Aval Consulting Group.

Energy Strategy

52 Avenue Road, St. John’s Wood, London NW8 6HS

52 Avenue Road Limited

July 2022

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1. Introduction

1.1 Overview

52 Avenue Road Ltd. ('the client') is seeking planning consent for development at 52 Avenue Road, St. John's Wood, London NW8 6HS (hereafter referred to as the 'proposed development'), which is within the London Borough of Camden (LBC).

The proposal is for the construction of 12 townhouses, with a spa and wellness centre.

Aval Consulting Group Limited (ACGL) was instructed by the client to produce an Energy Statement to accompany the planning application to LBC for consent to undertake the proposed work.

This report presents the sustainable design features of the development and demonstrates how they relate to applicable planning policy guidance as listed below:

- National Planning Policy Framework (NPPF) (2021).
- The London Plan (2021)
- The London Borough of Camden Planning Policy, including emerging policies.

This statement also provides a prediction of the proposed development's baseline energy prediction and outlines the use of energy efficiency measures.

The Energy strategy proposed adheres to the principles of the energy hierarchy by proposing "Lean and Green" measures to achieve a minimum of 35% reduction in carbon emissions by the use of passive measures and onsite renewable technology. The objective of the development is to exceed these requirements of the London Plan.

2. Applicable Standards and Policy

2.1 Planning Policies

2.1.1 The National Planning Policy Framework

The principal national planning policy guidance in respect of the proposed development is the National Planning Policy Framework (NPPF)[1]. The most recent update of the NPPF was published in July 2021 by the Ministry of Housing, Communities & Local Government.

The section of the NPPF "Planning for Climate Change" states that:

153. Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures or making provision for the possible future relocation of vulnerable development and infrastructure.

154. New development should be planned for in ways that:

a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and

b) can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.

155. To help increase the use and supply of renewable and low carbon energy and heat, plans should:

a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);

b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

c) identify opportunities for development to draw its energy supply from decentralised, renewable, or low carbon energy supply systems and for colocating potential heat customers and suppliers.

156. Local planning authorities should support community-led initiatives for renewable and low carbon energy, including developments outside areas identified in local plans or other strategic policies that are being taken forward through neighbourhood planning.

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[1] National Planning Policy Framework. Accessible at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

157. In determining planning applications, local planning authorities should expect new development to:

a) comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and

b) take account of landform, layout, building orientation, massing, and landscaping to minimise energy consumption.

158. When determining planning applications for renewable and low carbon development, local planning authorities should:

a) not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and

b) approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

2.1.2 The London Plan

The London Plan (2021) has been used in order to produce this strategy, as well as ensure that the proposed development meets all of the requirements imposed on it.

Policy SI 2: Minimising greenhouse gas emissions:

A. Major development should be net zero-carbon. This means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:

1) be lean: use less energy and manage demand during operation

2) be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly

3) be green: maximise opportunities for renewable energy by producing, storing, and using renewable energy on-site

4) be seen: monitor, verify and report on energy performance.

B. Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.

C. A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:

1) through a cash in lieu contribution to the borough's carbon offset fund, or
2) off-site provided that an alternative proposal is identified and delivery is certain.

D. Boroughs must establish and administer a carbon offset fund. Offset fund payments must be ring-fenced to implement projects that deliver carbon reductions. The operation of offset funds should be monitored and reported on annually

E. Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e. unregulated emissions.

F. Development proposals referable to the Mayor should calculate whole lifecycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

2.1.3 London Borough of Camden Local Plan

The London Borough of Camden Local Plan provides all relevant policies regarding planning for the borough.

"Policy CC1. Climate change mitigation" states:

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

We will:

a. promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy;

b. require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met;

c. ensure that the location of development and mix of land uses minimise the need to travel by car and help to support decentralised energy networks;

d. support and encourage sensitive energy efficiency improvements to existing buildings;

e. require all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building; and

f. expect all developments to optimise resource efficiency.

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

g. working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them;

h. protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes; and *i. requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network. To ensure that the Council can monitor the effectiveness of renewable and low carbon technologies, major developments will be required to install appropriate monitoring equipment."*

3. Energy

An energy strategy has been developed following the energy hierarchy 'Be Lean, Be Clean, Be Green'. It addresses energy issues and responds to the planning policies and guidance through minimising the proposed development's overall environmental impact and reducing resources to comply with performance standards as outlined by Building Regulations.

This approach places the primary emphasis on mitigating energy use in the first instance via passive and energy-efficient design (Be Lean).

The second step is to deliver the required energy as cleanly and efficiently as possible (Be Clean).

Once the energy demand of the development has been reduced as far as practically possible, renewable energy sources are utilised to offset the demand for the development (Be Green).

In line with the GLA's Sustainable Design and Construction SPG, London Borough of Camden Planning Policy, and the requirements set out in the London Plan, the following targets have been considered applicable when developing the design.

- 10% reduction in regulated carbon emissions compared to Building Regulations via passive design & energy efficiency measures (Be Lean) for domestic properties.
- 15% reduction in regulated carbon emissions compared to Building Regulations via passive design and energy efficiency measures (Be Lean) for non-domestic properties.
- Maximise renewable energy contribution where possible.
- An on-site reduction of a minimum of 35% beyond Part L 2013 for the proposed development (total cumulative).

3.1 Baseline Energy Prediction

Energy modelling for the proposed development was executed using a combination of SAP and iSBEM software, based on Building Regulations 2013 Part L compliance. The notional energy prediction for the proposed development used the dimensions of the proposed development, as well as notional U-values and heating specifications stated in the Building Regulations 2013. The model defined the Target Emissions Rate (TER) for Building Regulations 2013 Part L through the following formula:

$$TER_{2013} = C_H X\ FF + C_{PF} + C_L$$

The TER was determined by applying a fuel factor (FF) to space heating and hot water (C_H) which is then added to the energy use of pumps and fans (C_{PF}) and then added to the internal lighting load (C_L).

The GLA released guidance on preparing an energy assessment to support planning applications. From January 2019, it is required that SAP10 carbon factors be used to report on carbon emissions using carbon factors in order to reflect the decarbonisation of the national grid. Therefore outputs from energy calculating software have been manually converted using the carbon factors in Table 3.1.

Fuel Type	SAP2012 carbon factor	SAP10 carbon factor
Gas	0.216	0.210
Electricity	0.519	0.233

Table 3.1: SAP2012 and SAP10 carbon factor.

3.2 Be Clean

The London Plan includes the following hierarchy for considering the potential for supplying energy efficiently via heating and cooling infrastructure:

- Connect to local existing or planned heat networks.
- Use zero-emission or local secondary heat sources.
- Use low emission combined heat and power (CHP).

The GLA London Heat Map has been used to identify potential connections to existing and proposed district heating. The closest district heating network is the 'Church Street_COM' which is over 1km away (see Figure 3.1). Due to the distance from the site location, it is not deemed feasible to connect the proposed development to the network.

There are no proposed district heating networks in closer proximity to the site. Therefore, this has not been included within the calculations in this report.

Figure 3.1: An extract of the GLA London Heat Map.

3.3 Energy Efficient Building Design (Be Lean)

The design approach targets demand reduction measures, giving priority to the optimisation of the building fabric to reduce the need for heating, cooling, and artificial lighting. The objective is to have buildings as energy-efficient (i.e. 'lean') as possible without relying on systems or technologies which require energy to operate and deliver low carbon performance. Where energy is required to operate systems, the efficient plant has been selected to minimise demand.

The following passive design features are proposed.

- High levels of insulation for exposed solid envelope elements;
- High level of air-tightness;
- Maximised passive ventilation potential; and
- Double-glazed windows with enhanced u-values.

Building Fabric

The Building Regulation Part L presents the minimum requirements for the building fabric component highlighted in Table 3.3. The table presents the minimum specification, which can then be improved on during the detailed building fabric design to achieve the minimum Be Lean criteria. During the detailed building fabric design stage, a minimum of 10% reduction should be achieved.

Table 3.3: Minimum U-value requirement for the proposed development and target values.

Element	Building Regulations for Residential Buildings	Target Values for Town Houses	Building Regulations for Commercial Buildings	Target Values for Health and Wellness Centre
External walls	0.18 W/(m^2 K)	0.13 W/(m^2 K)	0.35 W/(m^2 K)	0.15 W/(m^2 K)
Floor	0.13 W/(m^2 K)	0.11 W/(m^2 K)	0.25 W/(m^2 K)	0.15 W/(m^2 K)
Roof	0.13 W/(m2 K)	0.12 W/(m^2 K)	0.25 W/(m^2 K)	0.15 W/(m^2 K)
Windows	1.4 W/(m2 K)	1.2 W/(m^2 K)	2.2 W/(m^2 K)	1.4 W/(m^2 K)
Airtightness	5.0 m^3/(hm^2)	3 m^3/(hm^2)	10.0m^3/(hm^2)	3m^3/(hm^2)
Thermal Mass Parameter	-	Low	-	-

3.3.1 Summary of 'Be Lean' Measures

The first step in the energy hierarchy is to reduce emissions through energy efficiency measures. Buildings can reduce their energy usage by passive means. This includes orientation, thermal insulation, and air infiltration. Table 3.4 below presents the minimum reduction expected following the implementation of the 'Be Lean' measures.

For the purpose of this assessment, the development has been considered as 'mixed-use' to determine carbon emissions for the townhouses and the health and wellness centre. Therefore residential and non-residential have been separated to determine compliance with the aforementioned requirements. However, it should be noted that the planning application is not for a mixed-use development, and therefore policies relating to new residential developments apply.

Table 3.4: Summary of predicted emissions following 'Be Lean' measures implemented within the Town Houses.

	Target emission rate ($kgCO_2/m^2$/year)	**Targetted CO_2 Emissions ($tonnesCO_2$/year)**	**'Be Lean' dwelling emission rate ($kgCO_2/m^2$/year)**	**CO_2 Emissions ($tonnesCO_2$/year)**
Town House 1	14.2	6.7	12.6	5.85
Town House 2	13.3	6.2	11.7	5.46
Town House 3	13.3	6.2	11.7	5.46
Town House 4	14.7	6.9	13.0	6.02
Town House 5	14.4	6.8	12.8	5.93
Town House 6	13.1	6.1	11.6	5.37
Town House 7	13.1	6.1	11.6	5.37
Town House 8	14.4	6.8	12.8	5.93
Town House 9	14.2	6.7	12.6	5.20
Town House 10	13.3	6.2	11.7	5.46
Town House 11	13.3	6.2	11.7	5.46
Town House 12	14.7	6.9	13.0	5.36
Total CO2 (tonnes/yr)		**77.76**		**68.8**

Table 3.5: Summary of predicted emissions following 'Be Lean' measures implemented within the Wellness and Health Centre.

	Target emission rate ($kgCO_2/m^2/year$)	**Targetted CO_2 Emissions ($tonnesCO_2/year$)**	**'Be Lean' Building emission rate ($kgCO_2/m^2/year$)**	**CO_2 Emissions ($tonnesCO_2/year$)**
Wellness and Health Centre	71.2	51.6	63.3	45.9
Total		**129.4**		**114.7**
Percentage difference				**11.3%**

By implementing these 'Lean' measures, it is anticipated that a carbon reduction of approximately 11% can be achieved by the development, which exceeds the 10% requirement of the London Plan. Although some aspects of the proposed development have been cosindered using the non-residential software, overall the development is considered residential and therefore been assessed against the policies relating to residential development.

3.4 Renewable and Low Carbon Technology (Be Green)

The 'Be Green' measures are achieved by generating energy by implementing renewable energy technologies. The following key points have been considered within the feasibility study:

- Local, regional, and national policies;
- The energy demand of the development;
- Practical implementation, installation, delivery and maintains procedures;
- The implication of site layout and design impact;
- Site geography, public acceptability, security, environment, and visual impact;
- Cost, benefit, payback and grants; and
- Availability of fuel supply and interaction of technologies with one another.

The following sections present the feasibility

As part of the policy requirement, developments (including refurbishments) of 5 or more dwellings and/or 500 sqm or more of any gross internal floorspace must demonstrate at least 20% 'Be Green'. The following strategies were considered for the proposed development:

Table 3.6: A feasibility study of potential renewable and low carbon technology

Renewable/ Low Carbon Technology	Feasibility	Further consideration
Photovoltaics	Solar photovoltaic technology can provide a guaranteed, although modest, contribution to the proposed development's electrical demand. It can be connected to the electrical mains distribution board via an inverter. The system does not contain any moving parts and is silent during operation. Therefore, will not contribute to any noise pollution. As the proposal includes green roofs, PV will not be included as there are concerns that they would reduce the impact of the green roofs.	No
Solar Hot Water	Solar water heating systems convert solar radiation to heat carried by water for use in space heating or the provision of domestic hot water. Although there is adequate space for this provision, there is concern regarding the cost. Potential gains of this method are also capped for domestic appliances as there is only a certain amount of water that can be used within a household. Thus, energy can be wasted.	No
Biomass	Biomass boilers require a constant supply of fuel, which has traditionally been an issue, and therefore the transport of fuel in London may be an issue. Emissions of biomass boilers (particularly NOx and particulate matter) are also a big issue. Therefore this could compromise the air quality within the area.	No
Wind turbines	Small scale wind turbines, building-integrated wind power, are proven, and viable technology. However, the average surface roughness in built-up areas is high, leading to both reduced wind speeds and increased turbulence. Due to the location of this site, in a dense urban area, there is a lack of open space. It is for these reasons, as well as noise pollution and lack of aesthetic appeal associated with wind turbines, that it has been deemed not feasible.	No
Heat Pumps	Ground or Air Source Heat pumps are common methods of providing buildings with heating and cooling via heat pumps. However, Ground Source Heat pumps require a large amount of space, which will be provided within the allotted basement plant areas. Further this system is far more efficient than an Air Source Heat Pump. Typical efficiencies are within the region of 150% and 350% although some are even higher than this.	Yes

Ground Source Heat Pumps have been incorporated as a low carbon heating system. Space heating and hot water will be provided through electric ground source heat pumps (GSHP). These will be located in the basement. The exact specification has not been decided, however, the developer will aim for the best possible specification and therefore the Viessmann Vitocal 222-G has been used to model the 'Be Green' stage of the hierarchy for the dwellings. Similarly, the efficiencies of this GSHP were used in iSBEM, and therefore this report should be used to provide an indication of the reductions that the development has the potential to achieve.

It should be noted that "the proposed ground source heat pump (GSHP) installation will provide the primary heat source for the development, comprising multiple ground source heat pumps connecting to a common closed loop heat exchange network via multiple boreholes. The results of ground investigations suggest that the ground conditions are favourable for a closed loop borehole heat exchange network, this is evidenced in the similar completed GSHP installations in the local vicinity.

The heat pumps will be configured in a modular arrangement to provide both optimal efficiency and redundancy and will heat up a series of thermal stores for the delivery of low temperature hot water to the development. Each thermal store will include electric immersion heating elements to provide further resilience in the event of failure or prolonged/unscheduled maintenance of the heat pumps.

The use and the proposed configuration of the ground source heat pump installation presents an opportunity to generate chilled water simultaneously with the production of low temperature hot water, the chilled water being available for cooling of the residential areas and reducing overheating risks where passive measures are not possible or effective. This can be achieved simply by bypassing the ground loop borehole network and charging chilled thermal stores directly whilst generating hot water, or by rejecting heat to the ground loop, this has the added benefit of improving the annual efficiency of the GSHP system and reducing the risk of over cooling of the ground during prolonged winter heating periods."

The provision of Ground Source Heat Pumps eliminates the need for low NOx boilers and therefore not only improves carbon emissions but also beneficial in eliminating NO_x emissions. It should be noted that small electric boilers will also be installed as a 'back-up' system on the extremely rare ocassion that the GSHP might need maintenance or repair. For the purpose of the model, it was assumed that the electric boilers would be responsible for 1% of the heating load.

3.4.1 Summary of 'Be Green' measures

The same calculation was repeated, this time incorporating the ground source heat pumps. The results are summarised in Table 3.7. The table below shows the expected carbon emission at the 'Be Green' stage for the proposed development.

Table 3.7: A summary of emissions following the installation of electric ground source heat pumps.

	Target emission rate ($kgCO_2/m^2/year$)	Targetted CO_2 Emissions ($tonnesCO_2/year$)	'Be Green' dwelling emission rate ($kgCO_2/m^2/year$)	CO_2 Emissions ($tonnesCO_2/year$)
Town House 1	14.2	6.7	3.9	1.8
Town House 2	13.3	6.2	3.6	1.7
Town House 3	13.3	6.2	3.6	1.7
Town House 4	14.7	6.9	4.0	1.9
Town House 5	14.4	6.8	4.0	1.9

Town House 6	13.1	6.1	3.5	1.7
Town House 7	13.1	6.1	3.5	1.7
Town House 8	14.4	6.8	4.0	1.9
Town House 9	14.2	6.7	3.9	1.9
Town House 10	13.3	6.2	3.6	1.7
Town House 11	13.3	6.2	3.6	1.7
Town House 12	14.7	6.9	4.0	1.9
Total CO2 (tonnes/yr)		**77.76**		**21.1**
		Percentage change (%)		72.9%

Table 3.8: Summary of emissions associated with the 'Be Green' stage of the hierarchy for the Health and Wellness Centre.

	Target emission rate ($kgCO_2/m^2/year$)	**Targetted CO_2 Emissions ($tonnesCO_2/year$)**	**'Be Green' Building emission rate ($kgCO_2/m^2/year$)**	**CO_2 Emissions ($tonnesCO_2/year$)**
Wellness and Health Centre	71.2	50.7	16.7	12.1
		Percentage change (%)		76%

It was estimated that the total targetted CO_2 emissions for the whole development would be 129.4 tonnes per year. However, it is predicted that the proposed development would produce around 33.2 tonnes of CO_2 annually with the adoption of the "Be Lean" and "Be Green" initiatives, which is a 74% improvement over the target CO_2 emissions. The final GSHP design will determine if a cash-in-lieu contribution is necessary. This improvement goes above and beyond what is required by the London Plan, which calls for projects to cut carbon emissions by at least 35%.

3.5 Be Seen

The exact measures in terms of 'Be Seen' have not yet been finalised, however, it is proposed that energy metres will be installed into the dwellings. The proposal seeks to ensure that energy usage is minimised during the operational phase of the development.

3.6 Summary

The proposed development's energy strategy prioritises demand reduction measures, by prioritising building fabric optimization to lessen the need for artificial lighting, heating, and cooling. The goal is to create as energy-efficient (or "lean") as feasible without using intricate systems or technologies to achieve low carbon performance.

It is suggested that by improving u-values and lowering air permeability in contrast to Part L of the Building Regulations, a reduction of 11% can be achieved. By adding electric Ground Source Heat Pumps in addition to the "Be Lean" measures, it is predicted that a reduction of 74.3% may be made over the whole development.

4. Conclusion

This report summarises the proposed energy strategy for the proposed development at 52 Avenue Road, St John's Wood, London, NW8 6HS.

Relevant policies have been identified and both passive energy-efficient measures and renewable and low carbon technologies have been considered. This report has summarised the ways in which the proposed development will follow the Energy Hierarchy.

By following the Energy Hierarchy and incorporating passive energy efficient measures (Be Lean), a reduction of 11% across the development, is proposed to be achieved. In order to achieve further reduction, Ground Source Heat Pumps were the most feasible renewable and low carbon technology to incorporate as part of the Be Green stage in the energy hierarchy.

It is proposed that space heating and hot water should be provided by GSHP. However, the exact specification was not known, and therefore this report should be used to provide an indication of the reductions that the development has the potential to achieve. There will also be electric boilers as a backup.

By incorporating these measures, an overall 74.3 % reduction in beyond Building Regulations is expected, through the combination of Be Lean and Be Green measures. This is an exceedance of the requirements of the London Plan. However, it should be noted that any change in design relative to this energy strategy could result in a variation in CO_2 emissions.

It can, therefore, be concluded that by incorporating measures outlined within this report, the proposed development is not considered to conflict with any national, regional, or local planning policy in relation to carbon emissions or energy consumption and instead seeks to exceed policy in all regards.

Appendix A: Be Lean

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.53

Property Address: Town House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Basement	81.36	(1a)	x	3.6	(2a)	=	292.9	(3a)
Ground floor	143.08	(1b)	x	4.25	(2b)	=	608.09	(3b)
First floor	81.36	(1c)	x	3.6	(2c)	=	292.9	(3c)
Second floor	81.36	(1d)	x	3.6	(2d)	=	292.9	(3d)
Third floor	81.36	(1e)	x	3.6	(2e)	=	292.9	(3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	468.52	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	1779.67	(5)

2. Ventilation rate:

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

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

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

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

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.15	(18)

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

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

DER WorkSheet: New dwelling design stage

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table 7													
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	
Wind Factor (22a)m = (22)m ÷ 4													
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18	
Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m													
	0.19	0.19	0.18	0.16	0.16	0.14	0.14	0.14	0.15	0.16	0.17	0.18	

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	0	(23c)

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

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

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

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)
(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)
(24d)m=	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.52	(24d)
(25)m=	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.52	(25)

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3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			3	x	1	=	3			(26)
Windows Type 1			14.26	x1/[1/(1.2)+ 0.04]		=	16.33			(27)
Windows Type 2			14.52	x1/[1/(1.2)+ 0.04]		=	16.63			(27)
Windows Type 3			15.82	x1/[1/(1.2)+ 0.04]		=	18.11			(27)
Floor			115.2	x	0.11	=	12.672			(28)
Walls	504.1	47.6	456.5	x	0.13	=	59.34			(29)
Roof	115.2	0	115.2	x	0.12	=	13.82			(30)
Total area of elements, m²			734.5							(31)

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

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	139.91	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	41631.8	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: Low	100	(35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K | 110.18 | (36)

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

Total fabric heat loss (33) + (36) = | 250.08 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	304.39	303.97	303.56	301.64	301.28	299.61	299.61	299.3	300.25	301.28	302.01	302.77	(38)

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

(39)m=	554.47	554.05	553.65	551.73	551.37	549.69	549.69	549.38	550.34	551.37	552.09	552.85	

Average = Sum(39)$_{1...12}$ /12= | 551.72 | (39)

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

(40)m=	1.18	1.18	1.18	1.18	1.18	1.17	1.17	1.17	1.17	1.18	1.18	1.18

Average = Sum(40)$_{1...12}$ /12= | 1.18 | (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N | 3.35 | (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 113.79 | (43)

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

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m=	125.17	120.61	116.06	111.51	106.96	102.41	102.41	106.96	111.51	116.06	120.61	125.17

Total = Sum(44)$_{1...12}$ = | 1365.44 | (44)

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

(45)m=	185.62	162.34	167.52	146.05	140.14	120.93	112.06	128.59	130.12	151.65	165.53	179.76

Total = Sum(45)$_{1...12}$ = | 1790.3 | (45)

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

(46)m=	27.84	24.35	25.13	21.91	21.02	18.14	16.81	19.29	19.52	22.75	24.83	26.96	(46)

Water storage loss:

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

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

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

Water storage loss:

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

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

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

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

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

If community heating see section 4.3

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

Temperature factor from Table 2b | 0.54 | (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.6 (54)

Enter (50) or (54) in (55) 0.6 (55)

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

(56)m=	18.62	16.82	18.62	18.02	18.62	18.02	18.62	18.62	18.02	18.62	18.02	18.62	(56)

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

(57)m=	18.62	16.82	18.62	18.02	18.62	18.02	18.62	18.62	18.02	18.62	18.02	18.62	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

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

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

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

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

(62)m=	227.5	200.17	209.41	186.58	182.02	161.46	153.94	170.47	170.66	193.53	206.07	221.65	(62)

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

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

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

Output from water heater

(64)m=	227.5	200.17	209.41	186.58	182.02	161.46	153.94	170.47	170.66	193.53	206.07	221.65

Output from water heater (annual)$_{1...12}$ 2283.47 (64)

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

(65)m=	95.23	84.24	89.21	80.99	80.1	72.64	70.77	76.26	75.69	83.93	87.47	93.28	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	(66)

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

(67)m=	60.71	53.92	43.85	33.2	24.82	20.95	22.64	29.43	39.5	50.15	58.53	62.4	(67)

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

(68)m=	583.75	589.8	574.54	542.04	501.02	462.47	436.71	430.65	445.92	478.42	519.44	557.99	(68)

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

(69)m=	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	(71)

Water heating gains (Table 5)

(72)m=	127.99	125.36	119.91	112.48	107.67	100.88	95.12	102.51	105.13	112.81	121.48	125.37	(72)

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

(73)m=	848.72	845.36	814.56	763.99	709.77	660.57	630.73	638.85	666.81	717.64	775.72	822.03	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	0.77	x	15.82	x	19.64	x	0.63	x	0.7	=	94.96	(76)
East	0.9x	0.77	x	15.82	x	38.42	x	0.63	x	0.7	=	185.76	(76)
East	0.9x	0.77	x	15.82	x	63.27	x	0.63	x	0.7	=	305.91	(76)
East	0.9x	0.77	x	15.82	x	92.28	x	0.63	x	0.7	=	446.16	(76)
East	0.9x	0.77	x	15.82	x	113.09	x	0.63	x	0.7	=	546.78	(76)
East	0.9x	0.77	x	15.82	x	115.77	x	0.63	x	0.7	=	559.73	(76)
East	0.9x	0.77	x	15.82	x	110.22	x	0.63	x	0.7	=	532.88	(76)
East	0.9x	0.77	x	15.82	x	94.68	x	0.63	x	0.7	=	457.74	(76)
East	0.9x	0.77	x	15.82	x	73.59	x	0.63	x	0.7	=	355.79	(76)
East	0.9x	0.77	x	15.82	x	45.59	x	0.63	x	0.7	=	220.41	(76)
East	0.9x	0.77	x	15.82	x	24.49	x	0.63	x	0.7	=	118.4	(76)
East	0.9x	0.77	x	15.82	x	16.15	x	0.63	x	0.7	=	78.09	(76)
South	0.9x	0.77	x	14.52	x	46.75	x	0.63	x	0.7	=	207.46	(78)
South	0.9x	0.77	x	14.52	x	76.57	x	0.63	x	0.7	=	339.77	(78)
South	0.9x	0.77	x	14.52	x	97.53	x	0.63	x	0.7	=	432.81	(78)
South	0.9x	0.77	x	14.52	x	110.23	x	0.63	x	0.7	=	489.17	(78)
South	0.9x	0.77	x	14.52	x	114.87	x	0.63	x	0.7	=	509.74	(78)
South	0.9x	0.77	x	14.52	x	110.55	x	0.63	x	0.7	=	490.56	(78)
South	0.9x	0.77	x	14.52	x	108.01	x	0.63	x	0.7	=	479.3	(78)
South	0.9x	0.77	x	14.52	x	104.89	x	0.63	x	0.7	=	465.47	(78)
South	0.9x	0.77	x	14.52	x	101.89	x	0.63	x	0.7	=	452.12	(78)
South	0.9x	0.77	x	14.52	x	82.59	x	0.63	x	0.7	=	366.47	(78)
South	0.9x	0.77	x	14.52	x	55.42	x	0.63	x	0.7	=	245.91	(78)
South	0.9x	0.77	x	14.52	x	40.4	x	0.63	x	0.7	=	179.27	(78)
West	0.9x	0.77	x	14.26	x	19.64	x	0.63	x	0.7	=	85.59	(80)
West	0.9x	0.77	x	14.26	x	38.42	x	0.63	x	0.7	=	167.44	(80)
West	0.9x	0.77	x	14.26	x	63.27	x	0.63	x	0.7	=	275.75	(80)
West	0.9x	0.77	x	14.26	x	92.28	x	0.63	x	0.7	=	402.16	(80)
West	0.9x	0.77	x	14.26	x	113.09	x	0.63	x	0.7	=	492.86	(80)
West	0.9x	0.77	x	14.26	x	115.77	x	0.63	x	0.7	=	504.53	(80)
West	0.9x	0.77	x	14.26	x	110.22	x	0.63	x	0.7	=	480.34	(80)
West	0.9x	0.77	x	14.26	x	94.68	x	0.63	x	0.7	=	412.6	(80)
West	0.9x	0.77	x	14.26	x	73.59	x	0.63	x	0.7	=	320.71	(80)
West	0.9x	0.77	x	14.26	x	45.59	x	0.63	x	0.7	=	198.68	(80)
West	0.9x	0.77	x	14.26	x	24.49	x	0.63	x	0.7	=	106.72	(80)
West	0.9x	0.77	x	14.26	x	16.15	x	0.63	x	0.7	=	70.39	(80)

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

(83)m=	388.01	692.96	1014.47	1337.48	1549.38	1554.82	1492.52	1335.81	1128.61	785.57	471.04	327.74	(83)

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

(84)m=	1236.73	1538.32	1829.03	2101.47	2259.16	2215.38	2123.26	1974.66	1795.42	1503.21	1246.76	1149.77	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.96	0.93	0.86	0.77	0.8	0.92	0.98	0.99	1	(86)

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

(87)m=	17.97	18.21	18.65	19.24	19.86	20.39	20.7	20.64	20.19	19.39	18.57	17.93	(87)

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

(88)m=	19.93	19.93	19.93	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94	(88)

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

(89)m=	0.99	0.99	0.98	0.96	0.91	0.81	0.67	0.72	0.89	0.97	0.99	1	(89)

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

(90)m=	15.83	16.17	16.82	17.68	18.56	19.31	19.71	19.65	19.04	17.9	16.7	15.76	(90)

fLA = Living area ÷ (4) = | 0.12 | (91)

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

(92)m=	16.08	16.41	17.03	17.86	18.71	19.44	19.82	19.76	19.18	18.07	16.92	16.01	(92)

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

(93)m=	16.08	16.41	17.03	17.86	18.71	19.44	19.82	19.76	19.18	18.07	16.92	16.01	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.96	0.93	0.88	0.78	0.65	0.7	0.86	0.95	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1222.64	1507.78	1763.97	1961.23	1983.18	1734.3	1386.23	1374.95	1536.96	1429.91	1224.72	1138.83	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	6530.78	6379.02	5830.16	4945.96	3866.98	2660.07	1772.45	1847.82	2794.18	4119.38	5421.51	6531.46	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	3949.26	3273.47	3025.25	2149.01	1401.54	0	0	0	0	2000.96	3021.69	4012.12	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = | 22833.29 | (98)

Space heating requirement in kWh/m²/year | 48.73 | (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.9	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	3949.26	3273.47	3025.25	2149.01	1401.54	0	0	0	0	2000.96	3021.69	4012.12		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	4205.81	3486.13	3221.77	2288.61	1492.59	0	0	0	0	2130.95	3217.98	4272.76		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													24316.61	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	227.5	200.17	209.41	186.58	182.02	161.46	153.94	170.47	170.66	193.53	206.07	221.65		
Efficiency of water heater													83.8	(216)
(217)m=	93.29	93.25	93.17	93	92.62	83.8	83.8	83.8	83.8	92.91	93.18	93.31		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	243.87	214.66	224.75	200.62	196.53	192.68	183.7	203.43	203.65	208.3	221.14	237.53		
Total = Sum(219a)$_{1...12}$ =													2530.86	(219)

Annual totals		kWh/year	kWh/year	
Space heating fuel used, main system 1			24316.61	
Water heating fuel used			2530.86	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			1072.2	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =			27949.67	(338)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	5252.39	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	546.67	(264)
Space and water heating	(261) + (262) + (263) + (264) =				5799.05	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	15.57	(267)
Electricity for lighting	(232)	x	0.519	=	556.47	(268)
Total CO2, kg/year			sum of (265)…(271) =		6371.1	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		13.6	(273)
EI rating (section 14)					83	(274)

Appendix B: Be Green

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.5.53

Property Address: Town House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Basement	81.36	(1a)	x	3.6	(2a)	=	292.9	(3a)
Ground floor	143.08	(1b)	x	4.25	(2b)	=	608.09	(3b)
First floor	81.36	(1c)	x	3.6	(2c)	=	292.9	(3c)
Second floor	81.36	(1d)	x	3.6	(2d)	=	292.9	(3d)
Third floor	81.36	(1e)	x	3.6	(2e)	=	292.9	(3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	468.52	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	1779.67	(5)

2. Ventilation rate:

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

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			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)				
Number of storeys in the dwelling (ns)			0	(9)
Additional infiltration		[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35				
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0	(12)
If no draught lobby, enter 0.05, else enter 0			0	(13)
Percentage of windows and doors draught stripped			0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =		0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =		0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			3	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.15	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
Number of sides sheltered			0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =		1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =		0.15	(21)

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Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table 7													
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	
Wind Factor (22a)m = (22)m ÷ 4													
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18	
Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m													
	0.19	0.19	0.18	0.16	0.16	0.14	0.14	0.14	0.15	0.16	0.17	0.18	

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	0	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]													
(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)
b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)													
(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)
c) If whole house extract ventilation or positive input ventilation from outside if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)													
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)
d) If natural ventilation or whole house positive input ventilation from loft if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]													
(24d)m=	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.52	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)													
(25)m=	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.52	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			3	x	1	=	3			(26)
Windows Type 1			14.26	x1/[1/(1.2)+ 0.04]		=	16.33			(27)
Windows Type 2			14.52	x1/[1/(1.2)+ 0.04]		=	16.63			(27)
Windows Type 3			15.82	x1/[1/(1.2)+ 0.04]		=	18.11			(27)
Floor			115.2	x	0.11	=	12.672			(28)
Walls	504.1	47.6	456.5	x	0.13	=	59.34			(29)
Roof	115.2	0	115.2	x	0.12	=	13.82			(30)
Total area of elements, m²			734.5							(31)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	139.91	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	41631.8	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: Low	100	(35)

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

Thermal bridges : S (L x Y) calculated using Appendix K | 110.18 | (36)

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

Total fabric heat loss (33) + (36) = | 250.08 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	304.39	303.97	303.56	301.64	301.28	299.61	299.61	299.3	300.25	301.28	302.01	302.77	(38)

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

(39)m=	554.47	554.05	553.65	551.73	551.37	549.69	549.69	549.38	550.34	551.37	552.09	552.85	

Average = Sum(39)$_{1…12}$ /12= | 551.72 | (39)

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

(40)m=	1.18	1.18	1.18	1.18	1.18	1.17	1.17	1.17	1.17	1.18	1.18	1.18	

Average = Sum(40)$_{1…12}$ /12= | 1.18 | (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N | 3.35 | (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 113.79 | (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	125.17	120.61	116.06	111.51	106.96	102.41	102.41	106.96	111.51	116.06	120.61	125.17

Total = Sum(44)$_{1…12}$ = | 1365.44 | (44)

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

(45)m=	185.62	162.34	167.52	146.05	140.14	120.93	112.06	128.59	130.12	151.65	165.53	179.76

Total = Sum(45)$_{1…12}$ = | 1790.3 | (45)

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

(46)m=	27.84	24.35	25.13	21.91	21.02	18.14	16.81	19.29	19.52	22.75	24.83	26.96	(46)

Water storage loss:

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

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

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

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): | 0.54 | (48)

Temperature factor from Table 2b | 0.81648 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 0 | (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a | 0 | (52)

Temperature factor from Table 2b | 0 | (53)

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Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0.82	(55)

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

(56)m=	25.31	22.86	25.31	24.49	25.31	24.49	25.31	25.31	24.49	25.31	24.49	25.31	(56)

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

(57)m=	25.31	22.86	25.31	24.49	25.31	24.49	25.31	25.31	24.49	25.31	24.49	25.31	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

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

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

(62)m=	210.93	185.2	192.83	170.54	165.45	145.42	137.37	153.9	154.62	176.96	190.03	205.07	(62)

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

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

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

Output from water heater

(64)m=	210.93	185.2	192.83	170.54	165.45	145.42	137.37	153.9	154.62	176.96	190.03	205.07	

Output from water heater (annual)$_{1…12}$ — 2088.32 (64)

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

(65)m=	61.72	53.98	55.7	48.56	46.6	40.21	37.26	42.76	43.27	50.42	55.04	59.77	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	167.55	(66)

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

(67)m=	60.71	53.92	43.85	33.2	24.82	20.95	22.64	29.43	39.5	50.15	58.53	62.4	(67)

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

(68)m=	583.75	589.8	574.54	542.04	501.02	462.47	436.71	430.65	445.92	478.42	519.44	557.99	(68)

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

(69)m=	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	-134.04	(71)

Water heating gains (Table 5)

(72)m=	82.95	80.32	74.87	67.45	62.63	55.85	50.08	57.47	60.09	67.77	76.44	80.34	(72)

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

(73)m=	810.68	807.32	776.53	725.95	671.73	622.53	592.7	600.81	628.77	679.6	737.68	783.99	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	0.77	x	15.82	x	19.64	x	0.63	x	0.7	=	94.96	(76)
East	0.9x	0.77	x	15.82	x	38.42	x	0.63	x	0.7	=	185.76	(76)
East	0.9x	0.77	x	15.82	x	63.27	x	0.63	x	0.7	=	305.91	(76)
East	0.9x	0.77	x	15.82	x	92.28	x	0.63	x	0.7	=	446.16	(76)
East	0.9x	0.77	x	15.82	x	113.09	x	0.63	x	0.7	=	546.78	(76)
East	0.9x	0.77	x	15.82	x	115.77	x	0.63	x	0.7	=	559.73	(76)
East	0.9x	0.77	x	15.82	x	110.22	x	0.63	x	0.7	=	532.88	(76)
East	0.9x	0.77	x	15.82	x	94.68	x	0.63	x	0.7	=	457.74	(76)
East	0.9x	0.77	x	15.82	x	73.59	x	0.63	x	0.7	=	355.79	(76)
East	0.9x	0.77	x	15.82	x	45.59	x	0.63	x	0.7	=	220.41	(76)
East	0.9x	0.77	x	15.82	x	24.49	x	0.63	x	0.7	=	118.4	(76)
East	0.9x	0.77	x	15.82	x	16.15	x	0.63	x	0.7	=	78.09	(76)
South	0.9x	0.77	x	14.52	x	46.75	x	0.63	x	0.7	=	207.46	(78)
South	0.9x	0.77	x	14.52	x	76.57	x	0.63	x	0.7	=	339.77	(78)
South	0.9x	0.77	x	14.52	x	97.53	x	0.63	x	0.7	=	432.81	(78)
South	0.9x	0.77	x	14.52	x	110.23	x	0.63	x	0.7	=	489.17	(78)
South	0.9x	0.77	x	14.52	x	114.87	x	0.63	x	0.7	=	509.74	(78)
South	0.9x	0.77	x	14.52	x	110.55	x	0.63	x	0.7	=	490.56	(78)
South	0.9x	0.77	x	14.52	x	108.01	x	0.63	x	0.7	=	479.3	(78)
South	0.9x	0.77	x	14.52	x	104.89	x	0.63	x	0.7	=	465.47	(78)
South	0.9x	0.77	x	14.52	x	101.89	x	0.63	x	0.7	=	452.12	(78)
South	0.9x	0.77	x	14.52	x	82.59	x	0.63	x	0.7	=	366.47	(78)
South	0.9x	0.77	x	14.52	x	55.42	x	0.63	x	0.7	=	245.91	(78)
South	0.9x	0.77	x	14.52	x	40.4	x	0.63	x	0.7	=	179.27	(78)
West	0.9x	0.77	x	14.26	x	19.64	x	0.63	x	0.7	=	85.59	(80)
West	0.9x	0.77	x	14.26	x	38.42	x	0.63	x	0.7	=	167.44	(80)
West	0.9x	0.77	x	14.26	x	63.27	x	0.63	x	0.7	=	275.75	(80)
West	0.9x	0.77	x	14.26	x	92.28	x	0.63	x	0.7	=	402.16	(80)
West	0.9x	0.77	x	14.26	x	113.09	x	0.63	x	0.7	=	492.86	(80)
West	0.9x	0.77	x	14.26	x	115.77	x	0.63	x	0.7	=	504.53	(80)
West	0.9x	0.77	x	14.26	x	110.22	x	0.63	x	0.7	=	480.34	(80)
West	0.9x	0.77	x	14.26	x	94.68	x	0.63	x	0.7	=	412.6	(80)
West	0.9x	0.77	x	14.26	x	73.59	x	0.63	x	0.7	=	320.71	(80)
West	0.9x	0.77	x	14.26	x	45.59	x	0.63	x	0.7	=	198.68	(80)
West	0.9x	0.77	x	14.26	x	24.49	x	0.63	x	0.7	=	106.72	(80)
West	0.9x	0.77	x	14.26	x	16.15	x	0.63	x	0.7	=	70.39	(80)

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

(83)m=	388.01	692.96	1014.47	1337.48	1549.38	1554.82	1492.52	1335.81	1128.61	785.57	471.04	327.74	(83)

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

(84)m=	1198.69	1500.28	1790.99	2063.44	2221.12	2177.35	2085.22	1936.62	1757.38	1465.17	1208.72	1111.73	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.97	0.93	0.87	0.77	0.81	0.92	0.98	0.99	1	(86)

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

(87)m=	19.8	18.2	18.64	19.21	19.85	20.39	20.69	20.64	20.17	19.38	18.53	18.86	(87)

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

(88)m=	19.93	19.93	19.93	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94	(88)

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

(89)m=	0.99	0.99	0.98	0.96	0.91	0.82	0.67	0.72	0.89	0.97	0.99	1	(89)

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

(90)m=	17.4	16.15	16.8	17.66	18.55	19.3	19.7	19.64	19.03	17.88	16.68	15.74	(90)

fLA = Living area ÷ (4) = 0.12 (91)

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

(92)m=	17.68	16.39	17.01	17.84	18.7	19.43	19.82	19.76	19.16	18.05	16.9	16.1	(92)

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

(93)m=	17.68	16.39	17.01	17.84	18.7	19.43	19.82	19.76	19.16	18.05	16.9	16.1	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.97	0.94	0.88	0.79	0.66	0.7	0.86	0.95	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1189.31	1472.03	1729.9	1930.12	1956.91	1714.99	1374.42	1360.84	1512.27	1397.14	1188.72	1102.14	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	7421.19	6368.2	5820.04	4935.17	3858.84	2654.38	1769.13	1843.75	2785.93	4109.48	5409.17	6581.68	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	4636.52	3290.22	3043.07	2163.64	1415.03	0	0	0	0	2017.98	3038.73	4076.78	

Total per year (kWh/year) = $\text{Sum}(98)_{1...5,9...12}$ = 23681.97 (98)

Space heating requirement in kWh/m²/year 50.55 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of main heating from main system 2		0.01	(203)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	0.99	(204)
Fraction of total heating from main system 2	(205) = (202) × (203) =	0.01	(205)

DER WorkSheet: New dwelling design stage

Efficiency of main space heating system 1	401.86	(206)
Efficiency of main space heating system 2	91	(207)
Efficiency of secondary/supplementary heating system, %	0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	4636.52	3290.22	3043.07	2163.64	1415.03	0	0	0	0	2017.98	3038.73	4076.78		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1142.24	810.57	749.68	533.03	348.6	0	0	0	0	497.14	748.61	1004.34		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													5834.23	(211)
(213)m =(98)m x (203) x 100 ÷ (207)	50.95	36.16	33.44	23.78	15.55	0	0	0	0	22.18	33.39	44.8		(213)
Total (kWh/year) =Sum(213)$_{1...5,10....12}$=													260.24	(213)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208) (215)m=	0	0	0	0	0	0	0	0	0	0	0	0		(215)
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	210.93	185.2	192.83	170.54	165.45	145.42	137.37	153.9	154.62	176.96	190.03	205.07		
Efficiency of water heater													309.51	(216)
(217)m=	309.51	309.51	309.51	309.51	309.51	309.51	309.51	309.51	309.51	309.51	309.51	309.51		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	68.15	59.84	62.3	55.1	53.46	46.98	44.38	49.72	49.96	57.17	61.4	66.26		
Total = Sum(219a)$_{1...12}$ =													674.72	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		5834.23	
Space heating fuel used, main system 2		260.24	
Water heating fuel used		674.72	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
Total electricity for the above, kWh/year — sum of (230a)…(230g) =		30	(231)
Electricity for lighting		1072.2	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =		7871.38	(338)

12a. CO_2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.519	=	3027.96	(261)
Space heating (main system 2)	(213)	x	0.519	=	135.07	(262)
Space heating (secondary)	(215)	x	0.519	=	0	(263)

DER WorkSheet: New dwelling design stage

Water heating	(219) x	0.519	=	350.18	(264)
Space and water heating	(261) + (262) + (263) + (264) =			3513.21	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	556.47	(268)
Total CO_2, kg/year	sum of (265)…(271) =			4085.25	(272)
Dwelling CO_2 Emission Rate	(272) ÷ (4) =			8.72	(273)
EI rating (section 14)				89	(274)