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SUSTAINABILITY & ENERGY STATEMENT

for

A NEW VICARAGE WITH SELF-CONTAINED APARTMENT OVER AND TWO ADDITIONAL DWELLINGS

at

ST PETERS VICARAGE,
53 BELSIZE SQUARE,
LONDON
NW3 4HY

14th April 2016

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APPENDICES

Executive Summary

This Statement accompanies a detailed planning application for the demolition of the existing Vicarage and the constructed of a new terrace comprising a new Vicarage with a self-contained apartment over and two additional houses at 53, Belsize Square. The Statement includes an energy demand assessment showing how selected energy efficiency and renewable energy measures have been incorporated into the development design.

The Ministerial Statement made on the 25th March 2015 has withdrawn the Code for Sustainable Homes and the Government have proposed local authorities do not seek to impose Code planning conditions with immediate effect.

Working drawings have yet to be progressed but representative SAP calculations have been prepared based upon the detailed planning drawings and an assumed construction specification.

It is proposed to enhance the fabric insulation standards of the homes and to install a photovoltaic array of 4.578 kW. This will be comprised of 14, 327W panels, which will be dispersed as five panels on the upper (third storey) flat section of the two 4-bedroom houses and four panels on the upper roof of the Vicarage. The panels will be laid flat and therefore will not be visible. The output of the panels has been discounted to allow for the comprised orientation.

The carbon dioxide emissions can be summarised as follows:

	Total Emissions	**% Reduction**
	kg CO_2/year	
Baseline (Building Regulations TER)	**10,114**	**-**
Be Lean - after energy efficiency (DER)	**9,401**	**7.05%** (of TER)
Be Green - after efficiency and LZCs	**7,399**	**26.84%** (of TER)
Reduction in emissions from renewable technologies	**2,002**	**21.29%** (of DER)

In addition the water efficiency target of 105 litres per person will be achieved for each of the units. This is in accordance with the now revoked Code for Sustainable Homes Level 4 and the London Plan.

1.0 Introduction

1.1 This report has been commissioned by Maven Plan and provides a Sustainability and Energy Statement for the proposed demolition of the existing Vicarage at 53, Belsize Square and the construction of a new Vicarage with self-contained apartment over and two new dwellings adjacent.

1.2 The report describes the methodology used in assessing the proposed development and the initiatives proposed.

1.3 The buildings will be designed and constructed to reduce energy demand and carbon dioxide emissions. The objective is to reduce the energy demand to an economic minimum by making investment in the parts of the homes that have the greatest impact on energy demand and are the most difficult and costly to change in the future, namely the building fabric. Once a cost effective structure has been designed, renewable technologies will be considered for installation to provide heat and/or electricity.

The following hierarchy will be followed:

- Lean reduce demand and consumption
- Clean increase energy efficiency
- Green provide low carbon renewable energy sources

1.4 The report has been prepared by Maven Sustainability who are Sustainability Consultants, licensed Code for Sustainable Homes, Ecohomes and BREEAM Domestic Refurbishment Assessors.

2.0 Planning Policy

National Policy

2.1 The UK Government published its sustainable development strategy in 1999 entitled "A better quality of life: A strategy for sustainable development in the UK". This sets out four main objectives for sustainable development in the UK:

- Social progress that recognises the needs of everyone.
- Effective protection of the environment.
- Prudent use of natural resources.
- Maintenance of high stable levels of economic growth and employment.

2.2 The Sustainable Communities: Building for the future, known colloquially as the Communities Plan was published in 2003. The Plan sets out a long-term programme of action for delivering sustainable communities in both urban and rural areas. It aims to tackle housing supply issues in the South East, low demand in other parts of the country, and the quality of our public spaces. The Communities Plan describes sustainable communities as: active, inclusive and safe, well run, environmentally sensitive, well designed and built, well connected, thriving, well served and fair for everyone.

2.3 The most relevant national planning policy guidance on sustainability is set out in:

- National Planning Policy Framework - 2012

"support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, by the development of renewable energy)"

Regional and Local Policies

2.4 The Development Plan comprises the London Plan (2015), the Camden Core Strategy 2010-2015 and the Camden Development Policies Document (adopted 2010).

2.5 **London Plan, published March 2015 –** the following policies are relevant to the application:

Policy 5.2 - Minimising carbon dioxide emissions

A Development proposals should make the fullest contribution to minimising 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

D As a minimum, energy assessments should include the following details:

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 (see paragraph 5.22) 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 decentralised 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 5.3 - Sustainable design and construction

A The highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments and to adapt to the effects of climate change over their lifetime.

B Development proposals should demonstrate that sustainable design standards are integral to

the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.

Policy 5.15 – Water Use and Supplies

B Development should minimise the use of mains water by:

a incorporating water saving measures and equipment

b designing residential development so that mains water consumption would meet a target of 105 litres or less per head per day

2.6 **Sustainable Design and Construction SPG – April 2014**

The SPG provides Guidance on how schemes should comply with the London Plan and this Sustainability Statement has been prepared in accordance with the Guidance provided.

London Borough of Camden

2.7 **Camden Core Strategy 2010-2015**

The following policies are specifically relevant to this topic area and have been edited for clarity and relevance.

CS13 – Tackling climate change through promoting higher environmental standards

Reducing the effects of and adapting to climate change

The Council will require all development to take measures to 6minimise 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 6minimise 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,

3. generating renewable energy on-site; and

d) ensuring buildings and spaces are designed to cope with, and m7inimise the effects of, climate change.

Policy CS13 also requires, "*developments to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation*"

2.8 **Camden Development Policies Document (adopted 2010)**

Development Policies DP22 – Promoting sustainable design and construction

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 (this states that the Council will have regard to costs and feasibility), 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.**

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.

* The Ministerial Statement made on the 25th March 2015 by the DCLG said,

"From the date the Deregulation Bill 2015 is given Royal Assent, local planning authorities and qualifying bodies preparing neighbourhood plans should not set in their emerging Local Plans, neighbourhood plans, or supplementary planning documents, any additional local technical standards or requirements relating to the construction, internal layout or performance of new dwellings. This includes any policy requiring any level of the Code for Sustainable Homes to be achieved by new development; the government has now withdrawn the code, aside from the management of legacy cases. Particular standards or requirements for energy performance are considered later in this statement."

"For the specific issue of energy performance, local planning authorities will continue to be able to set and apply policies in their Local Plans which require compliance with energy performance standards that exceed the energy requirements of Building Regulations until commencement of amendments to the Planning and Energy Act 2008 in the Deregulation Bill 2015."

"This is expected to happen alongside the introduction of zero carbon homes policy in late 2016. The government has stated that, from then, the energy performance requirements in Building Regulations will be set at a level equivalent to the (outgoing) Code for Sustainable Homes Level 4. Until the amendment is commenced, we would expect local planning authorities to take this statement of the government's intention into account in applying existing policies and not set conditions with requirements above a Code level 4 equivalent."

3.0 Assessment Methodology

3.1 The baseline energy demand and carbon dioxide emissions for the site have been calculated by preparing SAP calculations for representative units.

3.2 These calculations have been based upon certain assumptions as to the building specification and these are clarified below. These are not design calculations but serve to establish the environmental, technical and economic viability of various renewable and low carbon technologies.

Emission Factors

3.3 The CO_2 emission factors, where applicable, used throughout this report have been taken from the Building Regulation Approved Document L - 2013.

Fuel	kg CO_2/kWh
Natural Gas	0.216
Grid supplied electricity	0.519
Displaced electricity	0.519

3.4 In assessing this proposal we have also been informed by the following guidance:

- **London Sustainability Checklist**

- **BRE Green Guide to Specification**

  The Building Research Establishment Green Guide to Specification lists building materials and components, and ranks their potential life cycle environmental impact.

4.0 Proposal

4.1 The proposal is for the demolition of the existing Vicarage and the erection of a new terrace of buildings comprising a new Vicarage with self-contained 1-bedroom apartment over and two new 4-bedroom terrace houses.

The accommodation schedule in detail is as follows;

Unit Type	No.	Area	Totals
		m^2	m^2
1-Bedroom apartment	1	65.0	65.0
3-Bedroom maisonette (Vicarage)	1	178.0	178.0
4-Bedroom terrace house	2	247.0	494.0
Total			**737.0**

5.0 Demand Reduction (Be Lean and Be Clean)

Design

5.1 The energy performance of a building is affected by the building design, its construction and its use. Whilst occupant behaviour is beyond the remit of this statement, better design and construction methods can significantly reduce the life cycle emissions of a building and assist the occupant to reduce consumption.

5.2 Sustainable design is not just about incorporating renewable technologies, buildings should be designed at the outset to provide suitable environmental conditions for the occupants whilst also consuming as little energy as practical. It is possible to exceed Building Regulations requirements (Part L - 2013) through demand reduction measures alone, which typically include a combination of passive design measures (e.g. building design and efficient building fabric) and active design measures (e.g. variable speed motors)

Passive Design Measures

5.3 The passive design measures proposed include;

Passive Solar Gain

5.4 The architectural and structural features of a building will affect energy consumption and the use of natural daylight; orientation, thermal mass, shading and mitigation of wind exposure will reduce heating, cooling and lighting requirements.

5.5 The design and layout of the terrace within the site is in the context of surrounding development and respectful of the adjacent listed Church. However, the dwellings have been designed such that they all have multiple aspects and therefore benefit from good solar access throughout the day.

Efficient Building Fabric

Building Envelope

5.6 U-values of the dwelling envelope must meet Building Regulations Part L1A standards and further improvements to U-values will reduce the development heating requirements, favourably impacting in reduced energy demand.

5.7 The selection of high thermal density materials can help to stabilise temperature fluctuations in a building, reducing maximum demands on building services.

5.8 The construction will include external walls built in 350mm cavity construction with 100mm cavity wall insulation (CavityTherm XtraTherm or similar) and 50mm clear cavity. Ground floors will be insulated with 150mm Celotex PIR insulation or similar. Flat roofs will be insulated with at least 150mm 'Celotex' insulation or similar. The green roofs over the single-storey element will include 150mm PIR insulation over a concrete structure.

5.9 It is proposed to set maximum limits for the elemental U-values as follows;

Element	**Proposed** W/m^2K
External Walls	**0.17**
Flat roof (including green roof)	**0.11**
Floor	**0.11**
Windows	**1.40**

5.10 The increased thermal mass provided by traditional construction will assist in stabilising summer night-time.

Air Leakage

5.11 Large amounts of heat are lost in winter through air leakage from a building (also referred to as infiltration of air permeability) often through poor sealing of joints and openings in the building

5.12 ADL sets a minimum standard for air permeability of 10 m^3 of air per hour per m^2 of envelope area, at 50Pa. Air tightness standards for the homes will be constructed to the 'Accredited Construction Details' as compiled by Department of Communities and Local Government (DCLG). These will average a 60% improvement over Building Regulations and will achieve a permeability of less than $4m^3/hr/m^2$.

Thermal Bridging

5.13 The significance of Thermal Bridging, as a potentially major source of fabric heat losses, is increasingly understood. Improving the U-values for the main building fabric without accurately addressing the Thermal Bridging is no longer an option and will not achieve the fabric energy efficiency and energy and CO_2 reduction targets set out in this strategy.

5.14 Accredited Construction Details (ACD's) have been developed to provide the performance standards required to achieve the higher energy efficiency requirements of the Building Regulations. The bridging losses have been calculated using SAP Appendix K Table 1.

Ventilation

5.15 As a result of increasing thermal efficiency and air tightness, Building Regulations Approved Document F was also revised in 2006 to address the possibility of overheating and poor air quality. Mechanical ventilation will be used for control of air quality although maximum use will be made of natural ventilation and night-time cooling.

Overheating

5.16 The possibility of summertime overheating is addressed by providing opening windows to provide natural ventilation and night cooling. The increased thermal mass provided by traditional construction will assist in stabilising summer night-time.

Active Design Measures

5.17 The active design measures proposed include;

Efficient Lighting and Controls

5.18 Throughout the scheme natural lighting will be optimised.

5.19 Approved Document L1A requires three in four light fittings (75%) to be dedicated low energy fittings. The development will exceed this and all light fittings will be of a dedicated energy efficient type.

5.20 External lighting will be fitted with time controls and light sensors to ensure illumination is restricted to required times. External lighting will be limited to a maximum fitting output of 150w. Daylight and PIR sensors will also be used in some communal areas and automatic dimming lights used in conjunction with the sensors.

6.0 Establishing Carbon Dioxide Emissions

6.1 Detailed working drawing design has not been carried out but SAP calculations have been prepared based upon the detailed planning drawings and an assumed specification. A SAP calculation has been prepared for the mid-terrace and end-terrace houses.

6.2 The energy efficiency measures described above have been included within the calculation. The calculation has been based upon the use of gas boilers installed to each unit.

6.6 The results from the SAP calculations are summarised as follows:

4-Bed Mid-terrace house 247 sq m	**CO_2 TER**	**CO_2 DER**
	kg $CO_2/m^2/yr$	kg $CO_2/m^2/yr$
Space Heating	9.44	8.41
Water heating	2.32	2.33
Electricity for pumps and fans	0.16	0.16
Electricity for lighting	1.37	1.37
Total SAP	**13.29**	**12.27**

4-Bed End-terrace house 247 sq m	**CO_2 TER**	**CO_2 DER**
	kg $CO_2/m^2/yr$	kg $CO_2/m^2/yr$
Space Heating	10.10	9.14
Water heating	2.32	2.33
Electricity for pumps and fans	0.16	0.16
Electricity for lighting	1.37	1.37
Total SAP	**13.94**	**13.00**

6.7 Therefore the total TER and DER emissions from dwellings are;

Unit	Area	CO_2 TER	CO_2 BER/DER
	m^2	kg CO_2/yr	kg CO_2/yr
Mid-terrace house	247.0	3,283	3,031
End-terrace units	490.0	6,831	6,370
Total		**10,114**	**9,401**

6.8 The Building Regulation maximum carbon dioxide emissions (based on the TER) are assessed as;

- **10,114 kg CO_2 per year**

With the actual carbon dioxide emissions (based upon the DER) assessed as;

- **9,401 kg CO_2 per year**

The reduction in site CO_2 emissions as a result of the energy efficiency measures incorporated in the buildings are assessed as;

- **713 kg CO_2 per year, which equates to a reduction of 7.05%**

7.0 Renewable Technologies

7.1 The energy demand established above has been used to test the viability of various renewable and low carbon technologies as follows.

7.2 This section determines the appropriateness of each renewable technology and considers the ability of each technology to comply with the planning requirements as set out above in Section 2.0.

7.3 The Government's Renewable Obligation defines renewable energy in the UK. The identified technologies are;

- Small hydro-electric
- Landfill and sewage gas
- Onshore and offshore wind
- Biomass
- Tidal and wave power
- Geothermal power
- Solar

7.4 The use of landfill or sewage gas, offshore wind or any form of hydroelectric power is not suitable for the site due to its location. The remaining technologies are considered below;

Wind

7.5 Wind turbines are available in various sizes from large rotors able to supply whole communities to small roof or wall-mounted units for individual dwellings.

7.6 The Government wind speed database predicts local wind speeds at Belsize Square to be 5.6 m/s at 10m above ground level and 6.3 m/s at 25m above ground level. This is below the level generally required for commercial investment in large wind turbines and in addition the land take, potential for noise and signal interference make a large wind turbine unsuitable for this site.

7.7 Roof mounted turbines could be used at the development to generate small but valuable amounts of renewable electricity but the small output and contribution to total emissions means and investment would be small and purely tokenism.

Combined Heat and Power and Community Heating

7.8 Combined heat and power (CHP) also called co-generation is a de-centralised method of producing electricity from a fuel and 'capturing' the heat generated for us in buildings. The plant is essentially a small-scale electrical power station. The production and transportation of electricity via the National Grid is very inefficient with over 65% of the energy produced at the power station being lost to the atmosphere and through transportation.

7.9 Consequently CHP can demonstrate significant CO_2 savings and although not necessary classed as renewable energy (depending on the fuel used) the technology is low carbon.

7.10 For a CHP plant to be economic it needs to operate for as much of the time as possible (usually deemed to be in excess of 14 hours per day) and therefore the size of the unit is usually based upon the hot water load of the building (s) with additional boilers meeting the space heating demand.

7.11 Community heating schemes are similarly communal systems but seek to supply heat only without the electricity production. Therefore, unless using a biomass or biofuel a community heating system will not demonstrate significant CO_2 reductions

7.12 In order to optimise a combined heat and power system, the site needs is have a suitable minimum baseload. The baseload demand (hot water) for the dwellings is 7,950 kWh per year, which if using a micro CHP with an output of 12.5_{th}/ 5.5_{e} would run for 1.74 hours per day. This is not viable and the use of CHP is therefore not proposed.

Ground Source Heat Pumps

7.13 Sub soil temperatures are reasonable constant and predictable in the UK, providing a store of the sun's energy throughout the year. Ground source heat pumps (GSHP) extract this low-grade heat and convert it to usable heat for space heating.

7.14 GSHP operates on a similar principle to refrigerators, transferring heat from a cool place to a warmer place. They operate most efficiently when providing space heating at a low temperature, typically via under floor heating or with low temperature radiators.

7.15 There are generally two types of installation being a bore-hole (open loop) and a closed loop system.

7.16 Open loop bore holes extract energy from ground water located deep below the surface and discharge the water back to the ground reservoir whereas closed loop systems circulate a fluid around a series of boreholes or horizontal 'slinky' and extract heat from the ground.

7.17 Ground source heat pumps could be used subject to satisfactory ground investigation to establish whether the sub-strata is appropriate. There is insufficient ground area to accommodate a 'slinky' system and a borehole system would be required.

7.18 Ground source heat pumps could theoretically be used but there is insufficient ground area to accommodate a horizontal system and a bore-hole system would be necessary.

7.19 Prohibitive costs of providing bore-holes mean this technology is not proposed for this scheme.

Solar

(i) Solar Water Heating

7.20 Solar hot water panels use the suns energy to directly heat water circulating through panels or pipes. The technology is simple and easily understood by purchasers.

7.21 Solar hot water heating panels are based generally around two types, which are available being 'flat plate collectors' and 'evacuated tubes'. Flat plate collectors can achieve an output of up to 1,124 kWh/year* and evacuated tubes can achieve outputs up to 1,365 kWh/year **

* Figures taken for Schuco Compact K

** Figures taken from Riomay

7.22 Panels are traditionally roof mounted and for highest efficiencies should be mounted plus or minus 30 degrees of due south.

7.23 The total hot water demand of the dwellings is 7,950 kWh per year and assuming panels would reduce energy demand by 50% the reduction in CO_2 emissions would be **859 kg CO_2 per year**, which equates to a reduction of **9.14%.** This is insufficient to meet the requirements of the planning policy and additional technologies would be required.

7.24 Solar hot water heating panels are not proposed.

ii) Photovoltaics

7.25 Photovoltaic panels (PV) provide clean silent electricity. They generate electricity during most daylight conditions although they are most efficient when exposed to direct sunlight or are orientated to face plus or minus 30 degrees of due south.

7.26 PV panels can be integrated into many different aspects of a development including roofs, walls, shading devices or architectural panels. The panels typically have an electrical warranty of 20-25 years and an expected system lifespan of 25-40 years.

7.27 As a result of the higher CO_2 emissions factors for electricity versus gas, PV can be effective where planning policies seek reduction is CO_2 emissions rather than production of renewable **energy**.

7.28 In order to avoid any panel installation impacting on the aesthetics of the development, any panels will be laid flat on the upper (third storey) flat roof. Assuming the use of 327W PV panels and discounting the output to 90% to account for the horizontal aspect, to achieve the 20% reduction in emissions required by the planning policy a total of 14 panels would be required.

7.29 There is sufficient space on the flat roof section (third storey) of each unit to accommodate the requisite number of panels.

7.30 Photovoltaic panels are an appropriate technology an array of 14 panels would reduce emissions by **2,002 kg CO_2 per year**, which equates to a reduction in the DER emissions of **21.29%.**

Air Source Heat Pumps (ASHP)

7.31 Air sourced heat pumps operate using the same reverse refrigeration cycle as ground source heat pumps, however the initial heat energy is extracted from the external air rather than the ground. These heat pumps can be reversed to provide cooling to an area although this reduces the coefficient of performance of the pumps.

7.32 ASHP tend to have a lower coefficient of performance (CoP) than GSHP and with the emissions factor for electricity being 2.61 times that of gas (emissions factor is the weight of CO_2 emitted per kWh) installations with CoPs of less than this figure show little real saving in CO_2 emissions.

7.33 The efficiency of ASHPs can be significantly reduced where there is a high hot water demand and therefore their use is not appropriate for this site.

Other Technologies

7.34 New technologies are becoming available, which do not 'fit' into one of the above categories but which need to be considered and are regarded as low-carbon technologies.

Flue Gas Heat Recovery (FGHR)

7.35 One such system are flue gas heat recovery units. These devices are used in conjunction with gas-fired boilers and recover the heat exhausted through the boiler flue.

8.0 Summary of Calculations and Proposals for Low-carbon and Renewable Technologies

8.1 The total site CO_2 emissions are calculated as **10,114 kg CO_2 per year** (TER) and **9,401 kg CO_2 per year** (DER)**.**

8.2 To meet the requirements of the planning policy, the emissions need to be reduced by at least 20% through the installation of renewable technologies.

8.3 Various technologies are considered above and whilst wind turbines, combined heat and power, ground source and air source heat pumps and solar hot water heating panels are not considered appropriate the use of photovoltaic panels and flue-gas heat recovery units are considered feasible and viable. Flue-gas heat recovery units are regarded as 'low-carbon' and therefore do not qualify with the Council's requirement for renewable technologies.

Be Lean

8.4 The DER emissions are reduced from the TER emissions by **713 kg CO_2 per year**, which equates to a reduction of **7.05%** as a result of the energy efficiency measures.

Be Green

8.5 It is proposed to install a total of 14, 327W photovoltaic panels. There is sufficient space available on the third floor flat roof portion of each unit and the panels are shown on the Roof Plan within the architectural drawing pack. The panels will be dispersed as five panels for each of the 4-bedroom houses and four panels for the Vicarage. The panels will be laid flat and their output has been discounted to 90% of the maximum to allow for the compromised orientation.

8.6 The reduction in emissions as a result of renewable technologies is **2,002 kg CO_2 per year**, which as a percentage of the total site emissions equates to **21.29%** (% of DER)**.**

8.7 **The total emissions following energy efficiency measures, low-carbon and renewables technologies are 2,715 kg CO_2 per year, which equates to a reduction of 26.84% (% of TER).**

9.0 Climate change adaption and Water resources

Sustainable Drainage Systems (SUDS)

9.1 The site lies within Flood Zone 1 and there is a low risk of flooding.

9.2 The surface water system will drain into the combined sewer within Belsize Square as does the existing system. However, attenuation is provided in the form of green roofs, which are proposed for the lower flat roofs areas over the Living Room of each unit.

Surface Water Management

9.3 Consideration has been given to the use of grey water recycling. However, the excavations required for storage tanks would necessitate the removal of additional subsoil and when coupled with customer's resistance to the appearance of the recycled water and the cost of systems it does not currently make them a viable option. They have therefore not been included in the proposals.

Water efficiency measures

9.4 In the South East of England, water demand exceeds the volume licensed for abstraction, with the shortfall being met from ground water. In excess of 20% of the UK's water is used domestically with over 50% of this used for flushing WCs and washing (source: Environment Agency). The majority of this comes from drinking quality standard or potable water.

9.5 The water efficiency measures included in this development will ensure that the water use target of 105 litres per person per day is achieved using the measures described below.

9.6 Water efficient devices will be fully evaluated, and installed, wherever possible. The specification of such devices will be considered at detailed design stage and each will be subject to an evaluation based on technical performance, cost and market appeal, together with compliance with the water use regulations.

9.7 The following devices will be incorporated within the homes:

- Water efficient taps.
- Water efficient toilets.
- Low output showers.
- Flow restrictors to manage water pressures to achieve optimum levels.
- Water meters with guidance on water consumption and savings.

9.8 Water consumption calculations have been carried out using the Water Efficiency Calculator provided by the BRE. Although not perfect this calculator gives a good indication of the probable water use in a dwelling, although this is largely dependent on the way on which occupants use their homes.

9.9 Below is a typical specification, which would achieve the 105 Litres per person per year target.

Schedule of Appliance Water Consumption		
Appliance	Flow rate or capacity	Total Litres
WC	4/2.6 litres dual flush	14.72
Basin	1.7 litres/min.	5.98
Shower	8 litres/min	24.00
Bath	160 litres	25.60
Sink	4 litres/min	14.13
Washing Machine	Default used	16.66
Dishwasher	Default used	3.90
		104.99

10.0 Materials

10.1 The BRE Green Guide to Specification is a simple guide for design professionals. The guide provides environmental impact, cost and replacement interval information for a wide range of commonly used building specifications over a notional 60-year building life. The construction specification will prioritise materials within ratings A+, A or B.

10.2 Preference will be given to the use of local materials & suppliers where viable to reduce the transport distances and to support the local economy. A full evaluation of these suppliers will be undertaken at the next stage of design.

10.3 In addition, timber would be sourced, where practical, certified by PEFC or an equivalent approved certification body and all site timber used within the construction process would be recycled.

10.4 All insulation materials to will have a zero ozone depleting potential

Construction waste

10.5 A Site Waste Management Plan will be prepared which will monitor and report on waste generated on site into defined waste groups.

10.6 The Plan will indicate the setting of targets to promote resource efficiency in accordance with guidance from WRAP, Envirowise, BRE and DEFRA.

10.7 The overarching principle of waste management is that waste should be treated or disposed of within the region where it is produced.

10.8 Construction operations generate waste materials as a result of general handling losses and surpluses. These wastes can be reduced through appropriate selection of the construction method, good site management practices and spotting opportunities to avoid creating unnecessary waste.

10.9 The Construction Strategy will explore these issues, some of which are set out below:

- Proper handling and storage of all materials to avoid damage.
- Efficient purchasing arrangements to minimise over ordering.
- Segregation of construction waste to maximise potential for reuse/recycling.
- Suppliers who collect and reuse/recycle packaging materials

Construction waste is a key element to be considered in achieving a reduction in all waste – it is estimated that some 40% of all waste is construction related.

APPENDIX 1

TER and DER SAP Calculation Sheets for modelled units

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name: **Stroma Number:**

Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.1.25

Property Address: Belsize - 4-bed MID

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	121	(1a) x	2.4	(2a) =	290.4	(3a)
First floor	68	(1b) x	2.4	(2b) =	163.2	(3b)
Second floor	58	(1c) x	2.4	(2c) =	139.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	247	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		592.8	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							5	x 10 =	50	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	50	÷ (5) =	0.08 (8)

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

Number of storeys in the dwelling (ns)		0 (9)
Additional infiltration	[(9)-1]x0.1 =	0 (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0 (11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35		
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0 (12)
If no draught lobby, enter 0.05, else enter 0		0 (13)
Percentage of windows and doors draught stripped		0 (14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0 (15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0 (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4 (17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.28 (18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used		
Number of sides sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85 (20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.24 (21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

DER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.31	0.3	0.3	0.27	0.26	0.23	0.23	0.22	0.24	0.26	0.27	0.28

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0

(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0

(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0

(24c)

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

(24d)m=	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.52	0.53	0.53	0.54	0.54

(24d)

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

(25)m=	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.52	0.53	0.53	0.54	0.54

(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.89	x	1.6	=	3.024			(26)
Windows Type 1			1.7	x1/[1/(1.4)+ 0.04]		=	2.25			(27)
Windows Type 2			12.08	x1/[1/(1.4)+ 0.04]		=	16.02			(27)
Windows Type 3			12.08	x1/[1/(1.4)+ 0.04]		=	16.02			(27)
Windows Type 4			17.16	x1/[1/(1.4)+ 0.04]		=	22.75			(27)
Windows Type 5			2.73	x1/[1/(1.4)+ 0.04]		=	3.62			(27)
Windows Type 6			4.5	x1/[1/(1.4)+ 0.04]		=	5.97			(27)
Windows Type 7			4.5	x1/[1/(1.4)+ 0.04]		=	5.97			(27)
Windows Type 8			7.77	x1/[1/(1.4)+ 0.04]		=	10.3			(27)
Windows Type 9			1.89	x1/[1/(1.4)+ 0.04]		=	2.51			(27)
Windows Type 10			7.77	x1/[1/(1.4)+ 0.04]		=	10.3			(27)
Windows Type 11			1.89	x1/[1/(1.4)+ 0.04]		=	2.51			(27)
Windows Type 12			6	x1/[1/(1.4)+ 0.04]		=	7.95			(27)
Windows Type 13			6	x1/[1/(1.4)+ 0.04]		=	7.95			(27)
Floor			121	x	0.11	=	13.31			(28)
Walls	206.66	87.96	118.7	x	0.17	=	20.18			(29)
Roof Type1	58	0	58	x	0.11	=	6.38			(30)

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Roof Type2	10	0	10	x	0.11	=	1.1			(30)
Roof Type3	53	0	53	x	0.11	=	5.83			(30)
Total area of elements, m²			448.66							(31)
Party wall			128.69	x	0	=	0			(32)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 163.93 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 36977.3 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

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

Thermal bridges : S (L x Y) calculated using Appendix K 30.68 (36)

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

Total fabric heat loss (33) + (36) = 194.62 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	107.1	106.74	106.39	104.73	104.41	102.97	102.97	102.7	103.53	104.41	105.04	105.7	(38)

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

(39)m=	301.72	301.36	301	299.34	299.03	297.58	297.58	297.32	298.14	299.03	299.66	300.32	

Average = Sum(39)$_{1...12}$ /12= 299.34 (39)

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

(40)m=	1.22	1.22	1.22	1.21	1.21	1.2	1.2	1.2	1.21	1.21	1.21	1.22	

Average = Sum(40)$_{1...12}$ /12= 1.21 (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 3.06 (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) + 36 106.95 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	117.64	113.36	109.09	104.81	100.53	96.25	96.25	100.53	104.81	109.09	113.36	117.64	

Total = Sum(44)$_{1...12}$ = 1283.36 (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=	174.46	152.58	157.45	137.27	131.71	113.66	105.32	120.86	122.3	142.53	155.58	168.95	

Total = Sum(45)$_{1...12}$ = 1682.69 (45)

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

(46)m=	26.17	22.89	23.62	20.59	19.76	17.05	15.8	18.13	18.35	21.38	23.34	25.34	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

DER WorkSheet: New dwelling design stage

If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		0	(48)
Temperature factor from Table 2b		0	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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

(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

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

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

(61)m=	50.96	46.03	50.96	49.32	50.96	47.47	49.05	50.96	49.32	50.96	49.32	50.96	(61)

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

(62)m=	225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	(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=	225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	

Output from water heater (annual)$_{1...12}$: 2278.93 (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=	70.75	62.24	65.09	57.97	56.53	49.66	47.28	52.93	52.99	60.13	64.06	68.92	(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=	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	(66)

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

(67)m=	36.89	32.76	26.65	20.17	15.08	12.73	13.76	17.88	24	30.47	35.56	37.91	(67)

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

(68)m=	413.78	418.07	407.25	384.21	355.14	327.81	309.55	305.26	316.08	339.11	368.19	395.52	(68)

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

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(69)m=	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	(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=	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	(71)

Water heating gains (Table 5)

(72)m=	95.09	92.62	87.49	80.52	75.99	68.97	63.55	71.14	73.6	80.82	88.97	92.63	(72)

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

(73)m=	617.7	615.4	593.33	556.85	518.15	481.46	458.8	466.22	485.63	522.35	564.67	598.01	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x 0.77	x	1.7	x	10.63	x	0.85	x	0.7	=	7.45	(74)
North	0.9x 0.77	x	12.08	x	10.63	x	0.85	x	0.7	=	52.96	(74)
North	0.9x 0.77	x	4.5	x	10.63	x	0.85	x	0.7	=	19.73	(74)
North	0.9x 0.77	x	7.77	x	10.63	x	0.85	x	0.7	=	34.07	(74)
North	0.9x 0.77	x	6	x	10.63	x	0.85	x	0.7	=	26.31	(74)
North	0.9x 0.77	x	1.7	x	20.32	x	0.85	x	0.7	=	14.24	(74)
North	0.9x 0.77	x	12.08	x	20.32	x	0.85	x	0.7	=	101.22	(74)
North	0.9x 0.77	x	4.5	x	20.32	x	0.85	x	0.7	=	37.71	(74)
North	0.9x 0.77	x	7.77	x	20.32	x	0.85	x	0.7	=	65.11	(74)
North	0.9x 0.77	x	6	x	20.32	x	0.85	x	0.7	=	50.27	(74)
North	0.9x 0.77	x	1.7	x	34.53	x	0.85	x	0.7	=	24.2	(74)
North	0.9x 0.77	x	12.08	x	34.53	x	0.85	x	0.7	=	172	(74)
North	0.9x 0.77	x	4.5	x	34.53	x	0.85	x	0.7	=	64.07	(74)
North	0.9x 0.77	x	7.77	x	34.53	x	0.85	x	0.7	=	110.63	(74)
North	0.9x 0.77	x	6	x	34.53	x	0.85	x	0.7	=	85.43	(74)
North	0.9x 0.77	x	1.7	x	55.46	x	0.85	x	0.7	=	38.88	(74)
North	0.9x 0.77	x	12.08	x	55.46	x	0.85	x	0.7	=	276.27	(74)
North	0.9x 0.77	x	4.5	x	55.46	x	0.85	x	0.7	=	102.91	(74)
North	0.9x 0.77	x	7.77	x	55.46	x	0.85	x	0.7	=	177.7	(74)
North	0.9x 0.77	x	6	x	55.46	x	0.85	x	0.7	=	137.22	(74)
North	0.9x 0.77	x	1.7	x	74.72	x	0.85	x	0.7	=	52.37	(74)
North	0.9x 0.77	x	12.08	x	74.72	x	0.85	x	0.7	=	372.16	(74)
North	0.9x 0.77	x	4.5	x	74.72	x	0.85	x	0.7	=	138.64	(74)
North	0.9x 0.77	x	7.77	x	74.72	x	0.85	x	0.7	=	239.38	(74)
North	0.9x 0.77	x	6	x	74.72	x	0.85	x	0.7	=	184.85	(74)
North	0.9x 0.77	x	1.7	x	79.99	x	0.85	x	0.7	=	56.07	(74)
North	0.9x 0.77	x	12.08	x	79.99	x	0.85	x	0.7	=	398.41	(74)
North	0.9x 0.77	x	4.5	x	79.99	x	0.85	x	0.7	=	148.41	(74)

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North	0.9x	0.77	x	7.77	x	79.99	x	0.85	x	0.7	=	256.26	(74)
North	0.9x	0.77	x	6	x	79.99	x	0.85	x	0.7	=	197.88	(74)
North	0.9x	0.77	x	1.7	x	74.68	x	0.85	x	0.7	=	52.35	(74)
North	0.9x	0.77	x	12.08	x	74.68	x	0.85	x	0.7	=	371.96	(74)
North	0.9x	0.77	x	4.5	x	74.68	x	0.85	x	0.7	=	138.56	(74)
North	0.9x	0.77	x	7.77	x	74.68	x	0.85	x	0.7	=	239.25	(74)
North	0.9x	0.77	x	6	x	74.68	x	0.85	x	0.7	=	184.75	(74)
North	0.9x	0.77	x	1.7	x	59.25	x	0.85	x	0.7	=	41.53	(74)
North	0.9x	0.77	x	12.08	x	59.25	x	0.85	x	0.7	=	295.11	(74)
North	0.9x	0.77	x	4.5	x	59.25	x	0.85	x	0.7	=	109.93	(74)
North	0.9x	0.77	x	7.77	x	59.25	x	0.85	x	0.7	=	189.82	(74)
North	0.9x	0.77	x	6	x	59.25	x	0.85	x	0.7	=	146.58	(74)
North	0.9x	0.77	x	1.7	x	41.52	x	0.85	x	0.7	=	29.1	(74)
North	0.9x	0.77	x	12.08	x	41.52	x	0.85	x	0.7	=	206.79	(74)
North	0.9x	0.77	x	4.5	x	41.52	x	0.85	x	0.7	=	77.03	(74)
North	0.9x	0.77	x	7.77	x	41.52	x	0.85	x	0.7	=	133.01	(74)
North	0.9x	0.77	x	6	x	41.52	x	0.85	x	0.7	=	102.71	(74)
North	0.9x	0.77	x	1.7	x	24.19	x	0.85	x	0.7	=	16.96	(74)
North	0.9x	0.77	x	12.08	x	24.19	x	0.85	x	0.7	=	120.49	(74)
North	0.9x	0.77	x	4.5	x	24.19	x	0.85	x	0.7	=	44.88	(74)
North	0.9x	0.77	x	7.77	x	24.19	x	0.85	x	0.7	=	77.5	(74)
North	0.9x	0.77	x	6	x	24.19	x	0.85	x	0.7	=	59.84	(74)
North	0.9x	0.77	x	1.7	x	13.12	x	0.85	x	0.7	=	9.2	(74)
North	0.9x	0.77	x	12.08	x	13.12	x	0.85	x	0.7	=	65.34	(74)
North	0.9x	0.77	x	4.5	x	13.12	x	0.85	x	0.7	=	24.34	(74)
North	0.9x	0.77	x	7.77	x	13.12	x	0.85	x	0.7	=	42.03	(74)
North	0.9x	0.77	x	6	x	13.12	x	0.85	x	0.7	=	32.45	(74)
North	0.9x	0.77	x	1.7	x	8.86	x	0.85	x	0.7	=	6.21	(74)
North	0.9x	0.77	x	12.08	x	8.86	x	0.85	x	0.7	=	44.15	(74)
North	0.9x	0.77	x	4.5	x	8.86	x	0.85	x	0.7	=	16.45	(74)
North	0.9x	0.77	x	7.77	x	8.86	x	0.85	x	0.7	=	28.4	(74)
North	0.9x	0.77	x	6	x	8.86	x	0.85	x	0.7	=	21.93	(74)
East	0.9x	1	x	1.89	x	19.64	x	0.85	x	0.7	=	10.73	(76)
East	0.9x	1	x	1.89	x	19.64	x	0.85	x	0.7	=	10.73	(76)
East	0.9x	1	x	1.89	x	38.42	x	0.85	x	0.7	=	21	(76)
East	0.9x	1	x	1.89	x	38.42	x	0.85	x	0.7	=	21	(76)
East	0.9x	1	x	1.89	x	63.27	x	0.85	x	0.7	=	34.58	(76)
East	0.9x	1	x	1.89	x	63.27	x	0.85	x	0.7	=	34.58	(76)
East	0.9x	1	x	1.89	x	92.28	x	0.85	x	0.7	=	50.43	(76)
East	0.9x	1	x	1.89	x	92.28	x	0.85	x	0.7	=	50.43	(76)
East	0.9x	1	x	1.89	x	113.09	x	0.85	x	0.7	=	61.81	(76)

DER WorkSheet: New dwelling design stage

East	0.9x	1	x	1.89	x	113.09	x	0.85	x	0.7	=	61.81	(76)
East	0.9x	1	x	1.89	x	115.77	x	0.85	x	0.7	=	63.27	(76)
East	0.9x	1	x	1.89	x	115.77	x	0.85	x	0.7	=	63.27	(76)
East	0.9x	1	x	1.89	x	110.22	x	0.85	x	0.7	=	60.24	(76)
East	0.9x	1	x	1.89	x	110.22	x	0.85	x	0.7	=	60.24	(76)
East	0.9x	1	x	1.89	x	94.68	x	0.85	x	0.7	=	51.74	(76)
East	0.9x	1	x	1.89	x	94.68	x	0.85	x	0.7	=	51.74	(76)
East	0.9x	1	x	1.89	x	73.59	x	0.85	x	0.7	=	40.22	(76)
East	0.9x	1	x	1.89	x	73.59	x	0.85	x	0.7	=	40.22	(76)
East	0.9x	1	x	1.89	x	45.59	x	0.85	x	0.7	=	24.92	(76)
East	0.9x	1	x	1.89	x	45.59	x	0.85	x	0.7	=	24.92	(76)
East	0.9x	1	x	1.89	x	24.49	x	0.85	x	0.7	=	13.38	(76)
East	0.9x	1	x	1.89	x	24.49	x	0.85	x	0.7	=	13.38	(76)
East	0.9x	1	x	1.89	x	16.15	x	0.85	x	0.7	=	8.83	(76)
East	0.9x	1	x	1.89	x	16.15	x	0.85	x	0.7	=	8.83	(76)
South	0.9x	0.77	x	12.08	x	46.75	x	0.85	x	0.7	=	232.87	(78)
South	0.9x	0.3	x	2.73	x	46.75	x	0.85	x	0.7	=	20.5	(78)
South	0.9x	0.77	x	4.5	x	46.75	x	0.85	x	0.7	=	86.75	(78)
South	0.9x	0.77	x	7.77	x	46.75	x	0.85	x	0.7	=	149.79	(78)
South	0.9x	0.77	x	6	x	46.75	x	0.85	x	0.7	=	115.67	(78)
South	0.9x	0.77	x	12.08	x	76.57	x	0.85	x	0.7	=	381.38	(78)
South	0.9x	0.3	x	2.73	x	76.57	x	0.85	x	0.7	=	33.58	(78)
South	0.9x	0.77	x	4.5	x	76.57	x	0.85	x	0.7	=	142.07	(78)
South	0.9x	0.77	x	7.77	x	76.57	x	0.85	x	0.7	=	245.31	(78)
South	0.9x	0.77	x	6	x	76.57	x	0.85	x	0.7	=	189.43	(78)
South	0.9x	0.77	x	12.08	x	97.53	x	0.85	x	0.7	=	485.82	(78)
South	0.9x	0.3	x	2.73	x	97.53	x	0.85	x	0.7	=	42.78	(78)
South	0.9x	0.77	x	4.5	x	97.53	x	0.85	x	0.7	=	180.97	(78)
South	0.9x	0.77	x	7.77	x	97.53	x	0.85	x	0.7	=	312.48	(78)
South	0.9x	0.77	x	6	x	97.53	x	0.85	x	0.7	=	241.3	(78)
South	0.9x	0.77	x	12.08	x	110.23	x	0.85	x	0.7	=	549.08	(78)
South	0.9x	0.3	x	2.73	x	110.23	x	0.85	x	0.7	=	48.35	(78)
South	0.9x	0.77	x	4.5	x	110.23	x	0.85	x	0.7	=	204.54	(78)
South	0.9x	0.77	x	7.77	x	110.23	x	0.85	x	0.7	=	353.17	(78)
South	0.9x	0.77	x	6	x	110.23	x	0.85	x	0.7	=	272.72	(78)
South	0.9x	0.77	x	12.08	x	114.87	x	0.85	x	0.7	=	572.17	(78)
South	0.9x	0.3	x	2.73	x	114.87	x	0.85	x	0.7	=	50.38	(78)
South	0.9x	0.77	x	4.5	x	114.87	x	0.85	x	0.7	=	213.14	(78)
South	0.9x	0.77	x	7.77	x	114.87	x	0.85	x	0.7	=	368.03	(78)
South	0.9x	0.77	x	6	x	114.87	x	0.85	x	0.7	=	284.19	(78)
South	0.9x	0.77	x	12.08	x	110.55	x	0.85	x	0.7	=	550.64	(78)

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South	0.9x	0.3	x	2.73	x	110.55	x	0.85	x	0.7	=	48.48	(78)
South	0.9x	0.77	x	4.5	x	110.55	x	0.85	x	0.7	=	205.12	(78)
South	0.9x	0.77	x	7.77	x	110.55	x	0.85	x	0.7	=	354.18	(78)
South	0.9x	0.77	x	6	x	110.55	x	0.85	x	0.7	=	273.5	(78)
South	0.9x	0.77	x	12.08	x	108.01	x	0.85	x	0.7	=	538.01	(78)
South	0.9x	0.3	x	2.73	x	108.01	x	0.85	x	0.7	=	47.37	(78)
South	0.9x	0.77	x	4.5	x	108.01	x	0.85	x	0.7	=	200.42	(78)
South	0.9x	0.77	x	7.77	x	108.01	x	0.85	x	0.7	=	346.05	(78)
South	0.9x	0.77	x	6	x	108.01	x	0.85	x	0.7	=	267.22	(78)
South	0.9x	0.77	x	12.08	x	104.89	x	0.85	x	0.7	=	522.48	(78)
South	0.9x	0.3	x	2.73	x	104.89	x	0.85	x	0.7	=	46	(78)
South	0.9x	0.77	x	4.5	x	104.89	x	0.85	x	0.7	=	194.63	(78)
South	0.9x	0.77	x	7.77	x	104.89	x	0.85	x	0.7	=	336.07	(78)
South	0.9x	0.77	x	6	x	104.89	x	0.85	x	0.7	=	259.51	(78)
South	0.9x	0.77	x	12.08	x	101.89	x	0.85	x	0.7	=	507.49	(78)
South	0.9x	0.3	x	2.73	x	101.89	x	0.85	x	0.7	=	44.68	(78)
South	0.9x	0.77	x	4.5	x	101.89	x	0.85	x	0.7	=	189.05	(78)
South	0.9x	0.77	x	7.77	x	101.89	x	0.85	x	0.7	=	326.43	(78)
South	0.9x	0.77	x	6	x	101.89	x	0.85	x	0.7	=	252.07	(78)
South	0.9x	0.77	x	12.08	x	82.59	x	0.85	x	0.7	=	411.36	(78)
South	0.9x	0.3	x	2.73	x	82.59	x	0.85	x	0.7	=	36.22	(78)
South	0.9x	0.77	x	4.5	x	82.59	x	0.85	x	0.7	=	153.24	(78)
South	0.9x	0.77	x	7.77	x	82.59	x	0.85	x	0.7	=	264.59	(78)
South	0.9x	0.77	x	6	x	82.59	x	0.85	x	0.7	=	204.32	(78)
South	0.9x	0.77	x	12.08	x	55.42	x	0.85	x	0.7	=	276.03	(78)
South	0.9x	0.3	x	2.73	x	55.42	x	0.85	x	0.7	=	24.3	(78)
South	0.9x	0.77	x	4.5	x	55.42	x	0.85	x	0.7	=	102.83	(78)
South	0.9x	0.77	x	7.77	x	55.42	x	0.85	x	0.7	=	177.55	(78)
South	0.9x	0.77	x	6	x	55.42	x	0.85	x	0.7	=	137.1	(78)
South	0.9x	0.77	x	12.08	x	40.4	x	0.85	x	0.7	=	201.22	(78)
South	0.9x	0.3	x	2.73	x	40.4	x	0.85	x	0.7	=	17.72	(78)
South	0.9x	0.77	x	4.5	x	40.4	x	0.85	x	0.7	=	74.96	(78)
South	0.9x	0.77	x	7.77	x	40.4	x	0.85	x	0.7	=	129.43	(78)
South	0.9x	0.77	x	6	x	40.4	x	0.85	x	0.7	=	99.95	(78)
West	0.9x	0.77	x	17.16	x	19.64	x	0.85	x	0.7	=	138.97	(80)
West	0.9x	0.77	x	17.16	x	38.42	x	0.85	x	0.7	=	271.85	(80)
West	0.9x	0.77	x	17.16	x	63.27	x	0.85	x	0.7	=	447.7	(80)
West	0.9x	0.77	x	17.16	x	92.28	x	0.85	x	0.7	=	652.94	(80)
West	0.9x	0.77	x	17.16	x	113.09	x	0.85	x	0.7	=	800.21	(80)
West	0.9x	0.77	x	17.16	x	115.77	x	0.85	x	0.7	=	819.15	(80)
West	0.9x	0.77	x	17.16	x	110.22	x	0.85	x	0.7	=	779.87	(80)

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West	0.9x	0.77	x	17.16	x	94.68	x	0.85	x	0.7	=	669.89	(80)
West	0.9x	0.77	x	17.16	x	73.59	x	0.85	x	0.7	=	520.69	(80)
West	0.9x	0.77	x	17.16	x	45.59	x	0.85	x	0.7	=	322.57	(80)
West	0.9x	0.77	x	17.16	x	24.49	x	0.85	x	0.7	=	173.28	(80)
West	0.9x	0.77	x	17.16	x	16.15	x	0.85	x	0.7	=	114.28	(80)

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

(83)m=	906.54	1574.17	2236.54	2914.65	3399.14	3434.65	3286.29	2915.03	2469.5	1761.8	1091.21	772.36	(83)

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

(84)m=	1524.24	2189.57	2829.87	3471.5	3917.29	3916.11	3745.1	3381.26	2955.13	2284.16	1655.89	1370.36	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.95	0.85	0.66	0.48	0.35	0.4	0.65	0.93	0.99	1	(86)

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

(87)m=	19.68	19.99	20.37	20.74	20.93	20.99	21	21	20.95	20.63	20.05	19.62	(87)

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

(88)m=	19.9	19.9	19.91	19.91	19.91	19.92	19.92	19.92	19.91	19.91	19.91	19.91	(88)

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

(89)m=	1	0.98	0.94	0.81	0.6	0.4	0.26	0.31	0.57	0.9	0.99	1	(89)

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

(90)m=	18.71	19.02	19.39	19.72	19.87	19.91	19.92	19.92	19.89	19.64	19.08	18.65	(90)

fLA = Living area ÷ (4) = 0.14 (91)

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

(92)m=	18.85	19.15	19.53	19.87	20.02	20.07	20.07	20.07	20.04	19.78	19.22	18.79	(92)

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

(93)m=	18.7	19	19.38	19.72	19.87	19.92	19.92	19.92	19.89	19.63	19.07	18.64	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.98	0.93	0.8	0.6	0.4	0.26	0.31	0.57	0.89	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1517.66	2144.47	2628.62	2770.95	2343.38	1570.07	986.93	1044.2	1671.6	2031.87	1634.11	1366.67	(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=	4343.29	4250.47	3876.06	3238.49	2444.32	1581.83	988.08	1046.67	1727.57	2699.71	3587.31	4335.79	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	2102.27	1415.23	928.09	336.63	75.1	0	0	0	0	496.87	1406.3	2209.03	

Total per year (kWh/year) = Sum(98)$_{1…5,9…12}$ = 8969.52 (98)

Space heating requirement in kWh/m²/year 36.31 (99)

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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		93.3 (206)
Efficiency of secondary/supplementary heating system, %		0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)												
2102.27	1415.23	928.09	336.63	75.1	0	0	0	0	496.87	1406.3	2209.03	

(211)m = {[(98)m x (204)] } x 100 ÷ (206) (211)

2253.23	1516.86	994.74	360.81	80.49	0	0	0	0	532.55	1507.29	2367.66	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 9613.63 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

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

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

Water heating

Output from water heater (calculated above)

225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	

Efficiency of water heater 80.2 (216)

(217)m=	89.21	88.92	88.26	86.42	82.9	80.2	80.2	80.2	80.2	87.22	88.88	89.28	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	252.68	223.35	236.13	215.91	220.35	200.91	192.48	214.24	213.99	221.84	230.54	246.31	

Total = Sum(219a)$_{1...12}$ = 2668.72 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		9613.63
Water heating fuel used		2668.72
Electricity for pumps, fans and electric keep-hot		
central heating pump:	30	(230c)
boiler with a fan-assisted flue	45	(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		75 (231)
Electricity for lighting		651.46 (232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year
Space heating (main system 1)	(211) x	0.216 =	2076.54 (261)
Space heating (secondary)	(215) x	0.519 =	0 (263)
Water heating	(219) x	0.216 =	576.44 (264)
Space and water heating	(261) + (262) + (263) + (264) =		2652.99 (265)

DER WorkSheet: New dwelling design stage

Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	338.11	(268)
Total CO2, kg/year			sum of (265)…(271) =		3030.02	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		12.27	(273)
EI rating (section 14)					86	(274)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name: **Stroma Number:**

Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.1.25

Property Address: Belsize - 4-bed MID

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	121	(1a) x	2.4	(2a) =	290.4	(3a)
First floor	68	(1b) x	2.4	(2b) =	163.2	(3b)
Second floor	58	(1c) x	2.4	(2c) =	139.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	247	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		592.8	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							4	x 10 =	40	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.07 (8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)			
Number of storeys in the dwelling (ns)			0 (9)
Additional infiltration		[(9)-1]x0.1 =	0 (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0 (11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0 (12)
If no draught lobby, enter 0.05, else enter 0			0 (13)
Percentage of windows and doors draught stripped			0 (14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =		0 (15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =		0 (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			5 (17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.32 (18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered			2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =		0.85 (20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =		0.27 (21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

TER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.34	0.34	0.33	0.3	0.29	0.26	0.26	0.25	0.27	0.29	0.3	0.32

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.89	x	1	=	1.89			(26)
Windows Type 1			1.18	x1/[1/(1.4)+ 0.04]		=	1.56			(27)
Windows Type 2			8.4	x1/[1/(1.4)+ 0.04]		=	11.14			(27)
Windows Type 3			8.4	x1/[1/(1.4)+ 0.04]		=	11.14			(27)
Windows Type 4			11.93	x1/[1/(1.4)+ 0.04]		=	15.82			(27)
Windows Type 5			1.9	x1/[1/(1.4)+ 0.04]		=	2.52			(27)
Windows Type 6			3.13	x1/[1/(1.4)+ 0.04]		=	4.15			(27)
Windows Type 7			3.13	x1/[1/(1.4)+ 0.04]		=	4.15			(27)
Windows Type 8			5.4	x1/[1/(1.4)+ 0.04]		=	7.16			(27)
Windows Type 9			1.31	x1/[1/(1.4)+ 0.04]		=	1.74			(27)
Windows Type 10			5.4	x1/[1/(1.4)+ 0.04]		=	7.16			(27)
Windows Type 11			1.31	x1/[1/(1.4)+ 0.04]		=	1.74			(27)
Windows Type 12			4.17	x1/[1/(1.4)+ 0.04]		=	5.53			(27)
Windows Type 13			4.17	x1/[1/(1.4)+ 0.04]		=	5.53			(27)
Floor			121	x	0.13	=	15.73			(28)
Walls	206.66	61.72	144.94	x	0.18	=	26.09			(29)
Roof Type1	58	0	58	x	0.13	=	7.54			(30)

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Roof Type2	10	0	10	x	0.13	=	1.3			(30)
Roof Type3	53	0	53	x	0.13	=	6.89			(30)
Total area of elements, m²			448.66							(31)
Party wall			128.69	x	0	=	0			(32)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 138.76 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 40913.3 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

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

Thermal bridges : S (L x Y) calculated using Appendix K 23.11 (36)

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

Total fabric heat loss (33) + (36) = 161.87 (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=	109.39	108.94	108.5	106.43	106.04	104.24	104.24	103.91	104.93	106.04	106.83	107.65	(38)

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

(39)m=	271.26	270.82	270.37	268.3	267.92	266.11	266.11	265.78	266.81	267.92	268.7	269.52	

Average = Sum(39)$_{1...12}$ /12= 268.3 (39)

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

(40)m=	1.1	1.1	1.09	1.09	1.08	1.08	1.08	1.08	1.08	1.08	1.09	1.09	

Average = Sum(40)$_{1...12}$ /12= 1.09 (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 3.06 (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) + 36 106.95 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m=	117.64	113.36	109.09	104.81	100.53	96.25	96.25	100.53	104.81	109.09	113.36	117.64	

Total = Sum(44)$_{1...12}$ = 1283.36 (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=	174.46	152.58	157.45	137.27	131.71	113.66	105.32	120.86	122.3	142.53	155.58	168.95	

Total = Sum(45)$_{1...12}$ = 1682.69 (45)

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

(46)m=	26.17	22.89	23.62	20.59	19.76	17.05	15.8	18.13	18.35	21.38	23.34	25.34	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		0	(48)
Temperature factor from Table 2b		0	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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

(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

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

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

(61)m=	50.96	46.03	50.96	49.32	50.96	47.47	49.05	50.96	49.32	50.96	49.32	50.96	(61)

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

(62)m=	225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	(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=	225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	

Output from water heater (annual)$_{1...12}$ 2278.93 (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=	70.75	62.24	65.09	57.97	56.53	49.66	47.28	52.93	52.99	60.13	64.06	68.92	(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=	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	(66)

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

(67)m=	36.89	32.76	26.65	20.17	15.08	12.73	13.76	17.88	24	30.47	35.56	37.91	(67)

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

(68)m=	413.78	418.07	407.25	384.21	355.14	327.81	309.55	305.26	316.08	339.11	368.19	395.52	(68)

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

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(69)m=	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	(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=	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	(71)

Water heating gains (Table 5)

(72)m=	95.09	92.62	87.49	80.52	75.99	68.97	63.55	71.14	73.6	80.82	88.97	92.63	(72)

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

(73)m=	617.7	615.4	593.33	556.85	518.15	481.46	458.8	466.22	485.63	522.35	564.67	598.01	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x 0.77	x	1.18	x	10.63	x	0.63	x	0.7	=	3.83	(74)
North	0.9x 0.77	x	8.4	x	10.63	x	0.63	x	0.7	=	27.3	(74)
North	0.9x 0.77	x	3.13	x	10.63	x	0.63	x	0.7	=	10.17	(74)
North	0.9x 0.77	x	5.4	x	10.63	x	0.63	x	0.7	=	17.55	(74)
North	0.9x 0.77	x	4.17	x	10.63	x	0.63	x	0.7	=	13.55	(74)
North	0.9x 0.77	x	1.18	x	20.32	x	0.63	x	0.7	=	7.33	(74)
North	0.9x 0.77	x	8.4	x	20.32	x	0.63	x	0.7	=	52.17	(74)
North	0.9x 0.77	x	3.13	x	20.32	x	0.63	x	0.7	=	19.44	(74)
North	0.9x 0.77	x	5.4	x	20.32	x	0.63	x	0.7	=	33.54	(74)
North	0.9x 0.77	x	4.17	x	20.32	x	0.63	x	0.7	=	25.9	(74)
North	0.9x 0.77	x	1.18	x	34.53	x	0.63	x	0.7	=	12.45	(74)
North	0.9x 0.77	x	8.4	x	34.53	x	0.63	x	0.7	=	88.64	(74)
North	0.9x 0.77	x	3.13	x	34.53	x	0.63	x	0.7	=	33.03	(74)
North	0.9x 0.77	x	5.4	x	34.53	x	0.63	x	0.7	=	56.99	(74)
North	0.9x 0.77	x	4.17	x	34.53	x	0.63	x	0.7	=	44.01	(74)
North	0.9x 0.77	x	1.18	x	55.46	x	0.63	x	0.7	=	20	(74)
North	0.9x 0.77	x	8.4	x	55.46	x	0.63	x	0.7	=	142.39	(74)
North	0.9x 0.77	x	3.13	x	55.46	x	0.63	x	0.7	=	53.06	(74)
North	0.9x 0.77	x	5.4	x	55.46	x	0.63	x	0.7	=	91.53	(74)
North	0.9x 0.77	x	4.17	x	55.46	x	0.63	x	0.7	=	70.68	(74)
North	0.9x 0.77	x	1.18	x	74.72	x	0.63	x	0.7	=	26.94	(74)
North	0.9x 0.77	x	8.4	x	74.72	x	0.63	x	0.7	=	191.81	(74)
North	0.9x 0.77	x	3.13	x	74.72	x	0.63	x	0.7	=	71.47	(74)
North	0.9x 0.77	x	5.4	x	74.72	x	0.63	x	0.7	=	123.3	(74)
North	0.9x 0.77	x	4.17	x	74.72	x	0.63	x	0.7	=	95.22	(74)
North	0.9x 0.77	x	1.18	x	79.99	x	0.63	x	0.7	=	28.84	(74)
North	0.9x 0.77	x	8.4	x	79.99	x	0.63	x	0.7	=	205.33	(74)
North	0.9x 0.77	x	3.13	x	79.99	x	0.63	x	0.7	=	76.51	(74)

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North	0.9x	0.77	x	5.4	x	79.99	x	0.63	x	0.7	=	132	(74)
North	0.9x	0.77	x	4.17	x	79.99	x	0.63	x	0.7	=	101.93	(74)
North	0.9x	0.77	x	1.18	x	74.68	x	0.63	x	0.7	=	26.93	(74)
North	0.9x	0.77	x	8.4	x	74.68	x	0.63	x	0.7	=	191.71	(74)
North	0.9x	0.77	x	3.13	x	74.68	x	0.63	x	0.7	=	71.43	(74)
North	0.9x	0.77	x	5.4	x	74.68	x	0.63	x	0.7	=	123.24	(74)
North	0.9x	0.77	x	4.17	x	74.68	x	0.63	x	0.7	=	95.17	(74)
North	0.9x	0.77	x	1.18	x	59.25	x	0.63	x	0.7	=	21.37	(74)
North	0.9x	0.77	x	8.4	x	59.25	x	0.63	x	0.7	=	152.09	(74)
North	0.9x	0.77	x	3.13	x	59.25	x	0.63	x	0.7	=	56.67	(74)
North	0.9x	0.77	x	5.4	x	59.25	x	0.63	x	0.7	=	97.77	(74)
North	0.9x	0.77	x	4.17	x	59.25	x	0.63	x	0.7	=	75.5	(74)
North	0.9x	0.77	x	1.18	x	41.52	x	0.63	x	0.7	=	14.97	(74)
North	0.9x	0.77	x	8.4	x	41.52	x	0.63	x	0.7	=	106.58	(74)
North	0.9x	0.77	x	3.13	x	41.52	x	0.63	x	0.7	=	39.71	(74)
North	0.9x	0.77	x	5.4	x	41.52	x	0.63	x	0.7	=	68.52	(74)
North	0.9x	0.77	x	4.17	x	41.52	x	0.63	x	0.7	=	52.91	(74)
North	0.9x	0.77	x	1.18	x	24.19	x	0.63	x	0.7	=	8.72	(74)
North	0.9x	0.77	x	8.4	x	24.19	x	0.63	x	0.7	=	62.1	(74)
North	0.9x	0.77	x	3.13	x	24.19	x	0.63	x	0.7	=	23.14	(74)
North	0.9x	0.77	x	5.4	x	24.19	x	0.63	x	0.7	=	39.92	(74)
North	0.9x	0.77	x	4.17	x	24.19	x	0.63	x	0.7	=	30.83	(74)
North	0.9x	0.77	x	1.18	x	13.12	x	0.63	x	0.7	=	4.73	(74)
North	0.9x	0.77	x	8.4	x	13.12	x	0.63	x	0.7	=	33.67	(74)
North	0.9x	0.77	x	3.13	x	13.12	x	0.63	x	0.7	=	12.55	(74)
North	0.9x	0.77	x	5.4	x	13.12	x	0.63	x	0.7	=	21.65	(74)
North	0.9x	0.77	x	4.17	x	13.12	x	0.63	x	0.7	=	16.72	(74)
North	0.9x	0.77	x	1.18	x	8.86	x	0.63	x	0.7	=	3.2	(74)
North	0.9x	0.77	x	8.4	x	8.86	x	0.63	x	0.7	=	22.76	(74)
North	0.9x	0.77	x	3.13	x	8.86	x	0.63	x	0.7	=	8.48	(74)
North	0.9x	0.77	x	5.4	x	8.86	x	0.63	x	0.7	=	14.63	(74)
North	0.9x	0.77	x	4.17	x	8.86	x	0.63	x	0.7	=	11.3	(74)
East	0.9x	1	x	1.31	x	19.64	x	0.63	x	0.7	=	5.51	(76)
East	0.9x	1	x	1.31	x	19.64	x	0.63	x	0.7	=	5.51	(76)
East	0.9x	1	x	1.31	x	38.42	x	0.63	x	0.7	=	10.79	(76)
East	0.9x	1	x	1.31	x	38.42	x	0.63	x	0.7	=	10.79	(76)
East	0.9x	1	x	1.31	x	63.27	x	0.63	x	0.7	=	17.77	(76)
East	0.9x	1	x	1.31	x	63.27	x	0.63	x	0.7	=	17.77	(76)
East	0.9x	1	x	1.31	x	92.28	x	0.63	x	0.7	=	25.91	(76)
East	0.9x	1	x	1.31	x	92.28	x	0.63	x	0.7	=	25.91	(76)
East	0.9x	1	x	1.31	x	113.09	x	0.63	x	0.7	=	31.75	(76)

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East	0.9x	1	x	1.31	x	113.09	x	0.63	x	0.7	=	31.75	(76)
East	0.9x	1	x	1.31	x	115.77	x	0.63	x	0.7	=	32.5	(76)
East	0.9x	1	x	1.31	x	115.77	x	0.63	x	0.7	=	32.5	(76)
East	0.9x	1	x	1.31	x	110.22	x	0.63	x	0.7	=	30.95	(76)
East	0.9x	1	x	1.31	x	110.22	x	0.63	x	0.7	=	30.95	(76)
East	0.9x	1	x	1.31	x	94.68	x	0.63	x	0.7	=	26.58	(76)
East	0.9x	1	x	1.31	x	94.68	x	0.63	x	0.7	=	26.58	(76)
East	0.9x	1	x	1.31	x	73.59	x	0.63	x	0.7	=	20.66	(76)
East	0.9x	1	x	1.31	x	73.59	x	0.63	x	0.7	=	20.66	(76)
East	0.9x	1	x	1.31	x	45.59	x	0.63	x	0.7	=	12.8	(76)
East	0.9x	1	x	1.31	x	45.59	x	0.63	x	0.7	=	12.8	(76)
East	0.9x	1	x	1.31	x	24.49	x	0.63	x	0.7	=	6.88	(76)
East	0.9x	1	x	1.31	x	24.49	x	0.63	x	0.7	=	6.88	(76)
East	0.9x	1	x	1.31	x	16.15	x	0.63	x	0.7	=	4.53	(76)
East	0.9x	1	x	1.31	x	16.15	x	0.63	x	0.7	=	4.53	(76)
South	0.9x	0.77	x	8.4	x	46.75	x	0.63	x	0.7	=	120.02	(78)
South	0.9x	0.3	x	1.9	x	46.75	x	0.63	x	0.7	=	10.58	(78)
South	0.9x	0.77	x	3.13	x	46.75	x	0.63	x	0.7	=	44.72	(78)
South	0.9x	0.77	x	5.4	x	46.75	x	0.63	x	0.7	=	77.16	(78)
South	0.9x	0.77	x	4.17	x	46.75	x	0.63	x	0.7	=	59.58	(78)
South	0.9x	0.77	x	8.4	x	76.57	x	0.63	x	0.7	=	196.56	(78)
South	0.9x	0.3	x	1.9	x	76.57	x	0.63	x	0.7	=	17.32	(78)
South	0.9x	0.77	x	3.13	x	76.57	x	0.63	x	0.7	=	73.24	(78)
South	0.9x	0.77	x	5.4	x	76.57	x	0.63	x	0.7	=	126.36	(78)
South	0.9x	0.77	x	4.17	x	76.57	x	0.63	x	0.7	=	97.58	(78)
South	0.9x	0.77	x	8.4	x	97.53	x	0.63	x	0.7	=	250.38	(78)
South	0.9x	0.3	x	1.9	x	97.53	x	0.63	x	0.7	=	22.07	(78)
South	0.9x	0.77	x	3.13	x	97.53	x	0.63	x	0.7	=	93.3	(78)
South	0.9x	0.77	x	5.4	x	97.53	x	0.63	x	0.7	=	160.96	(78)
South	0.9x	0.77	x	4.17	x	97.53	x	0.63	x	0.7	=	124.3	(78)
South	0.9x	0.77	x	8.4	x	110.23	x	0.63	x	0.7	=	282.99	(78)
South	0.9x	0.3	x	1.9	x	110.23	x	0.63	x	0.7	=	24.94	(78)
South	0.9x	0.77	x	3.13	x	110.23	x	0.63	x	0.7	=	105.45	(78)
South	0.9x	0.77	x	5.4	x	110.23	x	0.63	x	0.7	=	181.92	(78)
South	0.9x	0.77	x	4.17	x	110.23	x	0.63	x	0.7	=	140.48	(78)
South	0.9x	0.77	x	8.4	x	114.87	x	0.63	x	0.7	=	294.89	(78)
South	0.9x	0.3	x	1.9	x	114.87	x	0.63	x	0.7	=	25.99	(78)
South	0.9x	0.77	x	3.13	x	114.87	x	0.63	x	0.7	=	109.88	(78)
South	0.9x	0.77	x	5.4	x	114.87	x	0.63	x	0.7	=	189.57	(78)
South	0.9x	0.77	x	4.17	x	114.87	x	0.63	x	0.7	=	146.39	(78)
South	0.9x	0.77	x	8.4	x	110.55	x	0.63	x	0.7	=	283.79	(78)

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South	0.9x	0.3	x	1.9	x	110.55	x	0.63	x	0.7	=	25.01	(78)
South	0.9x	0.77	x	3.13	x	110.55	x	0.63	x	0.7	=	105.75	(78)
South	0.9x	0.77	x	5.4	x	110.55	x	0.63	x	0.7	=	182.44	(78)
South	0.9x	0.77	x	4.17	x	110.55	x	0.63	x	0.7	=	140.88	(78)
South	0.9x	0.77	x	8.4	x	108.01	x	0.63	x	0.7	=	277.28	(78)
South	0.9x	0.3	x	1.9	x	108.01	x	0.63	x	0.7	=	24.44	(78)
South	0.9x	0.77	x	3.13	x	108.01	x	0.63	x	0.7	=	103.32	(78)
South	0.9x	0.77	x	5.4	x	108.01	x	0.63	x	0.7	=	178.25	(78)
South	0.9x	0.77	x	4.17	x	108.01	x	0.63	x	0.7	=	137.65	(78)
South	0.9x	0.77	x	8.4	x	104.89	x	0.63	x	0.7	=	269.28	(78)
South	0.9x	0.3	x	1.9	x	104.89	x	0.63	x	0.7	=	23.73	(78)
South	0.9x	0.77	x	3.13	x	104.89	x	0.63	x	0.7	=	100.34	(78)
South	0.9x	0.77	x	5.4	x	104.89	x	0.63	x	0.7	=	173.11	(78)
South	0.9x	0.77	x	4.17	x	104.89	x	0.63	x	0.7	=	133.68	(78)
South	0.9x	0.77	x	8.4	x	101.89	x	0.63	x	0.7	=	261.56	(78)
South	0.9x	0.3	x	1.9	x	101.89	x	0.63	x	0.7	=	23.05	(78)
South	0.9x	0.77	x	3.13	x	101.89	x	0.63	x	0.7	=	97.46	(78)
South	0.9x	0.77	x	5.4	x	101.89	x	0.63	x	0.7	=	168.14	(78)
South	0.9x	0.77	x	4.17	x	101.89	x	0.63	x	0.7	=	129.84	(78)
South	0.9x	0.77	x	8.4	x	82.59	x	0.63	x	0.7	=	212.01	(78)
South	0.9x	0.3	x	1.9	x	82.59	x	0.63	x	0.7	=	18.68	(78)
South	0.9x	0.77	x	3.13	x	82.59	x	0.63	x	0.7	=	79	(78)
South	0.9x	0.77	x	5.4	x	82.59	x	0.63	x	0.7	=	136.29	(78)
South	0.9x	0.77	x	4.17	x	82.59	x	0.63	x	0.7	=	105.25	(78)
South	0.9x	0.77	x	8.4	x	55.42	x	0.63	x	0.7	=	142.26	(78)
South	0.9x	0.3	x	1.9	x	55.42	x	0.63	x	0.7	=	12.54	(78)
South	0.9x	0.77	x	3.13	x	55.42	x	0.63	x	0.7	=	53.01	(78)
South	0.9x	0.77	x	5.4	x	55.42	x	0.63	x	0.7	=	91.46	(78)
South	0.9x	0.77	x	4.17	x	55.42	x	0.63	x	0.7	=	70.62	(78)
South	0.9x	0.77	x	8.4	x	40.4	x	0.63	x	0.7	=	103.71	(78)
South	0.9x	0.3	x	1.9	x	40.4	x	0.63	x	0.7	=	9.14	(78)
South	0.9x	0.77	x	3.13	x	40.4	x	0.63	x	0.7	=	38.64	(78)
South	0.9x	0.77	x	5.4	x	40.4	x	0.63	x	0.7	=	66.67	(78)
South	0.9x	0.77	x	4.17	x	40.4	x	0.63	x	0.7	=	51.48	(78)
West	0.9x	0.77	x	11.93	x	19.64	x	0.63	x	0.7	=	71.61	(80)
West	0.9x	0.77	x	11.93	x	38.42	x	0.63	x	0.7	=	140.08	(80)
West	0.9x	0.77	x	11.93	x	63.27	x	0.63	x	0.7	=	230.69	(80)
West	0.9x	0.77	x	11.93	x	92.28	x	0.63	x	0.7	=	336.45	(80)
West	0.9x	0.77	x	11.93	x	113.09	x	0.63	x	0.7	=	412.33	(80)
West	0.9x	0.77	x	11.93	x	115.77	x	0.63	x	0.7	=	422.1	(80)
West	0.9x	0.77	x	11.93	x	110.22	x	0.63	x	0.7	=	401.85	(80)

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West	0.9x	0.77	x	11.93	x	94.68	x	0.63	x	0.7	=	345.18	(80)
West	0.9x	0.77	x	11.93	x	73.59	x	0.63	x	0.7	=	268.3	(80)
West	0.9x	0.77	x	11.93	x	45.59	x	0.63	x	0.7	=	166.22	(80)
West	0.9x	0.77	x	11.93	x	24.49	x	0.63	x	0.7	=	89.29	(80)
West	0.9x	0.77	x	11.93	x	16.15	x	0.63	x	0.7	=	58.89	(80)

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

(83)m=	467.09	811.09	1152.35	1501.71	1751.31	1769.6	1693.16	1501.9	1272.37	907.76	562.25	397.96	(83)

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

(84)m=	1084.79	1426.48	1745.68	2058.55	2269.46	2251.05	2151.97	1968.12	1757.99	1430.11	1126.92	995.97	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.96	0.88	0.71	0.53	0.6	0.86	0.99	1	1	(86)

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

(87)m=	19.68	19.87	20.16	20.52	20.81	20.96	20.99	20.98	20.87	20.47	20	19.64	(87)

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

(88)m=	20	20	20.01	20.01	20.01	20.02	20.02	20.02	20.02	20.01	20.01	20.01	(88)

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

(89)m=	1	1	0.99	0.95	0.83	0.62	0.42	0.48	0.79	0.98	1	1	(89)

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

(90)m=	18.22	18.5	18.92	19.44	19.82	19.99	20.02	20.01	19.91	19.38	18.69	18.17	(90)

fLA = Living area ÷ (4) = 0.14 (91)

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

(92)m=	18.43	18.7	19.1	19.59	19.96	20.13	20.16	20.15	20.05	19.54	18.88	18.38	(92)

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

(93)m=	18.43	18.7	19.1	19.59	19.96	20.13	20.16	20.15	20.05	19.54	18.88	18.38	(93)

8. Space heating requirement

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

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

Utilisation factor for gains, hm:

(94)m=	1	1	0.98	0.94	0.83	0.63	0.44	0.5	0.8	0.97	1	1	(94)

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

(95)m=	1083.72	1420.7	1719.46	1942.55	1883.36	1413.57	939.32	983.84	1397.77	1390.39	1123.72	995.33	(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=	3831.8	3736.99	3406.41	2868.07	2213.92	1471.05	946.18	997.42	1587.4	2394	3164.45	3821.9	(97)

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

(98)m=	2044.58	1556.55	1255.09	666.38	245.94	0	0	0	0	746.69	1469.32	2102.97	

Total per year (kWh/year) = Sum(98)$_{1\ldots5,9\ldots12}$ = 10087.5 (98)

Space heating requirement in kWh/m²/year 40.84 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0 (201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1 (202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1 (204)
Efficiency of main space heating system 1		93.4 (206)
Efficiency of secondary/supplementary heating system, %		0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)												
2044.58	1556.55	1255.09	666.38	245.94	0	0	0	0	746.69	1469.32	2102.97	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)												(211)
2189.05	1666.54	1343.78	713.46	263.31	0	0	0	0	799.45	1573.15	2251.57	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 10800.32 (211)

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

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

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

Water heating

Output from water heater (calculated above)

225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	

Efficiency of water heater 80.3 (216)

(217)m=	89.28	89.13	88.81	87.98	85.8	80.3	80.3	80.3	80.3	88.12	89.03	89.34	(217)

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

(219)m=	252.47	222.83	234.67	212.08	212.9	200.66	192.24	213.97	213.72	219.58	230.15	246.16	

Total = Sum(219a)$_{1...12}$ = 2651.43 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		10800.32
Water heating fuel used		2651.43
Electricity for pumps, fans and electric keep-hot		
central heating pump:	30	(230c)
boiler with a fan-assisted flue	45	(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	75 (231)
Electricity for lighting		651.46 (232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year
Space heating (main system 1)	(211) x	0.216 =	2332.87 (261)
Space heating (secondary)	(215) x	0.519 =	0 (263)
Water heating	(219) x	0.216 =	572.71 (264)
Space and water heating	(261) + (262) + (263) + (264) =		2905.58 (265)

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Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	338.11	(268)
Total CO2, kg/year			sum of (265)…(271) =		3282.61	(272)

TER = 13.29 (273)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name: **Stroma Number:**

Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.1.25

Property Address: Belsize - 4-bed End

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	121	(1a) x	2.4	(2a) =	290.4	(3a)
First floor	68	(1b) x	2.4	(2b) =	163.2	(3b)
Second floor	58	(1c) x	2.4	(2c) =	139.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	247	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		592.8	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							5	x 10 =	50	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	50	÷ (5) =	0.08 (8)

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

Number of storeys in the dwelling (ns)		0 (9)
Additional infiltration	[(9)-1]x0.1 =	0 (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0 (11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35		
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0 (12)
If no draught lobby, enter 0.05, else enter 0		0 (13)
Percentage of windows and doors draught stripped		0 (14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0 (15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0 (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4 (17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.28 (18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used		
Number of sides sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85 (20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.24 (21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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Wind Factor (22a)m = (22)m ÷ 4

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

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

0.31	0.3	0.3	0.27	0.26	0.23	0.23	0.22	0.24	0.26	0.27	0.28

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0

(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0

(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0

(24c)

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

(24d)m=	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.52	0.53	0.53	0.54	0.54

(24d)

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

(25)m=	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.52	0.53	0.53	0.54	0.54

(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.89	x	1.6	=	3.024			(26)
Windows Type 1			1.7	x1/[1/(1.4)+ 0.04]		=	2.25			(27)
Windows Type 2			12.08	x1/[1/(1.4)+ 0.04]		=	16.02			(27)
Windows Type 3			12.08	x1/[1/(1.4)+ 0.04]		=	16.02			(27)
Windows Type 4			17.16	x1/[1/(1.4)+ 0.04]		=	22.75			(27)
Windows Type 5			2.73	x1/[1/(1.4)+ 0.04]		=	3.62			(27)
Windows Type 6			4.5	x1/[1/(1.4)+ 0.04]		=	5.97			(27)
Windows Type 7			4.5	x1/[1/(1.4)+ 0.04]		=	5.97			(27)
Windows Type 8			7.77	x1/[1/(1.4)+ 0.04]		=	10.3			(27)
Windows Type 9			1.89	x1/[1/(1.4)+ 0.04]		=	2.51			(27)
Windows Type 10			7.77	x1/[1/(1.4)+ 0.04]		=	10.3			(27)
Windows Type 11			1.89	x1/[1/(1.4)+ 0.04]		=	2.51			(27)
Windows Type 12			6	x1/[1/(1.4)+ 0.04]		=	7.95			(27)
Windows Type 13			6	x1/[1/(1.4)+ 0.04]		=	7.95			(27)
Floor			121	x	0.11	=	13.31			(28)
Walls	263.37	87.96	175.41	x	0.17	=	29.82			(29)
Roof Type1	58	0	58	x	0.11	=	6.38			(30)

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Roof Type2	10	0	10	x	0.11	=	1.1			(30)
Roof Type3	53	0	53	x	0.11	=	5.83			(30)
Total area of elements, m²			505.37							(31)
Party wall			72.14	x	0	=	0			(32)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 173.57 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 41525.3 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

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

Thermal bridges : S (L x Y) calculated using Appendix K 36.32 (36)

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

Total fabric heat loss (33) + (36) = 209.89 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	107.1	106.74	106.39	104.73	104.41	102.97	102.97	102.7	103.53	104.41	105.04	105.7	(38)

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

(39)m=	316.99	316.63	316.28	314.62	314.31	312.86	312.86	312.6	313.42	314.31	314.94	315.59	

Average = Sum(39)$_{1...12}$ /12= 314.62 (39)

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

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

Average = Sum(40)$_{1...12}$ /12= 1.27 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 3.06 (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) + 36 106.95 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	117.64	113.36	109.09	104.81	100.53	96.25	96.25	100.53	104.81	109.09	113.36	117.64	

Total = Sum(44)$_{1...12}$ = 1283.36 (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=	174.46	152.58	157.45	137.27	131.71	113.66	105.32	120.86	122.3	142.53	155.58	168.95	

Total = Sum(45)$_{1...12}$ = 1682.69 (45)

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

(46)m=	26.17	22.89	23.62	20.59	19.76	17.05	15.8	18.13	18.35	21.38	23.34	25.34	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		0	(48)
Temperature factor from Table 2b		0	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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

(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

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

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

(61)m=	50.96	46.03	50.96	49.32	50.96	47.47	49.05	50.96	49.32	50.96	49.32	50.96	(61)

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

(62)m=	225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	(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=	225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	

Output from water heater (annual)$_{1...12}$: 2278.93 (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=	70.75	62.24	65.09	57.97	56.53	49.66	47.28	52.93	52.99	60.13	64.06	68.92	(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=	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	(66)

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

(67)m=	36.89	32.76	26.65	20.17	15.08	12.73	13.76	17.88	24	30.47	35.56	37.91	(67)

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

(68)m=	413.78	418.07	407.25	384.21	355.14	327.81	309.55	305.26	316.08	339.11	368.19	395.52	(68)

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

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(69)m=	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	(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=	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	(71)

Water heating gains (Table 5)

(72)m=	95.09	92.62	87.49	80.52	75.99	68.97	63.55	71.14	73.6	80.82	88.97	92.63	(72)

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

(73)m=	617.7	615.4	593.33	556.85	518.15	481.46	458.8	466.22	485.63	522.35	564.67	598.01	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x 0.77	x	1.7	x	10.63	x	0.85	x	0.7	=	7.45	(74)
North	0.9x 0.77	x	12.08	x	10.63	x	0.85	x	0.7	=	52.96	(74)
North	0.9x 0.77	x	4.5	x	10.63	x	0.85	x	0.7	=	19.73	(74)
North	0.9x 0.77	x	7.77	x	10.63	x	0.85	x	0.7	=	34.07	(74)
North	0.9x 0.77	x	6	x	10.63	x	0.85	x	0.7	=	26.31	(74)
North	0.9x 0.77	x	1.7	x	20.32	x	0.85	x	0.7	=	14.24	(74)
North	0.9x 0.77	x	12.08	x	20.32	x	0.85	x	0.7	=	101.22	(74)
North	0.9x 0.77	x	4.5	x	20.32	x	0.85	x	0.7	=	37.71	(74)
North	0.9x 0.77	x	7.77	x	20.32	x	0.85	x	0.7	=	65.11	(74)
North	0.9x 0.77	x	6	x	20.32	x	0.85	x	0.7	=	50.27	(74)
North	0.9x 0.77	x	1.7	x	34.53	x	0.85	x	0.7	=	24.2	(74)
North	0.9x 0.77	x	12.08	x	34.53	x	0.85	x	0.7	=	172	(74)
North	0.9x 0.77	x	4.5	x	34.53	x	0.85	x	0.7	=	64.07	(74)
North	0.9x 0.77	x	7.77	x	34.53	x	0.85	x	0.7	=	110.63	(74)
North	0.9x 0.77	x	6	x	34.53	x	0.85	x	0.7	=	85.43	(74)
North	0.9x 0.77	x	1.7	x	55.46	x	0.85	x	0.7	=	38.88	(74)
North	0.9x 0.77	x	12.08	x	55.46	x	0.85	x	0.7	=	276.27	(74)
North	0.9x 0.77	x	4.5	x	55.46	x	0.85	x	0.7	=	102.91	(74)
North	0.9x 0.77	x	7.77	x	55.46	x	0.85	x	0.7	=	177.7	(74)
North	0.9x 0.77	x	6	x	55.46	x	0.85	x	0.7	=	137.22	(74)
North	0.9x 0.77	x	1.7	x	74.72	x	0.85	x	0.7	=	52.37	(74)
North	0.9x 0.77	x	12.08	x	74.72	x	0.85	x	0.7	=	372.16	(74)
North	0.9x 0.77	x	4.5	x	74.72	x	0.85	x	0.7	=	138.64	(74)
North	0.9x 0.77	x	7.77	x	74.72	x	0.85	x	0.7	=	239.38	(74)
North	0.9x 0.77	x	6	x	74.72	x	0.85	x	0.7	=	184.85	(74)
North	0.9x 0.77	x	1.7	x	79.99	x	0.85	x	0.7	=	56.07	(74)
North	0.9x 0.77	x	12.08	x	79.99	x	0.85	x	0.7	=	398.41	(74)
North	0.9x 0.77	x	4.5	x	79.99	x	0.85	x	0.7	=	148.41	(74)

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North	0.9x	0.77	x	7.77	x	79.99	x	0.85	x	0.7	=	256.26	(74)
North	0.9x	0.77	x	6	x	79.99	x	0.85	x	0.7	=	197.88	(74)
North	0.9x	0.77	x	1.7	x	74.68	x	0.85	x	0.7	=	52.35	(74)
North	0.9x	0.77	x	12.08	x	74.68	x	0.85	x	0.7	=	371.96	(74)
North	0.9x	0.77	x	4.5	x	74.68	x	0.85	x	0.7	=	138.56	(74)
North	0.9x	0.77	x	7.77	x	74.68	x	0.85	x	0.7	=	239.25	(74)
North	0.9x	0.77	x	6	x	74.68	x	0.85	x	0.7	=	184.75	(74)
North	0.9x	0.77	x	1.7	x	59.25	x	0.85	x	0.7	=	41.53	(74)
North	0.9x	0.77	x	12.08	x	59.25	x	0.85	x	0.7	=	295.11	(74)
North	0.9x	0.77	x	4.5	x	59.25	x	0.85	x	0.7	=	109.93	(74)
North	0.9x	0.77	x	7.77	x	59.25	x	0.85	x	0.7	=	189.82	(74)
North	0.9x	0.77	x	6	x	59.25	x	0.85	x	0.7	=	146.58	(74)
North	0.9x	0.77	x	1.7	x	41.52	x	0.85	x	0.7	=	29.1	(74)
North	0.9x	0.77	x	12.08	x	41.52	x	0.85	x	0.7	=	206.79	(74)
North	0.9x	0.77	x	4.5	x	41.52	x	0.85	x	0.7	=	77.03	(74)
North	0.9x	0.77	x	7.77	x	41.52	x	0.85	x	0.7	=	133.01	(74)
North	0.9x	0.77	x	6	x	41.52	x	0.85	x	0.7	=	102.71	(74)
North	0.9x	0.77	x	1.7	x	24.19	x	0.85	x	0.7	=	16.96	(74)
North	0.9x	0.77	x	12.08	x	24.19	x	0.85	x	0.7	=	120.49	(74)
North	0.9x	0.77	x	4.5	x	24.19	x	0.85	x	0.7	=	44.88	(74)
North	0.9x	0.77	x	7.77	x	24.19	x	0.85	x	0.7	=	77.5	(74)
North	0.9x	0.77	x	6	x	24.19	x	0.85	x	0.7	=	59.84	(74)
North	0.9x	0.77	x	1.7	x	13.12	x	0.85	x	0.7	=	9.2	(74)
North	0.9x	0.77	x	12.08	x	13.12	x	0.85	x	0.7	=	65.34	(74)
North	0.9x	0.77	x	4.5	x	13.12	x	0.85	x	0.7	=	24.34	(74)
North	0.9x	0.77	x	7.77	x	13.12	x	0.85	x	0.7	=	42.03	(74)
North	0.9x	0.77	x	6	x	13.12	x	0.85	x	0.7	=	32.45	(74)
North	0.9x	0.77	x	1.7	x	8.86	x	0.85	x	0.7	=	6.21	(74)
North	0.9x	0.77	x	12.08	x	8.86	x	0.85	x	0.7	=	44.15	(74)
North	0.9x	0.77	x	4.5	x	8.86	x	0.85	x	0.7	=	16.45	(74)
North	0.9x	0.77	x	7.77	x	8.86	x	0.85	x	0.7	=	28.4	(74)
North	0.9x	0.77	x	6	x	8.86	x	0.85	x	0.7	=	21.93	(74)
East	0.9x	1	x	1.89	x	19.64	x	0.85	x	0.7	=	10.73	(76)
East	0.9x	1	x	1.89	x	19.64	x	0.85	x	0.7	=	10.73	(76)
East	0.9x	1	x	1.89	x	38.42	x	0.85	x	0.7	=	21	(76)
East	0.9x	1	x	1.89	x	38.42	x	0.85	x	0.7	=	21	(76)
East	0.9x	1	x	1.89	x	63.27	x	0.85	x	0.7	=	34.58	(76)
East	0.9x	1	x	1.89	x	63.27	x	0.85	x	0.7	=	34.58	(76)
East	0.9x	1	x	1.89	x	92.28	x	0.85	x	0.7	=	50.43	(76)
East	0.9x	1	x	1.89	x	92.28	x	0.85	x	0.7	=	50.43	(76)
East	0.9x	1	x	1.89	x	113.09	x	0.85	x	0.7	=	61.81	(76)

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East	0.9x	1	x	1.89	x	113.09	x	0.85	x	0.7	=	61.81	(76)
East	0.9x	1	x	1.89	x	115.77	x	0.85	x	0.7	=	63.27	(76)
East	0.9x	1	x	1.89	x	115.77	x	0.85	x	0.7	=	63.27	(76)
East	0.9x	1	x	1.89	x	110.22	x	0.85	x	0.7	=	60.24	(76)
East	0.9x	1	x	1.89	x	110.22	x	0.85	x	0.7	=	60.24	(76)
East	0.9x	1	x	1.89	x	94.68	x	0.85	x	0.7	=	51.74	(76)
East	0.9x	1	x	1.89	x	94.68	x	0.85	x	0.7	=	51.74	(76)
East	0.9x	1	x	1.89	x	73.59	x	0.85	x	0.7	=	40.22	(76)
East	0.9x	1	x	1.89	x	73.59	x	0.85	x	0.7	=	40.22	(76)
East	0.9x	1	x	1.89	x	45.59	x	0.85	x	0.7	=	24.92	(76)
East	0.9x	1	x	1.89	x	45.59	x	0.85	x	0.7	=	24.92	(76)
East	0.9x	1	x	1.89	x	24.49	x	0.85	x	0.7	=	13.38	(76)
East	0.9x	1	x	1.89	x	24.49	x	0.85	x	0.7	=	13.38	(76)
East	0.9x	1	x	1.89	x	16.15	x	0.85	x	0.7	=	8.83	(76)
East	0.9x	1	x	1.89	x	16.15	x	0.85	x	0.7	=	8.83	(76)
South	0.9x	0.77	x	12.08	x	46.75	x	0.85	x	0.7	=	232.87	(78)
South	0.9x	0.3	x	2.73	x	46.75	x	0.85	x	0.7	=	20.5	(78)
South	0.9x	0.77	x	4.5	x	46.75	x	0.85	x	0.7	=	86.75	(78)
South	0.9x	0.77	x	7.77	x	46.75	x	0.85	x	0.7	=	149.79	(78)
South	0.9x	0.77	x	6	x	46.75	x	0.85	x	0.7	=	115.67	(78)
South	0.9x	0.77	x	12.08	x	76.57	x	0.85	x	0.7	=	381.38	(78)
South	0.9x	0.3	x	2.73	x	76.57	x	0.85	x	0.7	=	33.58	(78)
South	0.9x	0.77	x	4.5	x	76.57	x	0.85	x	0.7	=	142.07	(78)
South	0.9x	0.77	x	7.77	x	76.57	x	0.85	x	0.7	=	245.31	(78)
South	0.9x	0.77	x	6	x	76.57	x	0.85	x	0.7	=	189.43	(78)
South	0.9x	0.77	x	12.08	x	97.53	x	0.85	x	0.7	=	485.82	(78)
South	0.9x	0.3	x	2.73	x	97.53	x	0.85	x	0.7	=	42.78	(78)
South	0.9x	0.77	x	4.5	x	97.53	x	0.85	x	0.7	=	180.97	(78)
South	0.9x	0.77	x	7.77	x	97.53	x	0.85	x	0.7	=	312.48	(78)
South	0.9x	0.77	x	6	x	97.53	x	0.85	x	0.7	=	241.3	(78)
South	0.9x	0.77	x	12.08	x	110.23	x	0.85	x	0.7	=	549.08	(78)
South	0.9x	0.3	x	2.73	x	110.23	x	0.85	x	0.7	=	48.35	(78)
South	0.9x	0.77	x	4.5	x	110.23	x	0.85	x	0.7	=	204.54	(78)
South	0.9x	0.77	x	7.77	x	110.23	x	0.85	x	0.7	=	353.17	(78)
South	0.9x	0.77	x	6	x	110.23	x	0.85	x	0.7	=	272.72	(78)
South	0.9x	0.77	x	12.08	x	114.87	x	0.85	x	0.7	=	572.17	(78)
South	0.9x	0.3	x	2.73	x	114.87	x	0.85	x	0.7	=	50.38	(78)
South	0.9x	0.77	x	4.5	x	114.87	x	0.85	x	0.7	=	213.14	(78)
South	0.9x	0.77	x	7.77	x	114.87	x	0.85	x	0.7	=	368.03	(78)
South	0.9x	0.77	x	6	x	114.87	x	0.85	x	0.7	=	284.19	(78)
South	0.9x	0.77	x	12.08	x	110.55	x	0.85	x	0.7	=	550.64	(78)

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South	0.9x	0.3	x	2.73	x	110.55	x	0.85	x	0.7	=	48.48	(78)
South	0.9x	0.77	x	4.5	x	110.55	x	0.85	x	0.7	=	205.12	(78)
South	0.9x	0.77	x	7.77	x	110.55	x	0.85	x	0.7	=	354.18	(78)
South	0.9x	0.77	x	6	x	110.55	x	0.85	x	0.7	=	273.5	(78)
South	0.9x	0.77	x	12.08	x	108.01	x	0.85	x	0.7	=	538.01	(78)
South	0.9x	0.3	x	2.73	x	108.01	x	0.85	x	0.7	=	47.37	(78)
South	0.9x	0.77	x	4.5	x	108.01	x	0.85	x	0.7	=	200.42	(78)
South	0.9x	0.77	x	7.77	x	108.01	x	0.85	x	0.7	=	346.05	(78)
South	0.9x	0.77	x	6	x	108.01	x	0.85	x	0.7	=	267.22	(78)
South	0.9x	0.77	x	12.08	x	104.89	x	0.85	x	0.7	=	522.48	(78)
South	0.9x	0.3	x	2.73	x	104.89	x	0.85	x	0.7	=	46	(78)
South	0.9x	0.77	x	4.5	x	104.89	x	0.85	x	0.7	=	194.63	(78)
South	0.9x	0.77	x	7.77	x	104.89	x	0.85	x	0.7	=	336.07	(78)
South	0.9x	0.77	x	6	x	104.89	x	0.85	x	0.7	=	259.51	(78)
South	0.9x	0.77	x	12.08	x	101.89	x	0.85	x	0.7	=	507.49	(78)
South	0.9x	0.3	x	2.73	x	101.89	x	0.85	x	0.7	=	44.68	(78)
South	0.9x	0.77	x	4.5	x	101.89	x	0.85	x	0.7	=	189.05	(78)
South	0.9x	0.77	x	7.77	x	101.89	x	0.85	x	0.7	=	326.43	(78)
South	0.9x	0.77	x	6	x	101.89	x	0.85	x	0.7	=	252.07	(78)
South	0.9x	0.77	x	12.08	x	82.59	x	0.85	x	0.7	=	411.36	(78)
South	0.9x	0.3	x	2.73	x	82.59	x	0.85	x	0.7	=	36.22	(78)
South	0.9x	0.77	x	4.5	x	82.59	x	0.85	x	0.7	=	153.24	(78)
South	0.9x	0.77	x	7.77	x	82.59	x	0.85	x	0.7	=	264.59	(78)
South	0.9x	0.77	x	6	x	82.59	x	0.85	x	0.7	=	204.32	(78)
South	0.9x	0.77	x	12.08	x	55.42	x	0.85	x	0.7	=	276.03	(78)
South	0.9x	0.3	x	2.73	x	55.42	x	0.85	x	0.7	=	24.3	(78)
South	0.9x	0.77	x	4.5	x	55.42	x	0.85	x	0.7	=	102.83	(78)
South	0.9x	0.77	x	7.77	x	55.42	x	0.85	x	0.7	=	177.55	(78)
South	0.9x	0.77	x	6	x	55.42	x	0.85	x	0.7	=	137.1	(78)
South	0.9x	0.77	x	12.08	x	40.4	x	0.85	x	0.7	=	201.22	(78)
South	0.9x	0.3	x	2.73	x	40.4	x	0.85	x	0.7	=	17.72	(78)
South	0.9x	0.77	x	4.5	x	40.4	x	0.85	x	0.7	=	74.96	(78)
South	0.9x	0.77	x	7.77	x	40.4	x	0.85	x	0.7	=	129.43	(78)
South	0.9x	0.77	x	6	x	40.4	x	0.85	x	0.7	=	99.95	(78)
West	0.9x	0.77	x	17.16	x	19.64	x	0.85	x	0.7	=	138.97	(80)
West	0.9x	0.77	x	17.16	x	38.42	x	0.85	x	0.7	=	271.85	(80)
West	0.9x	0.77	x	17.16	x	63.27	x	0.85	x	0.7	=	447.7	(80)
West	0.9x	0.77	x	17.16	x	92.28	x	0.85	x	0.7	=	652.94	(80)
West	0.9x	0.77	x	17.16	x	113.09	x	0.85	x	0.7	=	800.21	(80)
West	0.9x	0.77	x	17.16	x	115.77	x	0.85	x	0.7	=	819.15	(80)
West	0.9x	0.77	x	17.16	x	110.22	x	0.85	x	0.7	=	779.87	(80)

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West	0.9x	0.77	x	17.16	x	94.68	x	0.85	x	0.7	=	669.89	(80)
West	0.9x	0.77	x	17.16	x	73.59	x	0.85	x	0.7	=	520.69	(80)
West	0.9x	0.77	x	17.16	x	45.59	x	0.85	x	0.7	=	322.57	(80)
West	0.9x	0.77	x	17.16	x	24.49	x	0.85	x	0.7	=	173.28	(80)
West	0.9x	0.77	x	17.16	x	16.15	x	0.85	x	0.7	=	114.28	(80)

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

(83)m=	906.54	1574.17	2236.54	2914.65	3399.14	3434.65	3286.29	2915.03	2469.5	1761.8	1091.21	772.36	(83)

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

(84)m=	1524.24	2189.57	2829.87	3471.5	3917.29	3916.11	3745.1	3381.26	2955.13	2284.16	1655.89	1370.36	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.96	0.86	0.69	0.5	0.37	0.42	0.68	0.93	0.99	1	(86)

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

(87)m=	19.6	19.91	20.3	20.69	20.91	20.98	21	20.99	20.94	20.58	19.98	19.54	(87)

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

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

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

(89)m=	1	0.98	0.94	0.82	0.62	0.42	0.27	0.32	0.59	0.91	0.99	1	(89)

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

(90)m=	18.59	18.9	19.28	19.64	19.81	19.86	19.87	19.87	19.84	19.55	18.98	18.53	(90)

fLA = Living area ÷ (4) = 0.14 (91)

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

(92)m=	18.73	19.04	19.42	19.79	19.97	20.02	20.03	20.03	19.99	19.7	19.12	18.67	(92)

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

(93)m=	18.58	18.89	19.27	19.64	19.82	19.87	19.88	19.88	19.84	19.55	18.97	18.52	(93)

8. Space heating requirement

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

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

Utilisation factor for gains, hm:

(94)m=	1	0.98	0.93	0.81	0.62	0.42	0.27	0.32	0.58	0.9	0.99	1	(94)

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

(95)m=	1517.52	2145.79	2640.29	2815.95	2418.01	1631.96	1023.73	1083.34	1725.56	2047.33	1634.43	1366.53	(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=	4527.38	4430.32	4040.01	3378.39	2551.79	1649.12	1025.52	1087.08	1800.4	2811.93	3738.3	4520.67	(97)

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

(98)m=	2239.34	1535.2	1041.39	404.95	99.53	0	0	0	0	568.86	1514.79	2346.68	

Total per year (kWh/year) = Sum(98)$_{1…5,9…12}$ = 9750.75 (98)

Space heating requirement in kWh/m²/year 39.48 (99)

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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		93.3 (206)
Efficiency of secondary/supplementary heating system, %		0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)												
2239.34	1535.2	1041.39	404.95	99.53	0	0	0	0	568.86	1514.79	2346.68	

(211)m = {[(98)m x (204)] } x 100 ÷ (206) (211)

2400.15	1645.45	1116.17	434.03	106.68	0	0	0	0	609.71	1623.57	2515.2	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 10450.96 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

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

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

Water heating

Output from water heater (calculated above)

225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	

Efficiency of water heater 80.2 (216)

(217)m=	89.27	89.02	88.44	86.85	83.49	80.2	80.2	80.2	80.2	87.5	88.97	89.34	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	252.51	223.12	235.65	214.84	218.79	200.91	192.48	214.24	213.99	221.12	230.31	246.16	

Total = Sum(219a)$_{1...12}$ = 2664.11 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		10450.96
Water heating fuel used		2664.11
Electricity for pumps, fans and electric keep-hot		
central heating pump:	30	(230c)
boiler with a fan-assisted flue	45	(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		75 (231)
Electricity for lighting		651.46 (232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year
Space heating (main system 1)	(211) x	0.216 =	2257.41 (261)
Space heating (secondary)	(215) x	0.519 =	0 (263)
Water heating	(219) x	0.216 =	575.45 (264)
Space and water heating	(261) + (262) + (263) + (264) =		2832.86 (265)

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Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	338.11	(268)
Total CO2, kg/year			sum of (265)…(271) =		3209.89	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		13	(273)
EI rating (section 14)					85	(274)

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User Details:

Assessor Name: **Stroma Number:**

Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.1.25

Property Address: Belsize - 4-bed End

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	121	(1a) x	2.4	(2a) =	290.4	(3a)
First floor	68	(1b) x	2.4	(2b) =	163.2	(3b)
Second floor	58	(1c) x	2.4	(2c) =	139.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	247	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		592.8	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							4	x 10 =	40	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.07 (8)

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

Number of storeys in the dwelling (ns)		0 (9)
Additional infiltration	[(9)-1]x0.1 =	0 (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0 (11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35		
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0 (12)
If no draught lobby, enter 0.05, else enter 0		0 (13)
Percentage of windows and doors draught stripped		0 (14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0 (15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0 (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5 (17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.32 (18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used		
Number of sides sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85 (20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.27 (21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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Wind Factor (22a)m = (22)m ÷ 4

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

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

0.34	0.34	0.33	0.3	0.29	0.26	0.26	0.25	0.27	0.29	0.3	0.32

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.89	x	1	=	1.89			(26)
Windows Type 1			1.18	x1/[1/(1.4)+ 0.04]		=	1.56			(27)
Windows Type 2			8.4	x1/[1/(1.4)+ 0.04]		=	11.14			(27)
Windows Type 3			8.4	x1/[1/(1.4)+ 0.04]		=	11.14			(27)
Windows Type 4			11.93	x1/[1/(1.4)+ 0.04]		=	15.82			(27)
Windows Type 5			1.9	x1/[1/(1.4)+ 0.04]		=	2.52			(27)
Windows Type 6			3.13	x1/[1/(1.4)+ 0.04]		=	4.15			(27)
Windows Type 7			3.13	x1/[1/(1.4)+ 0.04]		=	4.15			(27)
Windows Type 8			5.4	x1/[1/(1.4)+ 0.04]		=	7.16			(27)
Windows Type 9			1.31	x1/[1/(1.4)+ 0.04]		=	1.74			(27)
Windows Type 10			5.4	x1/[1/(1.4)+ 0.04]		=	7.16			(27)
Windows Type 11			1.31	x1/[1/(1.4)+ 0.04]		=	1.74			(27)
Windows Type 12			4.17	x1/[1/(1.4)+ 0.04]		=	5.53			(27)
Windows Type 13			4.17	x1/[1/(1.4)+ 0.04]		=	5.53			(27)
Floor			121	x	0.13	=	15.73			(28)
Walls	263.37	61.72	201.65	x	0.18	=	36.3			(29)
Roof Type1	58	0	58	x	0.13	=	7.54			(30)

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Roof Type2	10	0	10	x	0.13	=	1.3			(30)
Roof Type3	53	0	53	x	0.13	=	6.89			(30)
Total area of elements, m²			505.37							(31)
Party wall			72.14	x	0	=	0			(32)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 148.97 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 45461.3 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

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

Thermal bridges : S (L x Y) calculated using Appendix K 25.97 (36)

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

Total fabric heat loss (33) + (36) = 174.94 (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=	109.39	108.94	108.5	106.43	106.04	104.24	104.24	103.91	104.93	106.04	106.83	107.65	(38)

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

(39)m=	284.33	283.88	283.44	281.37	280.98	279.18	279.18	278.84	279.87	280.98	281.76	282.58	

Average = Sum(39)$_{1...12}$ /12= 281.37 (39)

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

(40)m=	1.15	1.15	1.15	1.14	1.14	1.13	1.13	1.13	1.13	1.14	1.14	1.14	

Average = Sum(40)$_{1...12}$ /12= 1.14 (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 3.06 (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) + 36 106.95 (43)

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

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

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

(44)m=	117.64	113.36	109.09	104.81	100.53	96.25	96.25	100.53	104.81	109.09	113.36	117.64	

Total = Sum(44)$_{1...12}$ = 1283.36 (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=	174.46	152.58	157.45	137.27	131.71	113.66	105.32	120.86	122.3	142.53	155.58	168.95	

Total = Sum(45)$_{1...12}$ = 1682.69 (45)

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

(46)m=	26.17	22.89	23.62	20.59	19.76	17.05	15.8	18.13	18.35	21.38	23.34	25.34	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		0	(48)
Temperature factor from Table 2b		0	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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

(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

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

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

(61)m=	50.96	46.03	50.96	49.32	50.96	47.47	49.05	50.96	49.32	50.96	49.32	50.96	(61)

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

(62)m=	225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	(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=	225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	

Output from water heater (annual)$_{1...12}$ 2278.93 (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=	70.75	62.24	65.09	57.97	56.53	49.66	47.28	52.93	52.99	60.13	64.06	68.92	(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=	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	153.15	(66)

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

(67)m=	36.89	32.76	26.65	20.17	15.08	12.73	13.76	17.88	24	30.47	35.56	37.91	(67)

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

(68)m=	413.78	418.07	407.25	384.21	355.14	327.81	309.55	305.26	316.08	339.11	368.19	395.52	(68)

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

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(69)m=	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	(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=	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	-122.52	(71)

Water heating gains (Table 5)

(72)m=	95.09	92.62	87.49	80.52	75.99	68.97	63.55	71.14	73.6	80.82	88.97	92.63	(72)

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

(73)m=	617.7	615.4	593.33	556.85	518.15	481.46	458.8	466.22	485.63	522.35	564.67	598.01	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x 0.77	x	1.18	x	10.63	x	0.63	x	0.7	=	3.83	(74)
North	0.9x 0.77	x	8.4	x	10.63	x	0.63	x	0.7	=	27.3	(74)
North	0.9x 0.77	x	3.13	x	10.63	x	0.63	x	0.7	=	10.17	(74)
North	0.9x 0.77	x	5.4	x	10.63	x	0.63	x	0.7	=	17.55	(74)
North	0.9x 0.77	x	4.17	x	10.63	x	0.63	x	0.7	=	13.55	(74)
North	0.9x 0.77	x	1.18	x	20.32	x	0.63	x	0.7	=	7.33	(74)
North	0.9x 0.77	x	8.4	x	20.32	x	0.63	x	0.7	=	52.17	(74)
North	0.9x 0.77	x	3.13	x	20.32	x	0.63	x	0.7	=	19.44	(74)
North	0.9x 0.77	x	5.4	x	20.32	x	0.63	x	0.7	=	33.54	(74)
North	0.9x 0.77	x	4.17	x	20.32	x	0.63	x	0.7	=	25.9	(74)
North	0.9x 0.77	x	1.18	x	34.53	x	0.63	x	0.7	=	12.45	(74)
North	0.9x 0.77	x	8.4	x	34.53	x	0.63	x	0.7	=	88.64	(74)
North	0.9x 0.77	x	3.13	x	34.53	x	0.63	x	0.7	=	33.03	(74)
North	0.9x 0.77	x	5.4	x	34.53	x	0.63	x	0.7	=	56.99	(74)
North	0.9x 0.77	x	4.17	x	34.53	x	0.63	x	0.7	=	44.01	(74)
North	0.9x 0.77	x	1.18	x	55.46	x	0.63	x	0.7	=	20	(74)
North	0.9x 0.77	x	8.4	x	55.46	x	0.63	x	0.7	=	142.39	(74)
North	0.9x 0.77	x	3.13	x	55.46	x	0.63	x	0.7	=	53.06	(74)
North	0.9x 0.77	x	5.4	x	55.46	x	0.63	x	0.7	=	91.53	(74)
North	0.9x 0.77	x	4.17	x	55.46	x	0.63	x	0.7	=	70.68	(74)
North	0.9x 0.77	x	1.18	x	74.72	x	0.63	x	0.7	=	26.94	(74)
North	0.9x 0.77	x	8.4	x	74.72	x	0.63	x	0.7	=	191.81	(74)
North	0.9x 0.77	x	3.13	x	74.72	x	0.63	x	0.7	=	71.47	(74)
North	0.9x 0.77	x	5.4	x	74.72	x	0.63	x	0.7	=	123.3	(74)
North	0.9x 0.77	x	4.17	x	74.72	x	0.63	x	0.7	=	95.22	(74)
North	0.9x 0.77	x	1.18	x	79.99	x	0.63	x	0.7	=	28.84	(74)
North	0.9x 0.77	x	8.4	x	79.99	x	0.63	x	0.7	=	205.33	(74)
North	0.9x 0.77	x	3.13	x	79.99	x	0.63	x	0.7	=	76.51	(74)

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North	0.9x	0.77	x	5.4	x	79.99	x	0.63	x	0.7	=	132	(74)
North	0.9x	0.77	x	4.17	x	79.99	x	0.63	x	0.7	=	101.93	(74)
North	0.9x	0.77	x	1.18	x	74.68	x	0.63	x	0.7	=	26.93	(74)
North	0.9x	0.77	x	8.4	x	74.68	x	0.63	x	0.7	=	191.71	(74)
North	0.9x	0.77	x	3.13	x	74.68	x	0.63	x	0.7	=	71.43	(74)
North	0.9x	0.77	x	5.4	x	74.68	x	0.63	x	0.7	=	123.24	(74)
North	0.9x	0.77	x	4.17	x	74.68	x	0.63	x	0.7	=	95.17	(74)
North	0.9x	0.77	x	1.18	x	59.25	x	0.63	x	0.7	=	21.37	(74)
North	0.9x	0.77	x	8.4	x	59.25	x	0.63	x	0.7	=	152.09	(74)
North	0.9x	0.77	x	3.13	x	59.25	x	0.63	x	0.7	=	56.67	(74)
North	0.9x	0.77	x	5.4	x	59.25	x	0.63	x	0.7	=	97.77	(74)
North	0.9x	0.77	x	4.17	x	59.25	x	0.63	x	0.7	=	75.5	(74)
North	0.9x	0.77	x	1.18	x	41.52	x	0.63	x	0.7	=	14.97	(74)
North	0.9x	0.77	x	8.4	x	41.52	x	0.63	x	0.7	=	106.58	(74)
North	0.9x	0.77	x	3.13	x	41.52	x	0.63	x	0.7	=	39.71	(74)
North	0.9x	0.77	x	5.4	x	41.52	x	0.63	x	0.7	=	68.52	(74)
North	0.9x	0.77	x	4.17	x	41.52	x	0.63	x	0.7	=	52.91	(74)
North	0.9x	0.77	x	1.18	x	24.19	x	0.63	x	0.7	=	8.72	(74)
North	0.9x	0.77	x	8.4	x	24.19	x	0.63	x	0.7	=	62.1	(74)
North	0.9x	0.77	x	3.13	x	24.19	x	0.63	x	0.7	=	23.14	(74)
North	0.9x	0.77	x	5.4	x	24.19	x	0.63	x	0.7	=	39.92	(74)
North	0.9x	0.77	x	4.17	x	24.19	x	0.63	x	0.7	=	30.83	(74)
North	0.9x	0.77	x	1.18	x	13.12	x	0.63	x	0.7	=	4.73	(74)
North	0.9x	0.77	x	8.4	x	13.12	x	0.63	x	0.7	=	33.67	(74)
North	0.9x	0.77	x	3.13	x	13.12	x	0.63	x	0.7	=	12.55	(74)
North	0.9x	0.77	x	5.4	x	13.12	x	0.63	x	0.7	=	21.65	(74)
North	0.9x	0.77	x	4.17	x	13.12	x	0.63	x	0.7	=	16.72	(74)
North	0.9x	0.77	x	1.18	x	8.86	x	0.63	x	0.7	=	3.2	(74)
North	0.9x	0.77	x	8.4	x	8.86	x	0.63	x	0.7	=	22.76	(74)
North	0.9x	0.77	x	3.13	x	8.86	x	0.63	x	0.7	=	8.48	(74)
North	0.9x	0.77	x	5.4	x	8.86	x	0.63	x	0.7	=	14.63	(74)
North	0.9x	0.77	x	4.17	x	8.86	x	0.63	x	0.7	=	11.3	(74)
East	0.9x	1	x	1.31	x	19.64	x	0.63	x	0.7	=	5.51	(76)
East	0.9x	1	x	1.31	x	19.64	x	0.63	x	0.7	=	5.51	(76)
East	0.9x	1	x	1.31	x	38.42	x	0.63	x	0.7	=	10.79	(76)
East	0.9x	1	x	1.31	x	38.42	x	0.63	x	0.7	=	10.79	(76)
East	0.9x	1	x	1.31	x	63.27	x	0.63	x	0.7	=	17.77	(76)
East	0.9x	1	x	1.31	x	63.27	x	0.63	x	0.7	=	17.77	(76)
East	0.9x	1	x	1.31	x	92.28	x	0.63	x	0.7	=	25.91	(76)
East	0.9x	1	x	1.31	x	92.28	x	0.63	x	0.7	=	25.91	(76)
East	0.9x	1	x	1.31	x	113.09	x	0.63	x	0.7	=	31.75	(76)

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East	0.9x	1	x	1.31	x	113.09	x	0.63	x	0.7	=	31.75	(76)
East	0.9x	1	x	1.31	x	115.77	x	0.63	x	0.7	=	32.5	(76)
East	0.9x	1	x	1.31	x	115.77	x	0.63	x	0.7	=	32.5	(76)
East	0.9x	1	x	1.31	x	110.22	x	0.63	x	0.7	=	30.95	(76)
East	0.9x	1	x	1.31	x	110.22	x	0.63	x	0.7	=	30.95	(76)
East	0.9x	1	x	1.31	x	94.68	x	0.63	x	0.7	=	26.58	(76)
East	0.9x	1	x	1.31	x	94.68	x	0.63	x	0.7	=	26.58	(76)
East	0.9x	1	x	1.31	x	73.59	x	0.63	x	0.7	=	20.66	(76)
East	0.9x	1	x	1.31	x	73.59	x	0.63	x	0.7	=	20.66	(76)
East	0.9x	1	x	1.31	x	45.59	x	0.63	x	0.7	=	12.8	(76)
East	0.9x	1	x	1.31	x	45.59	x	0.63	x	0.7	=	12.8	(76)
East	0.9x	1	x	1.31	x	24.49	x	0.63	x	0.7	=	6.88	(76)
East	0.9x	1	x	1.31	x	24.49	x	0.63	x	0.7	=	6.88	(76)
East	0.9x	1	x	1.31	x	16.15	x	0.63	x	0.7	=	4.53	(76)
East	0.9x	1	x	1.31	x	16.15	x	0.63	x	0.7	=	4.53	(76)
South	0.9x	0.77	x	8.4	x	46.75	x	0.63	x	0.7	=	120.02	(78)
South	0.9x	0.3	x	1.9	x	46.75	x	0.63	x	0.7	=	10.58	(78)
South	0.9x	0.77	x	3.13	x	46.75	x	0.63	x	0.7	=	44.72	(78)
South	0.9x	0.77	x	5.4	x	46.75	x	0.63	x	0.7	=	77.16	(78)
South	0.9x	0.77	x	4.17	x	46.75	x	0.63	x	0.7	=	59.58	(78)
South	0.9x	0.77	x	8.4	x	76.57	x	0.63	x	0.7	=	196.56	(78)
South	0.9x	0.3	x	1.9	x	76.57	x	0.63	x	0.7	=	17.32	(78)
South	0.9x	0.77	x	3.13	x	76.57	x	0.63	x	0.7	=	73.24	(78)
South	0.9x	0.77	x	5.4	x	76.57	x	0.63	x	0.7	=	126.36	(78)
South	0.9x	0.77	x	4.17	x	76.57	x	0.63	x	0.7	=	97.58	(78)
South	0.9x	0.77	x	8.4	x	97.53	x	0.63	x	0.7	=	250.38	(78)
South	0.9x	0.3	x	1.9	x	97.53	x	0.63	x	0.7	=	22.07	(78)
South	0.9x	0.77	x	3.13	x	97.53	x	0.63	x	0.7	=	93.3	(78)
South	0.9x	0.77	x	5.4	x	97.53	x	0.63	x	0.7	=	160.96	(78)
South	0.9x	0.77	x	4.17	x	97.53	x	0.63	x	0.7	=	124.3	(78)
South	0.9x	0.77	x	8.4	x	110.23	x	0.63	x	0.7	=	282.99	(78)
South	0.9x	0.3	x	1.9	x	110.23	x	0.63	x	0.7	=	24.94	(78)
South	0.9x	0.77	x	3.13	x	110.23	x	0.63	x	0.7	=	105.45	(78)
South	0.9x	0.77	x	5.4	x	110.23	x	0.63	x	0.7	=	181.92	(78)
South	0.9x	0.77	x	4.17	x	110.23	x	0.63	x	0.7	=	140.48	(78)
South	0.9x	0.77	x	8.4	x	114.87	x	0.63	x	0.7	=	294.89	(78)
South	0.9x	0.3	x	1.9	x	114.87	x	0.63	x	0.7	=	25.99	(78)
South	0.9x	0.77	x	3.13	x	114.87	x	0.63	x	0.7	=	109.88	(78)
South	0.9x	0.77	x	5.4	x	114.87	x	0.63	x	0.7	=	189.57	(78)
South	0.9x	0.77	x	4.17	x	114.87	x	0.63	x	0.7	=	146.39	(78)
South	0.9x	0.77	x	8.4	x	110.55	x	0.63	x	0.7	=	283.79	(78)

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South	0.9x	0.3	x	1.9	x	110.55	x	0.63	x	0.7	=	25.01	(78)
South	0.9x	0.77	x	3.13	x	110.55	x	0.63	x	0.7	=	105.75	(78)
South	0.9x	0.77	x	5.4	x	110.55	x	0.63	x	0.7	=	182.44	(78)
South	0.9x	0.77	x	4.17	x	110.55	x	0.63	x	0.7	=	140.88	(78)
South	0.9x	0.77	x	8.4	x	108.01	x	0.63	x	0.7	=	277.28	(78)
South	0.9x	0.3	x	1.9	x	108.01	x	0.63	x	0.7	=	24.44	(78)
South	0.9x	0.77	x	3.13	x	108.01	x	0.63	x	0.7	=	103.32	(78)
South	0.9x	0.77	x	5.4	x	108.01	x	0.63	x	0.7	=	178.25	(78)
South	0.9x	0.77	x	4.17	x	108.01	x	0.63	x	0.7	=	137.65	(78)
South	0.9x	0.77	x	8.4	x	104.89	x	0.63	x	0.7	=	269.28	(78)
South	0.9x	0.3	x	1.9	x	104.89	x	0.63	x	0.7	=	23.73	(78)
South	0.9x	0.77	x	3.13	x	104.89	x	0.63	x	0.7	=	100.34	(78)
South	0.9x	0.77	x	5.4	x	104.89	x	0.63	x	0.7	=	173.11	(78)
South	0.9x	0.77	x	4.17	x	104.89	x	0.63	x	0.7	=	133.68	(78)
South	0.9x	0.77	x	8.4	x	101.89	x	0.63	x	0.7	=	261.56	(78)
South	0.9x	0.3	x	1.9	x	101.89	x	0.63	x	0.7	=	23.05	(78)
South	0.9x	0.77	x	3.13	x	101.89	x	0.63	x	0.7	=	97.46	(78)
South	0.9x	0.77	x	5.4	x	101.89	x	0.63	x	0.7	=	168.14	(78)
South	0.9x	0.77	x	4.17	x	101.89	x	0.63	x	0.7	=	129.84	(78)
South	0.9x	0.77	x	8.4	x	82.59	x	0.63	x	0.7	=	212.01	(78)
South	0.9x	0.3	x	1.9	x	82.59	x	0.63	x	0.7	=	18.68	(78)
South	0.9x	0.77	x	3.13	x	82.59	x	0.63	x	0.7	=	79	(78)
South	0.9x	0.77	x	5.4	x	82.59	x	0.63	x	0.7	=	136.29	(78)
South	0.9x	0.77	x	4.17	x	82.59	x	0.63	x	0.7	=	105.25	(78)
South	0.9x	0.77	x	8.4	x	55.42	x	0.63	x	0.7	=	142.26	(78)
South	0.9x	0.3	x	1.9	x	55.42	x	0.63	x	0.7	=	12.54	(78)
South	0.9x	0.77	x	3.13	x	55.42	x	0.63	x	0.7	=	53.01	(78)
South	0.9x	0.77	x	5.4	x	55.42	x	0.63	x	0.7	=	91.46	(78)
South	0.9x	0.77	x	4.17	x	55.42	x	0.63	x	0.7	=	70.62	(78)
South	0.9x	0.77	x	8.4	x	40.4	x	0.63	x	0.7	=	103.71	(78)
South	0.9x	0.3	x	1.9	x	40.4	x	0.63	x	0.7	=	9.14	(78)
South	0.9x	0.77	x	3.13	x	40.4	x	0.63	x	0.7	=	38.64	(78)
South	0.9x	0.77	x	5.4	x	40.4	x	0.63	x	0.7	=	66.67	(78)
South	0.9x	0.77	x	4.17	x	40.4	x	0.63	x	0.7	=	51.48	(78)
West	0.9x	0.77	x	11.93	x	19.64	x	0.63	x	0.7	=	71.61	(80)
West	0.9x	0.77	x	11.93	x	38.42	x	0.63	x	0.7	=	140.08	(80)
West	0.9x	0.77	x	11.93	x	63.27	x	0.63	x	0.7	=	230.69	(80)
West	0.9x	0.77	x	11.93	x	92.28	x	0.63	x	0.7	=	336.45	(80)
West	0.9x	0.77	x	11.93	x	113.09	x	0.63	x	0.7	=	412.33	(80)
West	0.9x	0.77	x	11.93	x	115.77	x	0.63	x	0.7	=	422.1	(80)
West	0.9x	0.77	x	11.93	x	110.22	x	0.63	x	0.7	=	401.85	(80)

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West	0.9x	0.77	x	11.93	x	94.68	x	0.63	x	0.7	=	345.18	(80)
West	0.9x	0.77	x	11.93	x	73.59	x	0.63	x	0.7	=	268.3	(80)
West	0.9x	0.77	x	11.93	x	45.59	x	0.63	x	0.7	=	166.22	(80)
West	0.9x	0.77	x	11.93	x	24.49	x	0.63	x	0.7	=	89.29	(80)
West	0.9x	0.77	x	11.93	x	16.15	x	0.63	x	0.7	=	58.89	(80)

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

(83)m=	467.09	811.09	1152.35	1501.71	1751.31	1769.6	1693.16	1501.9	1272.37	907.76	562.25	397.96	(83)

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

(84)m=	1084.79	1426.48	1745.68	2058.55	2269.46	2251.05	2151.97	1968.12	1757.99	1430.11	1126.92	995.97	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.97	0.89	0.73	0.56	0.62	0.87	0.99	1	1	(86)

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

(87)m=	19.61	19.8	20.1	20.46	20.77	20.94	20.99	20.98	20.85	20.42	19.94	19.57	(87)

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

(88)m=	19.96	19.96	19.96	19.97	19.97	19.98	19.98	19.98	19.97	19.97	19.97	19.97	(88)

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

(89)m=	1	1	0.99	0.95	0.84	0.64	0.43	0.5	0.81	0.98	1	1	(89)

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

(90)m=	18.08	18.37	18.8	19.33	19.74	19.94	19.97	19.97	19.85	19.28	18.57	18.04	(90)

fLA = Living area ÷ (4) = 0.14 (91)

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

(92)m=	18.3	18.58	18.98	19.49	19.89	20.08	20.12	20.11	19.99	19.45	18.77	18.26	(92)

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

(93)m=	18.3	18.58	18.98	19.49	19.89	20.08	20.12	20.11	19.99	19.45	18.77	18.26	(93)

8. Space heating requirement

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

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

Utilisation factor for gains, hm:

(94)m=	1	1	0.99	0.95	0.84	0.65	0.45	0.52	0.81	0.97	1	1	(94)

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

(95)m=	1083.64	1420.6	1720.09	1949.12	1908.67	1454.45	971.97	1016.42	1419.95	1391.92	1123.62	995.27	(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=	3981.01	3882.41	3538.37	2979.6	2301.36	1530.18	981.84	1035.32	1648.58	2485.29	3287.48	3971.91	(97)

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

(98)m=	2155.64	1654.34	1352.8	741.94	292.17	0	0	0	0	813.47	1557.97	2214.62	

Total per year (kWh/year) = Sum(98)$_{1…5,9…12}$ = 10782.95 (98)

Space heating requirement in kWh/m²/year 43.66 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0 (201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1 (202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1 (204)
Efficiency of main space heating system 1		93.4 (206)
Efficiency of secondary/supplementary heating system, %		0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)												
2155.64	1654.34	1352.8	741.94	292.17	0	0	0	0	813.47	1557.97	2214.62	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)												(211)
2307.96	1771.24	1448.39	794.37	312.81	0	0	0	0	870.96	1668.07	2371.11	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 11544.92 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

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

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

Water heating

Output from water heater (calculated above)

225.42	198.61	208.41	186.59	182.67	161.13	154.37	171.82	171.62	193.49	204.9	219.91	

Efficiency of water heater 80.3 (216)

(217)m=	89.34	89.2	88.91	88.17	86.23	80.3	80.3	80.3	80.3	88.27	89.1	89.38	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	252.33	222.66	234.41	211.62	211.85	200.66	192.24	213.97	213.72	219.21	229.97	246.03	

Total = Sum(219a)$_{1...12}$ = 2648.67 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		11544.92
Water heating fuel used		2648.67
Electricity for pumps, fans and electric keep-hot		
central heating pump:	30	(230c)
boiler with a fan-assisted flue	45	(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	75 (231)
Electricity for lighting		651.46 (232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year
Space heating (main system 1)	(211) x	0.216	=	2493.7 (261)
Space heating (secondary)	(215) x	0.519	=	0 (263)
Water heating	(219) x	0.216	=	572.11 (264)
Space and water heating	(261) + (262) + (263) + (264) =			3065.82 (265)

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Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	338.11	(268)
Total CO2, kg/year			sum of (265)…(271) =		3442.85	(272)

TER = 13.94 (273)