

# 13 Murray Mews, London NW1 9RJ

# **Energy Assessment**

February 2017

### CUTTING THE COST OF CARBON

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# 1 Issue Register

Revision	Reason for Issue	Date of Issue	Issued By
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# 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<sub>2</sub>, 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<sub>2</sub>, 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.

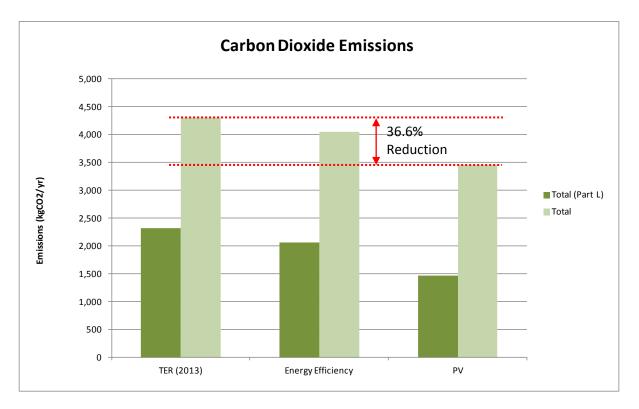
A summary of the reduction in emissions is shown in Tables 1 and 2 below, and graphically in Figure 1 below.

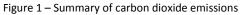
Stage	Regulated carbon dioxide emissions (heating, cooling, hot water, lighting, fans & pumps) (kgCO <sub>2</sub> /yr)	Unregulated carbon dioxide emissions (cooking, appliances, communal lighting & power) (kgCO <sub>2</sub> /yr)
Building Regulations Compliance (TER 2013)	2,326	1,983
Energy Efficiency 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	851	36.6						
Savings								

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





# 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
- I) 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.

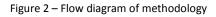
A Part L analysis is conducted to calculate carbon dioxide emissions for the following end uses: heating; hot water; cooling; fans, pumps and controls; and lighting. Various energy-saving measures are considered in terms of technical and economic feasibility and their effect on carbon dioxide emissions. 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.

Step 1	ENERGY AUDIT	Modelling the Proposed Development to achieve compliance with Part L of the Building Regulation. Include energy consumption from communal areas, cooking and appliances.
Step 2	ENERGY SAVING	Improving U-values (windows, roof, wall, floors), and air tightness. Include efficient heating, and hot water systems, and efficient lighting systems.
·····		
Step 3	CENTRALISED HEATING SYSTEM	Include community heating systems as they offer potential economies of scale in respect of efficiency, and greater opportunities for incorporation of renewables energy.
Step 4	COMBINED HEAT AND POWER	Investigate use of combined heat and power (CHP)
·····	<b>.</b>	
Step 5	RENEWABLE ENERGY	Undertake feasibility study to short list renewable options. Detailed Proposal with selected renewable energy source(s).
I		

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



# 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/m².K	0.30 W/m².K
Flat roof U-value (insulation between and under rafters)	0.11 W/m².K	0.20 W/m².K
Ground floor U-value	0.12 W/m².K	0.25 W/m².K
Window U-value	1.40 W/m².K	2.00 W/m².K
Door U-value	1.00 W/m².K	2.00 W/m².K
Party wall U-value	0.00 W/m <sup>2</sup> .K (fully filled party wall)	0.20 W/m².K
Air permeability	3.0 m³/hr/m² @ 50 Pa	10 m³/hr/m² @ 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.

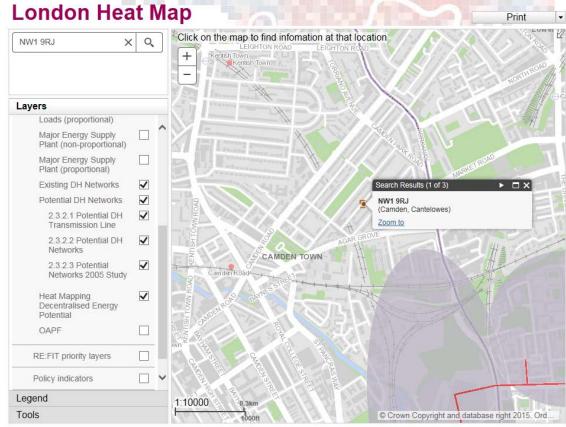


Figure 4 – London Heat Map

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  $592 \text{ kgCO}_2$  per annum, which equates to a reduction of 25.5% when calculated in accordance with the GLA guidelines.

# 10 Conclusion

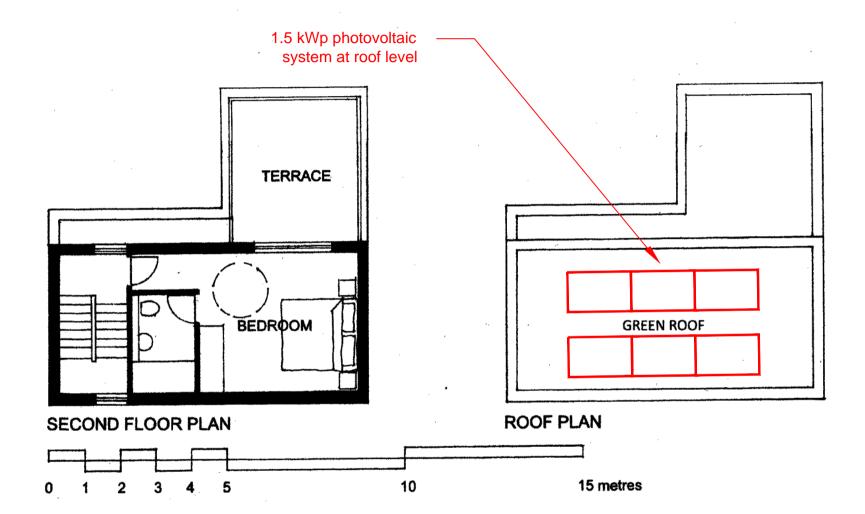
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The Proposed Development would feature significantly improved insulation and air tightness standards, when compared against the compliance requirements of Part L 2013 of the Building Regulations. In addition, energy efficient lighting is to be provided 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<sub>2</sub>, 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<sub>2</sub>, 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.



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	Telephone 020-3686 0762Email chris.apt@btinternet.com	Date Nov 2016	Scale @ A4 1:100	Drawing No MNJ 102	<u></u>	Rev	3

# 12 Appendix B – Baseline TER Worksheets

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

User Details:													
Assessor Name: Software Name:	Stroma FS	ber: rsion:		Versic	on: 1.0.4.6								
			Р	roperty	Address	: 13 Mur	ray Mew	/S					
Address : 13 Murray Mews, London, NW1 9RJ													
1. Overall dwelling dimer	isions:												
• • •				Are	a(m²)		Av. Hei	ight(m)	-	Volume(m <sup>3</sup> )	-		
Ground floor				ť	51.56	(1a) x	2	.57	(2a) =	132.51	(3a)		
First floor				ų	51.56	(1b) x	2	.85	(2b) =	146.95	(3b)		
Second floor				2	28.45	(1c) x	2	.95	(2c) =	83.93	(3c)		
Total floor area TFA = (1a	)+(1b)+(1c)+	(1d)+(1e	)+(1r	1) 1	31.57	(4)							
Dwelling volume						(3a)+(3b	)+(3c)+(3d	l)+(3e)+	.(3n) =	363.38	(5)		
2. Ventilation rate:											-		
	main heating		econdar leating	У	other		total			m <sup>3</sup> per hour			
Number of chimneys	0	] + [	0	] + [	0	] = [	0	×	40 =	0	(6a)		
Number of open flues	0	+	0	<u> </u> + [	0	_ _ = _	0	x	20 =	0	(6b)		
Number of intermittent fan	s					Ī	4	x	10 =	40	(7a)		
Number of passive vents						Ī	0	×	10 =	0	(7b)		
Number of flueless gas fire	es					Ē	0	X	40 =	0	(7c)		
									<b>A</b> <sup>1</sup> <b>I</b>		J		
		(0			(7.)			_		hanges per hou	-		
Infiltration due to chimney						continuo fi	40		÷ (5) =	0.11	(8)		
Number of storeys in the			u, procee	<i>u i</i> 0 ( <i>17)</i> ,	ounerwise (	continue n	0111 (9) 10 (	10)		0	(9)		
Additional infiltration	o arronnig (in	0)						[(9)	-1]x0.1 =	0	(10)		
Structural infiltration: 0.2	25 for steel o	r timber f	frame or	0.35 fo	r masoni	ry consti	ruction		1	0	(11)		
if both types of wall are pre			ponding to	the grea	ter wall are	a (after					]		
deducting areas of opening			ad) or 0	1 (000)		optor 0							
If suspended wooden floud lf no draught lobby, enter			ea) or u	i (seale	eu), eise	enter U				0	(12)		
Percentage of windows			rinned							0	(13)		
Window infiltration		augin 3t	nppeu		0.25 - [0.2	2 x (14) ÷ 1	= 1001			0	(14) (15)		
Infiltration rate					-		12) + (13) -	+ (15) =		0	(13)		
Air permeability value, c	150 expresse	ed in cub	ic metre	s per h					area	0	(10) (17)		
If based on air permeabilit	• • •			•	•	•		in clope	urou	0.36	(18)		
Air permeability value applies	-						is being us	sed		0.30			
Number of sides sheltered	1									2	(19)		
Shelter factor					(20) = 1 -	[0.075 x (′	19)] =			0.85	(20)		
Infiltration rate incorporation	ng shelter fac	ctor			(21) = (18	) x (20) =				0.31	(21)		
Infiltration rate modified fo	r monthly wir	nd speed	1										
Jan Feb N	Var Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
Monthly average wind spe	ed from Tab	le 7								1			
(22)m= 5.1 5 4	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7				

Wind Fa	actor (2	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	d infiltra	ation rat	e (allowi	ng for sł	nelter ar	nd wind s	peed) =	(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		
		<i>ctive air</i> al ventila	-	rate for t	he appli	cable ca	se			-		-		
				andix N (2	3h) - (23;	a) × Fmv (e	auation (N	(5)) other	wise (23h	) - (23a)				0 (23a)
			• • •		, ,	for in-use f				<i>)</i> = (200)				0 (23b)
			•		•			,		2b) m i ('	226) v [/	1 (22a)	· 100	0 (23c)
(24a)m=								0	0 = (2.	2b)m + (2 0		1 - (230)	- 100 <u>-</u> 	l (24a)
· · L	-			-	-		-	-		1 2b)m + (2	-	Ū		(210)
(24b)m=				0				0	0 = (22)		0	0		(24b)
Ľ	-				-	l ve input v	-	-	-		Ŭ	Ŭ		(= ···)
					-	-				.5 × (23b	))			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) lf n	atural	ventilatio	n or wh	l ole hous	e positi	ve input	ı ventilatio	on from l	oft					
						erwise (2				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)
Effect	tive air	change	rate - er	nter ( <mark>24a</mark>	) or (2 <mark>4</mark>	o) or (24	c) or (24	d) in box	(25)					
(25)m=	<mark>0</mark> .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	t losse	s and he	at loss r	paramet	ər.									
ELEMI		Gros		Openin		Net Ar	ea	U-valı	Je	AXU		k-value	9	A X k
		area	(m²)	'n	-	A ,r	n²	W/m2	K	(VV/ł	<b>&lt;</b> )	kJ/m²∙l	<	kJ/K
Doo <mark>rs</mark>						2.05	x	1	=	2.05				(26)
Window	's Type	e 1				1.75	x1.	/[1/( 1.4 )+	0.04] =	2.32				(27)
Window	s Type	2				4.09	x1.	/[1/( 1.4 )+	0.04] =	5.42				(27)
Window	s Type	93				2.28	x1.	/[1/( 1.4 )+	0.04] =	3.02				(27)
Window	s Type	9 4				1.75	x1.	/[1/( 1.4 )+	0.04] =	2.32				(27)
Window	s Type	9 5				4.19	x1.	/[1/( 1.4 )+	0.04] =	5.55	_			(27)
Window	s Type	e 6				1.75		/[1/( 1.4 )+	0.04] =	2.32				(27)
Window	s Type	e 7				1.75		/[1/( 1.4 )+	0.04] =	2.32	=			(27)
Window						2.05	<b>-</b> .	/[1/( 1.4 )+	0.04] =	2.72				(27)
Window						1.75	<b>-</b> .	/[1/( 1.4 )+		2.32	=			(27)
Window						1.75	╡.	/[1/( 1.4 )+		2.32				(27)
Window							= .	/[1/( 1.4 )+			=			
	зтуре	, 11				4.19			¦	5.55			_	(27)
Floor						51.56		0.13		6.7028	╡╎			(28)
Walls		207.	85	32.8	5 I	175	X	0.18	=	31.5				(29)
									=		=		=	
Roof		51.5	56	0		51.56	3 X	0.13	=	6.7				(30)
Total are Party wa		51.5	56				3 X							

* fan				ffe etime and				formanila	15/4/11	a).0041				
				nternal wal			ated using	Tormula 1,	/[(1/U-Valu	ie)+0.04] a	as given in	paragrapr	1 3.2	
Fabric heat loss, $W/K = S (A \times U)$ (26)(30) + (32) =												87.79	(33)	
Heat capacity $Cm = S(A \times k)$									((28)	.(30) + (32	2) + (32a).	(32e) =	0	(34)
Therm	al mass	parame	ter (TMF	<sup>-</sup> = Cm -	- TFA) ir	ר kJ/m²K			Indica	tive Value	: Medium		250	(35)
	-	sments wh ad of a dei			construct	ion are noi	t known pr	ecisely the	e indicative	values of	TMP in Ta	able 1f		
Therm	Thermal bridges : S (L x Y) calculated using Appendix K											17.54	(36)	
	details of thermal bridging are not known (36) = $0.15 \times (31)$													
	Total fabric heat loss (33) + (36) =											105.33	(37)	
Ventila	Ventilation heat loss calculated monthly $(38)m = 0.33 \times (25)m \times (5)$											1		
	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 ti	ansfer o	coefficier	nt, W/K			_			(39)m	= (37) + (3	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		
Heat lo	oss para	meter (H	HLP), W	/m²K						Average = = (39)m ÷	Sum(39) <sub>1.</sub> • (4)	12 /12=	172.08	(39)
(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)
Numbe		/s in mor	· ·						-	-			1	
	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)
<b>4.</b> Wa	ater heat	ting ener	rgy <mark>requ</mark>	irem <mark>ent</mark> :								kWh/ye	ear:	
Assum	ned occi	ipancy, I	N								2	0		(42)
if TF		9, N = 1		[ <mark>1 -</mark> exp	(-0.0003	349 x (TF	- <mark>A -1</mark> 3.9)	)2)] + 0.0	00 <mark>13 x (</mark>	TF <mark>A -13</mark> .		.5		( )
				ge in litre								3.05		(43)
		-		usage by r day (all w		-	-	o achieve	a water us	se target o	f			
normon			·	r			,	<b>A</b>	0.00	0.4	Neur	Dee	1	
Hot wat	Jan	Feb	Mar day for ea	Apr ach month	May	Jun	Jul Table 1c x	Aug	Sep	Oct	Nov	Dec		
			-		96.87	. <u> </u>		. ,	100.00	105 11	109.23	113.36	1	
(44)m=	113.36	109.23	105.11	100.99	90.87	92.75	92.75	96.87	100.99	105.11	m(44) <sub>112</sub> =		1236.6	(44)
Energy	content of	hot water	used - cal	culated m	onthly $= 4$ .	190 x Vd,r	n x nm x D	) Tm / 3600			ables 1b, 1		1230.0	()
(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		
						I				l Total = Su	m(45) <sub>112</sub> =		1621.38	(45)
lf instan	taneous w	vater heatii	ng at point	of use (no	o hot water	r storage),	enter 0 in	boxes (46						
(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)
	storage							<u> </u>	<u> </u>				1	
-		. ,		ng any so			-		ame ves	sel		0		(47)
	•	-		nk in dw	-			. ,	<b>`</b>	(0) .	( <b>-</b> )			
			not wate	er (this ir	icludes i	nstantar	neous co	mbi boil	ers) ente	er 'U' in (	47)			
	storage nanufact		eclared I	oss facto	or is kno	wn (kWł	n/dav):					0	]	(48)
		actor fro					· ·· <b>,</b> /·					0	1	(49)
				-							1	~	1	( /

Energy I b) If ma Hot wate If comm	anufacti er stora	urer's de age loss	eclared of factor fr	ylinder I om Tabl	oss facto		known:	(48) x (49	) =			0		(50) (51)
Volume		-										0		(52)
Tempera	ature fa	actor fro	m Table	2b								0		(53)
Energy I			-	, kWh/ye	ear			(47) x (51	) x (52) x (	53) =		0		(54)
Enter (5	, ,	, ,	,									0		(55)
Water st	torage	loss cal	culated f	or 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	dedicate	d solar sto	rage, (57)r	m = (56)m	x [(50) – (	H11)] ÷ (5	0), else (5	7)m = (56)	m where (	H11) is fro	m Append	хH	
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0		(57)
Primary	circuit	loss (ar	nual) fro	m Table	93					-		0		(58)
Primary		•	,			59)m = (	(58) ÷ 36	65 × (41)	m					
(modi	fied by	factor fi	rom Tab	e H5 if t	here is s	olar wat	ter heatir	ng and a	cylinde	r thermo	stat)			
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0		(59)
Combi lo	oss cal	culated	for each	month (	61)m =	(60) ÷ 36	65 × (41)	)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 he	eat requ	ired for	water h	eating ca	alculated	for eac	h month	(62)m =	0.85 ×	(45) <mark>m +</mark>	(46)m +	(57)m +	(59)m + (61)r	n
	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 DHV	N input c	alculated	using App	endix G or	Appendix	H (negati	ve quantity	/) (enter '0	' if no sola	r contribut	ion to wate	er heating)		
(add add						-								
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
∟ Output f	rom wa	ater hea	ter											
	219.06	193.05	202.67	181.58	176.28	155.26	148.75	165.82	167.16	188.3	199.23	213.76		
								L Outp	but from w	ater heate	r (annual)₁	12	2210.91	(64)
Heat gai	ins fror	n water	heatina.	kWh/mo	onth 0.2	5 ´ [0.85	× (45)m	ı + (61)n	ג 0.8 + 1ו	c [(46)m	+ (57)m	+ (59)m	1	
(65)m=							45.56		-		62.18		1	(65)
L												munity h	eating	
	. ,		e Table 5	. ,	•	,								
Metabol	Jan	<u>s (Table</u> 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														
Ē	26.71	23.72	19.29	14.61	_, equal 10.92	9.22	9.96	12.95	17.38	22.06	25.75	27.45		(67)
											20.70	21.40		(01)
	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)
											200.0	200.30		(00)
Cooking				·	· ·			· · · · · ·	·	1	07.40			(60)
	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 a	r	-	i i			-	_	-	-	-	-			
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3		(70)
Losses (	<u> </u>	•	<u> </u>		<i>,</i> ,	,	1							<u> </u>
(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	n + (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 a	nd associated equa	tions to convert to th	e applicable orientati	ion.		
Orientation: Access Factor	Area	Flux	g	FF		Gains	
Table 6d	m²	Table 6a	Table 6b	Table 6c		(W)	
Northeast 0.9x 0.77 x	4.09	11.28	× 0.63	× 0.7	= [	14.1	(75)
Northeast 0.9x 0.77 x	4.09	22.97	× 0.63	× 0.7	= [	28.71	(75)
Northeast 0.9x 0.77 x	4.09	41.38	× 0.63	× 0.7	=	51.72	(75)
Northeast 0.9x 0.77 x	4.09	67.96	× 0.63	× 0.7	=	84.94	(75)
Northeast 0.9x 0.77 x	4.09	91.35	× 0.63	× 0.7	=	114.18	(75)
Northeast 0.9x 0.77 x	4.09	97.38	x 0.63	× 0.7	=	121.73	(75)
Northeast 0.9x 0.77 x	4.09	91.1	× 0.63	× 0.7	=	113.87	(75)
Northeast 0.9x 0.77 x	4.09	72.63	× 0.63	× 0.7	=	90.78	(75)
Northeast 0.9x 0.77 x	4.09	50.42	× 0.63	× 0.7	=[	63.02	(75)
Northeast 0.9x 0.77 x	4.09	28.07	× 0.63	× 0.7		35.08	(75)
Northeast 0.9x 0.77 x	4.09	14.2	× 0.63	× 0.7	= [	17.75	(75)
Northeast 0.9x 0.77 x	4.09	9.21	× 0.63	x 0.7	=	11.52	(75)
Southeast 0.9x 0.77 x	1.75	36.79	× 0.63	x 0.7	_ = [	19.68	(77)
Southeast 0.9x 0.77 x	4.19	36.79	x 0.63	× 0.7	=	47.12	(77)
Southeast 0.9x 0.77 x	1.75	36.79	× 0.63	× 0.7	=	39.36	(77)
Southeast 0.9x 0.77 x	1.75	36.79	× 0.63	× 0.7	=	19.68	(77)
Southeast 0.9x 0.77 x	4.19	36.79	× 0.63	× 0.7	=	47.12	(77)
Southeast 0.9x 0.77 x	1.75	62.67	× 0.63	× 0.7	=	33.52	(77)
Southeast 0.9x 0.77 x	4.19	62.67	× 0.63	× 0.7	=	80.25	(77)
Southeast 0.9x 0.77 x	1.75	62.67	× 0.63	× 0.7	=	67.04	(77)
Southeast 0.9x 0.77 x	1.75	62.67	× 0.63	× 0.7	=	33.52	(77)
Southeast 0.9x 0.77 x	4.19	62.67	× 0.63	× 0.7	=	80.25	(77)
Southeast 0.9x 0.77 x	1.75	85.75	× 0.63	× 0.7	=	45.86	(77)
Southeast 0.9x 0.77 x	4.19	85.75	× 0.63	× 0.7	=	109.81	(77)
Southeast 0.9x 0.77 x	1.75	85.75	× 0.63	× 0.7	=	91.72	(77)
Southeast 0.9x 0.77 x	1.75	85.75	× 0.63	× 0.7	] = [	45.86	(77)
Southeast 0.9x 0.77 x	4.19	85.75	× 0.63	× 0.7	= [	109.81	(77)
Southeast 0.9x 0.77 x	1.75	106.25	× 0.63	× 0.7		56.83	(77)
Southeast 0.9x 0.77 x	4.19	106.25	× 0.63	× 0.7	= [	136.06	(77)
Southeast 0.9x 0.77 x	1.75	106.25	× 0.63	× 0.7	= [	113.65	(77)
Southeast 0.9x 0.77 x	1.75	106.25	× 0.63	× 0.7	= [	56.83	(77)
Southeast 0.9x 0.77 x							

Southeast 0.9x	0.77	] ×	1.75	×	119.01	×	0.63	x	0.7	=	63.65	(77)
Southeast 0.9x	0.77	) ^   x	4.19	l x	119.01	x x	0.63	x	0.7	=	152.4	_( <i>```)</i> _(77)
Southeast 0.9x	0.77	) ^   x	1.75	l x	119.01	^   x	0.63	x	0.7	=	127.3	_( <i>TT</i> )
Southeast 0.9x	0.77	) ^   x	1.75	l 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	) ×	1.75	l x	118.15	x	0.63	x	0.7	=	63.19	(77)
L 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	×	118.15	×	0.63	x	0.7	=	126.38	(77)
Southeast 0.9x	0.77	x	1.75	×	118.15	×	0.63	x	0.7	=	63.19	(77)
Southeast 0.9x	0.77	x	4.19	×	118.15	×	0.63	x	0.7	=	151.29	(77)
Southeast 0.9x	0.77	x	1.75	×	113.91	×	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	×	113.91	×	0.63	x	0.7	=	121.84	(77)
Southeast 0.9x	0.77	x	1.75	×	113.91	×	0.63	x	0.7	=	60.92	(77)
Southeast 0.9x	0.77	x	4.19	×	113.91	×	0.63	x	0.7	=	145.86	(77)
Southeast 0.9x	0.77	x	1.75	×	104.39	×	0.63	x	0.7	=	55.83	(77)
Southeast 0.9x	0.77	x	4.19	×	104.39	×	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	х	104.39	x	0.63	x	0.7	=	55.83	(77)
Southeast 0.9x	0.77	x	4.19	×	104.39	×	0.63	×	0.7	=	133.67	(77)
Southeast 0.9x	0.77	×	1.75	X	92.85	x	0.63	x	0.7	=	49.66	(77)
Southeast 0.9x	0.77	×	4.19	×	92.8 <mark>5</mark>	х	0.63	×	0.7	=	118.9	(77)
Southeast 0.9x	0.77	×	1.75	x	92.85	×	0.63	x	0.7	=	99.32	(77)
Southeast 0.9x	0.77	x	1.75	x	92.85	×	0.63	x	0.7	=	<mark>4</mark> 9.66	(77)
Southeast 0.9x	0.77	X	4.19	×	92.85	×	0.63	x	0.7	=	118.9	(77)
Southeast 0.9x	0.77	X	1.75	X	69.27	×	0.63	X	0.7	=	37.05	(77)
Southeast 0.9x	0.77	×	4.19	X	69.27	×	0.63	x	0.7	=	88.7	(77)
Southeast 0.9x	0.77	X	1.75	X	69.27	×	0.63	x	0.7	=	74.09	(77)
Southeast 0.9x	0.77	x	1.75	×	69.27	×	0.63	x	0.7	=	37.05	(77)
Southeast 0.9x	0.77	X	4.19	X V	69.27	×	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) (77)
Southeast 0.9x	0.77	x x	4.19	x x	44.07 44.07	x x	0.63	x x	0.7	=   =	56.43 47.14	_( <i>77</i> )
Southeast 0.9x	0.77	] ^ ] x	1.75	x	44.07	x	0.63	x	0.7	=	23.57	_( <i>77</i> )
Southeast 0.9x	0.77	] ^ ] x	4.19	l ^ l x	44.07	^   x	0.63	x	0.7	=	56.43	(77)
Southeast 0.9x	0.77	) ^   x	1.75	l ^ l x	31.49	^   ×	0.63	x	0.7	=	16.84	_( <i>``')</i> _(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	×	31.49	×	0.63	x	0.7	=	40.32	(77)
Southwest <sub>0.9x</sub>	0.77	x	1.75	×	36.79	i	0.63	x	0.7	=	19.68	(79)
L		-										-

Southwest <sub>0.9x</sub>	0.77	x	1.75	x	62.67		0.63	x	0.7	=	33.52	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.75	x	85.75		0.63	x	0.7	=	45.86	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.75	x	106.25		0.63	x	0.7	=	56.83	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.75	x	119.01		0.63	x	0.7	=	63.65	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.75	x	118.15		0.63	x	0.7	=	63.19	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.75	x	113.91		0.63	x	0.7	=	60.92	(79)
Southwest0.9x	0.77	x	1.75	x	104.39	ĺ	0.63	x	0.7	=	55.83	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.75	x	92.85	ĺ	0.63	x	0.7	=	49.66	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.75	x	69.27		0.63	x	0.7	=	37.05	(79)
Southwest0.9x	0.77	x	1.75	x	44.07		0.63	x	0.7	=	23.57	(79)
Southwest <sub>0.9x</sub>	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	×	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	×	0.7	=	12.28	(81)
Northwest 0.9x	0.77	x	2.28	x	41.38	×	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	×	2.05	x	41.38	Х	0.63	x	0.7	=	25.92	(81)
Northwest 0.9x	0.77	x	1.75	x	41.38	х	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	×	2.05	x	67.96	x	0.63	x	0.7	=	42.57	(81)
Northwest 0.9x	0.77	×	1.75	x	67.96	x	0.63	x	0.7	=	36.34	(81)
Northwest 0.9x	0.77	×	2.28	x	91.35	x	0.63	x	0.7	=	63.65	(81)
Northwest 0.9x	0.77	×	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	×	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	×	1.75	x	72.63	X	0.63	x	0.7	=	77.69	(81)

			,								
Northwest 0.9x 0.77	x	2.05	×	72.63	×	0.63	×	0.7	=	45.5	(81)
Northwest 0.9x 0.77	×	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	×	0.63	×	0.7	=	35.13	(81)
Northwest 0.9x 0.77	×	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	<b>x</b>	0.63	x	0.7	=	26.97	(81)
Northwest 0.9x 0.77	x	2.28	x	28.07	) x [	0.63	×	0.7	=	19.56	(81)
Northwest 0.9x 0.77	x	1.75	x	28.07	) x [	0.63	×	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	×	28.07	x	0.63	×	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	×	14.2	x	0.63	×	0.7	=	15.19	(81)
Northwest 0.9x 0.77	x	2.05	x	14.2	x	0.63	×	0.7	=	8.89	(81)
Northwest 0.9x 0.77	x	1.75	x	14.2	x	0.63	×	0.7	=	7.59	(81)
Northwest 0.9x 0.77	x	2.28	x	9.21	x	0.63	×	0.7	=	6.42	(81)
Northwest 0.9x 0.77	x	1.75	x	9.21	x	0.63	×	0.7	=	9.86	(81)
Northwest 0.9x 0.77	x	2.05	x	9.21	x	0.63	×	0.7	=	5.77	(81)
Northwest 0.9x 0.77	x	1.75	X	9.21	x	0.63	х	0.7		4.93	(81)
Solar gains in watts, calcula						Sum(74)m		1			(00)
(83)m= 239.76 424.05 621					849.92	696.74	479.88	290.03	203.34		(83)
Total gains – internal and s (84)m= 727.8 909.84 1090	).38 1280		<u> </u>	407.9 1341.75	1222.0	1 1084.01	895.47	738.21	676.54	1	(84)
	_	_		407.9 1341.75	1222.0	1 1084.01	695.47	730.21	070.34		(04)
7. Mean internal temperat			1				_				<b>-</b>
Temperature during heatir			-		ole 9, I	h1 (°C)				21	(85)
Utilisation factor for gains							<u> </u>			l	
	ar Ap		<u> </u>	Jun Jul	Aug		Oct	Nov	Dec		(86)
(86)m= 1 1 0.9	9 0.9	5 0.87		0.7 0.54	0.61	0.85	0.98	1	1		(00)
Mean internal temperature		- i	<u>`</u>		r	<u> </u>			1	1	
(87)m= 19.49 19.69 20	20.	4 20.74	2	20.93 20.98	20.97	20.82	20.37	19.85	19.45		(87)
Temperature during heatir	<u> </u>		of dw	elling from Ta	able 9,	Th2 (°C)		-		L	
(88)m= 19.82 19.82 19.8	82 19.8	33 19.84	1	9.84 19.84	19.85	19.84	19.84	19.83	19.83		(88)
Utilisation factor for gains	for rest o	of dwelling	<u>, h2</u>	m (see Table	9a)						
(89)m= 1 0.99 0.9	0.9	4 0.81		0.6 0.41	0.47	0.78	0.97	1	1		(89)
Mean internal temperature	e in the re	est of dwe	elling	T2 (follow ste	eps 3 to	7 in Table	e 9c)				
(90)m= 17.81 18.11 18.		- i		19.8 19.84	19.84	19.7	19.1	18.35	17.77		(90)
· · · · ·		•				fl	LA = Liv	ing area ÷ (4	4) =	0.26	(91)
Mean internal temperature	e (for the	whole dw	/ellin	a) = fl A x T1	+ (1 –	fIA) x T2					
(92)m= 18.25 18.52 18.1	<u> </u>	1	-	20.1 20.14	20.13	19.99	19.43	18.74	18.21		(92)
Apply adjustment to the m								<u> </u>	1	I	
	ean inte	nai tempe	Jaiu								
(93)m= 18.25 18.52 18.			_	20.1 20.14	20.13	19.99	19.43	18.74	18.21		(93)
	94 19.4		_		1		-	18.74	18.21		(93)
(93)m= 18.25 18.52 18.	94 19.4 Nent I tempera	19.89 ature obta		20.1 20.14	20.13	19.99	19.43			culate	(93)

Utilisa	ation fac	ctor for g	ains, hm	n:										
(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)
Usefu	ul gains,	hmGm	, W = (9	4)m x (84	4)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)
Montl	hly aver	age exte	ernal terr	perature	e from Ta	able 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 rat	e for me	an interr	al tempe	erature,	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		g require	ement fo	1		Wh/mont	th = 0.02	24 x [(97	)m – (95	)m] x (4	1)m			
(98)m=	1270.73	986.9	815.38	452.52	186.08	0	0	0	0	489.03	917.13	1301.55		_
								Tota	l per year	(kWh/yeai	r) = Sum(9	8)15,912 =	6419.33	(98)
Space	e heatir	ng require	ement in	kWh/m²	/year							[	48.79	(99)
9a. En	ergy ree	quiremer	nts – Ind	ividual h	eating sy	ystems i	ncluding	micro-C	CHP)					
Spac	e heati	ng:										_		
Fract	ion of sj	bace hea	at from s	econdar	y/supple	mentary	system						0	(201)
Fracti	ion of s	bace hea	at from m	nain syst	em(s)			(202) = 1	- (201) =			Ī	1	(202)
Fracti	ion of to	tal heati	ng from	main sys	stem 1			(204) = (2	02) × [1 –	(203)] =		Ì	1	(204)
Efficie	ency of	main spa	ace heat	ing syste	em 1								93.4	(206)
		seconda				g system	n, %					Ī	0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/yea	_l ar
Space	<u> </u>	g require		<u> </u>				Aug	<u> </u>	Ou		Dec	KVVII/yea	ai
opuo	1270.73	ř ·	815.38	452.52	186.08	0	0	0	0	489.03	917.13	1301.55		
(211)m	L	B)m x (20	(4)] \ x 1	$1 \rightarrow (20)$	16)									(211)
(211)/1		1056.64	873	484.49	199.23		0	0	0	523.59	981.94	1393.52		(=)
						-	-	Tota	l Il (kWh/yea		211) <sub>15,1012</sub>		6872.94	(211)
Snac	o hoatir	ig fuel (s	econdar	v) k\//b/	month					, , ,	· 15, 1012	L	0012.01	
•		D1)] } x 1		• •	monun									
(215)m=		0	0	0	0	0	0	0	0	0	0	0		
		1				1	1	Tota	l II (kWh/yea	ar) =Sum(2	215) <sub>15,1012</sub>	=	0	(215)
Water	heating	a										L		
		ater hea	ter (calc	ulated al	bove)									
	219.06	193.05	202.67	181.58	176.28	155.26	148.75	165.82	167.16	188.3	199.23	213.76		
Efficie	ncy of w	, ater hea	ter			•	•		•		•	·	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 fo	or water	heating,	kWh/m	onth										
• •		<u>)m x 100</u>												
(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		-
								Tota	II = Sum(2			l	2584.41	(219)
	al totals									k	Wh/year	г	kWh/year	-
Space	neating	g fuel use	ed, main	system	1							l	6872.94	
Water	heating	fuel use	ed										2584.41	1

Electricity for pumps, fans and electric keep-hot



# 13 Appendix C – Energy Efficient Worksheets

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

				User D	Details:						
Assessor Name: Software Name:	Stroma FS	AP 201		roporti (	Strom Softwa	are Ve		10	Versic	on: 1.0.4.6	
	13 Murray N	lowe L				. IS WU	ray wew	/5			
Address : 1. Overall dwelling dimer	,	news, Lu	Jhuon, r	1001 915	J						
	1510115.			۸ro	a(m²)		Av. Hei	iaht(m)		Volume(m <sup>3</sup> )	
Ground floor					• •	(1a) x		.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	e)+(1r	ווייייייייייייייייייייייייייייייייייי	31.57	(4)			]		]
Dwelling volume							)+(3c)+(3d	l)+(3e)+	.(3n) =	363.38	(5)
2. Ventilation rate:											], ,
	main heating		econdar neating	у	other		total			m <sup>3</sup> per hour	
Number of chimneys	0	+	0	+	0	] = [	0	x	40 =	0	(6a)
Number of open flues	0	+	0	+	0	] = [	0	<b>x</b> :	20 =	0	(6b)
Number of intermittent far	IS					_ [	5	x	10 =	50	(7a)
Number of passive vents							0	x	10 =	0	(7b)
Number of flueless gas fir	es						0	X	40 =	0	(7c)
									Air ch	nanges per hou	ır
Infiltration due to chimney						Ţ	50		÷ (5) =	0.14	(8)
If a pressurisation test has be			ed, procee	d to (17),	otherwise	continue fr	rom (9) to (	16)			٦
Number of storeys in the Additional infiltration	e aweiling (n:	5)						[(0)]	-1]x0.1 =	0	(9) (10)
Structural infiltration: 0.2	25 for steel o	r timber i	frame or	0.35 fo	r masoni	rv constr	ruction	[(0)	1]x0.1 =	0	(10)
if both types of wall are pre	esent, use the va	lue corres								0	]()
deducting areas of opening If suspended wooden flo			ed) or 0	.1 (seale	ed), else	enter 0				0	(12)
If no draught lobby, ente			,	,	,,					0	(13)
Percentage of windows	and doors dr	aught st	ripped							0	(14)
Window infiltration					0.25 - [0.2	2 x (14) ÷ 1	= [00]			0	(15)
Infiltration rate					(8) + (10)	+ (11) + (1	12) + (13) +	+ (15) =		0	(16)
Air permeability value, o	q50, expresse	ed in cub	oic metre	s per ho	our per s	quare m	etre of e	nvelope	area	3	(17)
If based on air permeabilit	y value, then	(18) = [(1	7) ÷ 20]+(	B), otherw	ise (18) =	(16)				0.29	(18)
Air permeability value applies		on test has	s been dor	ne or a de	gree air pe	rmeability	is being us	sed			-
Number of sides sheltered	ł				(20) = 1 -	[0 075 x (4	10)1 -			2	(19)
Shelter factor	na choltar fac	tor					[3]] –			0.85	(20)
Infiltration rate incorporation Infiltration rate modified for	-		4		(21) = (18	, ^ (20) =				0.24	(21)
i i i	Mar Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind spe			I	I	1 . 0	<u> </u>		I	L'	1	
· · · · · · · · · · · · · · · · · · ·	4.9 4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7		
	1										

Wind Factor (22a)m = $(22)m \div 4$										
(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	d wind s	peed) =	(21a) x (	22a)m					
	0.27 0.26	0.23	0.23	0.23	0.24	0.26	0.28	0.29		
Calculate effective air change rate If mechanical ventilation:	e for the applic	cable cas	se							(00-)
If exhaust air heat pump using Appendi	v N (23h) – (23a	) <b>v</b> Emv (a	auation (N	(5)) other	Nisa (23h	) - (23a)				0 (23a)
If balanced with heat recovery: efficience					•	) = (200)				0 (23b)
				,		Dh)m i ('	226) v [4	l (22a)		0 (23c)
a) If balanced mechanical ventil (24a)m= 0 0 0			0	1K) (24a)	$\frac{1}{0}$	20)11 + (2	23D) X [	0	÷ 100]	(24a)
b) If balanced mechanical ventil			-	-			-	Ū		(210)
(24b)m= 0 0 0				0	$\frac{1}{0} = (22)$	0	0	0		(24b)
c) If whole house extract ventila			-	_	-	Ů	•	Ŭ		(= ···)
if $(22b)m < 0.5 \times (23b)$ , there		-				5 x (23b	)			
(24c)m= 0 0 0	0 0	0	0	0	0	0	0	0		(24c)
d) If natural ventilation or whole	house positiv	re input v	/entilatio	on from lo	oft					
if (22b)m = 1, then (24d)m =						0.5]				
(24d)m= 0.55 0.55 0.54 0	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	c) or (24	d) in box	(25)					
(25)m= 0.55 0.55 0.54 0	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 para	ameter:									
	penings	Net Are	ea	U-valu	е	AXU		k-value	<b>)</b>	AXk
area (m²)	m <sup>2</sup>	n, A	ו <sup>2</sup>	W/m2l	<	(W/ł	<)	kJ/m²∙ł	<	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		[1/( 1.4 )+ (	0.04] =	6.27				(27)
Windows Type 6		1.98		[1/( 1.4 )+ (	0.04] =	2.62				(27)
Windows Type 7		1.98		[1/( 1.4 )+ (	0.04] = [	2.62				(27)
Windows Type 8		2.31		[1/( 1.4 )+ (	0.04] = [	3.06				(27)
Windows Type 9		1.98		([1/( 1.4 )+ (	Ļ	2.62	=			(27)
Windows Type 10		1.98		([1/( 1.4 )+ (		2.62				(27)
Windows Type 11				([1/( 1.4 )+ (						(27)
Floor		4.73				6.27			r	
		51.56		0.12	= [ r	6.1872				(28)
Walls 207.85	36.85	171	X	0.18	=	30.78				(29)
Roof 51.56					r				—	·
Tatal and a faile of the	0	51.56	= '	0.11	=	5.67				(30)
Total area of elements, m <sup>2</sup> Party wall	0	51.56 310.97	- '	0.11	= [	5.67				(30) (31) (32)

* for wir	ndows and	roof winde	ows, use e	ffective wi	ndow U-va	alue calcul	lated using	ı formula 1,	/[(1/U-valu	ie)+0.04] a	ns given in	paragrapl	n 3.2	
				nternal wal	ls and part	titions		(00) (00)	. (22)					_
		s, W/K =		U)				(26)(30)		(2.2)			90.82	(33)
		Cm = S(	. ,								2) + (32a).	(32e) =	0	(34)
				P = Cm ÷	,					tive Value			250	(35)
	-	sments wh ad of a dei			construct	ion are no	t known pr	ecisely the	indicative	values of	TMP in Te	able 1f		
				culated u	using Ap	pendix l	K						13.11	(36)
	0		,	own (36) =	0.	•								
Total f	abric he	at loss							(33) +	(36) =			103.93	(37)
Ventila	ation hea	at loss ca	alculated	monthl	y				(38)m	= 0.33 × (	25)m x (5)			
	Jan	Feb	Mar	Apr	Мау	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 t	ransfer o	coefficier	nt, W/K				-	-	(39)m	= (37) + (3	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 lo	oss para	meter (H	HLP), W	/m²K			1		(40)m	= (39)m ÷	(4)		1	
(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		_
Numb	ar of day	s in mor	oth (Tab	la 1a)					,	Average =	Sum(40) <sub>1</sub> .	12 /12=	1.28	(40)
Numb	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)
(41)11-		20	01			00			00		00		1	()
											_		_	
4. VVa	ater heat	ting ener	rgy <b>requ</b>	irement:								kWh/y	ear:	
		ipancy, I										.9		(42)
			+ 1.76 x	[1 - exp	(-0.0003	849 x (TF	FA -13.9	)2)] + 0.0	00 <mark>13 x (</mark>	TFA -13.	9)		-	
	A £ 13.9		ater usa	ne in litre	es per da	w Vd av	erage =	(25 x N)	+ 36		10	3.05	1	(43)
								to achieve		se target o		5.05	1	(10)
not mor	e that 125	litres per p	person pe	r day (all w	ater use, l	hot and co	ld)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wat	er usage ii	n litres per	day for ea	ach month	Vd,m = fa	ctor 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		
Enerav	content of	hot water	used - cal	culated m	onthly — A	100 v Vd r	т х пт х Г	) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) )			m(44) <sub>112</sub> =		1236.6	(44)
			·			r	. <u> </u>			·	-		1	
(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	4004.00	(45)
lf instan	taneous w	ater heatii	ng at poini	of use (no	hot water	<sup>r</sup> storage),	enter 0 in	boxes (46,		1 otal = Su	m(45) <sub>112</sub> =	•	1621.38	(43)
(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	1	(46)
· · ·	storage			10.01	10.01	10.10	10.22			20.0	22.10		J	( - <b>/</b>
Storag	je volum	e (litres)	includir	ng any so	olar or W	/WHRS	storage	within sa	ame ves	sel		0	]	(47)
If com	munity h	eating a	ind no ta	ınk in dw	velling, e	nter 110	) litres in	(47)					-	
			hot wate	er (this in	ncludes i	nstantar	neous co	mbi boil	ers) ente	er '0' in (	47)			
	storage		الحمامة			(1.1.1.1)	- /						1	
				oss facto	or is kno	wn (KVVI	i/day):					0	]	(48)
I empe	erature f	actor fro	m Table	20								0		(49)

b) If n	nanufact	urer's de	• storage eclared o	cylinder l	oss fact		known:	(48) x (49	) =		L	0		(50)
If com	munity h	eating s	factor fr		e 2 (KVV)	n/iitre/da	iy)					0		(51)
	e factor											0		(52)
Tempe	erature f	actor fro	m Table	2b								0		(53)
			storage	, kWh/ye	ear			(47) x (51	) x (52) x (	53) =		0		(54)
Enter	(50) or (	(54) in (5	55)									0		(55)
Water	storage	loss cal	culated f	for each	month			((56)m = (	55) × (41)	m				
(56)m=	0	0	0	0	0	0	0	0	0	0	0	0		(56)
If cylind	er contains	s dedicate	d solar sto	rage, (57)r	m = (56)m	x [(50) – (	H11)] ÷ (5	0), else (5	7)m = (56)	m where (	H11) is fro	m Appendi	хH	
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0		(57)
Primar	v circuit	loss (ar	nual) fro	om Table	e 3							0		(58)
	•	``	culated f			59)m = (	(58) ÷ 36	65 × (41)	m					
	•		rom Tab		`	,	· ·	• • •		r thermo	stat)			
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0		(59)
Combi	loss ca	lculated	for each	month (	(61)m =	(60) ÷ 36	65 × (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)
Tota <mark>l h</mark>	neat requ	uired for	water h	eating ca	alculated	for eac	h month	(62)m =	0.85 × 0	(45) <mark>m +</mark>	(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 DI	HW input of	calculated	using App	endix G or	Appendix	H (negati	ve quantity	/) (enter '0	if no sola	r contributi	ion to wate	er heating)		
(add a	dditiona	l lines <mark>if</mark>	FGHRS	and/or V	WWHRS	applies	, see Ap	pendix (	G)					
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	t from w	ater hea	ter							1		<u> </u>		
(64)m=	184.96	162.03	169.95	151.1	149.6	134.56	127.36	142.33	142.89	15 <mark>6.74</mark>	166.73	179.7		
			· · · · ·					Out	out from w	ater heate	r (annual)₁	12	1867.97	(64)
Heat g	ains fro	m water	heating,	kWh/mo	onth 0.2	5 ´ [0.85	× (45)m	ı + (61)n	n] + 0.8 x	(46)m	+ (57)m	+ (59)m	1	
-	62.36					-	40.21	· · ·				60.6	-	(65)
					only if c	vlinder i	s in the o	ı dwellina	nr hot w	ı ater is fr	om com	munity h	eating	
	. ,		e Table 5		•	ymaon		awoning	or not w		onn oonn	indiney in	Sating	
	Ŭ			,	)•									
Metab	olic gain Jan	s (Table Feb	<u>5), Wat</u> Mar	ts 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)
			ted in Ap											
(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)
			ulated in								20.10	21110		()
(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)
											200.0	200.30		(00)
	<u> </u>		ted in A				, 1	· · · · · ·	· · · · · ·	r	07.40	07.40		(60)
(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)
-	r		(Table 5	<u> </u>			r	r	·			,		
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3		(70)
Losse	s e.g. ev	aporatic	n (nega	tive valu	es) (Tab	le 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	n + (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 a	nd associated equa	tions to convert to th	ne applicable orientat	ion.		
Orientation: Access Factor	Area	Flux	g	FF		Gains	
Table 6d	m²	Table 6a	Table 6b	Table 6c		(W)	
Northeast 0.9x 0.77 x	4.62	11.28	× 0.72	× 0.7	= [	18.21	(75)
Northeast 0.9x 0.77 x	4.62	22.97	× 0.72	× 0.7	=	37.06	(75)
Northeast 0.9x 0.77 x	4.62	41.38	× 0.72	× 0.7	=	66.77	(75)
Northeast 0.9x 0.77 x	4.62	67.96	× 0.72	× 0.7	=	109.66	(75)
Northeast 0.9x 0.77 x	4.62	91.35	× 0.72	× 0.7	=	147.4	(75)
Northeast 0.9x 0.77 x	4.62	97.38	x 0.72	× 0.7	=	157.14	(75)
Northeast 0.9x 0.77 x	4.62	91.1	× 0.72	× 0.7	=	147	(75)
Northeast 0.9x 0.77 x	4.62	72.63	× 0.72	× 0.7	=	117.19	(75)
Northeast 0.9x 0.77 x	4.62	50.42	× 0.72	× 0.7		81.36	(75)
Northeast 0.9x 0.77 x	-4.62	28.07	× 0.72	× 0.7		45.29	(75)
Northeast 0.9x 0.77 x	4.62	14.2	× 0.72	× 0.7	=	22.91	(75)
Northeast 0.9x 0.77 x	4.62	9.21	× 0.72	x 0.7	=	14.87	(75)
Southeast 0.9x 0.77 x	1.98	36.79	× 0.72	x 0.7	=	25.45	(77)
Southeast 0.9x 0.77 x	4.73	36.79	x 0.72	× 0.7	=	60.79	(77)
Southeast 0.9x 0.77 x	1.98	36.79	× 0.72	x 0.7	=	50.89	(77)
Southeast 0.9x 0.77 x	1.98	36.79	× 0.72	× 0.7	=	25.45	(77)
Southeast 0.9x 0.77 x	4.73	36.79	× 0.72	× 0.7	=	60.79	(77)
Southeast 0.9x 0.77 x	1.98	62.67	× 0.72	x 0.7	=	43.34	(77)
Southeast 0.9x 0.77 x	4.73	62.67	× 0.72	x 0.7	= [	103.54	(77)
Southeast 0.9x 0.77 x	1.98	62.67	× 0.72	x 0.7	=	86.68	(77)
Southeast 0.9x 0.77 x	1.98	62.67	× 0.72	x 0.7	=	43.34	(77)
Southeast 0.9x 0.77 x	4.73	62.67	× 0.72	x 0.7	=	103.54	(77)
Southeast 0.9x 0.77 x	1.98	85.75	× 0.72	× 0.7	=	59.3	(77)
Southeast 0.9x 0.77 x	4.73	85.75	x 0.72	x 0.7	=	141.67	(77)
Southeast 0.9x 0.77 x	1.98	85.75	× 0.72	× 0.7	=	118.61	(77)
Southeast 0.9x 0.77 x	1.98	85.75	× 0.72	× 0.7	=	59.3	(77)
Southeast 0.9x 0.77 x	4.73	85.75	× 0.72	× 0.7	=	141.67	(77)
Southeast 0.9x 0.77 x	1.98	106.25	× 0.72	× 0.7	= [	73.48	(77)
Southeast 0.9x 0.77 x	4.73	106.25	x 0.72	× 0.7	= [	175.53	(77)
Southeast 0.9x 0.77 x	1.98	106.25	× 0.72	× 0.7	= [	146.96	(77)
Southeast 0.9x 0.77 x	1.98	106.25	× 0.72	× 0.7	= [	73.48	(77)
Southeast 0.9x 0.77 x	4.73	106.25	x 0.72	x 0.7	= [	175.53	(77)

		1		1		1		1		1		
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	×	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	×	0.72	x	0.7	=	81.71	(77)
Southeast 0.9x	0.77	x	4.73	x	118.15	×	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	×	0.72	x	0.7	] =	188.18	(77)
Southeast 0.9x	0.77	x	1.98	x	113.91	×	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	×	104.39	х	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	х	104.39	<b>x</b>	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	<b>x</b>	4.73	x	92.8 <mark>5</mark>	x	0.72	x	0.7	=	153.4	(77)
Southeast 0.9x	0.77	x	1.98	x	92.85	×	0.72	x	0.7	=	128.43	(77)
Southeast 0.9x	0.77	x	1.98	x	92.85	×	0.72	x	0.7	] =	64.21	(77)
Southeast 0.9x	0.77	x	4.73	x	92.85	×	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	×	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	×	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	×	0.72	x	0.7	] =	21.78	(77)
Southeast 0.9x	0.77	x	4.73	×	31.49	×	0.72	x	0.7	=	52.02	(77)
Southeast 0.9x	0.77	x	1.98	x	31.49	×	0.72	x	0.7	=	43.55	(77)
Southeast 0.9x	0.77	x	1.98	×	31.49	×	0.72	x	0.7	=	21.78	(77)
Southeast 0.9x	0.77	x	4.73	×	31.49	×	0.72	x	0.7	=	52.02	(77)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	36.79		0.72	x	0.7	=	25.45	(79)

Southwest0.9x	0.77	×	1.98	x	62.67		0.72	x	0.7	=	43.34	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	85.75		0.72	x	0.7	=	59.3	](79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	106.25		0.72	x	0.7	=	73.48	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	119.01		0.72	x	0.7	=	82.3	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	118.15		0.72	x	0.7	=	81.71	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	113.91		0.72	x	0.7	=	78.77	(79)
Southwest0.9x	0.77	x	1.98	x	104.39		0.72	x	0.7	=	72.19	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	92.85	İ	0.72	x	0.7	=	64.21	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	69.27		0.72	x	0.7	=	47.9	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	44.07		0.72	x	0.7	=	30.48	(79)
Southwest <sub>0.9x</sub>	0.77	×	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	×	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	×	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	×	0.7	=	15.88	(81)
Northwest 0.9x	0.77	x	2.57	x	41.38	×	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	×	2.31	x	41.38	х	0.72	x	0.7	=	<mark>3</mark> 3.39	(81)
Northwest 0.9x	0.77	×	1.98	x	41.38	х	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	×	2.31	x	67.96	x	0.72	x	0.7	=	54.83	(81)
Northwest 0.9x	0.77	×	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	×	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	×	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	×	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	×	1.98	x	91.1	x	0.72	x	0.7	=	126	(81)
Northwest 0.9x	0.77	×	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	×	2.31	×	72.63	x	0.72	×	0.7	=	58.6	(81)
Northwest 0.9x 0.77	×	1.98	x	72.63	x	0.72	×	0.7	=	50.23	(81)
Northwest 0.9x 0.77	x	2.57	x	50.42	×	0.72	×	0.7	=	45.26	(81)
Northwest 0.9x 0.77	x	1.98	×	50.42	x	0.72	×	0.7	=	69.74	(81)
Northwest 0.9x 0.77	x	2.31	x	50.42	<b>x</b>	0.72	x	0.7	=	40.68	(81)
Northwest 0.9x 0.77	x	1.98	x	50.42	<b>x</b>	0.72	×	0.7	=	34.87	(81)
Northwest 0.9x 0.77	x	2.57	×	28.07	<b>x</b>	0.72	×	0.7	=	25.19	(81)
Northwest 0.9x 0.77	x	1.98	×	28.07	<b>x</b>	0.72	×	0.7	=	38.82	(81)
Northwest 0.9x 0.77	x	2.31	x	28.07	<b>x</b>	0.72	x	0.7	=	22.65	(81)
Northwest 0.9x 0.77	x	1.98	x	28.07	<b>x</b>	0.72	×	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	<b>x</b>	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	<b>x</b>	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	<b>X</b>	9.21	x	0.72	x	0.7	=	6.37	(81)
Solar gains in watts, calcu			_			= Sum(74)m				,	(22)
		1084.93 1297.3			1097.	54 899.76	619.74	374.56	262.61		(83)
Total gains – internal and	solar	(04) m = $(73)$	n + (	os)m, walls	· · · · · · · · · · · · · · · · · · ·						
	2.45	4547 4700	24 4/	200 42 4640 46	1461	74 1070 61	1026.0	014.22	707.00	1	(84)
(84)m= 789.26 1025.01 126	3.15	1517 1700.:		699.42 1619.16	1461.	74 1278.61	1026.9	814.32	727.38		(84)
(84)m= 789.26 1025.01 126 7. Mean internal tempera	ture (	heating seas	on)		1		1026.9	814.32	727.38		
(84)m= 789.26 1025.01 126 7. Mean internal tempera Temperature during heat	ture ( ng pe	heating sease eriods in the li	on) ving	area from Tal	1		1026.9	814.32	727.38	21	(84)
(84)m= 789.26 1025.01 126 7. Mean internal tempera Temperature during heat Utilisation factor for gains	ture ( ing pe	heating seas eriods in the li ving area, h1	on) ving ,m (s	area from Tal	ble 9, 1	Th1 (°C)				21	
(84)m= 789.26 1025.01 126 7. Mean internal tempera Temperature during heat Utilisation factor for gains Jan Feb M	ture ( ing pe for li /lar	heating sease priods in the li ving area, h1 Apr Ma	on) ving ,m (s y	area from Tal ee Table 9a) Jun Jul	ole 9, <sup>-</sup> Au	Th1 (°C) g Sep	Oct	Nov	Dec	21	(85)
(84)m= 789.26 1025.01 126 7. Mean internal tempera Temperature during heat Utilisation factor for gains Jan Feb M	ture ( ing pe	heating seas eriods in the li ving area, h1	on) ving ,m (s y	area from Tal	ble 9, 1	Th1 (°C) g Sep				] 21	
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heating the second s	ture ( ing pe for lin /lar 98 e in li	heating seas priods in the li ving area, h1 Apr Ma 0.92 0.79 ving area T1	on) ving ,m (s y (follo	area from Table 9a) Jun Jul 0.6 0.45	ble 9, Au 0.51 7 in Ta	Th1 (°C) g Sep 0.78 able 9c)	Oct 0.96	Nov 1	Dec 1	21 21	(85)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heating the second s	ture ( ing pe for lin /lar 98	heating sease priods in the li ving area, h1 Apr Ma 0.92 0.79	on) ving ,m (s y (follo	area from Tal ee Table 9a) Jun Jul 0.6 0.45	ole 9, Au 0.51	Th1 (°C) g Sep 0.78 able 9c)	Oct	Nov	Dec	] 21 21	(85)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heating the second s	ture ( for lind for lind for lind Mar 98 e in lind .15	heating sease priods in the li ving area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 priods in rest	on) ving ,m (s y (follo t 2 of dw	area from Table 9a) Jun Jul 0.6 0.45 ow steps 3 to 7 20.97 20.99	ole 9, Au 0.51 7 in Ta 20.91	Th1 (°C) g Sep 0.78 able 9c) 9 20.89	Oct 0.96	Nov 1	Dec 1	] <u>21</u>	(85)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heating the second s	ture ( for lind for lind for lind Mar 98 e in lind .15	heating seas eriods in the li ving area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84	on) ving ,m (s y (follo t 2 of dw	area from Table 9a) Jun Jul 0.6 0.45 ow steps 3 to 7 20.97 20.99	ole 9, Au 0.51 7 in Ta 20.91	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 , Th2 (°C)	Oct 0.96	Nov 1	Dec 1	] 21 21 ]	(85)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heating the second s	ture ( ng pe for liv Aar 98 e in li .15 .15 ng pe	heating seasebriods in the lipving area, h1AprMa0.920.79ving area T120.5520.84priods in rest19.8619.86	on) ving ,m (s y (follo t 2 of dw 3	area from Tal eee Table 9a) Jun Jul 0.6 0.45 ow steps 3 to 7 20.97 20.99 velling from Ta 19.86 19.86	ole 9, Au 0.51 7 in Ta 20.9 able 9, 19.8	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 , Th2 (°C)	Oct 0.96 20.47	Nov 1 19.93	Dec 1 19.53	] 21 21 ] ]	(85) (86) (87)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heating the second s	ture ( ng pe for liv Aar 98 e in li .15 .15 ng pe	heating seasebriods in the lipving area, h1AprMa0.920.79ving area T120.5520.84priods in rest19.8619.86	on) ving ,m (s y (follc 1 2 of dw 3 7	area from Tal eee Table 9a) Jun Jul 0.6 0.45 ow steps 3 to 7 20.97 20.99 velling from Ta 19.86 19.86	ole 9, Au 0.51 7 in Ta 20.9 able 9, 19.8	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 , Th2 (°C) 7 19.86	Oct 0.96 20.47	Nov 1 19.93	Dec 1 19.53	] 21 21 ] ]	(85) (86) (87)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heating the second s	ture ( ing pe for lin /ar 98 e in li .15 ng pe .85 for re 97	heating seas priods in the living area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72	on)       ving       ,m (s       y       (follc       i       i       i       i       i       i       i       i       i       i       i       i	area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         ,m (see Table         0.51       0.34	ole 9,       Au       0.51       7 in Ta       20.91       able 9,       19.8       9a)       0.39	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 , Th2 (°C) 7 19.86 9 0.69	Oct 0.96 20.47 19.86 0.94	Nov 1 19.93 19.86	Dec 1 19.53 19.85	] 21 ] ] ]	(85) (86) (87) (88)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heat Temperature during heat Utilisation factor for gains <u>Jan Feb M</u> (86)m = 1 0.99 0. Mean internal temperature (87)m = 19.58 19.81 200 Temperature during heat (88)m = 19.85 19.85 19 Utilisation factor for gains (89)m = 1 0.99 0. Mean internal temperature	ture ( ing pe for lin /ar 98 e in li .15 ng pe .85 for re 97	heating seas priods in the living area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72	on)           ving           ,m (s           y           (folloc           i           j	area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         ,m (see Table         0.51       0.34	ole 9,       Au       0.51       7 in Ta       20.91       able 9,       19.8       9a)       0.39	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 , Th2 (°C) 7 19.86 0 0.69 to 7 in Table	Oct 0.96 20.47 19.86 0.94	Nov 1 19.93 19.86 0.99	Dec 1 19.53 19.85	] 21 21 ] ] ] ]	(85) (86) (87) (88)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heat Temperature during heat Utilisation factor for gains <u>Jan Feb M</u> (86)m = 1 0.99 0. Mean internal temperature (87)m = 19.58 19.81 200 Temperature during heat (88)m = 19.85 19.85 19 Utilisation factor for gains (89)m = 1 0.99 0. Mean internal temperature	ture ( ing pe for lin /lar 98 e in li .15 ng pe .85 for re 97 e in th	heating sease priods in the living area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwe	on)           ving           ,m (s           y           (folloc           i           j	area from Tal         iee Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Tal         19.86       19.86         ,m (see Table         0.51       0.34         172 (follow stepsed)	ole 9,       Au       0.51       7 in Ta       20.9       able 9,       19.8       9a)       0.39       0.39       apps 3 f	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 , Th2 (°C) 7 19.86 0 0.69 to 7 in Table 6 19.78	Oct 0.96 20.47 19.86 0.94 2.9c) 19.26	Nov 1 19.93 19.86 0.99	Dec 1 19.53 19.85 1 1	] 21 ] ] ] ] ] 0.26	(85) (86) (87) (88) (89)
$\begin{array}{r c c c c c c c c c c c c c c c c c c c$	ture ( ing pe for lin /ar 98 e in li .15 ng pe .85 for re 97 e in tl .79	heating seas eriods in the li ving area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwe 19.36 19.72	p(follow)	area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         ,m (see Table         0.51       0.34         172 (follow step         19.84       19.86	ole 9,       Au       0.51       7 in Ta       20.91       able 9,       19.8       9a)       0.39       ops 3 f       19.8	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 9 20.89 9 20.89 9 10.69 19.86 19.86 19.78 6 19.78	Oct 0.96 20.47 19.86 0.94 2.9c) 19.26	Nov 1 19.93 19.86 0.99 18.49	Dec 1 19.53 19.85 1 1	   ] ] ]	(85) (86) (87) (88) (89) (90)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heat Temperature during heat Utilisation factor for gains <u>Jan Feb M</u> (86)m = 1 0.99 0. Mean internal temperature (87)m = 19.58 19.81 200 Temperature during heat (88)m = 19.85 19.85 19 Utilisation factor for gains (89)m = 1 0.99 0. Mean internal temperature (90)m = 17.96 18.3 18 Mean internal temperature	ture ( ing pe for lin /ar 98 e in li .15 ng pe .85 for re 97 e in tl .79	heating seas eriods in the li ving area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwe 19.36 19.72	on)           ving           ,m (s           y           (follo           1           2           ,m (s           y           ,m (s           y           ,m (s           y           ,m (s           y           ,m (s           (follo           1           2           y	area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         ,m (see Table         0.51       0.34         172 (follow step         19.84       19.86	ole 9,       Au       0.51       7 in Ta       20.91       able 9,       19.8       9a)       0.39       ops 3 f       19.8	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 9 20.89 9 20.89 9 20.89 9 0.69 19.86 9 0.69 19.78 6 19.78 ft - fLA) × T2	Oct 0.96 20.47 19.86 0.94 2.9c) 19.26	Nov 1 19.93 19.86 0.99 18.49	Dec 1 19.53 19.85 1 1	   ] ] ]	(85) (86) (87) (88) (89) (90)
(84)m = 789.26 1025.01 126 7. Mean internal temperature during heat Temperature during heat Utilisation factor for gains	ture ( ing pe for lin /1ar 98 e in li .15 ng pe .85 for re 97 e in tl .79 e (for .15	heating seas priods in the living area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 priods in rest 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwelling 19.36 19.72 the whole dw 19.67 20.07	on)       ving       ,m (s       y       (follo       i       i       i       i       i       i       i       i       i       velling       i       i	area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         ,m (see Table         0.51       0.34         172 (follow steps         19.84       19.86         19.84       19.86	Au         0.51         7 in Ta         20.91         19.8         9a)         0.39         9a)         0.39         + (1 -         20.11	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 9 20.89 9 20.89 9 20.89 9 20.89 9 0.69 19.86 19.78 6 19.78 ft - fLA) × T2 6 20.07	Oct 0.96 20.47 19.86 0.94 9C) 19.26 A = Liv 19.58	Nov 1 19.93 19.86 0.99 18.49 ing area ÷ (4	Dec 1 19.53 19.85 1 1 17.9 4) =	   ] ] ]	(85) (86) (87) (88) (89) (90) (91)
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(84)m = 789.26 1025.01 126 7. Mean internal temperature during heat Temperature during heat Utilisation factor for gains <u>Jan Feb M</u> (86)m = 1 0.99 0. Mean internal temperature (87)m = 19.58 19.81 200 Temperature during heat (88)m = 19.85 19.85 19 Utilisation factor for gains (89)m = 1 0.99 0. Mean internal temperature (90)m = 17.96 18.3 18 Mean internal temperature (92)m = 18.38 18.7 19 Apply adjustment to the m	ture ( ing pe for lin /ar 98 e in li .15 ng pe .85 for re 97 e in tl .79 e (for .15 nean .15	heating seas priods in the living area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwe 19.36 19.72 the whole dw 19.67 20.07 internal temp	on)           ving           ,m (s           y           (follot           1           2           y	area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         0.51       0.34         172 (follow steps 19.86         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86	Au         0.51         7 in Ta         20.9         able 9,         19.8         9a)         0.39         eps 3 1         19.8         + (1 -         20.10         24e, w	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 9 20.89 9 20.89 9 20.89 9 0.69 19.76 19.86 9 0.69 19.78 1	Oct 0.96 20.47 19.86 0.94 9C) 19.26 A = Liv 19.58 priate	Nov 1 19.93 19.86 0.99 18.49 ing area ÷ (4 18.87	Dec 1 19.53 19.85 1 1 17.9 4) = 18.32	   ] ] ]	(85) (86) (87) (88) (89) (90) (91) (92)
(84)m=789.261025.011267. Mean internal temperature7. Mean internal temperatureTemperature during heatUtilisation factor for gains $\boxed{Jan  Feb  N}$ (86)m=10.990.Mean internal temperature(87)m=19.5819.5819.81200Temperature during heat(88)m=19.8519.8519.8510.990.Mean internal temperature(89)m=10.990.Mean internal temperature(90)m=17.9618.3818.71918.38Apply adjustment to the mean(93)m=18.3818.3918.71919.393. Space heating requiredSet Ti to the mean internal	ture ( ing pe for lin /ar 98 e in li .15 ing pe .85 for re 97 e in tl .79 e (for .15 nean .15 nean .15	heating seas priods in the living area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwelling 19.36 19.72 the whole dw 19.67 20.07 internal temp 19.67 20.07	on)         ving         ,m (s         y         ,m (s)         ,m (s)         ,m (s)         y         ,m (s)	area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         ,m (see Table         0.51       0.34         172 (follow stee         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86	Au         0.51         7 in Ta         20.91         able 9,         19.8         9a)         0.39         9a)         0.39         + (1 -         20.11         20.11	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 20.89 9 20.89 9 20.89 9 0.69 0 0.69 19.78 6 19.78 ft - fLA) × T2 6 20.07 /here appro 6 20.07	Oct 0.96 20.47 19.86 0.94 9C) 19.26 A = Liv 19.58 priate 19.58	Nov 1 19.93 19.86 0.99 18.49 ing area ÷ (4 18.87	Dec 1 19.53 19.85 1 17.9 4) = 18.32 18.32	 ] ] ]  ]  ] ]	(85) (86) (87) (88) (89) (90) (91) (92)
(84)m=789.261025.011267. Mean internal temperature7. Mean internal temperatureTemperature during heatUtilisation factor for gains $\boxed{30m}$ <t< td=""><td>ture ( ing pe for lin /ar 98 e in li .15 ng pe .85 for re 97 e in tl .79 e (for .15 nean .15 nean .15 nean .15</td><td>heating seas priods in the living area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwelling 19.36 19.72 the whole dw 19.67 20.07 internal temp 19.67 20.07</td><td>(follow (follow (fol</td><td>area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         ,m (see Table         0.51       0.34         172 (follow stee         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86</td><td>Au         0.51         7 in Ta         20.91         able 9,         19.8         9a)         0.39         9a)         0.39         + (1 -         20.11         20.11</td><td>Th1 (°C) g Sep 0.78 able 9c) 9 20.89 9 20.89 9 20.89 9 20.89 9 20.89 9 0.69 19.86 19.86 19.78 6 19.78 ft 6 19.78 ft 6 20.07 4 9b, so that</td><td>Oct 0.96 20.47 19.86 0.94 9C) 19.26 A = Liv 19.58 priate 19.58</td><td>Nov 1 19.93 19.86 0.99 18.49 ing area ÷ (4 18.87 18.87 (76)m an</td><td>Dec 1 19.53 19.85 1 17.9 4) = 18.32 18.32</td><td> ] ] ]  ]  ] ]</td><td>(85) (86) (87) (88) (89) (90) (91) (92)</td></t<>	ture ( ing pe for lin /ar 98 e in li .15 ng pe .85 for re 97 e in tl .79 e (for .15 nean .15 nean .15 nean .15	heating seas priods in the living area, h1 Apr Ma 0.92 0.79 ving area T1 20.55 20.84 eriods in rest 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwelling 19.36 19.72 the whole dw 19.67 20.07 internal temp 19.67 20.07	(follow (fol	area from Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Table         19.86       19.86         ,m (see Table         0.51       0.34         172 (follow stee         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86         19.84       19.86	Au         0.51         7 in Ta         20.91         able 9,         19.8         9a)         0.39         9a)         0.39         + (1 -         20.11         20.11	Th1 (°C) g Sep 0.78 able 9c) 9 20.89 9 20.89 9 20.89 9 20.89 9 20.89 9 0.69 19.86 19.86 19.78 6 19.78 ft 6 19.78 ft 6 20.07 4 9b, so that	Oct 0.96 20.47 19.86 0.94 9C) 19.26 A = Liv 19.58 priate 19.58	Nov 1 19.93 19.86 0.99 18.49 ing area ÷ (4 18.87 18.87 (76)m an	Dec 1 19.53 19.85 1 17.9 4) = 18.32 18.32	 ] ] ]  ]  ] ]	(85) (86) (87) (88) (89) (90) (91) (92)

Utilisa	ation fac	tor for g	ains, hm	n:										
(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)
Usefu	ul gains,	hmGm	, W = (9	4)m x (84	4)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)
Mont	hly aver	age exte	ernal terr	perature	e from Ta	able 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	e for mea	an interr	al tempe	erature,	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)
Spac	e heatin	ř		or each n	· · ·	Wh/mon	th = 0.02	24 x [(97]	)m – (95	)m] x (4	1)m			
(98)m=	1193.57	891.39	689.08	336.14	111.57	0	0	0	0	404.85	846.29	1234.71		_
								Tota	l per year	(kWh/yeai	r) = Sum(9	8)15,912 =	5707.59	(98)
Spac	e heatin	g require	ement in	kWh/m²	/year							]	43.38	(99)
9a. En	erav rea	nuiremer	nts – Ind	ividual h	eating s	vstems i	ncludina	micro-C	CHP)			L		
	e heati						9		,					
-		-	at from s	econdar	y/supple	mentary	system					[	0	(201)
Fract	ion of sp	bace hea	at from m	nain syst	em(s)			(202) = 1 -	- (201) =			Ī	1	(202)
				main sys	. ,			(204) = (2	02) × [1 –	(203)] =			1	(204)
			•	ing syste					<i>,</i> -				92.8	(206)
		· · ·		0,		a oveter	- 0/							
EIIICI		seconda	ry/suppi	ementar	y neating	g system	1, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ar
Spac		ř · ·	<u>`</u>	alculate		r								
	1193.57	891.39	689.08	336.14	111.57	0	0	0	0	404.85	846.29	1234.71		
(211 <mark>)</mark> n	n = {[(98	i	<u> </u>	00 ÷ (20										(211)
	1286.17	960.55	742.54	<u>362</u> .22	120.23	0	0	0	0	43 <mark>6.27</mark>	911.95	1330.51		_
								Tota	ıl (kWh/yea	ar) =Sum(2	211) <sub>15,1012</sub>	= [	6150.43	(211)
•		•		y), kWh/	month									
		01)] } x 1	· · ·	)8)	<u> </u>									
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		<b>-</b>
								lota	ii (kvvn/yea	ar) = Sum(2)	215) <sub>15,1012</sub>	= [	0	(215)
	heating													
Outpu	t from w 184.96	ater hea 162.03	ter (calc 169.95	ulated a	bove) 149.6	134.56	127.36	142.33	142.89	156.74	166.73	179.7		
Efficio		ater hea		151.1	149.0	134.50	127.50	142.55	142.09	150.74	100.73	179.7	07.0	(216)
		i	i	00.04	00.05	07.0	07.0	07.0	07.0	00.00	00.00	00.47	87.3	(217)
(217)m=	L	89.41	89.29	89.01	88.35	87.3	87.3	87.3	87.3	89.09	89.38	89.47		(217)
		heating, m x 100												
• •	206.76	181.23	190.33	169.76	169.33	154.14	145.89	163.04	163.68	175.94	186.55	200.84		
	L	1	1		I	1	1	Tota	l = Sum(2	19a) <sub>112</sub> =	1		2107.48	(219)
Annua	al totals	i									Wh/year	Ľ	kWh/year	
			ed, main	system	1							[	6150.43	7
Water	heating	fuel use	d									ľ	2107.48	ī
	0													

Electricity for pumps, fans and electric keep-hot

central heating pump:			30		(230c)
boiler with a fan-assisted flue			45		(230e)
Total electricity for the above, kWh/year	SU	ım of (230a)(230g) =		75	(231)
Electricity for lighting				471.7	(232)
12a. CO2 emissions – Individual heating systems	including micro-CH	ΗP			
	<b>Energy</b> kWh/year	Emission fac kg CO2/kWh	tor	<b>Emissions</b> kg CO2/yea	r
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.

Assessor Name:Stroma FSAP 2012Stroma Number:Software Name:Stroma FSAP 2012Software Version:Version: 1.0.4.6Property Address: 13 Murray MewsAddress: 13 Murray Mews, London, NW1 9RJAddress :13 Murray Mews, London, NW1 9RJ1. Overall dwelling dimensions:Area(m²)Av. Height(m)Volume(m³)Ground floorFirst floor $51.56$ (1a) x $2.57$ (2a) = $132.51$ Second floor $28.45$ (1c) x $2.95$ (2c) = $83.93$	) (3a) (3b) (3c)
Address :13 Murray Mews, London, NW1 9RJ1. Overall dwelling dimensions:Area(m²)Av. Height(m)Volume(m³)Ground floor $51.56$ (1a) x $2.57$ (2a) = $132.51$ First floor $51.56$ (1b) x $2.85$ (2b) = $146.95$	(3a) (3b)
Area(m²)Av. Height(m)Volume(m³)Ground floor $51.56$ $(1a) \times$ $2.57$ $(2a) =$ $132.51$ First floor $51.56$ $(1b) \times$ $2.85$ $(2b) =$ $146.95$	(3a) (3b)
Area(m²)Av. Height(m)Volume(m³)Ground floor $51.56$ $(1a) \times$ $2.57$ $(2a) =$ $132.51$ First floor $51.56$ $(1b) \times$ $2.85$ $(2b) =$ $146.95$	(3a) (3b)
Ground floor $51.56$ $(1a) \times$ $2.57$ $(2a) =$ $132.51$ First floor $51.56$ $(1b) \times$ $2.85$ $(2b) =$ $146.95$	(3a) (3b)
	4
Second floor $28.45$ (1c) x $2.95$ (2c) = $83.93$	(3c)
Total floor area TFA = $(1a)+(1b)+(1c)+(1d)+(1e)+(1n)$ (4)	
Dwelling volume $(3a)+(3b)+(3c)+(3d)+(3e)+(3n) = 363.38$	(5)
2. Ventilation rate:	
main secondary other total m <sup>3</sup> per hou heating heating	
Number of chimneys $0 + 0 + 0 = 0 \times 40 = 0$	(6a)
Number of open flues $0$ + $0$ = $0$ × 20 = $0$	(6b)
Number of intermittent fans   5   x 10 =   50	(7a)
Number of passive vents   0   × 10 =   0	(7b)
Number of flueless gas fires	(7c)
Air changes per ho	ur
Infiltration due to chimneys, flues and fans = $(6a)+(6b)+(7a)+(7c) =$ 50 $\div$ (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)0Additional infiltration[(9)-1]x0.1 =0	(9) (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	(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 $(18) = [(17) \div 20]+(8)$ , 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           Shelter factor         (20) = 1 - [0.075 x (19)] =         0.85	(19)
	(20)
Infiltration rate incorporating shelter factor $(21) = (18) \times (20) =$ $0.24$ Infiltration rate modified for monthly wind speed	(21)
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 $\div$ 4										
(22a)m= 1.27 1.25 1.23 1	1.1 1.08	0.95	0.95	0.92	1	1.08	1.12	1.18		
Adjusted infiltration rate (allowing	for shelter and	I wind sp	eed) =	(21a) x (	22a)m					
	.27 0.26	0.23	0.23	0.23	0.24	0.26	0.28	0.29		
Calculate effective air change rate If mechanical ventilation:	for the applic	able cas	е							(00-)
If exhaust air heat pump using Appendix	v N (23h) – (23a)	× Emy (eq	wation (N	(5)) other	wise (23h	) - (23a)				0 (23a)
If balanced with heat recovery: efficienc						) = (200)				0 (23b)
				,		Ph\m ↓ (/	22h) v [4	(220)		0 (23c)
a) If balanced mechanical ventil (24a)m= 0 0 0				0 1K) (24a)	m = (22)	0	230) <b>x</b> [1 0	- (230) 0	÷ 100]	(24a)
b) If balanced mechanical ventil			-				-	0		(210)
				0	$\frac{111}{0} = (22)$	0	0	0		(24b)
c) If whole house extract ventila			-	-	-	Ů	0	0		()
if $(22b)m < 0.5 \times (23b)$ , ther	-	-				5 x (23b	)			
		0	0	0	0	0	0	0		(24c)
d) If natural ventilation or whole	house positive	e input ve	entilatio	n from lo	oft					
if (22b)m = 1, then (24d)m =						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 (2 <mark>4</mark> 0	d) 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 para	ameter									
	penings	Net Are	a	U-valu	е	AXU		k-value	)	AXk
area (m²)	m <sup>2</sup>	A ,m²	2	W/m2ł	<	(W/ł	()	kJ/m²∙ł	<	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	Γ	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	ſ	4.73	x1/	[1/( 1.4 )+ (	0.04] =	6.27	Ē			(27)
Windows Type 6	ſ	1.98		[1/( 1.4 )+ (	0.04] =	2.62	=			(27)
Windows Type 7	L [	1.98		[1/( 1.4 )+ (	0.04] = [	2.62	=			(27)
Windows Type 8	L [	2.31		[1/( 1.4 )+ (	0.04] = [	3.06	$\exists$			(27)
Windows Type 9	L [	1.98		[1/( 1.4 )+ (	L L	2.62	=			(27)
Windows Type 10	Ľ	1.98		[1/( 1.4 )+ (		2.62	$\dashv$			(27)
Windows Type 11	L			[1/( 1.4 )+ (	L L		4			(27)
Floor	Ĺ	4.73	=, ,			6.27	╡┍		r	
		51.56		0.12		6.1872	╡╞		¦	(28)
Walls 207.85	36.85	171	×	0.18	=	30.78				(29)
Roof 51.56			r		r					·
Tatal and a failer in the C	0	51.56	× [	0.11	=	5.67				(30)
Total area of elements, m <sup>2</sup> Party wall	0	51.56 310.97	×[	0.11	] = [	5.67				(30) (31) (32)

* for win	ndows and	roof wind	ows, use e	effective wi	indow U-va	alue calcui	lated using	formula 1,	/[(1/U-valu	ie)+0.04] a	as given in	paragrapl	n 3.2	
				nternal wal	ls and par	titions		(00) (00)	(22)					_
		s, W/K :		U)				(26)(30)					90.82	(33)
		Cm = S(	. ,								2) + (32a).	(32e) =	0	(34)
				P = Cm -						tive Value			250	(35)
	-	sments wh ad of a de			construct	ion are no	t known pr	ecisely the	e indicative	values of	TMP in Ta	able 1f		
				culated	using Ap	pendix l	K						13.11	(36)
	0		,	own (36) =	• •	•								
Total f	abric he	at loss							(33) +	(36) =			103.93	(37)
Ventila	ation hea	at loss ca	alculated	monthl	у				(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 t	ransfer o	coefficier	nt, W/K	-	-	-		-	(39)m	= (37) + (3	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 lo	<u> </u>	meter (H	HLP), W	/m²K		-			(40)m	= (39)m ÷	(4)		1	
(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		_
Numb	ar of day	s in mo	nth (Tab	(1 ما					,	Average =	Sum(40)1.	12 /12=	1.28	(40)
Numb	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)
(41)11-		20	01			00							1	()
													_	
<b>4.</b> VVa	ater heat	ing ener	rgy <b>requ</b>	irement:								kWh/y	ear:	
		ipancy, l										.9	]	(42)
			+ 1.76 x	[ <mark>1 -</mark> exp	(-0.0003	849 x (TF	<sup>-</sup> A -13.9	)2)] + 0.0	00 <mark>13 x (</mark>	TFA -13.	9)			
	A £ 13.9		ater usa	ne in litre	es ner da	av Vd av	erage =	(25 x N)	+ 36		10	3.05	1	(43)
								to achieve		se target o		5.00	1	(10)
not mor	e that 125	litres per j	person pe	r day (all w	ater use, l	hot and co	ld)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wat	er usage i	n litres per	r day for ea	ach month	Vd,m = fa	ctor 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		
Enerav	content of	hot water	used - cal	culated m	onthly — A	100 v Vd i	т у пт у Г	) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) )			m(44) <sub>112</sub> =		1236.6	(44)
			i	1	-	1	i	i	r	·			1	
(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	4004.00	(45)
lf instan	taneous w	ater heatii	ng at poini	of use (no	o hot water	r storage),	enter 0 in	boxes (46		1 otal = Su	m(45) <sub>112</sub> =	•	1621.38	(43)
(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	1	(46)
· · ·	storage												J	
Storag	je volum	e (litres)	includir	ng any so	olar or W	/WHRS	storage	within sa	ame ves	sel		0	]	(47)
If com	munity h	eating a	ind no ta	nk in dw	velling, e	nter 110	) litres in	(47)					-	
			hot wate	er (this ir	ncludes i	nstantar	neous co	ombi boil	ers) ente	er '0' in (	47)			
	storage		مامتعط	000 40 54	or io lun -	WD (1.1.1/1							1	
				oss facto	UT IS KNO	wn (KVVI	i/uay):					0	]	(48)
I empe	erature f	actor fro	m Table	20								0		(49)

b) If m	nanufact	urer's de	storage eclared o	cylinder I	oss fact		known:	(48) x (49	) =			0		(50)
If com	munity h	eating s	factor fr		e 2 (KVV)	n/iitre/da	iy)					0	(	(51)
		from Ta										0	(	(52)
Tempe	erature f	actor fro	m Table	2b								0	(	(53)
Energy	y lost fro	m water	<sup>-</sup> storage	, kWh/ye	ear			(47) x (51	) x (52) x (	53) =		0	(	(54)
Enter	(50) or (	(54) in (5	55)									0	(	(55)
Water	storage	loss cal	culated f	for each	month			((56)m = (	55) × (41)	m				
(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(	(56)
If cylinde	er contains	s dedicate	d solar sto	rage, (57)r	m = (56)m	x [(50) – (	H11)] ÷ (5	0), else (5	7)m = (56)	m where (	H11) is fro	m Appendi	хH	
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(	(57)
Primar	v circuit	loss (ar	nnual) fro	om Table	93							0	(	(58)
	•	•	culated			59)m = (	(58) ÷ 36	65 × (41)	m					
(mo	dified by	factor f	rom Tab	le H5 if t	here is s	solar wat	ter heatii	ng and a	a cylinde	r thermo	stat)			
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(	(59)
Combi	loss ca	lculated	for each	month (	(61)m =	(60) ÷ 36	65 × (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)
Tota <mark>l h</mark>	neat requ	uired for	water h	eating ca	alculated	for eac	h month	(62)m =	0.85 × 0	(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 Di	HW input of	calculated	using App	endix G or	· Appendix	H (negati	ve quantity	/) (enter '0	if no sola	r contributi	ion to wate	er heating)		
			FGHRS			-								
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(	(63)
Output	t from w	ater hea	ter									11		
(64)m=	184.96	162.03	169.95	151.1	149.6	134.56	127.36	142.33	142.89	15 <mark>6.74</mark>	166.73	179.7		
			!					LOutp	Dut from w	ater heater	r (annual)₁	12	1867.97	(64)
Heat o	ains fro	m water	heating	kWh/m	onth 0.2	5 ´ [0 85	x (45)m	. + (61)n	nl + 0.8 x	([(46)m	+ (57)m	+ (59)m	1	
-		54.73				-	40.21					60.6	-	(65)
												munity h		
	. ,				•	yinder is	S III UIE (	Jwennig	of not w			munity n	eaung	
5. IN	ternal ga	ains (see	e Table 5	and 5a	):									
Metab			e 5), Wat				<u> </u>							
	Jan	Feb	Mar	Apr	Мау	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)
Lightin		(calcula	ted in Ap	pendix l	L, equat	ion L9 o	r L9a), a	lso 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)
Applia	nces ga	ins (calc	ulated in	Append	dix L, eq	uation L	13 or L1	3a), also	o see Ta	ble 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)
Cookir	ng gains	(calcula	ated in A	ppendix	L, equat	ion L15	or L15a)	), also se	e Table	5		<u> </u>		
(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	s and fai	ns aains	(Table 5	5a)			I			1				
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(	(70)
			n (nega				I	I	I	I		I		
(71)m=	<u> </u>	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	-115.96	(	(71)
(, ,),,,=	110.00	110.00	1 10.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	(	

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	n + (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 a	nd associated equa	tions to convert to th	ne applicable orientat	ion.		
Orientation: Access Factor	Area	Flux	g	FF		Gains	
Table 6d	m²	Table 6a	Table 6b	Table 6c		(W)	
Northeast 0.9x 0.77 x	4.62	11.28	× 0.72	× 0.7	= [	18.21	(75)
Northeast 0.9x 0.77 x	4.62	22.97	× 0.72	× 0.7	=	37.06	(75)
Northeast 0.9x 0.77 x	4.62	41.38	× 0.72	× 0.7	=	66.77	(75)
Northeast 0.9x 0.77 x	4.62	67.96	× 0.72	× 0.7	=	109.66	(75)
Northeast 0.9x 0.77 x	4.62	91.35	× 0.72	× 0.7	=	147.4	(75)
Northeast 0.9x 0.77 x	4.62	97.38	x 0.72	× 0.7	=	157.14	(75)
Northeast 0.9x 0.77 x	4.62	91.1	× 0.72	× 0.7	=	147	(75)
Northeast 0.9x 0.77 x	4.62	72.63	× 0.72	× 0.7	=	117.19	(75)
Northeast 0.9x 0.77 x	4.62	50.42	× 0.72	× 0.7		81.36	(75)
Northeast 0.9x 0.77 x	-4.62 >	28.07	× 0.72	× 0.7		45.29	(75)
Northeast 0.9x 0.77 x	4.62	14.2	× 0.72	× 0.7	=	22.91	(75)
Northeast 0.9x 0.77 x	4.62	9.21	× 0.72	x 0.7	=	14.87	(75)
Southeast 0.9x 0.77 x	1.98	36.79	× 0.72	x 0.7	=	25.45	(77)
Southeast 0.9x 0.77 x	4.73	36,79	x 0.72	× 0.7	=	60.79	(77)
Southeast 0.9x 0.77 x	1.98	36.79	× 0.72	x 0.7	=	50.89	(77)
Southeast 0.9x 0.77 x	1.98	36.79	× 0.72	× 0.7	=	25.45	(77)
Southeast 0.9x 0.77 x	4.73	36.79	× 0.72	× 0.7	=	60.79	(77)
Southeast 0.9x 0.77 x	1.98	62.67	× 0.72	x 0.7	=	43.34	(77)
Southeast 0.9x 0.77 x	4.73	62.67	× 0.72	x 0.7	= [	103.54	(77)
Southeast 0.9x 0.77 x	1.98	62.67	× 0.72	x 0.7	=	86.68	(77)
Southeast 0.9x 0.77 x	1.98	62.67	× 0.72	x 0.7	=	43.34	(77)
Southeast 0.9x 0.77 x	4.73	62.67	× 0.72	× 0.7	=	103.54	(77)
Southeast 0.9x 0.77 x	1.98	85.75	× 0.72	x 0.7	=	59.3	(77)
Southeast 0.9x 0.77 x	4.73	85.75	x 0.72	x 0.7	=	141.67	(77)
Southeast 0.9x 0.77 x	1.98	85.75	× 0.72	× 0.7	=	118.61	(77)
Southeast 0.9x 0.77 x	1.98	85.75	× 0.72	× 0.7	=	59.3	(77)
Southeast 0.9x 0.77 x	4.73	85.75	× 0.72	× 0.7	=	141.67	(77)
Southeast 0.9x 0.77 x	1.98	106.25	× 0.72	× 0.7	= [	73.48	(77)
Southeast 0.9x 0.77 x	4.73	106.25	x 0.72	× 0.7	= [	175.53	(77)
Southeast 0.9x 0.77 x	1.98	106.25	× 0.72	× 0.7	= [	146.96	(77)
Southeast 0.9x 0.77 x	1.98	106.25	× 0.72	× 0.7	= [	73.48	(77)
Southeast 0.9x 0.77 x	4.73	106.25	x 0.72	x 0.7	= [	175.53	(77)

		1		1		1		1		1		
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	×	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	×	0.72	x	0.7	=	81.71	(77)
Southeast 0.9x	0.77	x	4.73	x	118.15	×	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	×	0.72	x	0.7	] =	188.18	(77)
Southeast 0.9x	0.77	x	1.98	x	113.91	×	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	×	104.39	х	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	х	104.39	<b>x</b>	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	<b>x</b>	4.73	x	92.8 <mark>5</mark>	x	0.72	x	0.7	=	153.4	(77)
Southeast 0.9x	0.77	x	1.98	x	92.85	×	0.72	x	0.7	=	128.43	(77)
Southeast 0.9x	0.77	x	1.98	x	92.85	×	0.72	x	0.7	] =	64.21	(77)
Southeast 0.9x	0.77	x	4.73	x	92.85	×	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	×	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	×	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	×	0.72	x	0.7	] =	21.78	(77)
Southeast 0.9x	0.77	x	4.73	×	31.49	×	0.72	x	0.7	=	52.02	(77)
Southeast 0.9x	0.77	x	1.98	x	31.49	×	0.72	x	0.7	=	43.55	(77)
Southeast 0.9x	0.77	x	1.98	×	31.49	×	0.72	x	0.7	=	21.78	(77)
Southeast 0.9x	0.77	x	4.73	×	31.49	×	0.72	x	0.7	=	52.02	(77)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	36.79		0.72	x	0.7	=	25.45	(79)

Southwest0.9x	0.77	×	1.98	x	62.67		0.72	x	0.7	=	43.34	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	85.75		0.72	x	0.7	=	59.3	](79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	106.25		0.72	x	0.7	=	73.48	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	119.01		0.72	x	0.7	=	82.3	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	118.15		0.72	x	0.7	=	81.71	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	113.91		0.72	x	0.7	=	78.77	(79)
Southwest0.9x	0.77	x	1.98	x	104.39		0.72	x	0.7	=	72.19	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	92.85	İ	0.72	x	0.7	=	64.21	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	69.27		0.72	x	0.7	=	47.9	(79)
Southwest <sub>0.9x</sub>	0.77	x	1.98	x	44.07		0.72	x	0.7	=	30.48	(79)
Southwest <sub>0.9x</sub>	0.77	×	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	×	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	×	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	×	0.7	=	15.88	(81)
Northwest 0.9x	0.77	x	2.57	x	41.38	×	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	×	2.31	x	41.38	х	0.72	x	0.7	=	<mark>3</mark> 3.39	(81)
Northwest 0.9x	0.77	×	1.98	x	41.38	х	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	×	2.31	x	67.96	x	0.72	x	0.7	=	54.83	(81)
Northwest 0.9x	0.77	×	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	×	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	×	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	×	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	×	1.98	x	91.1	x	0.72	x	0.7	=	126	(81)
Northwest 0.9x	0.77	×	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	×	0.7	=	58.6	(81)
Northwest 0.9x 0.77	x	1.98	x	72.63	x	0.72	×	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	<b>x</b>	9.21	x	0.72	x	0.7	=	6.37	(81)
Solar gains in watts, calcul	ated	for each mon	th		(83)m	= Sum(74)m	. <mark>(8</mark> 2)m	_		,	
				324.09 1261.53	1097	2.54 899.76	619.7	4 374.56	262.61		(83)
Total gains – internal and s			<u> </u>	·				_		,	
(84)m= 789.26 1025.01 126	3.15	1517 1700.3	21   16	SOO 12   1610 16							
	0.10			699.42 1619.16	1461	.74 1278.61	1026.	9 814.32	727.38		(84)
7. Mean internal temperat				1019.10	1461	.74 1278.61	1026.	9 814.32	727.38		(04)
	ture (	heating seaso	on)		<u>ı</u>		1026.	9 814.32	727.38	21	(84)
7. Mean internal temperat	ture ( ng pe	heating seaso eriods in the li	on) ving	area from Tab	<u>ı</u>		1026.	9 814.32	727.38	21	
7. Mean internal temperat Temperature during heati Utilisation factor for gains	ture ( ng pe	heating seaso eriods in the li	on) ving m (s	area from Tab	ble 9		Oct		727.38 Dec	21	
7. Mean internal temperat Temperature during heati Utilisation factor for gains Jan Feb M	ture ( ng pe for li	heating sease eriods in the li ving area, h1,	on) ving m (s	area from Tal ee Table 9a)	ble 9	Th1 (°C) Jg Sep			I	21	
7. Mean internal temperat Temperature during heati Utilisation factor for gains Jan Feb M	ture ( ng pe for li 1ar 98	heating seaso priods in the li ving area, h1, Apr Ma 0.92 0.79	on) ving m (s y	area from Tal ee Table 9a) Jun Jul 0.6 0.45	ble 9 A	Th1 (°C) ug Sep 1 0.78	Oct	Nov	Dec	21	(85)
7. Mean internal temperatTemperature during heatiUtilisation factor for gains $\boxed{Jan Feb M}$ (86)m=10.990.1Mean internal temperature	ture ( ng pe for li 1ar 98	heating seaso priods in the li ving area, h1, Apr Ma 0.92 0.79	on) ving m (s y (follo	area from Tal ee Table 9a) Jun Jul 0.6 0.45	ble 9 A	Th1 (°C) Jg Sep 11 0.78 Table 9c)	Oct	Nov 1	Dec	21	(85)
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7. Mean internal temperatureTemperature during heatiUtilisation factor for gainsJanFebMean internal temperature(87)m=19.5819.5819.8120Temperature during heati	ture ( ng pe for li /lar 98 e in li .15	heating sease priods in the li ving area, h1, Apr Ma 0.92 0.79 iving area T1 20.55 20.84	on) ving m (s y (follo f dw	area from Table 9a) Jun Jul 0.6 0.45 ow steps 3 to 7 20.97 20.99	ble 9 A 0.5 7 in T 20.	Th1 (°C) ug Sep 1 0.78 able 9c) 99 20.89 0, Th2 (°C)	Oct 0.96	<ul> <li>Nov</li> <li>1</li> <li>19.93</li> </ul>	Dec 1	  ]	(85)
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7. Mean internal temperatureTemperature during heatiUtilisation factor for gains(86)m=10.990.1(86)m=10.990.1Mean internal temperature(87)m=19.5819.8120Temperature during heati(87)m=19.8519.8519Utilisation factor for gains(89)m=10.990.1Mean internal temperature900m=17.9618.318Mean internal temperature900m=17.9618.318Mean internal temperature900m=18.3818.719Apply adjustment to the m19.3818.7198. Space heating requiremSet Ti to the mean internal19	ture ( ng pe for li Aar 98 e in li .15 ng pe .85 for re 97 e in tl .79 e (for .15 nean .15 nean .15	heating sease priods in the li ving area, h1, Apr Ma 0.92 0.79 iving area T1 20.55 20.84 eriods in rest of 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwe 19.36 19.72 the whole dw 19.67 20.01 internal tempo 19.67 20.01	2n)         ving         m (s         y         (folloc         i         (folloc         i         i         g, h2         i         g, h2         i <t< td=""><td>area from Tak         ee Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Tak         19.86       19.86         ,m (see Table         0.51       0.34         T2 (follow step         19.84       19.86         19.84       19.86         g) = fLA × T1         20.14       20.16         ure from Table         20.14       20.16</td><td>ble 9 A 0.5 7 in T 20. 20. 19. 9a) 0.3 9a) 19. + (1 20. + (1 20. + (20. 20. </td><td>Th1 (°C) ug Sep 1 0.78 able 9c) 9 20.89 2, Th2 (°C) 87 19.86 9 0.69 to 7 in Table 86 19.78 fL - fLA) × T2 16 20.07 where appro 16 20.07</td><td>Oct 0.96 20.47 19.86 0.94 9 9c) 19.26 A = Liv 19.58 priate 19.58</td><td><ul> <li>Nov</li> <li>1</li> <li>19.93</li> <li>19.86</li> <li>0.99</li> <li>18.49</li> <li>ving area ÷ (</li> <li>18.87</li> <li>18.87</li> </ul></td><td>Dec 1 19.53 19.85 1 17.9 4) = 18.32 18.32</td><td> ] ] ]  ]  ]</td><td>(85) (86) (87) (88) (89) (90) (91) (92)</td></t<>	area from Tak         ee Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Tak         19.86       19.86         ,m (see Table         0.51       0.34         T2 (follow step         19.84       19.86         19.84       19.86         g) = fLA × T1         20.14       20.16         ure from Table         20.14       20.16	ble 9 A 0.5 7 in T 20. 20. 19. 9a) 0.3 9a) 19. + (1 20. + (1 20. + (20. 20. 	Th1 (°C) ug Sep 1 0.78 able 9c) 9 20.89 2, Th2 (°C) 87 19.86 9 0.69 to 7 in Table 86 19.78 fL - fLA) × T2 16 20.07 where appro 16 20.07	Oct 0.96 20.47 19.86 0.94 9 9c) 19.26 A = Liv 19.58 priate 19.58	<ul> <li>Nov</li> <li>1</li> <li>19.93</li> <li>19.86</li> <li>0.99</li> <li>18.49</li> <li>ving area ÷ (</li> <li>18.87</li> <li>18.87</li> </ul>	Dec 1 19.53 19.85 1 17.9 4) = 18.32 18.32	 ] ] ]  ]  ]	(85) (86) (87) (88) (89) (90) (91) (92)
7. Mean internal temperatureTemperature during heatiUtilisation factor for gainsJan Feb M(86)m=10.990.1Mean internal temperature(87)m=19.5819.8120Temperature during heati(87)m=19.5819.8120Temperature during heati(88)m=19.8519Utilisation factor for gains(89)m=10.990.1Mean internal temperature(90)m=17.9618.318Mean internal temperature(92)m=18.3818.719Apply adjustment to the m(93)m=18.3818.719Set Ti to the mean internat the utilisation factor for gains	ture ( ng pe for li /ar 98 e in li .15 ng pe .85 for re 97 e in th .79 e (for .15 nean .15 nean .15	heating sease priods in the li ving area, h1, Apr Ma 0.92 0.79 iving area T1 20.55 20.84 eriods in rest of 19.86 19.86 est of dwelling 0.89 0.72 he rest of dwe 19.36 19.72 the whole dw 19.67 20.01 internal tempo 19.67 20.01	2n) ving m (s y (follc (follc , 2 , , h2 , , h2 , , h2 , , , , , , , , , , , , ,	area from Tak         ee Table 9a)         Jun       Jul         0.6       0.45         ow steps 3 to 7         20.97       20.99         velling from Tak         19.86       19.86         ,m (see Table         0.51       0.34         T2 (follow step         19.84       19.86         19.84       19.86         g) = fLA × T1         20.14       20.16         ure from Table         20.14       20.16	ble 9 Ai 0.5 7 in T 20. 19. 9a) 0.3 9a) 19. + (1 20. + (1 20. + (1 20. - - - - - - - - - - - - -	Th1 (°C) ug Sep 1 0.78 able 9c) 9 20.89 2, Th2 (°C) 87 19.86 9 0.69 to 7 in Table 86 19.78 fL - fLA) × T2 16 20.07 where appro 16 20.07	Oct 0.96 20.47 19.86 0.94 9 9c) 19.26 A = Liv 19.58 priate 19.58	<ul> <li>Nov</li> <li>1</li> <li>19.93</li> <li>19.86</li> <li>0.99</li> <li>18.49</li> <li>ving area ÷ (</li> <li>18.87</li> <li>18.87</li> <li>18.87</li> <li>18.87</li> </ul>	Dec 1 19.53 19.85 1 17.9 4) = 18.32 18.32		(85) (86) (87) (88) (89) (90) (91) (92)

	(94)
	(95)
	(96)
	(97)
5707.59	(98)
43.38	(99)
	1
0	(201)
1	(202)
1	(204)
	(206)
0	(208)
kWh/yea	r
	(211)
6150.43	(211)
	1
0	(215)
07.2	(216)
01.3	(217)
	(217)
2107.48	(219)
kWh/year	J
-	1
6150.43	
	43.38 0 1 92.8 0 kWh/yea 6150.43 6150.43 87.3

Electricity for pumps, fans and electric keep-hot

central heating pump:		Γ	30		(230c)	
boiler with a fan-assisted flue			45		(230e)	
Total electricity for the above, kWh/year	s	um 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-C	HP			_	
	<b>Energy</b> kWh/year	<b>Emission fact</b> kg CO2/kWh	or	<b>Emissions</b> 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 Total CO2, kg/year <b>Dwelling CO2 Emission Rate</b> El rating (section 14)		0.519 sum of (265)(271) = (272) ÷ (4) =	=	-592.04 1475.4 11.21 89	(269) (272) (273) (274)	