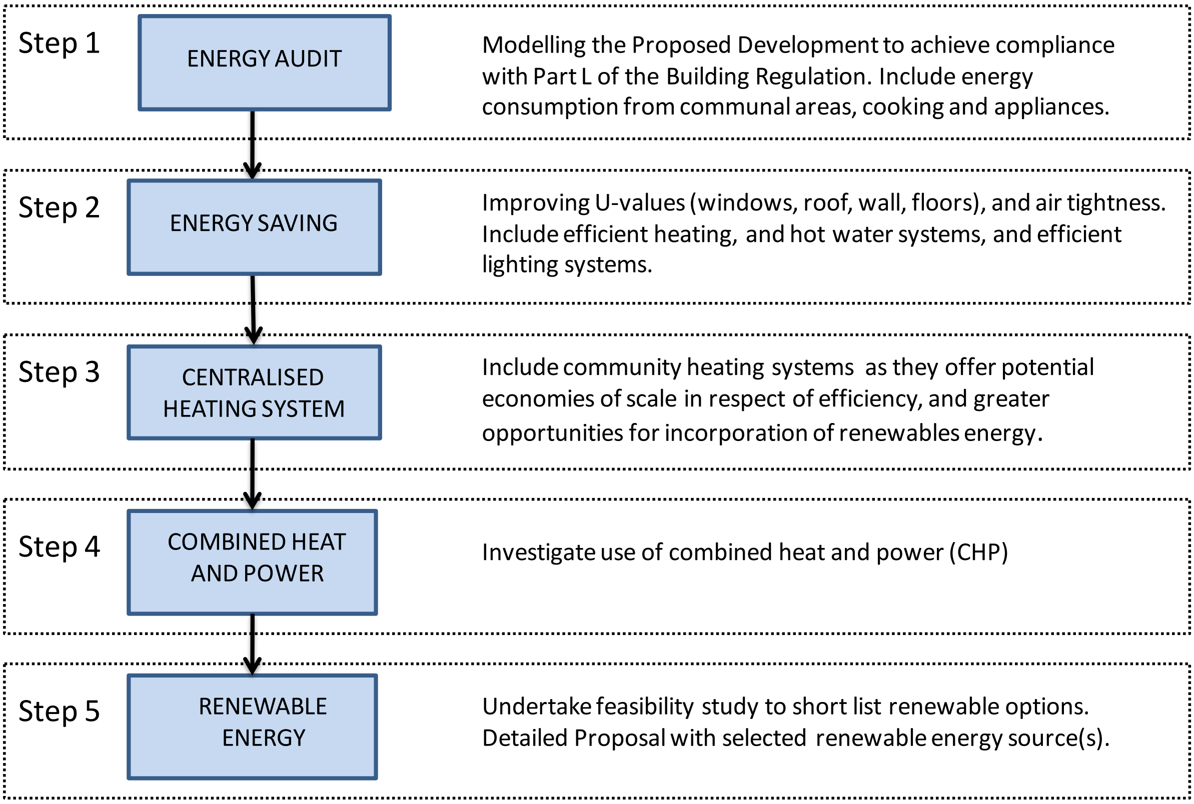


Figure 2 – Flow diagram of methodology

6 Energy Demand

The Development would feature energy saving measures such that compliance with Part L of the Building Regulations (2013) would be achieved without reliance on the contribution of renewable technologies.

As required under Part L, the new build residential dwelling has been assessed under Part L1A, with calculations undertaken using the NHER Plan Assessor software to establish the energy consumption of the scheme.

The minimum requirements for compliance with Part L1A were established using a gas baseline, and feasible improvements were included to further reduce the carbon dioxide emissions. The measures outlined below have been used in the Part L1A calculations, and exceed the requirements of Part L1A. The proposed fabric performance is compared against the Part L1A 2013 requirements in Table 4 below:

Element	Proposed Development	Part L1A 2013 Requirements
External wall U-value	0.18 $W/m^2.K$	0.30 $W/m^2.K$
Flat roof U-value (insulation between and under rafters)	0.11 $W/m^2.K$	0.20 $W/m^2.K$
Ground floor U-value	0.12 $W/m^2.K$	0.25 $W/m^2.K$
Window U-value	1.40 $W/m^2.K$	2.00 $W/m^2.K$
Door U-value	1.00 $W/m^2.K$	2.00 $W/m^2.K$
Party wall U-value	0.00 $W/m^2.K$ (fully filled party wall)	0.20 $W/m^2.K$
Air permeability	3.0 $m^3/hr/m^2$ @ 50 Pa	10 $m^3/hr/m^2$ @ 50 Pa
Thermal bridging	Celotex Accredited Construction Details to be used	0.15
Low energy lighting	100%	75%

Table 4 – Comparison of proposed residential performance for new build dwellings

A high efficiency gas-fired condensing boiler has been used for the gas baseline calculations, with a Ideal Code Combi boiler and a SEDBUK 2012 efficiency of 88.9%. Radiators have been included within the model, with time and temperature zone control and weather compensation.

The enhanced insulation, air tightness and ventilation standards proposed for the dwelling equate to a 11.1% reduction against Part L1A 2013 requirements in terms of carbon footprint, and also equate to a 21.5% reduction against the Target Fabric Energy Efficiency requirements.

It is not considered feasible to further improve insulation and air tightness standards, as the law of diminishing returns dictates that further enhancements have a limited benefit but incur significant construction costs.

7 Community Heating & CHP

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.

There are no existing district heating systems in the immediate vicinity of the site, and therefore not considered to be feasible to connect to a district heating system. The surrounding area comprises low density residential properties, and therefore it is unlikely that a district heating network would be installed in this area in the future. The site falls outside of the opportunity zones noted on the London Heat Map in Camden Town.

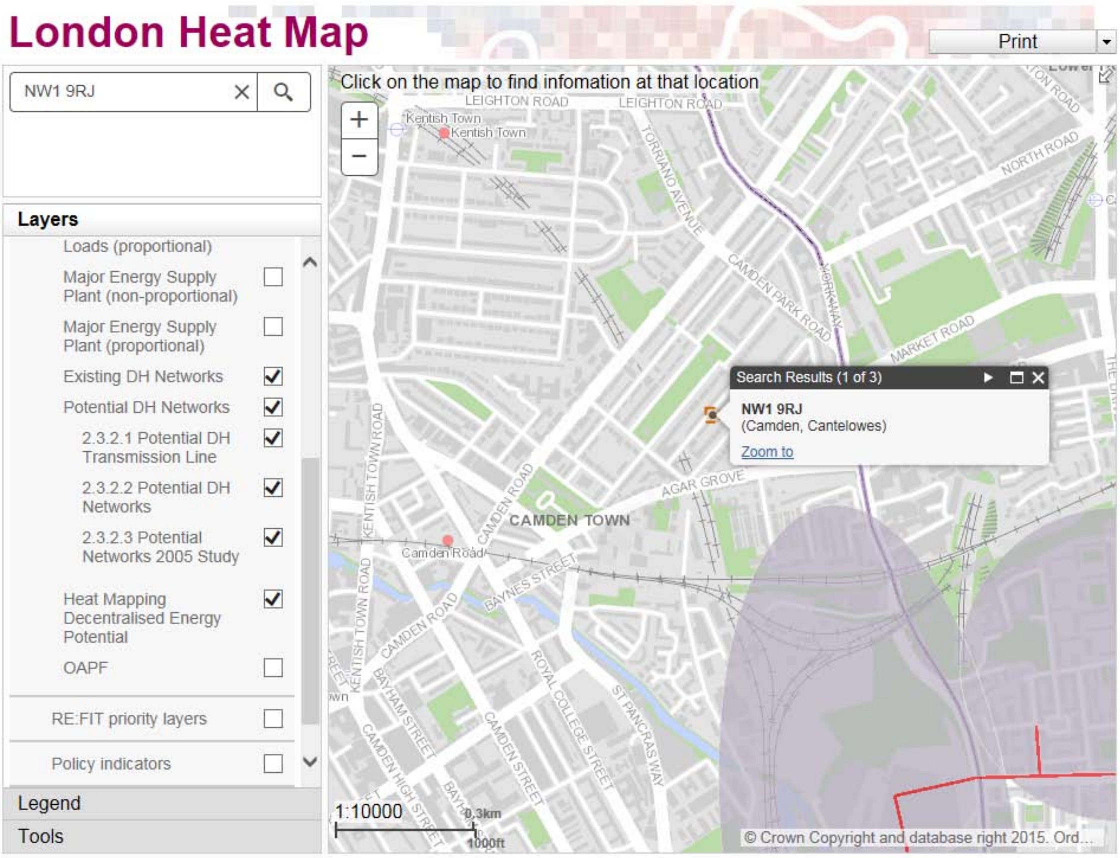


Figure 4 – London Heat Map

Combined heat and power (CHP) has been assessed in terms of feasibility. There is no economic or sustainable justification for over-sizing the CHP plant, and therefore the CHP unit size needs to be carefully matched to the demands of the development. The Proposed Development is not large enough to contain a district wide CHP system to serve surrounding buildings and future schemes, and the smallest commercially available CHP unit is too large for the scheme due to the limited number of residential dwellings. CHP systems are usually specified for large schemes with more than 100-150 dwellings due to the need to have a large enough heat demand to supply from the CHP system – the smallest commercially available CHP unit (the Baxi DACHS micro-CHP unit) would supply 60 dwellings, and therefore would not be economically or technically feasible for this scheme. Therefore CHP is not considered to be viable for the Proposed Development.

8 Renewables – Feasibility Study

The LRT provides benchmark sizing and cost data for “renewable energy technologies suitable for London”. It therefore provides information to assess the various technologies at an early design stage, with initial measurements of the impact of using each technology on the building’s carbon dioxide emissions. Table 5 (below) outlines these technologies and the variations proposed in the LRT used in this assessment.

Technology	End Use Demand Met
Wind	Electricity
PV Cells - rooftop	Electricity
PV Cells - cladding	Electricity
Solar Water Heating	Annual DHW (50 %)
Biomass heating (a)	Annual Space Heating +Domestic Hot Water (33%)
Biomass heating (b)	Annual Space Heating +Domestic Hot Water (50%)
Biomass heating (c)	Annual Space Heating +Domestic Hot Water (100%)
Biomass CHP (a)	Annual Space Heating +Domestic Hot Water (33%)
Biomass CHP (b)	Annual Space Heating +Domestic Hot Water (50%)
Ground sourced heat pumps (a)	Annual Space Heating +Domestic Hot Water (50%)
Ground sourced heat pumps (b)	Annual Space Heating +Domestic Hot Water (100%)
Ground sourced heat pumps (c)	Peak Space Heating (50 %) Annual Space Heating + Domestic Hot Water (85 %)
Ground cooling (a)	Annual Cooling (50%)
Ground cooling (b)	Annual Cooling (100%)

Table 5 – Renewable energy technologies suitable for London

The following other “acceptable renewable energy technologies” are considered to be not typically appropriate in London:

- Fuel cells using hydrogen from renewable sources;
- Gas from anaerobic digestion;
- Geothermal;
- Ground cooling air systems;
- Micro hydro; and
- Solar air collectors.

On the basis of this preliminary analysis, and a review of the general advantages and disadvantages of the different technologies relative to the Proposed Development, the following technologies were not considered to be appropriate to the Proposed Development:

- **Wind turbines:** on the basis of visual appearance, noise issues and concerns over outputs in urban areas. Wind turbines are not considered appropriate for the urban context. There are still concerns over noise with the horizontal axis turbines, and therefore they are not considered appropriate for the development. The average wind speed for the Proposed Development is noted on the Encraft website as 4.7m/s at 10m – this is significantly below the required average wind speed to make wind turbines a practical solution, particularly when the power output of the turbines is reduced by 7/8ths when the wind speed is halved;

- **Biomass:** on the basis of concerns over air quality issues from flue discharge; concerns over transport issues relating to regular deliveries of biomass; security and cost of fuel supply; concerns over disposal of ash; and relatively high maintenance. Biomass is not considered to be a suitable fuel for use within an urban development, and therefore this technology is not considered appropriate for the development. Deliveries of biomass pellets is undertaken by large vehicles the equivalent size of domestic oil delivery tankers and it is not considered appropriate to have vehicles of this size navigating the local streets and making regular deliveries to the site;

- **Biomass CHP:** on the basis of embodied impacts; high maintenance; concerns over air quality issues from flue discharge; concerns over transport issues relating to regular deliveries of biomass; lack of micro-scale units on the market to suit this scale of development; and it being an immature technology. Biomass is not considered to be a suitable fuel for use within an urban development, therefore this technology is not considered appropriate for the development. A large biomass fuelled CHP with heat output of 200 kW is available, but this is significantly larger than required for this scheme, particularly as the current biomass fuelled CHP units need to operate 24/7 – biomass CHP is therefore not considered to be feasible for this scheme;

- **Solar thermal:** due to changes in the Building Regulations calculations, the incorporation of photovoltaic panels provide a greater percentage reduction in carbon dioxide than a solar thermal system, and therefore the proposed strategy of photovoltaic panels is considered to be the most appropriate solution; and

- **Ground source:** due to the limited site area at ground level, there is insufficient area available for horizontal loops. The use of open loop boreholes has been discounted as there is a risk of drilling and not finding a suitable aquifer. The use of closed loop boreholes has been discounted because there is insufficient site area to contain the required number. The resultant carbon footprint of the scheme with gas boilers and photovoltaic panels is significantly lower than that using ground source or air source heat pumps, and therefore the proposed strategy is considered to be the most appropriate solution.

9 Renewables - Detailed Proposal

On the basis of this preliminary analysis, and a review of the general advantages and disadvantages of the different technologies relative to the Proposed Development, the following technologies were considered to be appropriate to the Proposed Development:

- Photovoltaic panels.

9.1 Photovoltaic Panels

Photovoltaic panels extract the energy of the sun to generate electricity. It is proposed that photovoltaic panels be installed on the roofs, to generate electricity for the development. These electrical generation systems would be connected to the National Grid so that any surplus electricity can be exported to the Grid, and would be eligible for the feed-in tariffs.

It is proposed that photovoltaic panels are installed at roof level, facing due South-East. It has been calculated that 6 panels sized 1680mm by 1050mm can be installed at roof level, to generate approximately 1,141 kWh of electricity per annum. The proposed panel locations are shown in Appendix A. At this stage it has been assumed that 6 number 250 Wp panels would be installed, but this would be dependent on the available module sizes and outputs at the time of installation – however, this would be installed to achieve the minimum generation output noted above of 1,141 kWh per annum. The panels would be mounted horizontally at an inclination of 5°, and would benefit from the cooler summer time roof temperatures of the proposed green roof.

Figure 5 - Typical photovoltaic panel installations

The provision of the photovoltaic system would reduce the carbon emissions by 592 $kgCO_2$ per annum, which equates to a reduction of 25.5% when calculated in accordance with the GLA guidelines.

10 Conclusion

This document has responded to planning policy in respect of energy consumption and carbon dioxide emissions. The methodology used herein is consistent with the latest GLA guidance and Part L of the Building Regulations.

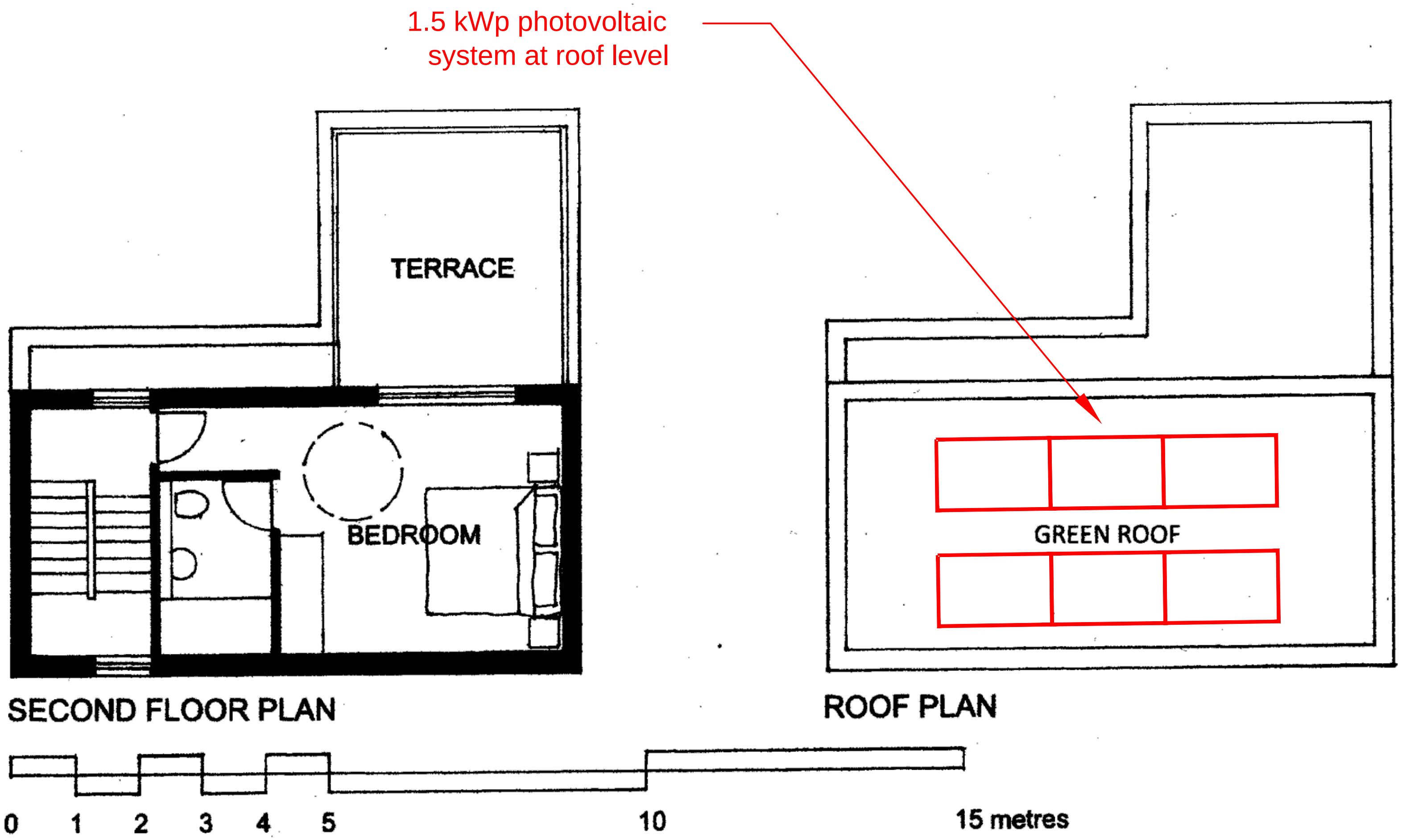
There are no installed district heating schemes in the immediate vicinity of the site, and therefore it is not considered feasible to connect the Proposed Development to a district heating scheme. CHP has been assessed in terms of feasibility. There is no economic or sustainable justification for over-sizing the CHP plant, and therefore the CHP unit size needs to be carefully matched to the demands of the development. The smallest commercially available CHP unit is too large for the scheme due to the limited number of residential dwellings, and therefore CHP is not considered to be viable for the Proposed Development.

The Proposed Development would feature significantly improved insulation and air tightness standards, when compared against the compliance requirements of Part L 2013 of the Building Regulations. In addition, energy efficient lighting is to be provided throughout the dwelling in excess of the Part L1 2013 requirements, with high efficiency gas boiler and heating controls. The proposed energy efficiency measures would reduce the annual carbon dioxide emissions of the site by 259 $kgCO_2$, which equates to a reduction of 11.1% against the gas baseline TER 2013.

A feasibility study of the currently available low and zero carbon technologies has been undertaken, with photovoltaic panels proposed for the development at roof level, to generate electricity for the site. It has been estimated that the proposed photovoltaic system would reduce the annual carbon dioxide emissions of the site by 592 $kgCO_2$, which equates to a reduction of 25.5%.

The incorporation of the energy efficiency measures and photovoltaic panels would equate to a reduction of 36.6% against the Building Regulations compliant TER 2013 for the scheme. Further energy reductions are not considered to be feasible due to the limited benefit of increasing the enhanced insulation and air tightness standards already proposed.

11 Appendix A – Proposed PV Layout



A|P|T	**Architecture, Planning, Technology** APT Partnership 7 Montagu Mews London W1H 2EE Telephone 020-3686 0762Email chris.apt@btinternet.com	Project **MURRAY MEWS CAMDEN**		Drawn MW	Chkd CG	App
		Title **PROPOSED SECOND FLOOR and ROOF PLANS**				
		Date Nov 2016	Scale @ A4 1:100	Drawing No **MNJ 102**	Rev B	

12 Appendix B – Baseline TER Worksheets

Attached are the TER worksheets for the dwelling, which form the gas baseline emissions for the development.

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.4.6

Property Address: 13 Murray Mews

Address : 13 Murray Mews, London, NW1 9RJ

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	51.56	(1a)	x	2.57	(2a)	=	132.51	(3a)
First floor	51.56	(1b)	x	2.85	(2b)	=	146.95	(3b)
Second floor	28.45	(1c)	x	2.95	(2c)	=	83.93	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	131.57	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			363.38	(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) =	0.11	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)

if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.36	(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) =	0.31	(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

TER WorkSheet: New dwelling design stage

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

0.39	0.38	0.37	0.34	0.33	0.29	0.29	0.28	0.31	0.33	0.34	0.36

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=	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(24d)

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

(25)m=	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	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			2.05	x	1	=	2.05			(26)
Windows Type 1			1.75	x1/[1/(1.4)+ 0.04]		=	2.32			(27)
Windows Type 2			4.09	x1/[1/(1.4)+ 0.04]		=	5.42			(27)
Windows Type 3			2.28	x1/[1/(1.4)+ 0.04]		=	3.02			(27)
Windows Type 4			1.75	x1/[1/(1.4)+ 0.04]		=	2.32			(27)
Windows Type 5			4.19	x1/[1/(1.4)+ 0.04]		=	5.55			(27)
Windows Type 6			1.75	x1/[1/(1.4)+ 0.04]		=	2.32			(27)
Windows Type 7			1.75	x1/[1/(1.4)+ 0.04]		=	2.32			(27)
Windows Type 8			2.05	x1/[1/(1.4)+ 0.04]		=	2.72			(27)
Windows Type 9			1.75	x1/[1/(1.4)+ 0.04]		=	2.32			(27)
Windows Type 10			1.75	x1/[1/(1.4)+ 0.04]		=	2.32			(27)
Windows Type 11			4.19	x1/[1/(1.4)+ 0.04]		=	5.55			(27)
Floor			51.56	x	0.13	=	6.7028			(28)
Walls	207.85	32.85	175	x	0.18	=	31.5			(29)
Roof	51.56	0	51.56	x	0.13	=	6.7			(30)
Total area of elements, m²			310.97							(31)
Party wall			37.33	x	0	=	0			(32)

TER WorkSheet: New dwelling design stage

** 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) =	87.79	(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		17.54	(36)

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

Total fabric heat loss	(33) + (36) =	105.33	(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=	69.09	68.73	68.39	66.75	66.45	65.03	65.03	64.76	65.57	66.45	67.07	67.71	(38)

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

(39)m=	174.41	174.06	173.71	172.08	171.77	170.35	170.35	170.09	170.9	171.77	172.39	173.04	

Average = Sum(39)$_{1…12}$ /12= 172.08 (39)

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

(40)m=	1.33	1.32	1.32	1.31	1.31	1.29	1.29	1.29	1.3	1.31	1.31	1.32	

Average = Sum(40)$_{1…12}$ /12= 1.31 (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)

DRAFT

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.9 (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) + 36 103.05 (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=	113.36	109.23	105.11	100.99	96.87	92.75	92.75	96.87	100.99	105.11	109.23	113.36	

Total = Sum(44)$_{1…12}$ = 1236.6 (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=	168.1	147.02	151.71	132.27	126.91	109.52	101.48	116.45	117.85	137.34	149.92	162.8	

Total = Sum(45)$_{1…12}$ = 1621.38 (45)

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

(46)m=	25.22	22.05	22.76	19.84	19.04	16.43	15.22	17.47	17.68	20.6	22.49	24.42	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (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)

TER WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year	(48) x (49) =		0	(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	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	50.96	46.03	50.96	49.32	49.36	45.74	47.26	49.36	49.32	50.96	49.32	50.96	(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=	219.06	193.05	202.67	181.58	176.28	155.26	148.75	165.82	167.16	188.3	199.23	213.76	(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=	219.06	193.05	202.67	181.58	176.28	155.26	148.75	165.82	167.16	188.3	199.23	213.76

Output from water heater (annual)$_{1...12}$ — 2210.91 — (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=	68.63	60.39	63.18	56.31	54.54	47.85	45.56	51.06	51.51	58.4	62.18	66.87	(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=	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	(66)

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

(67)m=	26.71	23.72	19.29	14.61	10.92	9.22	9.96	12.95	17.38	22.06	25.75	27.45	(67)

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

(68)m=	299.6	302.71	294.88	278.2	257.15	237.36	224.14	221.03	228.86	245.54	266.6	286.38	(68)

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

(69)m=	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	(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=	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	(71)

Water heating gains (Table 5)

(72)m=	92.25	89.87	84.93	78.21	73.31	66.46	61.24	68.63	71.55	78.5	86.35	89.88	(72)

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

(73)m=	488.05	485.79	468.58	440.5	410.85	382.52	364.82	372.09	387.27	415.59	448.19	473.2	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	4.09	x	11.28	x	0.63	x	0.7	=	14.1	(75)
Northeast	0.9x	0.77	x	4.09	x	22.97	x	0.63	x	0.7	=	28.71	(75)
Northeast	0.9x	0.77	x	4.09	x	41.38	x	0.63	x	0.7	=	51.72	(75)
Northeast	0.9x	0.77	x	4.09	x	67.96	x	0.63	x	0.7	=	84.94	(75)
Northeast	0.9x	0.77	x	4.09	x	91.35	x	0.63	x	0.7	=	114.18	(75)
Northeast	0.9x	0.77	x	4.09	x	97.38	x	0.63	x	0.7	=	121.73	(75)
Northeast	0.9x	0.77	x	4.09	x	91.1	x	0.63	x	0.7	=	113.87	(75)
Northeast	0.9x	0.77	x	4.09	x	72.63	x	0.63	x	0.7	=	90.78	(75)
Northeast	0.9x	0.77	x	4.09	x	50.42	x	0.63	x	0.7	=	63.02	(75)
Northeast	0.9x	0.77	x	4.09	x	28.07	x	0.63	x	0.7	=	35.08	(75)
Northeast	0.9x	0.77	x	4.09	x	14.2	x	0.63	x	0.7	=	17.75	(75)
Northeast	0.9x	0.77	x	4.09	x	9.21	x	0.63	x	0.7	=	11.52	(75)
Southeast	0.9x	0.77	x	1.75	x	36.79	x	0.63	x	0.7	=	19.68	(77)
Southeast	0.9x	0.77	x	4.19	x	36.79	x	0.63	x	0.7	=	47.12	(77)
Southeast	0.9x	0.77	x	1.75	x	36.79	x	0.63	x	0.7	=	39.36	(77)
Southeast	0.9x	0.77	x	1.75	x	36.79	x	0.63	x	0.7	=	19.68	(77)
Southeast	0.9x	0.77	x	4.19	x	36.79	x	0.63	x	0.7	=	47.12	(77)
Southeast	0.9x	0.77	x	1.75	x	62.67	x	0.63	x	0.7	=	33.52	(77)
Southeast	0.9x	0.77	x	4.19	x	62.67	x	0.63	x	0.7	=	80.25	(77)
Southeast	0.9x	0.77	x	1.75	x	62.67	x	0.63	x	0.7	=	67.04	(77)
Southeast	0.9x	0.77	x	1.75	x	62.67	x	0.63	x	0.7	=	33.52	(77)
Southeast	0.9x	0.77	x	4.19	x	62.67	x	0.63	x	0.7	=	80.25	(77)
Southeast	0.9x	0.77	x	1.75	x	85.75	x	0.63	x	0.7	=	45.86	(77)
Southeast	0.9x	0.77	x	4.19	x	85.75	x	0.63	x	0.7	=	109.81	(77)
Southeast	0.9x	0.77	x	1.75	x	85.75	x	0.63	x	0.7	=	91.72	(77)
Southeast	0.9x	0.77	x	1.75	x	85.75	x	0.63	x	0.7	=	45.86	(77)
Southeast	0.9x	0.77	x	4.19	x	85.75	x	0.63	x	0.7	=	109.81	(77)
Southeast	0.9x	0.77	x	1.75	x	106.25	x	0.63	x	0.7	=	56.83	(77)
Southeast	0.9x	0.77	x	4.19	x	106.25	x	0.63	x	0.7	=	136.06	(77)
Southeast	0.9x	0.77	x	1.75	x	106.25	x	0.63	x	0.7	=	113.65	(77)
Southeast	0.9x	0.77	x	1.75	x	106.25	x	0.63	x	0.7	=	56.83	(77)
Southeast	0.9x	0.77	x	4.19	x	106.25	x	0.63	x	0.7	=	136.06	(77)

Southeast	0.9x	0.77	x	1.75	x	119.01	x	0.63	x	0.7	=	63.65	(77)
Southeast	0.9x	0.77	x	4.19	x	119.01	x	0.63	x	0.7	=	152.4	(77)
Southeast	0.9x	0.77	x	1.75	x	119.01	x	0.63	x	0.7	=	127.3	(77)
Southeast	0.9x	0.77	x	1.75	x	119.01	x	0.63	x	0.7	=	63.65	(77)
Southeast	0.9x	0.77	x	4.19	x	119.01	x	0.63	x	0.7	=	152.4	(77)
Southeast	0.9x	0.77	x	1.75	x	118.15	x	0.63	x	0.7	=	63.19	(77)
Southeast	0.9x	0.77	x	4.19	x	118.15	x	0.63	x	0.7	=	151.29	(77)
Southeast	0.9x	0.77	x	1.75	x	118.15	x	0.63	x	0.7	=	126.38	(77)
Southeast	0.9x	0.77	x	1.75	x	118.15	x	0.63	x	0.7	=	63.19	(77)
Southeast	0.9x	0.77	x	4.19	x	118.15	x	0.63	x	0.7	=	151.29	(77)
Southeast	0.9x	0.77	x	1.75	x	113.91	x	0.63	x	0.7	=	60.92	(77)
Southeast	0.9x	0.77	x	4.19	x	113.91	x	0.63	x	0.7	=	145.86	(77)
Southeast	0.9x	0.77	x	1.75	x	113.91	x	0.63	x	0.7	=	121.84	(77)
Southeast	0.9x	0.77	x	1.75	x	113.91	x	0.63	x	0.7	=	60.92	(77)
Southeast	0.9x	0.77	x	4.19	x	113.91	x	0.63	x	0.7	=	145.86	(77)
Southeast	0.9x	0.77	x	1.75	x	104.39	x	0.63	x	0.7	=	55.83	(77)
Southeast	0.9x	0.77	x	4.19	x	104.39	x	0.63	x	0.7	=	133.67	(77)
Southeast	0.9x	0.77	x	1.75	x	104.39	x	0.63	x	0.7	=	111.66	(77)
Southeast	0.9x	0.77	x	1.75	x	104.39	x	0.63	x	0.7	=	55.83	(77)
Southeast	0.9x	0.77	x	4.19	x	104.39	x	0.63	x	0.7	=	133.67	(77)
Southeast	0.9x	0.77	x	1.75	x	92.85	x	0.63	x	0.7	=	49.66	(77)
Southeast	0.9x	0.77	x	4.19	x	92.85	x	0.63	x	0.7	=	118.9	(77)
Southeast	0.9x	0.77	x	1.75	x	92.85	x	0.63	x	0.7	=	99.32	(77)
Southeast	0.9x	0.77	x	1.75	x	92.85	x	0.63	x	0.7	=	49.66	(77)
Southeast	0.9x	0.77	x	4.19	x	92.85	x	0.63	x	0.7	=	118.9	(77)
Southeast	0.9x	0.77	x	1.75	x	69.27	x	0.63	x	0.7	=	37.05	(77)
Southeast	0.9x	0.77	x	4.19	x	69.27	x	0.63	x	0.7	=	88.7	(77)
Southeast	0.9x	0.77	x	1.75	x	69.27	x	0.63	x	0.7	=	74.09	(77)
Southeast	0.9x	0.77	x	1.75	x	69.27	x	0.63	x	0.7	=	37.05	(77)
Southeast	0.9x	0.77	x	4.19	x	69.27	x	0.63	x	0.7	=	88.7	(77)
Southeast	0.9x	0.77	x	1.75	x	44.07	x	0.63	x	0.7	=	23.57	(77)
Southeast	0.9x	0.77	x	4.19	x	44.07	x	0.63	x	0.7	=	56.43	(77)
Southeast	0.9x	0.77	x	1.75	x	44.07	x	0.63	x	0.7	=	47.14	(77)
Southeast	0.9x	0.77	x	1.75	x	44.07	x	0.63	x	0.7	=	23.57	(77)
Southeast	0.9x	0.77	x	4.19	x	44.07	x	0.63	x	0.7	=	56.43	(77)
Southeast	0.9x	0.77	x	1.75	x	31.49	x	0.63	x	0.7	=	16.84	(77)
Southeast	0.9x	0.77	x	4.19	x	31.49	x	0.63	x	0.7	=	40.32	(77)
Southeast	0.9x	0.77	x	1.75	x	31.49	x	0.63	x	0.7	=	33.68	(77)
Southeast	0.9x	0.77	x	1.75	x	31.49	x	0.63	x	0.7	=	16.84	(77)
Southeast	0.9x	0.77	x	4.19	x	31.49	x	0.63	x	0.7	=	40.32	(77)
Southwest	0.9x	0.77	x	1.75	x	36.79		0.63	x	0.7	=	19.68	(79)

TER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	1.75	x	62.67		0.63	x	0.7	=	33.52	(79)
Southwest	0.9x	0.77	x	1.75	x	85.75		0.63	x	0.7	=	45.86	(79)
Southwest	0.9x	0.77	x	1.75	x	106.25		0.63	x	0.7	=	56.83	(79)
Southwest	0.9x	0.77	x	1.75	x	119.01		0.63	x	0.7	=	63.65	(79)
Southwest	0.9x	0.77	x	1.75	x	118.15		0.63	x	0.7	=	63.19	(79)
Southwest	0.9x	0.77	x	1.75	x	113.91		0.63	x	0.7	=	60.92	(79)
Southwest	0.9x	0.77	x	1.75	x	104.39		0.63	x	0.7	=	55.83	(79)
Southwest	0.9x	0.77	x	1.75	x	92.85		0.63	x	0.7	=	49.66	(79)
Southwest	0.9x	0.77	x	1.75	x	69.27		0.63	x	0.7	=	37.05	(79)
Southwest	0.9x	0.77	x	1.75	x	44.07		0.63	x	0.7	=	23.57	(79)
Southwest	0.9x	0.77	x	1.75	x	31.49		0.63	x	0.7	=	16.84	(79)
Northwest	0.9x	0.77	x	2.28	x	11.28	x	0.63	x	0.7	=	7.86	(81)
Northwest	0.9x	0.77	x	1.75	x	11.28	x	0.63	x	0.7	=	12.07	(81)
Northwest	0.9x	0.77	x	2.05	x	11.28	x	0.63	x	0.7	=	7.07	(81)
Northwest	0.9x	0.77	x	1.75	x	11.28	x	0.63	x	0.7	=	6.03	(81)
Northwest	0.9x	0.77	x	2.28	x	22.97	x	0.63	x	0.7	=	16	(81)
Northwest	0.9x	0.77	x	1.75	x	22.97	x	0.63	x	0.7	=	24.57	(81)
Northwest	0.9x	0.77	x	2.05	x	22.97	x	0.63	x	0.7	=	14.39	(81)
Northwest	0.9x	0.77	x	1.75	x	22.97	x	0.63	x	0.7	=	12.28	(81)
Northwest	0.9x	0.77	x	2.28	x	41.38	x	0.63	x	0.7	=	28.83	(81)
Northwest	0.9x	0.77	x	1.75	x	41.38	x	0.63	x	0.7	=	44.26	(81)
Northwest	0.9x	0.77	x	2.05	x	41.38	x	0.63	x	0.7	=	25.92	(81)
Northwest	0.9x	0.77	x	1.75	x	41.38	x	0.63	x	0.7	=	22.13	(81)
Northwest	0.9x	0.77	x	2.28	x	67.96	x	0.63	x	0.7	=	47.35	(81)
Northwest	0.9x	0.77	x	1.75	x	67.96	x	0.63	x	0.7	=	72.69	(81)
Northwest	0.9x	0.77	x	2.05	x	67.96	x	0.63	x	0.7	=	42.57	(81)
Northwest	0.9x	0.77	x	1.75	x	67.96	x	0.63	x	0.7	=	36.34	(81)
Northwest	0.9x	0.77	x	2.28	x	91.35	x	0.63	x	0.7	=	63.65	(81)
Northwest	0.9x	0.77	x	1.75	x	91.35	x	0.63	x	0.7	=	97.71	(81)
Northwest	0.9x	0.77	x	2.05	x	91.35	x	0.63	x	0.7	=	57.23	(81)
Northwest	0.9x	0.77	x	1.75	x	91.35	x	0.63	x	0.7	=	48.85	(81)
Northwest	0.9x	0.77	x	2.28	x	97.38	x	0.63	x	0.7	=	67.86	(81)
Northwest	0.9x	0.77	x	1.75	x	97.38	x	0.63	x	0.7	=	104.17	(81)
Northwest	0.9x	0.77	x	2.05	x	97.38	x	0.63	x	0.7	=	61.01	(81)
Northwest	0.9x	0.77	x	1.75	x	97.38	x	0.63	x	0.7	=	52.08	(81)
Northwest	0.9x	0.77	x	2.28	x	91.1	x	0.63	x	0.7	=	63.48	(81)
Northwest	0.9x	0.77	x	1.75	x	91.1	x	0.63	x	0.7	=	97.45	(81)
Northwest	0.9x	0.77	x	2.05	x	91.1	x	0.63	x	0.7	=	57.08	(81)
Northwest	0.9x	0.77	x	1.75	x	91.1	x	0.63	x	0.7	=	48.72	(81)
Northwest	0.9x	0.77	x	2.28	x	72.63	x	0.63	x	0.7	=	50.61	(81)
Northwest	0.9x	0.77	x	1.75	x	72.63	x	0.63	x	0.7	=	77.69	(81)

Northwest 0.9x	0.77	x	2.05	x	72.63	x	0.63	x	0.7	=	45.5	(81)
Northwest 0.9x	0.77	x	1.75	x	72.63	x	0.63	x	0.7	=	38.84	(81)
Northwest 0.9x	0.77	x	2.28	x	50.42	x	0.63	x	0.7	=	35.13	(81)
Northwest 0.9x	0.77	x	1.75	x	50.42	x	0.63	x	0.7	=	53.93	(81)
Northwest 0.9x	0.77	x	2.05	x	50.42	x	0.63	x	0.7	=	31.59	(81)
Northwest 0.9x	0.77	x	1.75	x	50.42	x	0.63	x	0.7	=	26.97	(81)
Northwest 0.9x	0.77	x	2.28	x	28.07	x	0.63	x	0.7	=	19.56	(81)
Northwest 0.9x	0.77	x	1.75	x	28.07	x	0.63	x	0.7	=	30.02	(81)
Northwest 0.9x	0.77	x	2.05	x	28.07	x	0.63	x	0.7	=	17.58	(81)
Northwest 0.9x	0.77	x	1.75	x	28.07	x	0.63	x	0.7	=	15.01	(81)
Northwest 0.9x	0.77	x	2.28	x	14.2	x	0.63	x	0.7	=	9.89	(81)
Northwest 0.9x	0.77	x	1.75	x	14.2	x	0.63	x	0.7	=	15.19	(81)
Northwest 0.9x	0.77	x	2.05	x	14.2	x	0.63	x	0.7	=	8.89	(81)
Northwest 0.9x	0.77	x	1.75	x	14.2	x	0.63	x	0.7	=	7.59	(81)
Northwest 0.9x	0.77	x	2.28	x	9.21	x	0.63	x	0.7	=	6.42	(81)
Northwest 0.9x	0.77	x	1.75	x	9.21	x	0.63	x	0.7	=	9.86	(81)
Northwest 0.9x	0.77	x	2.05	x	9.21	x	0.63	x	0.7	=	5.77	(81)
Northwest 0.9x	0.77	x	1.75	x	9.21	x	0.63	x	0.7	=	4.93	(81)

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

(83)m=	239.76	424.05	621.8	840.14	1004.66	1025.38	976.93	849.92	696.74	479.88	290.03	203.34	(83)

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

(84)m=	727.8	909.84	1090.38	1280.64	1415.51	1407.9	1341.75	1222.01	1084.01	895.47	738.21	676.54	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.95	0.87	0.7	0.54	0.61	0.85	0.98	1	1	(86)

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

(87)m=	19.49	19.69	20	20.4	20.74	20.93	20.98	20.97	20.82	20.37	19.85	19.45	(87)

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

(88)m=	19.82	19.82	19.82	19.83	19.84	19.84	19.84	19.85	19.84	19.84	19.83	19.83	(88)

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

(89)m=	1	0.99	0.98	0.94	0.81	0.6	0.41	0.47	0.78	0.97	1	1	(89)

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

(90)m=	17.81	18.11	18.56	19.14	19.59	19.8	19.84	19.84	19.7	19.1	18.35	17.77	(90)

fLA = Living area ÷ (4) = 0.26 (91)

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

(92)m=	18.25	18.52	18.94	19.47	19.89	20.1	20.14	20.13	19.99	19.43	18.74	18.21	(92)

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

(93)m=	18.25	18.52	18.94	19.47	19.89	20.1	20.14	20.13	19.99	19.43	18.74	18.21	(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

TER WorkSheet: New dwelling design stage

Utilisation factor for gains, hm:

(94)m=	1	0.99	0.98	0.93	0.82	0.63	0.44	0.51	0.79	0.96	0.99	1	(94)

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

(95)m=	725.55	902.27	1065.03	1190.76	1156.69	882.18	594.21	619.39	855.24	860.21	733.18	675.01	(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=	2433.53	2370.87	2160.98	1819.25	1406.8	936.23	602.85	634.99	1007.36	1517.51	2006.98	2424.41	(97)

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

(98)m=	1270.73	986.9	815.38	452.52	186.08	0	0	0	0	489.03	917.13	1301.55

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 6419.33 (98)

Space heating requirement in kWh/m²/year 48.79 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.4	(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)													
	1270.73	986.9	815.38	452.52	186.08	0	0	0	0	489.03	917.13	1301.55	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1360.53	1056.64	873	484.49	199.23	0	0	0	0	523.59	981.94	1393.52	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 6872.94 (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)

219.06	193.05	202.67	181.58	176.28	155.26	148.75	165.82	167.16	188.3	199.23	213.76

Efficiency of water heater 80.3 (216)

(217)m=	88.76	88.58	88.19	87.26	85.19	80.3	80.3	80.3	80.3	87.35	88.42	88.82	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	246.81	217.95	229.81	208.1	206.93	193.34	185.24	206.5	208.17	215.58	225.33	240.65

Total = Sum(219a)$_{1...12}$ = 2584.41 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		6872.94
Water heating fuel used		2584.41
Electricity for pumps, fans and electric keep-hot		

TER WorkSheet: New dwelling design stage

central heating pump:		30	(230c)
boiler with a fan-assisted flue		45	(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	75	(231)
Electricity for lighting		471.7	(232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	1484.56	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	558.23	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2042.79	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	244.81	(268)
Total CO2, kg/year		sum of (265)…(271) =		2326.53	(272)

TER = 17.68 (273)

13 Appendix C – Energy Efficient Worksheets

Attached are the DER worksheets for the dwelling, which include the proposed energy efficiency measures.

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.6

Property Address: 13 Murray Mews

Address : 13 Murray Mews, London, NW1 9RJ

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	51.56	(1a)	x	2.57	(2a)	=	132.51	(3a)
First floor	51.56	(1b)	x	2.85	(2b)	=	146.95	(3b)
Second floor	28.45	(1c)	x	2.95	(2c)	=	83.93	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	131.57	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	363.38	(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							5	x 10 =	50	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	50 ÷ (5) =	0.14	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)			
Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.29	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.24	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.31	0.31	0.3	0.27	0.26	0.23	0.23	0.23	0.24	0.26	0.28	0.29

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.05	x	1	=	2.05			(26)
Windows Type 1			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 2			4.62	x1/[1/(1.4)+ 0.04]		=	6.12			(27)
Windows Type 3			2.57	x1/[1/(1.4)+ 0.04]		=	3.41			(27)
Windows Type 4			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 5			4.73	x1/[1/(1.4)+ 0.04]		=	6.27			(27)
Windows Type 6			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 7			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 8			2.31	x1/[1/(1.4)+ 0.04]		=	3.06			(27)
Windows Type 9			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 10			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 11			4.73	x1/[1/(1.4)+ 0.04]		=	6.27			(27)
Floor			51.56	x	0.12	=	6.1872			(28)
Walls	207.85	36.85	171	x	0.18	=	30.78			(29)
Roof	51.56	0	51.56	x	0.11	=	5.67			(30)
Total area of elements, m²			310.97							(31)
Party wall			37.33	x	0	=	0			(32)

DER WorkSheet: New dwelling design stage

** 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) =		90.82	(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		13.11	(36)

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

Total fabric heat loss	(33) + (36) =	103.93	(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=	65.78	65.56	65.33	64.29	64.1	63.19	63.19	63.02	63.54	64.1	64.49	64.9	(38)

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

(39)m=	169.72	169.49	169.27	168.23	168.03	167.13	167.13	166.96	167.47	168.03	168.43	168.84	

Average = Sum(39)$_{1…12}$ /12= 168.23 (39)

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

(40)m=	1.29	1.29	1.29	1.28	1.28	1.27	1.27	1.27	1.27	1.28	1.28	1.28	

Average = Sum(40)$_{1…12}$ /12= 1.28 (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	2.9	(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	103.05	(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)

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=	113.36	109.23	105.11	100.99	96.87	92.75	92.75	96.87	100.99	105.11	109.23	113.36	

Total = Sum(44)$_{1…12}$ = 1236.6 (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=	168.1	147.02	151.71	132.27	126.91	109.52	101.48	116.45	117.85	137.34	149.92	162.8	

Total = Sum(45)$_{1…12}$ = 1621.38 (45)

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

(46)m=	25.22	22.05	22.76	19.84	19.04	16.43	15.22	17.47	17.68	20.6	22.49	24.42	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(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)

DER WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year	(48) x (49) =	0	(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	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	25.88	23.38	25.88	25.04	25.88	25.04	25.88	25.88	25.04	25.88	25.04	25.88	(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=	193.98	170.4	177.59	157.31	152.79	134.56	127.36	142.33	142.89	163.22	174.96	188.68	(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=	184.96	162.03	169.95	151.1	149.6	134.56	127.36	142.33	142.89	156.74	166.73	179.7

Output from water heater (annual)$_{1...12}$ — 1867.97 — (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=	62.36	54.73	56.92	50.24	48.67	42.68	40.21	45.19	45.44	52.13	56.11	60.6	(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=	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	(66)

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

(67)m=	26.71	23.72	19.29	14.61	10.92	9.22	9.96	12.95	17.38	22.06	25.75	27.45	(67)

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

(68)m=	299.6	302.71	294.88	278.2	257.15	237.36	224.14	221.03	228.86	245.54	266.6	286.38	(68)

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

(69)m=	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	(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=	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	(71)

Water heating gains (Table 5)

(72)m=	83.82	81.44	76.5	69.78	65.42	59.27	54.05	60.74	63.12	70.07	77.93	81.45	(72)

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

(73)m=	479.62	477.36	460.15	432.07	402.96	375.33	357.63	364.2	378.84	407.16	439.76	464.77	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	4.62	x	11.28	x	0.72	x	0.7	=	18.21	(75)
Northeast	0.9x	0.77	x	4.62	x	22.97	x	0.72	x	0.7	=	37.06	(75)
Northeast	0.9x	0.77	x	4.62	x	41.38	x	0.72	x	0.7	=	66.77	(75)
Northeast	0.9x	0.77	x	4.62	x	67.96	x	0.72	x	0.7	=	109.66	(75)
Northeast	0.9x	0.77	x	4.62	x	91.35	x	0.72	x	0.7	=	147.4	(75)
Northeast	0.9x	0.77	x	4.62	x	97.38	x	0.72	x	0.7	=	157.14	(75)
Northeast	0.9x	0.77	x	4.62	x	91.1	x	0.72	x	0.7	=	147	(75)
Northeast	0.9x	0.77	x	4.62	x	72.63	x	0.72	x	0.7	=	117.19	(75)
Northeast	0.9x	0.77	x	4.62	x	50.42	x	0.72	x	0.7	=	81.36	(75)
Northeast	0.9x	0.77	x	4.62	x	28.07	x	0.72	x	0.7	=	45.29	(75)
Northeast	0.9x	0.77	x	4.62	x	14.2	x	0.72	x	0.7	=	22.91	(75)
Northeast	0.9x	0.77	x	4.62	x	9.21	x	0.72	x	0.7	=	14.87	(75)
Southeast	0.9x	0.77	x	1.98	x	36.79	x	0.72	x	0.7	=	25.45	(77)
Southeast	0.9x	0.77	x	4.73	x	36.79	x	0.72	x	0.7	=	60.79	(77)
Southeast	0.9x	0.77	x	1.98	x	36.79	x	0.72	x	0.7	=	50.89	(77)
Southeast	0.9x	0.77	x	1.98	x	36.79	x	0.72	x	0.7	=	25.45	(77)
Southeast	0.9x	0.77	x	4.73	x	36.79	x	0.72	x	0.7	=	60.79	(77)
Southeast	0.9x	0.77	x	1.98	x	62.67	x	0.72	x	0.7	=	43.34	(77)
Southeast	0.9x	0.77	x	4.73	x	62.67	x	0.72	x	0.7	=	103.54	(77)
Southeast	0.9x	0.77	x	1.98	x	62.67	x	0.72	x	0.7	=	86.68	(77)
Southeast	0.9x	0.77	x	1.98	x	62.67	x	0.72	x	0.7	=	43.34	(77)
Southeast	0.9x	0.77	x	4.73	x	62.67	x	0.72	x	0.7	=	103.54	(77)
Southeast	0.9x	0.77	x	1.98	x	85.75	x	0.72	x	0.7	=	59.3	(77)
Southeast	0.9x	0.77	x	4.73	x	85.75	x	0.72	x	0.7	=	141.67	(77)
Southeast	0.9x	0.77	x	1.98	x	85.75	x	0.72	x	0.7	=	118.61	(77)
Southeast	0.9x	0.77	x	1.98	x	85.75	x	0.72	x	0.7	=	59.3	(77)
Southeast	0.9x	0.77	x	4.73	x	85.75	x	0.72	x	0.7	=	141.67	(77)
Southeast	0.9x	0.77	x	1.98	x	106.25	x	0.72	x	0.7	=	73.48	(77)
Southeast	0.9x	0.77	x	4.73	x	106.25	x	0.72	x	0.7	=	175.53	(77)
Southeast	0.9x	0.77	x	1.98	x	106.25	x	0.72	x	0.7	=	146.96	(77)
Southeast	0.9x	0.77	x	1.98	x	106.25	x	0.72	x	0.7	=	73.48	(77)
Southeast	0.9x	0.77	x	4.73	x	106.25	x	0.72	x	0.7	=	175.53	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	1.98	x	119.01	x	0.72	x	0.7	=	82.3	(77)
Southeast	0.9x	0.77	x	4.73	x	119.01	x	0.72	x	0.7	=	196.61	(77)
Southeast	0.9x	0.77	x	1.98	x	119.01	x	0.72	x	0.7	=	164.61	(77)
Southeast	0.9x	0.77	x	1.98	x	119.01	x	0.72	x	0.7	=	82.3	(77)
Southeast	0.9x	0.77	x	4.73	x	119.01	x	0.72	x	0.7	=	196.61	(77)
Southeast	0.9x	0.77	x	1.98	x	118.15	x	0.72	x	0.7	=	81.71	(77)
Southeast	0.9x	0.77	x	4.73	x	118.15	x	0.72	x	0.7	=	195.19	(77)
Southeast	0.9x	0.77	x	1.98	x	118.15	x	0.72	x	0.7	=	163.42	(77)
Southeast	0.9x	0.77	x	1.98	x	118.15	x	0.72	x	0.7	=	81.71	(77)
Southeast	0.9x	0.77	x	4.73	x	118.15	x	0.72	x	0.7	=	195.19	(77)
Southeast	0.9x	0.77	x	1.98	x	113.91	x	0.72	x	0.7	=	78.77	(77)
Southeast	0.9x	0.77	x	4.73	x	113.91	x	0.72	x	0.7	=	188.18	(77)
Southeast	0.9x	0.77	x	1.98	x	113.91	x	0.72	x	0.7	=	157.55	(77)
Southeast	0.9x	0.77	x	1.98	x	113.91	x	0.72	x	0.7	=	78.77	(77)
Southeast	0.9x	0.77	x	4.73	x	113.91	x	0.72	x	0.7	=	188.18	(77)
Southeast	0.9x	0.77	x	1.98	x	104.39	x	0.72	x	0.7	=	72.19	(77)
Southeast	0.9x	0.77	x	4.73	x	104.39	x	0.72	x	0.7	=	172.46	(77)
Southeast	0.9x	0.77	x	1.98	x	104.39	x	0.72	x	0.7	=	144.38	(77)
Southeast	0.9x	0.77	x	1.98	x	104.39	x	0.72	x	0.7	=	72.19	(77)
Southeast	0.9x	0.77	x	4.73	x	104.39	x	0.72	x	0.7	=	172.46	(77)
Southeast	0.9x	0.77	x	1.98	x	92.85	x	0.72	x	0.7	=	64.21	(77)
Southeast	0.9x	0.77	x	4.73	x	92.85	x	0.72	x	0.7	=	153.4	(77)
Southeast	0.9x	0.77	x	1.98	x	92.85	x	0.72	x	0.7	=	128.43	(77)
Southeast	0.9x	0.77	x	1.98	x	92.85	x	0.72	x	0.7	=	64.21	(77)
Southeast	0.9x	0.77	x	4.73	x	92.85	x	0.72	x	0.7	=	153.4	(77)
Southeast	0.9x	0.77	x	1.98	x	69.27	x	0.72	x	0.7	=	47.9	(77)
Southeast	0.9x	0.77	x	4.73	x	69.27	x	0.72	x	0.7	=	114.43	(77)
Southeast	0.9x	0.77	x	1.98	x	69.27	x	0.72	x	0.7	=	95.81	(77)
Southeast	0.9x	0.77	x	1.98	x	69.27	x	0.72	x	0.7	=	47.9	(77)
Southeast	0.9x	0.77	x	4.73	x	69.27	x	0.72	x	0.7	=	114.43	(77)
Southeast	0.9x	0.77	x	1.98	x	44.07	x	0.72	x	0.7	=	30.48	(77)
Southeast	0.9x	0.77	x	4.73	x	44.07	x	0.72	x	0.7	=	72.81	(77)
Southeast	0.9x	0.77	x	1.98	x	44.07	x	0.72	x	0.7	=	60.95	(77)
Southeast	0.9x	0.77	x	1.98	x	44.07	x	0.72	x	0.7	=	30.48	(77)
Southeast	0.9x	0.77	x	4.73	x	44.07	x	0.72	x	0.7	=	72.81	(77)
Southeast	0.9x	0.77	x	1.98	x	31.49	x	0.72	x	0.7	=	21.78	(77)
Southeast	0.9x	0.77	x	4.73	x	31.49	x	0.72	x	0.7	=	52.02	(77)
Southeast	0.9x	0.77	x	1.98	x	31.49	x	0.72	x	0.7	=	43.55	(77)
Southeast	0.9x	0.77	x	1.98	x	31.49	x	0.72	x	0.7	=	21.78	(77)
Southeast	0.9x	0.77	x	4.73	x	31.49	x	0.72	x	0.7	=	52.02	(77)
Southwest	0.9x	0.77	x	1.98	x	36.79		0.72	x	0.7	=	25.45	(79)

Southwest	0.9x	0.77	x	1.98	x	62.67		0.72	x	0.7	=	43.34	(79)
Southwest	0.9x	0.77	x	1.98	x	85.75		0.72	x	0.7	=	59.3	(79)
Southwest	0.9x	0.77	x	1.98	x	106.25		0.72	x	0.7	=	73.48	(79)
Southwest	0.9x	0.77	x	1.98	x	119.01		0.72	x	0.7	=	82.3	(79)
Southwest	0.9x	0.77	x	1.98	x	118.15		0.72	x	0.7	=	81.71	(79)
Southwest	0.9x	0.77	x	1.98	x	113.91		0.72	x	0.7	=	78.77	(79)
Southwest	0.9x	0.77	x	1.98	x	104.39		0.72	x	0.7	=	72.19	(79)
Southwest	0.9x	0.77	x	1.98	x	92.85		0.72	x	0.7	=	64.21	(79)
Southwest	0.9x	0.77	x	1.98	x	69.27		0.72	x	0.7	=	47.9	(79)
Southwest	0.9x	0.77	x	1.98	x	44.07		0.72	x	0.7	=	30.48	(79)
Southwest	0.9x	0.77	x	1.98	x	31.49		0.72	x	0.7	=	21.78	(79)
Northwest	0.9x	0.77	x	2.57	x	11.28	x	0.72	x	0.7	=	10.13	(81)
Northwest	0.9x	0.77	x	1.98	x	11.28	x	0.72	x	0.7	=	15.61	(81)
Northwest	0.9x	0.77	x	2.31	x	11.28	x	0.72	x	0.7	=	9.1	(81)
Northwest	0.9x	0.77	x	1.98	x	11.28	x	0.72	x	0.7	=	7.8	(81)
Northwest	0.9x	0.77	x	2.57	x	22.97	x	0.72	x	0.7	=	20.62	(81)
Northwest	0.9x	0.77	x	1.98	x	22.97	x	0.72	x	0.7	=	31.77	(81)
Northwest	0.9x	0.77	x	2.31	x	22.97	x	0.72	x	0.7	=	18.53	(81)
Northwest	0.9x	0.77	x	1.98	x	22.97	x	0.72	x	0.7	=	15.88	(81)
Northwest	0.9x	0.77	x	2.57	x	41.38	x	0.72	x	0.7	=	37.14	(81)
Northwest	0.9x	0.77	x	1.98	x	41.38	x	0.72	x	0.7	=	57.23	(81)
Northwest	0.9x	0.77	x	2.31	x	41.38	x	0.72	x	0.7	=	33.39	(81)
Northwest	0.9x	0.77	x	1.98	x	41.38	x	0.72	x	0.7	=	28.62	(81)
Northwest	0.9x	0.77	x	2.57	x	67.96	x	0.72	x	0.7	=	61	(81)
Northwest	0.9x	0.77	x	1.98	x	67.96	x	0.72	x	0.7	=	93.99	(81)
Northwest	0.9x	0.77	x	2.31	x	67.96	x	0.72	x	0.7	=	54.83	(81)
Northwest	0.9x	0.77	x	1.98	x	67.96	x	0.72	x	0.7	=	47	(81)
Northwest	0.9x	0.77	x	2.57	x	91.35	x	0.72	x	0.7	=	81.99	(81)
Northwest	0.9x	0.77	x	1.98	x	91.35	x	0.72	x	0.7	=	126.34	(81)
Northwest	0.9x	0.77	x	2.31	x	91.35	x	0.72	x	0.7	=	73.7	(81)
Northwest	0.9x	0.77	x	1.98	x	91.35	x	0.72	x	0.7	=	63.17	(81)
Northwest	0.9x	0.77	x	2.57	x	97.38	x	0.72	x	0.7	=	87.42	(81)
Northwest	0.9x	0.77	x	1.98	x	97.38	x	0.72	x	0.7	=	134.69	(81)
Northwest	0.9x	0.77	x	2.31	x	97.38	x	0.72	x	0.7	=	78.57	(81)
Northwest	0.9x	0.77	x	1.98	x	97.38	x	0.72	x	0.7	=	67.35	(81)
Northwest	0.9x	0.77	x	2.57	x	91.1	x	0.72	x	0.7	=	81.78	(81)
Northwest	0.9x	0.77	x	1.98	x	91.1	x	0.72	x	0.7	=	126	(81)
Northwest	0.9x	0.77	x	2.31	x	91.1	x	0.72	x	0.7	=	73.5	(81)
Northwest	0.9x	0.77	x	1.98	x	91.1	x	0.72	x	0.7	=	63	(81)
Northwest	0.9x	0.77	x	2.57	x	72.63	x	0.72	x	0.7	=	65.19	(81)
Northwest	0.9x	0.77	x	1.98	x	72.63	x	0.72	x	0.7	=	100.45	(81)

Northwest	0.9x	0.77	x	2.31	x	72.63	x	0.72	x	0.7	=	58.6	(81)
Northwest	0.9x	0.77	x	1.98	x	72.63	x	0.72	x	0.7	=	50.23	(81)
Northwest	0.9x	0.77	x	2.57	x	50.42	x	0.72	x	0.7	=	45.26	(81)
Northwest	0.9x	0.77	x	1.98	x	50.42	x	0.72	x	0.7	=	69.74	(81)
Northwest	0.9x	0.77	x	2.31	x	50.42	x	0.72	x	0.7	=	40.68	(81)
Northwest	0.9x	0.77	x	1.98	x	50.42	x	0.72	x	0.7	=	34.87	(81)
Northwest	0.9x	0.77	x	2.57	x	28.07	x	0.72	x	0.7	=	25.19	(81)
Northwest	0.9x	0.77	x	1.98	x	28.07	x	0.72	x	0.7	=	38.82	(81)
Northwest	0.9x	0.77	x	2.31	x	28.07	x	0.72	x	0.7	=	22.65	(81)
Northwest	0.9x	0.77	x	1.98	x	28.07	x	0.72	x	0.7	=	19.41	(81)
Northwest	0.9x	0.77	x	2.57	x	14.2	x	0.72	x	0.7	=	12.74	(81)
Northwest	0.9x	0.77	x	1.98	x	14.2	x	0.72	x	0.7	=	19.64	(81)
Northwest	0.9x	0.77	x	2.31	x	14.2	x	0.72	x	0.7	=	11.45	(81)
Northwest	0.9x	0.77	x	1.98	x	14.2	x	0.72	x	0.7	=	9.82	(81)
Northwest	0.9x	0.77	x	2.57	x	9.21	x	0.72	x	0.7	=	8.27	(81)
Northwest	0.9x	0.77	x	1.98	x	9.21	x	0.72	x	0.7	=	12.74	(81)
Northwest	0.9x	0.77	x	2.31	x	9.21	x	0.72	x	0.7	=	7.43	(81)
Northwest	0.9x	0.77	x	1.98	x	9.21	x	0.72	x	0.7	=	6.37	(81)

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

(83)m=	309.64	547.65	803	1084.93	1297.35	1324.09	1261.53	1097.54	899.76	619.74	374.56	262.61	(83)

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

(84)m=	789.26	1025.01	1263.15	1517	1700.31	1699.42	1619.16	1461.74	1278.61	1026.9	814.32	727.38	(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	0.92	0.79	0.6	0.45	0.51	0.78	0.96	1	1	(86)

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

(87)m=	19.58	19.81	20.15	20.55	20.84	20.97	20.99	20.99	20.89	20.47	19.93	19.53	(87)

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

(88)m=	19.85	19.85	19.85	19.86	19.86	19.86	19.86	19.87	19.86	19.86	19.86	19.85	(88)

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

(89)m=	1	0.99	0.97	0.89	0.72	0.51	0.34	0.39	0.69	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=	17.96	18.3	18.79	19.36	19.72	19.84	19.86	19.86	19.78	19.26	18.49	17.9	(90)

fLA = Living area ÷ (4) = | 0.26 | (91)

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

(92)m=	18.38	18.7	19.15	19.67	20.01	20.14	20.16	20.16	20.07	19.58	18.87	18.32	(92)

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

(93)m=	18.38	18.7	19.15	19.67	20.01	20.14	20.16	20.16	20.07	19.58	18.87	18.32	(93)

8. Space heating requirement

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

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

Utilisation factor for gains, hm:

(94)m=	1	0.99	0.96	0.89	0.73	0.53	0.37	0.42	0.71	0.94	0.99	1	(94)

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

(95)m=	785.98	1011.85	1214.88	1344.94	1246.55	899.52	591.04	619.94	906.91	964.35	806.36	725.25	(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=	2390.24	2338.33	2141.07	1811.79	1396.5	925.4	594.64	627	999.82	1508.51	1981.76	2384.81	(97)

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

(98)m=	1193.57	891.39	689.08	336.14	111.57	0	0	0	0	404.85	846.29	1234.71

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5707.59 (98)

Space heating requirement in kWh/m²/year 43.38 (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		92.8	(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)	1193.57	891.39	689.08	336.14	111.57	0	0	0	0	404.85	846.29	1234.71	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1286.17	960.55	742.54	362.22	120.23	0	0	0	0	436.27	911.95	1330.51	(211)

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 6150.43 (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)

184.96	162.03	169.95	151.1	149.6	134.56	127.36	142.33	142.89	156.74	166.73	179.7

Efficiency of water heater 87.3 (216)

(217)m=	89.46	89.41	89.29	89.01	88.35	87.3	87.3	87.3	87.3	89.09	89.38	89.47	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	206.76	181.23	190.33	169.76	169.33	154.14	145.89	163.04	163.68	175.94	186.55	200.84

Total = Sum(219a)$_{1...12}$ = 2107.48 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		6150.43
Water heating fuel used		2107.48
Electricity for pumps, fans and electric keep-hot		

DER WorkSheet: New dwelling design stage

central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			471.7	(232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	1328.49	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	455.22	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1783.71	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	244.81	(268)
Total CO2, kg/year		sum of (265)…(271) =		2067.45	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		15.71	(273)
El rating (section 14)				84	(274)

14 Appendix D – Renewables Worksheets

Attached are the DER worksheets for the dwelling, which include the proposed photovoltaic panels in addition to the proposed energy efficiency measures.

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.6

Property Address: 13 Murray Mews

Address : 13 Murray Mews, London, NW1 9RJ

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	51.56	(1a)	x	2.57	(2a)	=	132.51	(3a)
First floor	51.56	(1b)	x	2.85	(2b)	=	146.95	(3b)
Second floor	28.45	(1c)	x	2.95	(2c)	=	83.93	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	131.57	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			363.38	(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							5	x 10 =	50	(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) =	50	÷ (5) =	0.14	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.29	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.24	(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

DER WorkSheet: New dwelling design stage

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

0.31	0.31	0.3	0.27	0.26	0.23	0.23	0.23	0.24	0.26	0.28	0.29

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.05	x	1	=	2.05			(26)
Windows Type 1			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 2			4.62	x1/[1/(1.4)+ 0.04]		=	6.12			(27)
Windows Type 3			2.57	x1/[1/(1.4)+ 0.04]		=	3.41			(27)
Windows Type 4			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 5			4.73	x1/[1/(1.4)+ 0.04]		=	6.27			(27)
Windows Type 6			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 7			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 8			2.31	x1/[1/(1.4)+ 0.04]		=	3.06			(27)
Windows Type 9			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 10			1.98	x1/[1/(1.4)+ 0.04]		=	2.62			(27)
Windows Type 11			4.73	x1/[1/(1.4)+ 0.04]		=	6.27			(27)
Floor			51.56	x	0.12	=	6.1872			(28)
Walls	207.85	36.85	171	x	0.18	=	30.78			(29)
Roof	51.56	0	51.56	x	0.11	=	5.67			(30)
Total area of elements, m²			310.97							(31)
Party wall			37.33	x	0	=	0			(32)

DER WorkSheet: New dwelling design stage

** 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) =	90.82	(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		13.11	(36)

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

Total fabric heat loss	(33) + (36) =	103.93	(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=	65.78	65.56	65.33	64.29	64.1	63.19	63.19	63.02	63.54	64.1	64.49	64.9	(38)

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

(39)m=	169.72	169.49	169.27	168.23	168.03	167.13	167.13	166.96	167.47	168.03	168.43	168.84	

Average = Sum(39)$_{1…12}$ /12= 168.23 (39)

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

(40)m=	1.29	1.29	1.29	1.28	1.28	1.27	1.27	1.27	1.27	1.28	1.28	1.28	

Average = Sum(40)$_{1…12}$ /12= 1.28 (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 2.9 (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) + 36 103.05 (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=	113.36	109.23	105.11	100.99	96.87	92.75	92.75	96.87	100.99	105.11	109.23	113.36	

Total = Sum(44)$_{1…12}$ = 1236.6 (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=	168.1	147.02	151.71	132.27	126.91	109.52	101.48	116.45	117.85	137.34	149.92	162.8	

Total = Sum(45)$_{1…12}$ = 1621.38 (45)

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

(46)m=	25.22	22.05	22.76	19.84	19.04	16.43	15.22	17.47	17.68	20.6	22.49	24.42	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (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) =	0	(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	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	25.88	23.38	25.88	25.04	25.88	25.04	25.88	25.88	25.04	25.88	25.04	25.88	(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=	193.98	170.4	177.59	157.31	152.79	134.56	127.36	142.33	142.89	163.22	174.96	188.68	(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=	184.96	162.03	169.95	151.1	149.6	134.56	127.36	142.33	142.89	156.74	166.73	179.7	

Output from water heater (annual)$_{1...12}$ | 1867.97 | (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=	62.36	54.73	56.92	50.24	48.67	42.68	40.21	45.19	45.44	52.13	56.11	60.6	(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=	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	144.95	(66)

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

(67)m=	26.71	23.72	19.29	14.61	10.92	9.22	9.96	12.95	17.38	22.06	25.75	27.45	(67)

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

(68)m=	299.6	302.71	294.88	278.2	257.15	237.36	224.14	221.03	228.86	245.54	266.6	286.38	(68)

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

(69)m=	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	37.49	(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=	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	(71)

DER WorkSheet: New dwelling design stage

Water heating gains (Table 5)

(72)m=	83.82	81.44	76.5	69.78	65.42	59.27	54.05	60.74	63.12	70.07	77.93	81.45	(72)

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

(73)m=	479.62	477.36	460.15	432.07	402.96	375.33	357.63	364.2	378.84	407.16	439.76	464.77	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	4.62	x	11.28	x	0.72	x	0.7	=	18.21	(75)
Northeast	0.9x	0.77	x	4.62	x	22.97	x	0.72	x	0.7	=	37.06	(75)
Northeast	0.9x	0.77	x	4.62	x	41.38	x	0.72	x	0.7	=	66.77	(75)
Northeast	0.9x	0.77	x	4.62	x	67.96	x	0.72	x	0.7	=	109.66	(75)
Northeast	0.9x	0.77	x	4.62	x	91.35	x	0.72	x	0.7	=	147.4	(75)
Northeast	0.9x	0.77	x	4.62	x	97.38	x	0.72	x	0.7	=	157.14	(75)
Northeast	0.9x	0.77	x	4.62	x	91.1	x	0.72	x	0.7	=	147	(75)
Northeast	0.9x	0.77	x	4.62	x	72.63	x	0.72	x	0.7	=	117.19	(75)
Northeast	0.9x	0.77	x	4.62	x	50.42	x	0.72	x	0.7	=	81.36	(75)
Northeast	0.9x	0.77	x	4.62	x	28.07	x	0.72	x	0.7	=	45.29	(75)
Northeast	0.9x	0.77	x	4.62	x	14.2	x	0.72	x	0.7	=	22.91	(75)
Northeast	0.9x	0.77	x	4.62	x	9.21	x	0.72	x	0.7	=	14.87	(75)
Southeast	0.9x	0.77	x	1.98	x	36.79	x	0.72	x	0.7	=	25.45	(77)
Southeast	0.9x	0.77	x	4.73	x	36.79	x	0.72	x	0.7	=	60.79	(77)
Southeast	0.9x	0.77	x	1.98	x	36.79	x	0.72	x	0.7	=	50.89	(77)
Southeast	0.9x	0.77	x	1.98	x	36.79	x	0.72	x	0.7	=	25.45	(77)
Southeast	0.9x	0.77	x	4.73	x	36.79	x	0.72	x	0.7	=	60.79	(77)
Southeast	0.9x	0.77	x	1.98	x	62.67	x	0.72	x	0.7	=	43.34	(77)
Southeast	0.9x	0.77	x	4.73	x	62.67	x	0.72	x	0.7	=	103.54	(77)
Southeast	0.9x	0.77	x	1.98	x	62.67	x	0.72	x	0.7	=	86.68	(77)
Southeast	0.9x	0.77	x	1.98	x	62.67	x	0.72	x	0.7	=	43.34	(77)
Southeast	0.9x	0.77	x	4.73	x	62.67	x	0.72	x	0.7	=	103.54	(77)
Southeast	0.9x	0.77	x	1.98	x	85.75	x	0.72	x	0.7	=	59.3	(77)
Southeast	0.9x	0.77	x	4.73	x	85.75	x	0.72	x	0.7	=	141.67	(77)
Southeast	0.9x	0.77	x	1.98	x	85.75	x	0.72	x	0.7	=	118.61	(77)
Southeast	0.9x	0.77	x	1.98	x	85.75	x	0.72	x	0.7	=	59.3	(77)
Southeast	0.9x	0.77	x	4.73	x	85.75	x	0.72	x	0.7	=	141.67	(77)
Southeast	0.9x	0.77	x	1.98	x	106.25	x	0.72	x	0.7	=	73.48	(77)
Southeast	0.9x	0.77	x	4.73	x	106.25	x	0.72	x	0.7	=	175.53	(77)
Southeast	0.9x	0.77	x	1.98	x	106.25	x	0.72	x	0.7	=	146.96	(77)
Southeast	0.9x	0.77	x	1.98	x	106.25	x	0.72	x	0.7	=	73.48	(77)
Southeast	0.9x	0.77	x	4.73	x	106.25	x	0.72	x	0.7	=	175.53	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	1.98	x	119.01	x	0.72	x	0.7	=	82.3	(77)
Southeast	0.9x	0.77	x	4.73	x	119.01	x	0.72	x	0.7	=	196.61	(77)
Southeast	0.9x	0.77	x	1.98	x	119.01	x	0.72	x	0.7	=	164.61	(77)
Southeast	0.9x	0.77	x	1.98	x	119.01	x	0.72	x	0.7	=	82.3	(77)
Southeast	0.9x	0.77	x	4.73	x	119.01	x	0.72	x	0.7	=	196.61	(77)
Southeast	0.9x	0.77	x	1.98	x	118.15	x	0.72	x	0.7	=	81.71	(77)
Southeast	0.9x	0.77	x	4.73	x	118.15	x	0.72	x	0.7	=	195.19	(77)
Southeast	0.9x	0.77	x	1.98	x	118.15	x	0.72	x	0.7	=	163.42	(77)
Southeast	0.9x	0.77	x	1.98	x	118.15	x	0.72	x	0.7	=	81.71	(77)
Southeast	0.9x	0.77	x	4.73	x	118.15	x	0.72	x	0.7	=	195.19	(77)
Southeast	0.9x	0.77	x	1.98	x	113.91	x	0.72	x	0.7	=	78.77	(77)
Southeast	0.9x	0.77	x	4.73	x	113.91	x	0.72	x	0.7	=	188.18	(77)
Southeast	0.9x	0.77	x	1.98	x	113.91	x	0.72	x	0.7	=	157.55	(77)
Southeast	0.9x	0.77	x	1.98	x	113.91	x	0.72	x	0.7	=	78.77	(77)
Southeast	0.9x	0.77	x	4.73	x	113.91	x	0.72	x	0.7	=	188.18	(77)
Southeast	0.9x	0.77	x	1.98	x	104.39	x	0.72	x	0.7	=	72.19	(77)
Southeast	0.9x	0.77	x	4.73	x	104.39	x	0.72	x	0.7	=	172.46	(77)
Southeast	0.9x	0.77	x	1.98	x	104.39	x	0.72	x	0.7	=	144.38	(77)
Southeast	0.9x	0.77	x	1.98	x	104.39	x	0.72	x	0.7	=	72.19	(77)
Southeast	0.9x	0.77	x	4.73	x	104.39	x	0.72	x	0.7	=	172.46	(77)
Southeast	0.9x	0.77	x	1.98	x	92.85	x	0.72	x	0.7	=	64.21	(77)
Southeast	0.9x	0.77	x	4.73	x	92.85	x	0.72	x	0.7	=	153.4	(77)
Southeast	0.9x	0.77	x	1.98	x	92.85	x	0.72	x	0.7	=	128.43	(77)
Southeast	0.9x	0.77	x	1.98	x	92.85	x	0.72	x	0.7	=	64.21	(77)
Southeast	0.9x	0.77	x	4.73	x	92.85	x	0.72	x	0.7	=	153.4	(77)
Southeast	0.9x	0.77	x	1.98	x	69.27	x	0.72	x	0.7	=	47.9	(77)
Southeast	0.9x	0.77	x	4.73	x	69.27	x	0.72	x	0.7	=	114.43	(77)
Southeast	0.9x	0.77	x	1.98	x	69.27	x	0.72	x	0.7	=	95.81	(77)
Southeast	0.9x	0.77	x	1.98	x	69.27	x	0.72	x	0.7	=	47.9	(77)
Southeast	0.9x	0.77	x	4.73	x	69.27	x	0.72	x	0.7	=	114.43	(77)
Southeast	0.9x	0.77	x	1.98	x	44.07	x	0.72	x	0.7	=	30.48	(77)
Southeast	0.9x	0.77	x	4.73	x	44.07	x	0.72	x	0.7	=	72.81	(77)
Southeast	0.9x	0.77	x	1.98	x	44.07	x	0.72	x	0.7	=	60.95	(77)
Southeast	0.9x	0.77	x	1.98	x	44.07	x	0.72	x	0.7	=	30.48	(77)
Southeast	0.9x	0.77	x	4.73	x	44.07	x	0.72	x	0.7	=	72.81	(77)
Southeast	0.9x	0.77	x	1.98	x	31.49	x	0.72	x	0.7	=	21.78	(77)
Southeast	0.9x	0.77	x	4.73	x	31.49	x	0.72	x	0.7	=	52.02	(77)
Southeast	0.9x	0.77	x	1.98	x	31.49	x	0.72	x	0.7	=	43.55	(77)
Southeast	0.9x	0.77	x	1.98	x	31.49	x	0.72	x	0.7	=	21.78	(77)
Southeast	0.9x	0.77	x	4.73	x	31.49	x	0.72	x	0.7	=	52.02	(77)
Southwest	0.9x	0.77	x	1.98	x	36.79		0.72	x	0.7	=	25.45	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	1.98	x	62.67		0.72	x	0.7	=	43.34	(79)
Southwest	0.9x	0.77	x	1.98	x	85.75		0.72	x	0.7	=	59.3	(79)
Southwest	0.9x	0.77	x	1.98	x	106.25		0.72	x	0.7	=	73.48	(79)
Southwest	0.9x	0.77	x	1.98	x	119.01		0.72	x	0.7	=	82.3	(79)
Southwest	0.9x	0.77	x	1.98	x	118.15		0.72	x	0.7	=	81.71	(79)
Southwest	0.9x	0.77	x	1.98	x	113.91		0.72	x	0.7	=	78.77	(79)
Southwest	0.9x	0.77	x	1.98	x	104.39		0.72	x	0.7	=	72.19	(79)
Southwest	0.9x	0.77	x	1.98	x	92.85		0.72	x	0.7	=	64.21	(79)
Southwest	0.9x	0.77	x	1.98	x	69.27		0.72	x	0.7	=	47.9	(79)
Southwest	0.9x	0.77	x	1.98	x	44.07		0.72	x	0.7	=	30.48	(79)
Southwest	0.9x	0.77	x	1.98	x	31.49		0.72	x	0.7	=	21.78	(79)
Northwest	0.9x	0.77	x	2.57	x	11.28	x	0.72	x	0.7	=	10.13	(81)
Northwest	0.9x	0.77	x	1.98	x	11.28	x	0.72	x	0.7	=	15.61	(81)
Northwest	0.9x	0.77	x	2.31	x	11.28	x	0.72	x	0.7	=	9.1	(81)
Northwest	0.9x	0.77	x	1.98	x	11.28	x	0.72	x	0.7	=	7.8	(81)
Northwest	0.9x	0.77	x	2.57	x	22.97	x	0.72	x	0.7	=	20.62	(81)
Northwest	0.9x	0.77	x	1.98	x	22.97	x	0.72	x	0.7	=	31.77	(81)
Northwest	0.9x	0.77	x	2.31	x	22.97	x	0.72	x	0.7	=	18.53	(81)
Northwest	0.9x	0.77	x	1.98	x	22.97	x	0.72	x	0.7	=	15.88	(81)
Northwest	0.9x	0.77	x	2.57	x	41.38	x	0.72	x	0.7	=	37.14	(81)
Northwest	0.9x	0.77	x	1.98	x	41.38	x	0.72	x	0.7	=	57.23	(81)
Northwest	0.9x	0.77	x	2.31	x	41.38	x	0.72	x	0.7	=	33.39	(81)
Northwest	0.9x	0.77	x	1.98	x	41.38	x	0.72	x	0.7	=	28.62	(81)
Northwest	0.9x	0.77	x	2.57	x	67.96	x	0.72	x	0.7	=	61	(81)
Northwest	0.9x	0.77	x	1.98	x	67.96	x	0.72	x	0.7	=	93.99	(81)
Northwest	0.9x	0.77	x	2.31	x	67.96	x	0.72	x	0.7	=	54.83	(81)
Northwest	0.9x	0.77	x	1.98	x	67.96	x	0.72	x	0.7	=	47	(81)
Northwest	0.9x	0.77	x	2.57	x	91.35	x	0.72	x	0.7	=	81.99	(81)
Northwest	0.9x	0.77	x	1.98	x	91.35	x	0.72	x	0.7	=	126.34	(81)
Northwest	0.9x	0.77	x	2.31	x	91.35	x	0.72	x	0.7	=	73.7	(81)
Northwest	0.9x	0.77	x	1.98	x	91.35	x	0.72	x	0.7	=	63.17	(81)
Northwest	0.9x	0.77	x	2.57	x	97.38	x	0.72	x	0.7	=	87.42	(81)
Northwest	0.9x	0.77	x	1.98	x	97.38	x	0.72	x	0.7	=	134.69	(81)
Northwest	0.9x	0.77	x	2.31	x	97.38	x	0.72	x	0.7	=	78.57	(81)
Northwest	0.9x	0.77	x	1.98	x	97.38	x	0.72	x	0.7	=	67.35	(81)
Northwest	0.9x	0.77	x	2.57	x	91.1	x	0.72	x	0.7	=	81.78	(81)
Northwest	0.9x	0.77	x	1.98	x	91.1	x	0.72	x	0.7	=	126	(81)
Northwest	0.9x	0.77	x	2.31	x	91.1	x	0.72	x	0.7	=	73.5	(81)
Northwest	0.9x	0.77	x	1.98	x	91.1	x	0.72	x	0.7	=	63	(81)
Northwest	0.9x	0.77	x	2.57	x	72.63	x	0.72	x	0.7	=	65.19	(81)
Northwest	0.9x	0.77	x	1.98	x	72.63	x	0.72	x	0.7	=	100.45	(81)

Northwest 0.9x	0.77	x	2.31	x	72.63	x	0.72	x	0.7	=	58.6	(81)
Northwest 0.9x	0.77	x	1.98	x	72.63	x	0.72	x	0.7	=	50.23	(81)
Northwest 0.9x	0.77	x	2.57	x	50.42	x	0.72	x	0.7	=	45.26	(81)
Northwest 0.9x	0.77	x	1.98	x	50.42	x	0.72	x	0.7	=	69.74	(81)
Northwest 0.9x	0.77	x	2.31	x	50.42	x	0.72	x	0.7	=	40.68	(81)
Northwest 0.9x	0.77	x	1.98	x	50.42	x	0.72	x	0.7	=	34.87	(81)
Northwest 0.9x	0.77	x	2.57	x	28.07	x	0.72	x	0.7	=	25.19	(81)
Northwest 0.9x	0.77	x	1.98	x	28.07	x	0.72	x	0.7	=	38.82	(81)
Northwest 0.9x	0.77	x	2.31	x	28.07	x	0.72	x	0.7	=	22.65	(81)
Northwest 0.9x	0.77	x	1.98	x	28.07	x	0.72	x	0.7	=	19.41	(81)
Northwest 0.9x	0.77	x	2.57	x	14.2	x	0.72	x	0.7	=	12.74	(81)
Northwest 0.9x	0.77	x	1.98	x	14.2	x	0.72	x	0.7	=	19.64	(81)
Northwest 0.9x	0.77	x	2.31	x	14.2	x	0.72	x	0.7	=	11.45	(81)
Northwest 0.9x	0.77	x	1.98	x	14.2	x	0.72	x	0.7	=	9.82	(81)
Northwest 0.9x	0.77	x	2.57	x	9.21	x	0.72	x	0.7	=	8.27	(81)
Northwest 0.9x	0.77	x	1.98	x	9.21	x	0.72	x	0.7	=	12.74	(81)
Northwest 0.9x	0.77	x	2.31	x	9.21	x	0.72	x	0.7	=	7.43	(81)
Northwest 0.9x	0.77	x	1.98	x	9.21	x	0.72	x	0.7	=	6.37	(81)

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

(83)m=	309.64	547.65	803	1084.93	1297.35	1324.09	1261.53	1097.54	899.76	619.74	374.56	262.61	(83)

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

(84)m=	789.26	1025.01	1263.15	1517	1700.31	1699.42	1619.16	1461.74	1278.61	1026.9	814.32	727.38	(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	0.92	0.79	0.6	0.45	0.51	0.78	0.96	1	1	(86)

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

(87)m=	19.58	19.81	20.15	20.55	20.84	20.97	20.99	20.99	20.89	20.47	19.93	19.53	(87)

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

(88)m=	19.85	19.85	19.85	19.86	19.86	19.86	19.86	19.87	19.86	19.86	19.86	19.85	(88)

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

(89)m=	1	0.99	0.97	0.89	0.72	0.51	0.34	0.39	0.69	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=	17.96	18.3	18.79	19.36	19.72	19.84	19.86	19.86	19.78	19.26	18.49	17.9	(90)

fLA = Living area ÷ (4) = 0.26 (91)

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

(92)m=	18.38	18.7	19.15	19.67	20.01	20.14	20.16	20.16	20.07	19.58	18.87	18.32	(92)

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

(93)m=	18.38	18.7	19.15	19.67	20.01	20.14	20.16	20.16	20.07	19.58	18.87	18.32	(93)

8. Space heating requirement

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

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

Utilisation factor for gains, hm:

(94)m=	1	0.99	0.96	0.89	0.73	0.53	0.37	0.42	0.71	0.94	0.99	1	(94)

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

(95)m=	785.98	1011.85	1214.88	1344.94	1246.55	899.52	591.04	619.94	906.91	964.35	806.36	725.25	(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=	2390.24	2338.33	2141.07	1811.79	1396.5	925.4	594.64	627	999.82	1508.51	1981.76	2384.81	(97)

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

(98)m=	1193.57	891.39	689.08	336.14	111.57	0	0	0	0	404.85	846.29	1234.71

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5707.59 (98)

Space heating requirement in kWh/m²/year 43.38 (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		92.8	(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)	1193.57	891.39	689.08	336.14	111.57	0	0	0	0	404.85	846.29	1234.71		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1286.17	960.55	742.54	362.22	120.23	0	0	0	0	436.27	911.95	1330.51		(211)

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 6150.43 (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)

	184.96	162.03	169.95	151.1	149.6	134.56	127.36	142.33	142.89	156.74	166.73	179.7

Efficiency of water heater 87.3 (216)

(217)m=	89.46	89.41	89.29	89.01	88.35	87.3	87.3	87.3	87.3	89.09	89.38	89.47	(217)

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

(219)m=	206.76	181.23	190.33	169.76	169.33	154.14	145.89	163.04	163.68	175.94	186.55	200.84

Total = Sum(219a)$_{1...12}$ = 2107.48 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		6150.43
Water heating fuel used		2107.48
Electricity for pumps, fans and electric keep-hot		

DER WorkSheet: New dwelling design stage

central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			471.7	(232)
Electricity generated by PVs			-1140.74	(233)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	1328.49	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	455.22	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1783.71	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	244.81	(268)
Energy saving/generation technologies Item 1		0.519	=	-592.04	(269)
Total CO2, kg/year		sum of (265)…(271) =		1475.4	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		11.21	(273)
EI rating (section 14)				89	(274)