156 West End Lane

a2dominion

Revised Energy Statement

June 2016

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156 West End Lane, Camden

Revised Energy Statement

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Report Number:	EMS067	

Rev No	Comments	Author	Checker	Date
1	Draft for comments	MA	MH	02/10/15
2	For planning application	MA	MH	12/11/15
3	Draft for comments after GLA, council's comments	YP	MH	20/05/16
4	Final for Planning Application	YP	MH	27/0516

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Executive Summary

This revised Energy Statement reflects the design revisions made as a result of the feedback received and further information requested by the London Borough of Camden officers and Greater London Authority (GLA) officers, following the November 2015 planning application submission. The revised scheme has been reassessed to consider the changes and suggestions to the proposals together with their potential environmental impacts.

This Energy Statement describes the details of the energy strategy proposed by A2Dominion Developments Limited (A2Dominion) for the proposed redevelopment of 156 West End Lane, Camden, in response to the London Plan and Camden Borough Council energy policies.

The energy statement describes the design and technology options appraised, and the preferred energy strategy option in line with the London Plan (2015) and Camden Council policies. The proposed energy solution for the development follows and responds to the Be Lean, Be Clean, Be Green principles (London Plan Policy 5.2A) and includes various energy efficiency measures as well as low-carbon and renewable energy technologies as summarised in the table below.

Energy Principles	Energy Strategy Response
Be Lean: Use less energy. Minimise energy demand through efficient design and the incorporation of passive measures	**Passive design** • Optimised orientation to enable controlled solar gain and improved direct and indirect natural lighting. • Incorporation of balconies into the design which provide shading to reduce risks of overheating in summer. • Integration of green roofs which will keep the buildings warm/cool. **Building Fabric** • Use of optimal building fabric standards. **Energy Efficiency** • 100% energy efficient lighting and appropriate controls • Variable speed heating system with high delta T and low return temperatures • High efficiency motors and variable speed pumps for heating and extraction systems • High efficiency heating system • Appropriate controls for heating system • Temperature and time zoning • Appropriate insulation of heating distribution system • Provision of energy efficient white goods
Be Clean: Supply energy efficiently. Reduce energy consumption through use of low-carbon technology	**Energy efficient energy supply** • On-site CHP system connected to on-site heat network to supply domestic hot water and space heating to the entire development

Energy Principles	Energy Strategy Response
	• Energy efficient multi-split (VRF) systems to supply comfort cooling to private residential and the non-residential units
Be Green: Use renewable energy systems	**Renewable energy** • Photovoltaics (PV) system to supply renewable electricity to the non-residential units.

The development will significantly reduce the generated CO_2 emissions by incorporating a range of passive design and energy efficiency measures throughout the site, including improved building fabric standards beyond the requirements of Building Regulations and energy efficient mechanical and electrical plant. The implementation of all passive design and energy efficiency measures can reduce the CO_2 emissions by circa 3.7% and simultaneously lessen the future energy costs for the residents.

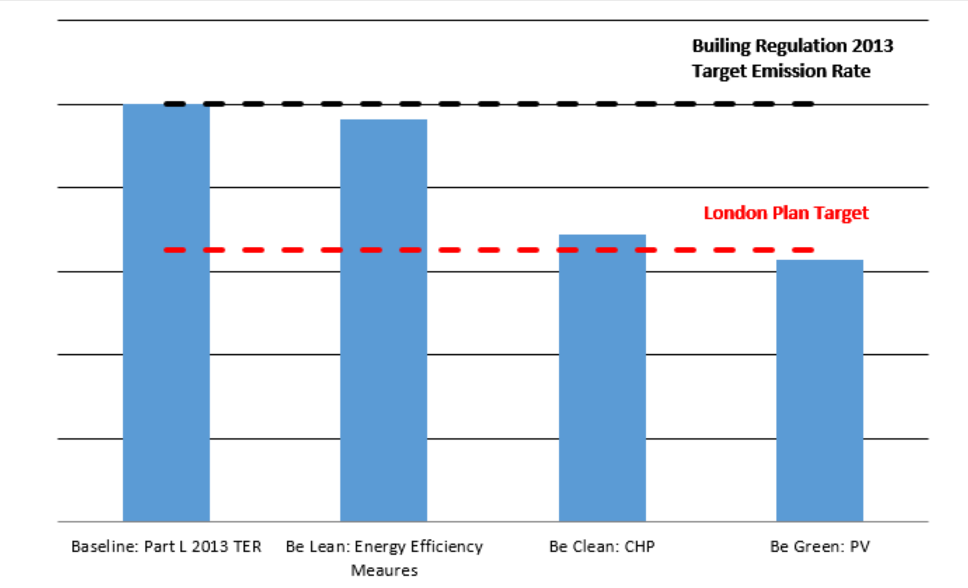
Once energy demand has been reduced, the strategy proposes implementation of a gas-fired Combined Heat and Power (CHP) engine and efficient gas-fired boilers connected to a site-wide district heating network (DHN), which will supply heating and hot water for the entire development. It is anticipated that the use of the CHP engine and DHN would help to reduce the regulated CO_2 emissions by approximately 27.3%.

In addition, it is proposed to provide a dedicated Photovoltaics (PV) system for the non-residential units in order to achieve the required CO_2 reductions for the entire development. The renewable electricity can reduce the regulated CO_2 emissions of the site by circa 6.2%. The regulated energy CO_2 savings expressed in terms of actual and percentage reduction after each stage of the energy hierarchy are presented in the table below.

	Regulated Energy CO_2 savings	
	Tonnes per annum	**%**
Savings from energy demand reduction	7.9	3.7%
Savings from CHP	58.3	27.3%
Savings from renewables	13.1	6.2%
Total cumulative savings	**79.3**	**37.2%**
Total Target Savings	**74.7**	**35%**
Annual Surplus	**4.6**	**2.2%**

The table shows that the proposed strategy can achieve regulated CO_2 savings of 79.3 tCO_2 which is equivalent to circa 37.2% reduction when compared to the baseline. The table also shows the annual CO_2 savings surplus which is expected to be 4.6 tCO_2.

The increased CO_2 reduction compared to the previous planning application scheme is a result of the following actions. The improved figures in the generic specification of the CHP according to the current market availability can increase the savings from the CHP. While the utilisation of greater amount of roof space for the application of PV panels will help to provide a further reduction in CO_2 emissions from renewables.



A summary of the overall reduction in CO_2 emissions after each stage of the energy hierarchy is presented in the following table.

	CO_2 emissions (tonnes per year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	213.4	239.5	452.9
After energy demand reduction	205.5	213.4	418.9
After use of CHP technology	147.1	213.4	360.5
After use of PV technology	134.0	213.4	347.4

This table shows that the overall CO_2 emissions from both regulated and unregulated energy can be reduced by circa 105.5 tCO_2 per annum which is equivalent to circa 23.3% reduction.

In summary, the proposed energy solution for the development:

1. Informs the built form and orientation of the buildings to respond to daylight and overheating issues.
2. Includes optimal fabric standards, energy efficient design of building services and energy efficient appliances.
3. Complies with Part L 2013 Building Regulations and meets TFEE requirements.
4. Includes an efficient on-site heating network with a CHP system designed to meet the hot water and space heating demands of the development.
5. Includes PV renewable technology.
6. Meets the 35% regulated energy CO_2 emissions reduction requirement.

7. Achieves BREEAM ‘Very Good’ energy section requirements.

1. Introduction

The revised Energy Statement has been prepared following the reassessment of the proposal following design revisions to the planning application (November 2015) as a result of feedback and requests received from Camden Council and to address comments made in the Mayor's Stage One Report.

1.1 Background

Silver has been instructed by A2Dominion to prepare an Energy Statement focusing on the proposed energy strategy for the proposed redevelopment of 156 West End Lane, Camden. The Energy Statement is prepared to support the full planning application in response to the local, regional and national legislation.

To support the planning application this document identifies and describes the energy efficiency design and low carbon and renewable technology options that were explored for this proposal and describes the preferred option for achieving the carbon emissions and renewable energy targets. The document is produced to demonstrate how the development can fulfil the relevant national, the London Plan and the Camden's Local Plan policies.

In order to achieve the energy and sustainability objectives defined by national, regional and local policies, research has been undertaken to identify and present the most appropriate commercially viable technology to achieve the carbon and renewable reductions targets. The energy options have been considered in this report at a strategic level only.

This second version of the Energy Statement has been prepared to address and accommodate the comments received from the council and GLA.

1.2 Description of the Development

The proposals are for demolition of all existing buildings and redevelopment of the site to provide 163 mixed-tenure homes (Use Class C3), new floor space for town centre uses (Use Classes A1, A2, A3, D1 or D2), new employment floor space (including four dedicated units for start-up businesses) (Use Class B1), a community meeting room and new and improved public open spaces, together with associated new landscaping, on-site access, servicing and disabled car parking.

The residential element proposes 163 mixed tenure units, with 50% of the residential floor area allocated for affordable housing. The affordable rented element includes a high proportion of family units.

2. Planning Requirements

This section summarises the relevant energy policy context for the proposed development. The national, regional and local policies and regulations related to energy and sustainability are summarised below.

2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) document sets out the Government's planning policies for England and was published on 27th March 2012.

The NPPF is designed to consolidate circulars and guidance documents into a single document, making the planning system more user-friendly and transparent. The primary objective of the NPPF is sustainable development, therefore focussing on the 3 pillars of sustainability. The framework is split into three sections; planning for prosperity (Economic), planning for people (Social) and planning for places (Environmental), each of which outline guidance to tackle issues such as housing, transport infrastructure, business and economic development, climate change, etc.

In regard to climate change, the NPPF supports reduction in greenhouse gas emissions and the delivery of renewable and low carbon energy. Climate change is covered in section 10 'Meeting the challenge of climate change, flooding and coastal change'. In summary the framework advises the following:

To support the move to a low carbon future, local planning authorities should:

- plan for new developments in locations and ways which reduce greenhouse gas emissions;
- actively support energy efficiency improvements to existing buildings; and
- adopting nationally described standards when setting any local requirement for a building's sustainability.

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

- comply with adopted Local Plan policies on local requirements for decentralised energy supply, unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
- take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

2.2 The London Plan (2015)

As a major development in London, the planning application will be governed by the London Plan (2015).

The London Plan requires all developments to actively tackle climate change through their design as an integral part of sustainable development. Chapter 5 (London's Response to Climate Change) of the London Plan contains the following crosscutting policies supporting London as an exemplar city in adapting to climate change.

1. Policy 5.1 - Climate change mitigation

2. Policy 5.2 - Minimising carbon dioxide emissions
3. Policy 5.3 - Sustainable design and construction
4. Policy 5.5 - Decentralised energy networks
5. Policy 5.6 - Decentralised energy in development proposals
6. Policy 5.7 - Renewable energy
7. Policy 5.8 - Innovative energy technologies
8. Policy 5.9 - Overheating and cooling

The London Plan requires that developments include energy assessments with the planning applications explaining the strategy for carbon emissions reduction based on the energy hierarchy.

The London Plan requires that major development proposals include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined below are to be met within the framework of the energy hierarchy.

Policy 5.2 of the London Plan requires carbon dioxide emissions to be minimised 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

Policy 5.2 also requires that major developments meet the following targets for carbon dioxide emission reduction in buildings. The targets are expressed in the tables below as minimum improvements over Target Emission Rate (TER) outlined in the national Building Regulations.

Residential Buildings

Year	Improvement on 2010 Building Regulations
2013 - 2016	40% CO_2 emissions reduction
2016 - 2031	Zero Carbon

Non-Residential Buildings

Year	Improvement on 2010 Building Regulations
2013 - 2016	40 % CO_2 emissions reduction
2016 - 2019	As per the Building Regulation requirements
2019 - 2031	Zero Carbon

London Plan Policy 5.6 requires development proposals to select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks.
2. Connection to site wide CHP network.

3. Development of communal heating and cooling networks.

London Plan Policy 5.7 requires major developments to provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation where feasible.

In April 2014 the Greater London Authority (GLA) published a revised Sustainable Design and Construction SPG and Energy Planning Guidance, which provide guidance on how the energy targets need to be assessed and met over Part L 2013 that came into force on the 6th of April 2014.

As outlined in the Sustainable Design and Construction SPG, from 6th April 2014 a 35% carbon reduction target beyond Part L 2013 of the Building Regulations needs to be met which deemed to be broadly equivalent to the 40% target beyond Part L 2010, as set out in London Plan Policy 5.2 for 2013-2016. This target applies to all Stage 1 applications received by the Mayor on or after 6th April 2014.

Generally, the carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant Borough. Guidance in the SPG can be used, including the suggested price of £60 per tonne, to form the basis of the carbon off-setting fund or develop a locally specific fund. Contributions will be secured by a S106 agreement.

The Greater London Authority Guidance (March 2016) on preparing energy assessments document guidance notes define that the ‘Be Lean’ case should assume that the heating is provided by gas boilers and that any active cooling will be provided by electrically powered equipment. The boilers should be assumed to have an efficiency of 89.5% for residential and 91% for non-residential together with controls aligned with the Part L notional building assumptions. Higher efficiencies should only be used if gas boilers will be part of the final strategy (i.e. after the ‘be clean’ and ‘be green’ tiers of the hierarchy have been addressed), in which case the gross efficiency of the gas boiler model to be specified can be used.

2.3 Local Policy - Camden Local Plan

The site is located in the London Borough of Camden and therefore the development should comply with local planning policies set out within Camden’s adopted Development Plan. The Development Plan comprises, but is not limited to, the Camden Core Strategy (2010), Development Policies (2010) and Camden Planning Guidance documents.

2.3.1 Core Strategy

The energy related requirements of the Core Strategy Policy CS13 - Tackling climate change through promoting higher environmental standards are as follows:

Reducing the effects of and adapting to climate change

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

- ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;
- promoting the efficient use of land and buildings;
- minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:

  - ensuring developments use less energy,
  - making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;
  - generating renewable energy on-site; and
- ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

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

Local energy generation

The Council will promote local energy generation and networks by:

- working with our partners and developers to implement local energy networks in the parts of Camden most likely to support them, i.e. in the vicinity of:
  - housing estates with community heating or the potential for community heating and other uses with large heating loads;
  - the growth areas of King's Cross, Euston; Tottenham Court Road; West Hampstead Interchange and Holborn;
  - schools to be redeveloped as part of Building Schools for the Future programme;
  - existing or approved combined heat and power/local energy networks.
- protecting existing local energy networks where possible (e.g. at Gower Street and Bloomsbury) and safeguarding potential network routes (e.g. Euston Road).

2.3.2 Development Policies (2010)

Development Policies (2010) Policy DP22 - Promoting sustainable design and construction

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

- demonstrate how sustainable development principles have been incorporated into the design and proposed implementation; and
- incorporate green or brown roofs and green walls wherever suitable.

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

- 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;
- expecting non-domestic developments of 500sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

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

- summer shading and planting;
- limiting run-off;
- reducing water consumption;

- reducing air pollution; and
- not locating vulnerable uses in basements in flood-prone areas.

2.3.3 Camden Planning Guidance 3 - Sustainability

Camden Council prepared Camden Planning Guidance 3 to support the energy and sustainability policies in the Local Development Framework (LDF). This guidance forms a Supplementary Planning Document (SPD) which is an additional “material consideration” in planning decisions.

The Camden Planning Guidance provides information regarding a range of topics as well as sustainability (such as design, housing, amenity and planning obligations). This guidance provides information on ways to achieve carbon reductions and more sustainable developments. It also highlights the Council’s requirements and guidelines which support the relevant Local Development Framework (LDF) policies:

- CS13 - Tackling climate change through promoting higher environmental standards
- DP22 - Promoting sustainable design and construction
- DP23 - Water

Among other sustainable development issues the guidance covers the following aspects:

- Energy efficiency – in new and existing buildings
- Decentralised energy and combined heat and power (CHP)
- Renewable energy

2.4 Sustainability Requirements

2.4.1 Code for Sustainable Homes

Camden’s Development Plan Policy DP22 requires all new residential developments to be rated against Code for Sustainable Homes. However, the Deregulation Act 2015, which received Royal Assent on the 26th March 2015, has withdrawn the Code for Sustainable Homes.

The Council has confirmed that it will not require compliance against the Code for Sustainable Homes in-line with the Deregulation Act.

2.4.2 BREEAM

BREEAM (Building Research Establishment’s Environmental Assessment Method) is a standard assessment method established by the Building Research Establishment (BRE) and used to assess the environmental impact of non-domestic buildings.

The first BREEAM version for assessing new office buildings was launched in 1990 and was followed by versions for other buildings including superstores, industrial units and existing offices. The latest major update in 2011 resulted in the launch of BREEAM New Construction. The current version of BREEAM New Construction was published in May 2014 and should be used to assess and certify all new non-residential buildings in the UK.

Overall BREEAM covers a range of issues and credits which are awarded where a building achieves a benchmark performance. BREEAM is a voluntary standard although central government and some planning authorities require compliance.

The Development Policies Document requires all non-residential development to achieve BREEAM "Very Good" rating. The Deregulation Act 2015 does not have an impact on the BREEAM requirements.

2.5 Part L Building Regulations

The development will need to comply with the current version of Part L (2013) which came into force on the 6th of April 2014. Residential units will need to comply with Part L1A and non-residential with Part L2A.

2.5.1 Part L1A 2013

Approved Document Part L1A 2013 incorporates a number of changes and additions compared to Part L1A 2010. Part L1A 2013 requires new homes to reduce their carbon emissions by a further 6% across the build mix, compared to Part L1A 2010. In addition to achieving an overall carbon emission target, (i.e. TER or Target Emission Rate), there is a further requirement to achieve or better fabric energy efficiency targets (TFEE: "Target Fabric Energy Efficiency"). This means the thermal performance of the building fabric now has its own standards which cannot be compensated by services strategy or renewable features.

Approved Document Part L1A 2013 also includes the notional dwelling specification. The document states that if the actual dwelling is constructed entirely to the notional dwelling specification, it will meet the carbon dioxide and fabric energy efficiency targets and the limiting values for individual fabric elements and building services. The summary of the notional dwelling specification is provided in Table 2.1.

Table 2.1 Notional dwelling specification

Element or System	**Values**
Opening areas (windows and doors)	Same as actual dwelling up to a maximum proportion of 25% of total floor area
External walls U-value	0.18 $W/(m^2K)$
Party walls U-value	0.0 $W/(m^2K)$
Floor U-value	0.13 $W/(m^2K)$
Roof U-value	0.13 $W/(m^2K)$
Windows U-value (whole window U-value)	1.4 $W/(m^2K)$
Windows g-value	0.63
Opaque doors U-value	1.0 $W/(m^2k)$
Semi glazed doors u-value	1.2 $W/(m^2k)$
Airtightness	5.0 $m^3/(hm^2)$ at 50 Pa
Linear thermal transmittance	Standard Psi values as per SAP 2012 Appendix R expect use of ψ=0.05 $W/(m^2K)$ if default value of ψ=0.15 $W/(m^2K)$ is used in the actual dwelling

Element or System	Values
Ventilation type	Natural with intermittent extract fans
Air-conditioning	None
Heating system	Main gas, combi or regular boiler and radiators. Room sealed, fan flue, efficiency - 89.5%
Heading controls	Time and temperature zone control, weather compensation, modulating boiler with interlock
Primary pipework	Fully insulated
Hot water cylinder	If combi boiler no cylinder otherwise 150 litres (declared loss factor = 0.85 x (0.2 + 0.051 $V^{2/3}$) kWh/day, where V is the volume of the cylinder in litres
Secondary space heating	None
Low-energy lighting	100%
Thermal mass parameter (TMP)	Medium – 250

Developers are free to vary the specification, provided the same overall level of carbon emissions and fabric energy efficiency performance are achieved or bettered.

2.5.2 Part L2A 2013

Approved Document Part L2A 2013 incorporates a number of changes and additions compared to Part L2A 2010. Part L2A 2013 requires new non-domestic buildings to reduce their carbon emissions by a further 9% across the build mix, compared to Part L2A 2010.

Part L2A 2010 was based on comparing the actual building against a notional building. This approach remains the same for Part L2A 2013. However, the notional building has been modified to have more energy efficient building fabric and air permeability. Similarly to Part L 2010, the notional building standards will change depending on the type of the non-domestic building.

Contrary to Part L2A 2010, in Part L2A 2013 not only the efficacy of the light fittings is controlled, but also the level of the lighting provided. In addition, lighting in new and existing buildings should meet the minimum standard.

There are also various other changes on minimum standards for HVAC system.

2.6 Summary of Policy Requirements

The following section provides a summary of local and national planning policy requirements which should be met to achieve compliance.

- Comply with Part L 2013 Building Regulations.

- Achieve a minimum of 35% reduction in carbon emissions (against current 2013 Building Regulations) to comply with the London Plan by following Lean, Clean and Green principles.
- Expect to select energy systems in accordance with the following hierarchy:
    1. Connection to existing heating or cooling networks;
    2. Connection to site wide CHP network;
    3. Development of communal heating and cooling networks.
- Provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.
- Meet BREEAM “Very Good” energy requirement for non-residential units.

3. Approach to the Energy Strategy Development

3.1 Energy Strategy Development Principles

In accordance with the London Plan and the Camden planning requirements, the proposed energy strategy for the development should focus on three key principles:

1. **Be Lean:** Use less energy. Minimise energy demand through efficient design and the incorporation of passive measures;
2. **Be Clean:** Supply energy efficiently. Reduce energy consumption through use of low-carbon technology; and
3. **Be Green:** Use renewable energy systems.

The first principle stresses the primacy of seeking to reduce energy consumption. Within the built environment this comprises of energy efficiency measures in both the design and construction of new buildings.

The second principle addresses the efficiency of energy supply. This will require 'decarbonising' and improving efficiency in the generation and distribution of energy.

The third principle comprises the use of 'green' energy systems. These are renewable sources of energy with low or zero carbon emissions and include, amongst others, solar generated heat and power, wind energy and biomass.

The suggested approach to energy and carbon has been proposed in line with the overall approach to climate change, reflecting requirements of the London Plan, Local Policies, Building Regulations Part L and BREEAM Very Good.

The proposed low carbon and renewable energy supply solutions match energy profiles of the development, ensuring effective use of these technologies. The solutions also take into consideration viability and flexibility of the scheme from a technical and economic point of view by identifying an optimal combination of energy efficiency measures, decentralised energy and renewable energy.

Applying these principles, A2Dominion is aiming to achieve the following objectives:

- Comply with the relevant regulatory requirements;
- Improve viability of the scheme by developing a technically robust and cost effective energy strategy; and
- Improve feasibility, operation and management of the energy systems by promoting holistic design methods and solutions.

The proposed energy strategy aims to achieve the required 35% CO_2 reductions on-site.

3.2 CO_2 Emissions Reduction Assessment Methodology

The CO_2 emissions reduction methodology requires separate energy assessments for the residential and non-residential floor space. The results from these assessments will be combined to provide the overall CO_2 emissions reduction for the entire development.

3.2.1 Residential

The Standard Assessment Procedure (SAP) 2012 methodology has been used to assess to evaluate an initial CO_2 performance of the residential development. To assess energy performance of the entire residential development, an energy and carbon assessment model has been produced to predict the regulated energy consumption and CO_2 performance of the residential development.

The BREEAM methodology has been used to estimate the unregulated CO_2 emissions of the residential development.

3.2.2 Non-residential

An initial assessment of CO_2 performance of the non-residential units is carried out using the standard National Calculation Methodology (NCM).

The assessment of the energy performance of the development considers regulated energy usage for different building services such as cooling, heating, lighting and ventilation. An estimate is also provided of unregulated electricity use (equipment) associated with computers, small power, security systems, etc.

4. Energy Assessment

4.1 Baseline CO_2 Emissions

In order to assess CO_2 performance of the proposed energy strategy, a CO_2 emissions baseline needs to be established. This section sets out the approach adopted to calculate the baseline CO2 emissions for the residential and the non-residential parts of the development.

Baseline emissions have been calculated for both regulated CO_2 emissions covered by Part L Building Regulations 2013 as well as the unregulated CO_2 emissions not covered by Part L, 2013. However, the unregulated CO_2 emissions should be excluded from the calculation of compliance with the planning policy.

Further to the feedback received from the GLA in its Stage One Report dated 20th January 2016, Sample DER and TER sheets and BRUKL sheets (including efficiency measures alone i.e excluding CHP and PV) have been provided in Appendix B to support the savings that have been calculated.

4.1.1 Residential Baseline

Baseline emissions have been calculated for both regulated (space heating, hot water, fans and pumps and fixed lighting) CO_2 emissions covered by Part L Building Regulations 2013 as well as the unregulated (cooking and appliances) CO_2 emissions not covered by Part L. The regulated CO_2 emissions baseline is based on the Part L 2013 Target Emission Rate (TER).

The unregulated CO_2 emissions have been calculated separately using BREDEM methodology. The regulated, unregulated and total baseline CO_2 emissions for the residential units of the development are summarised in Table 4.1.

Table 4.1 Residential baseline CO_2 emissions

	CO_2 emissions (tonnes/year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	159.1	217.5	376.6

4.1.2 Non-residential Baseline

The baseline CO_2 emissions are based on the calculation of the energy consumption of a 'notional' building under the standard National Calculation Methodology (NCM). The regulated, unregulated and total baseline CO2 emissions for the non-residential floor space are summarised in Table 4.2.

Table 4.2 Non-residential baseline CO_2 emissions

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Non-residential CO_2 Emissions Baseline	54.3	21.9	76.2

4.1.3 Total Baseline

For the entire development (residential and non-residential), the CO_2 emissions baseline is determined by adding the CO_2 emissions baselines for the residential and the non-residential parts of the development. The regulated, unregulated and total baseline CO_2 emissions for the entire development are summarised in Table 4.3.

Table 4.3 Total baseline CO_2 emissions

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Total CO_2 Emissions Baseline	213.4	239.5	452.9

4.2 Energy Demand Reduction (Be Lean)

The key focus for the proposed energy strategy is to reduce the energy demands of the development as much as practically and cost effectively possible by implementing various energy demand reduction measures.

Reducing the energy demand is the most effective way to reduce the CO_2 emissions associated with energy use. Energy efficiency measures can be adopted to reduce energy demand without making a significant impact on the design, appearance or character of the building. Reducing energy demand also helps to reduce fuel demand and hence reduces the future energy costs for the residents.

A range of measures to reduce CO_2 emissions and increase resilience to climate change will be incorporated into the design of the building. This will include good building fabric standards as well as an energy efficient M&E systems and lighting.

4.2.1 Residential

4.2.1.1 Passive Design

Policy 5.3 of the London Plan requires the development to demonstrate that passive design and energy efficiency have been considered from the beginning and all the way through the design process. In addition, Policy 5.9 requires the development to reduce potential overheating and reliance on air conditioning systems.

Through adopting best practice in design, and in response to these policies, the development has considered sustainable design and construction standards to reduce potential overheating and reliance on air conditioning systems through the following approaches and measures.

The development will incorporate a number of passive solar design measures, presented below. The layout of the building (S, U shape and different roof height) allows for self-shading between its parts. Furthermore, balconies and external corridors provide shading to the development. The proposed windows aim to maximise daylight and again minimise overheating. The glazing specification will be selected to provide a balance of solar control and access to passive solar gain.

The inclusion of green roofs in the development will enhance biodiversity, absorb rainfall, improve the performance of the building, reduce the urban heat island effect and improve the appearance of a development. All the above, contribute to the greening of the infrastructure and have similar cooling effects on the air surrounding the buildings they are installed on. They also add an additional insulation value on the building elements they are applied to, although this will depend on the construction and the level of moisture content in the living element.

Taking into consideration building fabric and low carbon energy proposals, it is assumed that an appropriate mechanical ventilation strategy with heat recovery (MVHR) will likely be provided as continuous background ventilation to ensure compliance with Part F Building Regulations. Natural ventilation in order to provide the desired Indoor Air Quality (IAQ) to the dwelling has been considered but due to the high energy efficiency requirements and CO_2 reduction targets as well as noise sources arising from the surroundings, it may be difficult to implement this strategy all around the year. While, on the other hand, natural ventilation is proposed as a purge ventilation during the summer period to deal with the warm spells.

The majority of the units are dual aspect which will maximise daylight. Openable windows are proposed despite the fact that they will not be essential to provide the essential fresh air supply to the rooms. They will, however, provide some further allowance to residents and occupiers to control their environment during spring and summer and thus, increase their adaptive approach to comfort. The openable windows will also be used for purge natural ventilation to reduce the risk of overheating.

The ventilation strategy will be reviewed as the design progresses to ensure compliance with all the relevant regulations and standards.

The development reflects the cooling hierarchy as set out in the London Plan Policy 5.9 and has been assessed, from an early stage, against the performance criteria of this policy. An Overheating Assessment has been prepared and is submitted as further information following feedback and requests from the GLA Stage One Report.

The results of the modelling showed that if the proposed strategies and assumptions are adopted the building can meet the TM52 Adaptive Overheating criteria without the use of active cooling and as a result, can comply with the Cooling hierarchy of London Plan Policy 5.9.

Thus, the proposed passive design will minimise the risk of overheating. All units have adequate natural ventilation, especially the dual aspect affordable units which also benefit from the overshadowing of recessed balconies on the southern elevation.

Despite the aforementioned, a mechanical comfort cooling system in the private dwellings is also incorporated within the design in order to satisfy predominantly the market expectations.

The supply of comfort cooling to private dwellings will enable residents to achieve a more controlled and pleasant internal environment during hot days in summer. The ability to create a more controlled and pleasant internal environment will particularly benefit the residents who are intolerant to high temperatures and vulnerable residents with health issues.

It is anticipated that the affordable block dwellings will have better cross ventilation than the dwellings within the private blocks, due to the proposed architectural design. Therefore it is not proposed to provide comfort cooling to the affordable block dwellings.

4.2.1.2 Building Fabric

In order to achieve the Part L 2013 Target Fabric Energy Efficiency (TFEE) targets, good building fabric standards will be used. The use of good fabric standards is one of the most cost-effective measures to reduce CO_2 emissions; it can also help to improve the cost effectiveness of all other energy and CO_2 reduction measures. Good standards of insulation can pay for itself in the reduction in running costs and also reduce the costs of low carbon and renewable energy systems.

In order to achieve this, it is necessary to go beyond the Part L1A 2013 minimum building fabric standards. The minimum building fabric requirements for Part L1A 2013 and the proposed specification for individual building elements for the residential part of the development are presented in Table 4.4.

Table 4.4 Proposed fabric energy efficiency targets for individual building elements

Element	**U-values W/m²K**	
	Part L1A 2013 minimum fabric requirements	**Proposed specification for the development**
External walls	0.30	0.18
Roof	0.20	0.15
First floor	0.25	0.15
Windows [1]	2.00	1.30
Airtightness	10 ($m^3/(hm^2)$ at 50 Pa)	4 ($m^3/(hm^2)$ at 50 Pa
y - value	0.15	0.04 [2]

[1] Glazing performance will need to be reviewed alongside acoustic performance as the design is developed.

[2] Target value. It is proposed to use 'Accredited Construction Details' or the equivalent standard on all junctions.

Implementing these (or similar) building fabric standards will help to deliver substantial reductions in CO_2 emissions compared with the current building performance and regulations and meet the TFEE. The proposed specification should be viewed as guidance and may change subject to detailed design.

Following the GLA Stage One Report which states that*; "The applicant is targeting high performance with regards to thermal bridging. It is recommended that modelling is carried out early on in the design process to confirm that such high targets are achievable in practice."* We can confirm that the values used are indicative and represent good market building practice. Modelling which will provide further clarification is suggested to be carried out early on the design process.

4.2.1.3 Energy Efficient Systems

Energy demand can be significantly reduced by using energy efficient M&E systems. Some of the proposed key measures for the non-residential development are listed below:

- 100% energy efficient lighting and appropriate controls
- Variable flow rate heating system with high delta T and low return temperatures
- High efficiency motors and variable speed pumps for heating
- Energy efficient ventilation system with heat recovery
- Appropriate controls for heating
- Appropriate temperature and time zoning
- Enhanced insulation of heating pipework and valves
- Energy efficient cooling systems for private dwellings with seasonal energy efficiency ratio (SEER) of 5 or higher
- Appropriate smart energy metering and monitoring

Implementing these or similar energy efficiency measures will help to deliver substantial reductions in CO_2 emissions compared with the baseline.

The overarching principle for final selection of the building fabric standards and energy efficient systems is to achieve compliance with Part L1A 2013 requirements through energy demand reduction measures alone.

Mechanical Ventilation with Heat Recovery

An important component of the design is to provide an appropriate ventilation system for the dwellings. At this stage an MVHR system is proposed for each dwelling of the residential development.

MVHR systems are balanced whole home ventilation systems which are intended to work continuously all year round. MVHR systems recycle the heat from exhaust air by passing it to incoming air. This is a passive process that relies on heat exchangers with large surface areas and it requires no additional energy input. There are also other benefits using MVHR systems including filtration of incoming air, improvement of hourly air changes in air tight dwellings and replacement of window trickle vents in dwellings where windows must remain closed for acoustic or pollutant reasons. In addition, MVHR systems warm up the cold incoming outside air in winter helping to avoid cold draughts.

There is a risk that in summer months MVHR systems will keep returning heat into the building. This would compound rather than reduce overheating risk. Therefore, it will be required to specify MVHR systems which include measures to overcome this issue. These measures can include purge ventilation, controls and summer by-pass. The MVHR system should be specified to have purge ventilation or boost. When systems are in boost mode they cannot recover heat efficiently due to the volume of air flow through them and can help to quickly remove heat from overheated rooms. In addition, the MVHR systems should be selected to meet Specific Fan Power of 0.5 W/l/s or less. This can be achieved by using systems with high efficiency fan motors and radiused bends and turning vanes in ductwork.

Metering Systems and Energy Display Devices

Use of intelligent controls and a high degree of sub metering / monitoring will be used to optimise the efficiency of energy systems through analysis of empiric data. Smart metering systems including smart in-home displays are proposed for dwellings to assist occupiers in reducing energy consumption and to control the cost energy.

Energy Efficient Appliances

The unregulated energy demand and the associated CO_2 emissions can be reduced by providing energy efficient white goods. It is assumed that energy efficient white goods will be provided in dwellings.

It is estimated that provision of the energy efficient appliances can reduce the total unregulated CO_2 emissions associated with the residential development by circa 26.1 tCO_2 per annum, which equates to approximately 12.0%.

4.2.2 Non-residential

4.2.2.1 Passive Design

The design of the non-residential unit proposes to incorporate a number of passive design measures to reduce CO_2 emissions and improve indoor climate. The unit has been designed to optimise the amount of direct sunlight which will help to minimise the use of energy-intensive artificial lighting.

The passive solar design will incorporate measures which enable controlled solar gain and improved direct and indirect natural lighting. Internal glare control measures such as occupant controlled devises and internal blinds should be considered and introduced as required by the non-residential tenants. These devises can also be used to limit overheating of the non-residential floor space.

The glazing will be selected aiming to maximise daylight and minimise overheating. In addition, the glazing specification will be selected to provide a balance of solar control and access of direct and indirect natural lighting.

It is assumed at this stage that the non-residential units will not have openable widows. Therefore, energy efficient mechanical ventilation will need to be provided in line with Part F Building Regulations. The ventilation strategy needs to be constantly under review when fit-out design develops to ensure compliance with all the relevant regulations and standards.

4.2.2.2 Building Fabric

Part L of the 2013 Building Regulations for non-residential buildings highlights the need to ensure energy efficiency in design. The introduction of BREEAM has moved this agenda further forward and has focused on ensuring buildings are well insulated and airtight which will help to reduce the space heating and cooling demand and associated primary energy.

The use of good fabric standards for non-residential floor space is one of the most cost-effective measures to reduce CO_2 emissions and can also help to improve the cost effectiveness of all other energy and CO_2 reduction measures.

Correct selection of good fabric standards can pay for itself in the reductions in running costs and also reduce the costs of low carbon and renewable energy systems. The use of good building fabric standards will help to deliver substantial reductions in CO_2 emissions and to achieve the BREEAM energy requirements.

The minimum building fabric requirements for Part L2A 2013 and the proposed specification for individual building elements for the non-residential floor space are presented in Table 4.5.

Table 4.5 Proposed fabric energy efficiency targets for individual building elements

Element	**U-values W/m^{2}K**	
	Part L2A 2013 minimum fabric requirements	**Proposed specification for the development**
External walls	0.35	0.18
Ground floor	0.25	0.15
Windows [1]	2.2	1.30
Airtightness	10 (m^3/(hm^2) at 50 Pa)	4 (m^3/(hm^2) at 50 Pa)
ψ - value	0.15	0.04 [2]

[1] Glazing performance will need to be reviewed alongside acoustic performance as the design is developed.
[2] Target value. It is proposed to use 'Accredited Construction Details' or the equivalent standard on all junctions.

Implementing these (or similar) building fabric standards will help to deliver substantial reductions in CO_2 emissions compared with the current building performance and regulations. The proposed specification should be viewed as guidance and may change subject to detailed design.

4.2.2.3 Energy Efficient Systems

Energy demand can be significantly reduced by using energy efficient M&E systems. The recommended indicative energy efficiency measures for the proposed non-residential units which have been used to carry out the energy and carbon modelling are provided below. As the non-residential units will be provided as shell and core, it will be the responsibility of the future tenants to review the proposed energy efficiency measures and incorporate them into the final design as required to meet the regulatory requirements. The proposed strategy sets out attainable measures to achieve compliance by the future tenants. The future tenants may vary, according to their preference, the proposed energy efficiency measures/specification for specific requirements and needs.

For the purposes of final BREEAM shell and core energy modelling, green fit-out agreement will be required to enable the design team to substitute the minimum energy efficiency standards or backstop levels required by the relevant national building regulations with more realistic and appropriate energy efficiency measures.

The overarching principle for the final selection of building fabric standards and energy efficient systems is to achieve compliance with the BREEAM energy requirements and Part L2A 2013 requirements (if possible) through energy demand reduction measures alone.

Heating

The following design specifications are proposed to achieve energy efficient heating system:

- Optimised plant start/stop times;
- Variable flow rate heating system with high delta T and low return temperatures;
- High efficiency motors and variable speed pumps for heating;
- Appropriate controls for heating;
- Appropriate temperature and time zoning;
- Enhanced insulation of heating pipework and valves;
- Appropriate smart energy metering and monitoring.

Lighting

High efficiency internal and external lighting should be used throughout the development in conjunction with a lighting control system incorporating daylight and presence detection as appropriate. This will ensure that lights are switched off when not required. Energy efficient lighting with appropriate controls should be considered and provided to the non-residential areas as required.

Ventilation

It is proposed to consider an energy efficient ventilation system for the non-residential units. Mechanical ventilation with heat recovery system with low Specific Fan Powers (SFP) is recommended. This can be achieved by using systems with high efficiency fan motors and radiused bends and turning vanes in ductwork.

It is suggested that the ventilation system is specified to meet highest standards of air leakage and to ensure heat recovery complies with the Enhanced Capital Allowance (ECA) criteria for efficiency and low pressure drops.

A more detailed ventilation strategy will be developed during the detailed design with the aim to specify the most appropriate ventilation system and achieve pleasant indoor climate in non-residential areas.

The overall ventilation strategy approach needs to be constantly reviewed as the design progresses to ensure cost effectiveness and compliance with all the relevant regulations and standards.

Cooling

Cooling will need to be provided for the non-residential units. The cooling systems will need to be specified to the following minimum energy efficiency standards:

- Energy efficient cooling systems with seasonal energy efficiency ratio (SEER) of 5 or higher;
- High efficiency motors, variable speed pumps and energy efficient compressors for circulation of refrigerant in the cooling system;
- Enhanced insulation of distribution pipework and valves; and
- Appropriate controls, temperature and time zoning.

The specification of the cooling system will be defined during the detailed design stage or the fit-out by the future tenants.

Energy Metering and Monitoring

Sub metering of major energy consuming systems together with an accessible energy monitoring and management system or separate accessible energy sub-meters with pulsed or other open protocol systems will be provided. The energy metering and monitoring strategy will be fully compliant with the BREEAM energy monitoring requirements.

4.2.3 Summary of CO_2 Savings after Energy Demand Reduction

4.2.3.1 Residential CO_2 Savings from Energy Demand Reduction Measures

The regulated energy and carbon baselines were calculated by extrapolating the Dwelling Emission Rates (DER) of the typical dwellings across the entire residential development. The total energy demand and the CO_2 emissions for the residential development were calculated using the energy and carbon assessment model. DERs do not include the unregulated energy use for appliances and cooking and these CO_2 emissions have been calculated separately using the BREDEM methodology.

The energy assessment shows that by implementing the energy efficient design, by incorporating enhanced building fabric standards and by using energy efficient systems, the regulated CO_2 emissions can be reduced by circa 4.0 tCO_2 per annum, which equates to circa 2.5% reduction in total CO_2 emissions over the baseline. The regulated, unregulated and total emissions after energy demand reduction are summarised in Table 4.6.

Table 4.6 Residential CO_2 emissions after energy demand reduction

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	159.1	217.5	376.6
After energy demand reduction	155.1	191.4	346.5

4.2.3.2 Non-residential CO_2 Savings from Energy Demand Reduction Measures

The Building Emission Rate (BER) has been used to determine anticipated CO_2 emissions of an ‘actual’ building under the standard National Calculation Methodology (NCM). The total energy demand and the CO_2 emissions for the non-residential units were calculated using the energy and carbon assessment model.

The energy assessment shows that by implementing the energy efficient design, by incorporating enhanced building fabric standards and by using energy efficient systems, the regulated CO_2 emissions can be reduced by circa 3.9 tCO_2 per annum, which equates to circa 7.2% reduction in regulated emissions over the baseline.

Table 4.7 Anticipated CO_2 emissions after non-residential demand reduction

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Non-residential CO_2 Emissions Baseline	54.3	21.9	76.2
After energy demand reduction	50.4	21.9	72.3

4.2.3.3 Total Anticipated CO_2 Savings from Energy Demand Reduction Measures

The CO_2 assessment shows that by implementing the energy efficient design, the CO_2 can be reduced by circa 7.9 tCO_2 per annum for the entire development, which equates to circa 3.7% reduction in regulated CO_2 emissions over the baseline.

The summary of regulated, unregulated and total CO_2 emissions and anticipated savings are presented in Table 4.8.

Table 4.8 Summary of CO_2 emissions after energy demand reduction

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Total CO_2 Emissions Baseline	213.4	239.5	452.9
After energy demand reduction	205.5	213.4	418.9

The CO_2 emissions reduction is slightly lower than the previous planning application scheme due to GLA's Guidance requirement to assess the 'be lean' case against gas boilers with the relatively low efficiency of 89.5%. The common commercially available gas boilers have higher efficiencies, thus this result should be read as a means of assessing the building fabric efficiency and not the actual case.

4.3 Energy Efficient Supply (Be Clean)

London Plan Policy 5.6 and Camden Planning Guidance 3 require all major development proposals to evaluate and where appropriate select decentralised energy options systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks;
2. Site wide CHP network;
3. Communal heating and cooling.

4.3.1 Residential Energy Demand

The residential space heating, hot water and cooling demands have been estimated based on SAP methodology.

The estimated residential hot water demand is expected to present a consistent load throughout the year, although there will be peaks and troughs in daily use. These peaks and troughs can be managed through use of a thermal store that will transform the hot water load into a consistent base load which can potentially be delivered by a CHP technology connected to a district heating network.

During the summer months the space heating may not be needed or its requirement will be relatively low. The space heating demand during colder months of the year can also be delivered by the CHP technology. The remaining space heating demand can effectively be supplied by gas boilers which work well in conjunction with the CHP technology.

It is proposed that all private residential units will include mechanical comfort cooling. This cooling can be supplied effectively by Variable Refrigerant Flow (VRF) systems or conventional air or water cooled chillers. The VRF systems are generally more efficient than conventional cooling systems.

Therefore, where appropriate, the VRF systems should be used over the conventional cooling systems. It is considered that the use of absorption chillers is unsuitable in this instance due to the relatively small anticipated cooling load and low efficiencies.

4.3.2 Non-residential Energy Demand

The non-residential space heating, hot water and cooling demands have been estimated based on NCM methodology.

It is more difficult to assess non-residential heat demand because the non-residential units will be provided as shell and core and tenants of the units are currently unknown.

However, it is anticipated that the space heating and hot water demand of the non-residential units will be relatively low. The non-residential space heating and hot water demand alone would not have justified the use of the CHP technology but if combined with the residential heat demand, it can make use of the CHP technology effective as it will boost the normalisation of the heat demand.

The estimated non-residential cooling load is expected to be apparent all year round, but predominantly during the summer months. This relatively small load can be supplied effectively by either multi-split (VRF) systems or conventional air or water cooled chillers. It is considered that use of absorption chillers is unsuitable in this instance due to the relatively small anticipated cooling load and low efficiencies.

The VRF systems are generally more efficient than conventional cooling systems. Therefore, where appropriate, the VRF systems should be used over the conventional cooling systems.

4.3.3 Energy Supply Options Assessment

Policy 5.5 and Policy 5.6 of the London Plan as well as Camden Core Strategy Policy CS13 encourage development of decentralised energy networks. Policy 5.6 requires all major development proposals to evaluate, and where appropriate, select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks;
2. Site wide CHP network;
3. Communal heating and cooling.

4.3.3.1 Connection to Existing Heating or Cooling Networks

In response to the London Plan Policy 5.6 hierarchy, an investigation using the London Heat Map was carried out to identify existing and planned district heating networks in the vicinity of the site. The London Heat Map indicates that there are no existing or planned district heating networks around the site.

However, the snapshot of the London Heat Map provided in Figure 4.1 indicates that the site is located within the district heating opportunity area which is shown in violet colour on the map.

Figure 4.1 District heating opportunity areas in the vicinity of the site

This means that district heating or community heating schemes may potentially be developed within the opportunity area and there may be a possibility to connect the development to the district heating or community heating schemes in the future if site-wide heating network for the site is provided.

4.3.3.2 Site-wide Heating Network

As there could be a possibility in the future to connect the development to a wider heat network, investigation into on-site decentralised energy is required for the site.

The development has reasonably high density which makes site-wide heating network justifiable. The provision of an on-site district heating system will provide an opportunity for the proposed development to be ‘future proofed’ to make the best use of efficient energy generation with current and future technologies. In particular, such a system will enable the necessary infrastructure to be brought forward to link with other potential decentralised energy generation schemes which may be developed in the area after completion of the proposed development.

Site-wide CCHP/CHP system is favoured by Policy 5.5 and Policy 5.6. A CHP technology requires a relatively consistent heat demand throughout the year and the estimated total hot water demand (residential and non-residential) is expected to be high enough to justify the use of this technology. It will also help to deliver significant CO_2 savings which can help to achieve the CO_2 reduction targets.

Therefore, it is proposed to develop a site-wide heating network with CHP to supply hot water and space heating to both residential and non-residential parts of the development.

The CCHP system was considered but due to an anticipated relatively small non-residential cooling demand and low efficiencies of absorption chillers as well as space and practical constraints, this system is considered to be unsuitable to supply cooling for the development.

Heating Network Design

The proposed design of the development's on-site heating system will incorporate:

1. gas-fired CHP engine;
2. thermal store(s) for hot water storage; and
3. gas-fired boilers as back-up/top-up.

These systems together with all the associated ancillary equipment will be located in the basement in the energy centre with a total floor area of circa 205 m^2. This size of energy centre will be sufficient for the size development and the proposed design. The gas intake and the controls will be located in different basement plantrooms. Figure 4.2 provides the proposed location and layout of the energy centre in the lower ground floor.

Capped pipework connections will be provided to enable physical connection of the on-site heat network to the near-site energy generation facilities and networks should they become available and feasible in the future.

This arrangement will enable connection of the development to near-site energy generation facilities and networks by providing capped connections, should these options become available in the future. This will also allow installation of emerging low carbon/renewable energy technologies such as biofuel CHP and fuel cells in the future should they become technically and economically feasible.

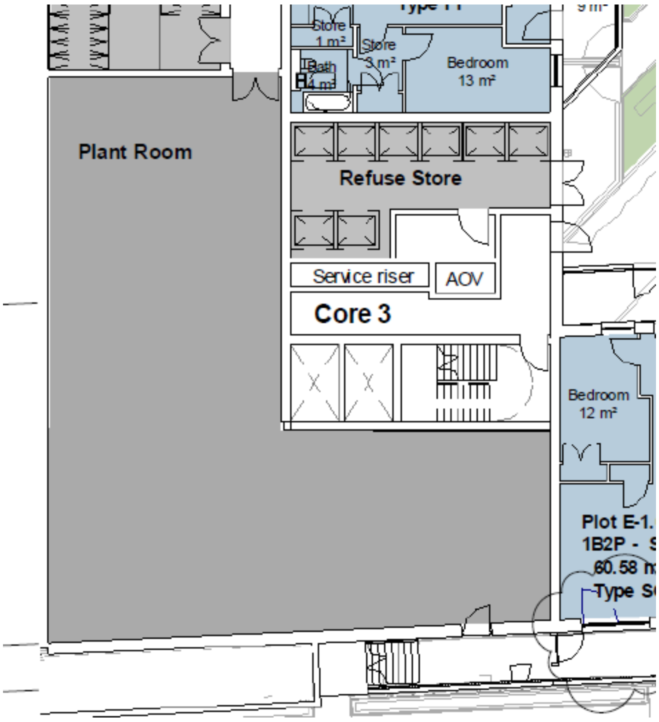
Capped pipework connections will be provided to enable physical connection of the on-site heat network to the near-site energy generation facilities and networks should they become available and feasible in the future, as requested by the council comments. The safeguarded route for a future heat pipe to deliver heat to the development plant room from the road is demonstrated in Appendix D through an outline sketch of the future pipework layout demonstrating the designated location and route.

It is expected that the space heating to all dwellings will be provided via radiator heating systems. The space heating to the non-residential units will be either provided via radiator, underfloor or air heating systems.

The design of the proposed site-wide heating system will be developed during the detailed design stage. However, the overarching design principle is to design the system in accordance with standards and design recommendations provided within emerging Heat Networks Code of Practice, the London Heat Network Manual, CIBSE AM12 Combined Heat and Power for Buildings and other relevant publications.

The design of the site-wide heating system needs to ensure that heat distribution pipework runs are minimised, particularly lateral pipework in the corridors, and the heating infrastructure including distribution pipework and Hydraulic Interface Units (HIUs) are insulated to the highest possible standards to minimise heat losses.

Figure 4.2 Location of Energy Centre



Choice of Fuel for CHP

Most CHP systems in the UK run on natural gas or diesel but there are other fuels which are technically feasible, such as biomass and biogas.

Specially designed CHP engines can run on biogas, however, it would not be possible to produce biogas on site (e.g. via anaerobic digestion) due to space and technical (food stock etc.) constraints. In addition, there are a limited number of biogas suppliers, therefore there are concerns regarding the fuel supply security and fuel cost. Taking into consideration the above, this option has been ruled out.

Small biomass CHP systems are in development. However, this technology is still unproven, representing high technical risks at this time.

Liquid biofuels can be used to run biodiesel CHP engines however there are similar concerns with biogas regarding security of supply and over the sustainability of liquid biofuel production. In addition, delivery of liquid biofuels will be an issue for the site.

Taking into account the aforementioned issues, biofuel CHP is neither reliable nor cost effective and has been disregarded for the application. It is therefore proposed to use proven and reliable gas-fired CHP units.

CHP System Sizing and Selection

Based on the assessment of the space heating and hot water demand profiles, it is proposed to size the CHP system to supply up to 80% of the total heat demand of the development. It is assumed that the CHP system will supply all annual domestic water demand of the development. Some of the space heating demand will also be supplied by the CHP. The remaining space heating load will be covered by energy efficient gas boilers, installed in parallel to the CHP unit in the energy centre.

Based on the available information, a preliminary CHP sizing has been carried out which indicates that the CHP engine should be 80 kWth (40 kWel) as a minimum to supply the targeted demand.

The performance of CHP units vary significantly across manufacturer's and unit models. In undertaking the assessment generic performance figures for the CHP have been used which can be achieved and bettered within commercially available plants. The efficiency and energy output figures utilised for the purpose of the calculations are:

- Heat output ratio: 66%;
- Electrical output ratio: 34%
- CHP efficiency: 87%.

To facilitate achievement of the heat supply contribution from the CHP system, a sufficiently sized thermal store should be provided. The size of the thermal store must be such that the operation of the CHP is maximised and a full assessment must be undertaken at detail design stage. At present the thermal store is considered to be in the region of 2,000 litres with the defined above CHP performance.

Sizing and selection of the CHP system should be carried out during detailed design stage. The underlining principle for sizing and selecting the CHP system will be to maximise CO_2 reduction and reduce life cycle costs as well as achieve all other requirements such as NOx emissions and noise levels.

In April 2014, the GLA published specific NOx requirements related to the CHP engines which are provided in the Sustainable Design and Construction SPG. The CHP engine will be selected to comply with these requirements.

In addition, the CHP system will be selected to facilitate minimum 5,000 operating hours per year and should improve the financial viability of the heating system operation whilst maintaining the technical ability of the system to meet variations in hot water and space heating demand.

In response to Guidance note 55 – GLA Stage One Report the monthly load profiles of the simulated CHP are demonstrated in Appendix C. Furthermore, the estimated proportion of heat demand addressed by the CHP was calculated as 83.7% and its average daily operating hours 16.1, resulting in 5,876 operational hours.

Heating System Operation and Management

The detailed design of the heating system is to be completed during the detailed design stage but the intention is that the CHP engine will act as a primary heat source followed by the thermal store and top-up gas boilers. Heat will be provided from the CHP engine to meet the demand from the development and / or to charge the thermal storage vessel. If the heat demand of the building cannot be met by the CHP, the thermal store will discharge heat into the heating system. If the thermal store contains insufficient heat to meet the required heat demand which exceeds that provided by the CHP, the gas-fired boilers will operate.

The inclusion of a thermal store allows the CHP to run when there is low demand to build up a reserve of heat energy in the stored hot water. This energy can be released to provide heat at periods of peak demand. Releasing stored heat energy in this way means that the use of the top-up gas boilers is reduced and the proportion of heat supplied from the CHP increased. There are other benefits from the thermal store in that the CHP system will run at optimum output for the majority of the time. An optimum run time also reduces the size and life cycle cost of CHP required to meet a given energy load and increases CO_2 savings.

The gas boiler system will be sized to provide full hot water demand backup in the event of failure or maintenance of the CHP units.

When there is an electricity demand in the landlord areas, the electrical output of the CHP system will be fully utilised on site with no export to the grid. If the electricity demand is lower than the electricity supplied by the CHP unit, the surplus will be exported to the grid. To improve the viability of the system operation, a possibility to supply electricity from the CHP directly to the non-residential areas should be investigated during detailed design.

It is not possible to provide specific details regarding the electricity export arrangements due to the lack of available technical information at this stage. In addition, the utility companies do not generally engage with potential electricity exporters at early project stages or provide site specific information related to electricity export arrangements.

Even if it is possible to supply the CHP electricity to the non-residential units, it is envisaged that some of the CHP electricity will need to be exported to the grid. Therefore, an import and export electricity meter will be installed on site and the G59 requirements met to enable the electricity to be exported.

Currently, it is not possible to confirm an operator of the site-wide energy system; once more it is early in the design process. However, at this stage, it is expected that it will not be less viable to operate the site-wide energy system with CHP than without CHP. In addition, site-wide energy system operators will more likely favour an energy centre with CHP as it would provide an additional financial incentive regarding the potential electricity sale and export. As requested by the Guidance note 56 the discussions with possible operators at the earliest convenience after this stage.

As required, the electricity export contractual arrangements should be discussed and agreed with a DNO during later stages of the project. The electricity demand of the landlord areas will also be determined during later stages of the project when more details about the M&E design of the development is available.

Management of the Heating Network

It is expected that A2Dominion Developments Limited will own and operate the heating system with a commitment to deliver heat to all residential and non-residential customers. The CHP system will be monitored and the evidence of continued compliance with emissions limits will be provided annually in the form of an annual maintenance report.

4.3.4 Summary of Anticipated CO_2 Reductions from CHP system

4.3.4.1 Anticipated CO_2 Savings from CHP System - Residential

The energy assessment shows that by use of the proposed site-wide heating network with CHP, it is possible to achieve a reduction of CO_2 emissions of approximately 56.9 tCO_2 per annum for the residential part of the development. This is equivalent to a reduction in the regulated CO_2 emissions from the energy efficient building of circa 36.7%. The regulated, unregulated and total regulated emissions savings through use of CHP technology is summarised in Table 4.9.

Table 4.9 Residential CO_2 emissions after use of CHP technology

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	159.1	217.5	376.6
After energy demand reduction	155.1	191.4	346.5

After use of CHP technology	98.2	191.4	289.6

Table 4.9 shows that the building fabric and energy efficiency measures combined with the use of the district heating network can achieve 38.3% CO_2 reduction over the residential baseline. This means that the London Plan target of 35% can be met without contribution from additional low carbon or renewable energy technologies. Therefore, the use of additional low carbon or renewable energy technologies is not required for the residential development.

4.3.4.2 Anticipated CO_2 Savings from CHP System – Non-residential

The energy assessment shows that by use of the proposed site-wide heating network with CHP, it is possible to achieve a further reduction of CO_2 emissions of approximately 1.4 tCO_2 per annum for the non-residential unit. This is equivalent to a reduction in the regulated CO_2 emissions from the energy efficient building of circa 2.8%. The anticipated CO_2 savings are low due to low hot water and space heating demands associated with the non-residential units. The regulated, unregulated and total regulated emissions savings through use of CHP technology is summarised in Table 4.10.

Table 4.10 Non-residential CO_2 emissions after use of CHP technology

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Non-residential CO2 Emissions Baseline	54.3	21.9	76.2
After energy demand reduction	50.4	21.9	72.3
After use of CHP technology	49	21.9	70.9

4.3.4.3 Anticipated CO_2 Savings from CHP System – Entire Development

The energy assessment shows that by use of the proposed site-wide heating network with CHP, it is possible to achieve a further reduction of CO_2 emissions of approximately 58.4 tCO_2 per annum for the entire development. This is equivalent to a reduction in the regulated CO_2 emissions from the energy efficient building of circa 28.4%. The regulated, unregulated and total regulated emissions savings through use of CHP technology is summarised in Table 4.11.

Table 4.11 Total CO_2 emissions after use of CHP technology

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Total CO_2 Emissions Baseline	213.4	239.5	452.9
After energy demand reduction	205.5	213.4	418.9
After use of CHP technology	147.1	213.4	360.5

4.4 Renewable Energy

Policy 5.7 of the London Plan requires providing a reduction in expected CO_2 emissions through the use of on-site renewable energy generation, where feasible.

The likely energy use of the proposed development allows for a feasibility assessment of the renewable energy technology options to determine which are most favourable for this particular development. The following technologies have been assessed for their potential to meet the renewable energy target:

- Biomass boilers
- Ground source heat pumps
- Air source heat pumps
- Wind turbines
- Solar thermal systems
- Photovoltaic (PV) systems

The assessment of these technologies shows that the installation of PV systems is considered to be the most suitable renewable energy technology option for the development. All other renewable energy technology options are considered to be less suitable (or unsuitable) for this development. A summary of the assessment of the renewable technology options is provided in Appendix A. The preferred PV option is further discussed below.

4.4.1.1 Photovoltaic (PV) Systems

The renewable energy assessment shows that PV systems can be provided to generate renewable power. The technology can work well with all the other proposed technologies (e.g. CHP and gas boilers) and can supply the remaining required CO_2 reduction for the non-residential units.

PV systems are suitable for any type of building but they require significant un-shaded south facing space, as even a small shadow may significantly reduce output. PV systems can be incorporated into the units in various ways: on sloped roofs and flat roofs, or in facades, atria and shading devices.

Currently, there are four types of solar PV cells available: mono-crystalline, poly-crystalline, thin film and hybrid. Mono-crystalline and hybrid cells are the most expensive to produce but are 12-20%, poly-crystalline cells are cheaper but their efficiency is 9-15% and thin film cells are only 5-8% efficient but can be produced as thin flexible sheets.

Generally, PV systems should ideally face south with an incline of 30º, although orientations within 45º of south and other angles can still generate high outputs. The panels should be ideally mounted on the roof of the building to facilitate correct orientation and minimise shading.

The technology is easily scalable, which means that the required amount can be installed to meet the renewable energy requirements and the required CO_2 reduction targets. The only technically limiting factor on the maximum size of PV system is the available south facing un-shaded roof area, as surplus electricity can be fed back into the grid.

Optimum design of the PV installation is required to ensure maximum electrical output, per kWp installed, is achieved. There are a number of design considerations to be made to ensure the best use of the system.

The key design considerations are:

- Design of PV installation to optimise inclination and orientation;
- Ensure that all parts of the PV panels are un-shaded (as much as possible);
- Ensure correct installation of PV arrays for good ventilation;
- Ensure that the electrical wiring from PV arrays to inverters is kept to minimum to reduce electrical losses;

- Provide sufficient space around PV installations for safe access and maintenance of the modules and other equipment installed on the roof;
- Ensure that inverter performance is monitored to ensure consistent electrical generation in line with the strategy.

A preliminary assessment to define the feasible capacity of the PV systems for all the non-residential areas has been carried out. The assessment shows that circa 31.7 kWp of total PV capacity is required for the non-residential units to achieve the London Plan target reduction and achieve Camden's council minimum Energy Standards.

It is assumed that 1 kWp of PV will require circa 15 m^2 of unobstructed roof area (including access) if energy efficient PV panels (e.g. mono-crystalline) are used. Therefore, 475.5 m^2 of unshaded suitable roof area will be required to accommodate the required PV capacity. Assuming that 1 kWp of PV panels can generate circa 800 kWh per annum, the PV plant can produce circa 25,360 kWh/year renewable electricity. A Roof Plan indicating the layout and the location of PV panels is attached in Appendix D to this report as requested by Camden Council and the GLA.

The PV system design and layout will be developed during the detailed design stage. The design will ensure that the visual impact of the PV panels is minimised.

The total system capacity, indicative available roof area and the estimated total electricity production for the development are provided in Table 4.5.

Table 4.12 Proposed PV system capacity and anticipated CO_2 emissions reduction

Building Type	Total PV system capacity (kW)	Total indicative roof area covered with PV panels (m^2)	Estimated total electricity production kWh/year)
Non-Residential	31.7	475.5	25,360

The required PV capacity and roof area should be re-assessed and confirmed during detailed design stage.

It is proposed to connect the PV system to the non-residential units through a private wire arrangement, as described in Ene 01 issue of the BREEAM technical manual. This arrangement will benefit future non-residential tenants as most of the produced PV electricity can be used in the non-residential units reducing their reliance on the grid electricity. In addition, applying this arrangement will help achieve BREEAM "Very Good" rating as the CO_2 savings associated with the dedicated PV systems will be directly related to the non-residential areas.

4.4.2 Summary of Anticipated CO_2 Savings from Renewable Systems

4.4.2.1 Anticipated CO_2 Savings from Renewable Systems – Non-residential

The energy assessment shows that PV may result in circa 13.2 tCO_2 further reduction of regulated CO_2 emissions per annum which equates to circa 26.9% reduction. The regulated, unregulated and total emissions after use of PV technology is summarised in Table 4.13.

Table 4.13 Non-residential CO_2 emissions after use of PV technologies

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Non-residential CO_2 Emissions Baseline	54.3	21.9	76.2
After energy demand reduction	50.4	21.9	72.3
After use of CHP technology	49.0	21.9	70.9
After use of PV technology	35.8	21.9	57.8

4.4.2.2 Anticipated CO_2 Savings from Renewable Systems – Entire Development

The energy assessment shows that by use of the proposed renewable energy technologies, it is possible to achieve a further reduction of CO_2 emissions of approximately 13.1 tCO_2 per annum for the entire development. This is equivalent to a reduction in the regulated CO_2 emissions from the energy efficient building of circa 9.0%. The regulated, unregulated and total regulated emissions savings through use of the renewable energy technologies are also tabulated in Table 4.14.

Table 4.14 Total CO_2 emissions after use of renewable technologies

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Total CO_2 Emissions Baseline	213.4	239.5	452.9
After energy demand reduction	205.5	213.4	418.9
After use of CHP technology	147.1	213.4	360.5
After use of PV technology	134.0	213.4	347.4

As requested by the GLA Guidance "Energy Planning" (March 2016) document, the separated energy hierarchy for the domestic and non-domestic parts of the development is illustrated below.

Figure 4.3 Domestic Energy Hierarchy

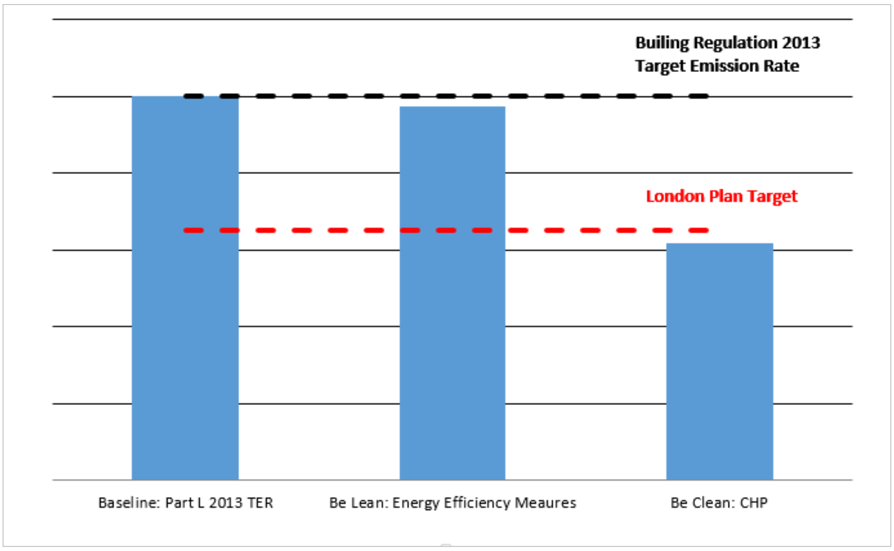
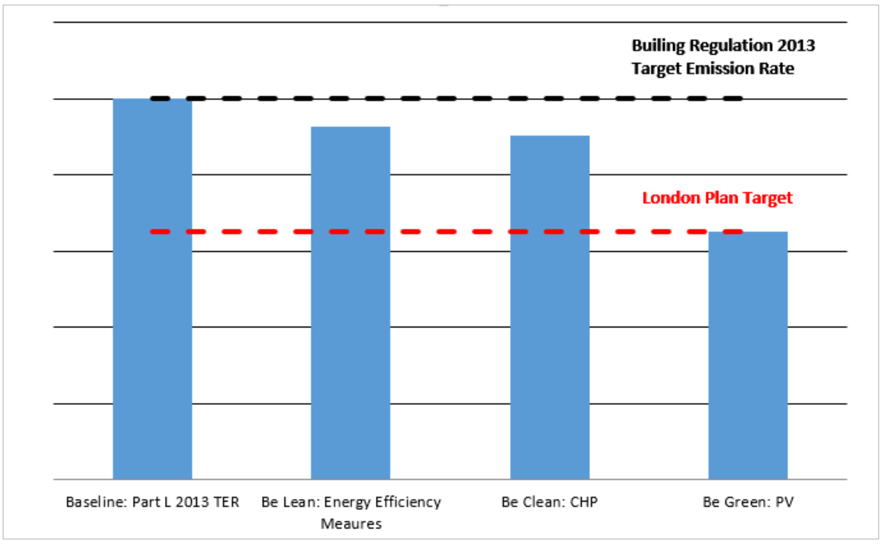


Figure 4.4 Non-Domestic Energy Hierarchy



5. Summary and Conclusions

The proposed strategy is to reduce the overall energy demand as far as practically and economically possible, relative to the policy requirements, by implementing energy efficiency measures before applying low carbon and renewable energy technologies.

The strategy follows and responds to the Be Lean, Be Clean and Be Green energy hierarchy principles as summarised and presented in Table 5.1.

Table 5.1 The Energy Strategy: Be Lean, Be Clean and Be Green principles

Energy Principles	Energy Strategy Response
Be Lean: Use less energy. Minimise energy demand through efficient design and the incorporation of passive measures	**Passive design** • Optimised orientation to enable controlled solar gain and improved direct and indirect natural lighting. • Incorporation of balconies into the design which provide shading to reduce risks of overheating in summer. • Integration of green roofs which will keep the buildings warm/cool. **Building Fabric** • Use of optimal building fabric standards. **Energy Efficiency** • 100% energy efficient lighting and appropriate controls • Variable speed heating system with high delta T and low return temperatures • High efficiency motors and variable speed pumps for heating and extraction systems • High efficiency heating system • Appropriate controls for heating system • Temperature and time zoning • Appropriate insulation of heating distribution system • Provision of energy efficient white goods
Be Clean: Supply energy efficiently. Reduce energy consumption through use of low-carbon technology	**Energy efficient energy supply** • On-site CHP system connected to on-site heating network to supply domestic hot water and space heating to the development • Energy efficient multi-split (VRF) systems to supply comfort cooling to private residential and the non-residential units
Be Green: Use renewable energy systems	**Renewable energy** • Photovoltaics (PV) system to supply renewable electricity to the non-residential units.

The regulated CO_2 savings expressed in terms of actual and percentage reduction after each stage of the energy hierarchy are presented in Table 5.2.

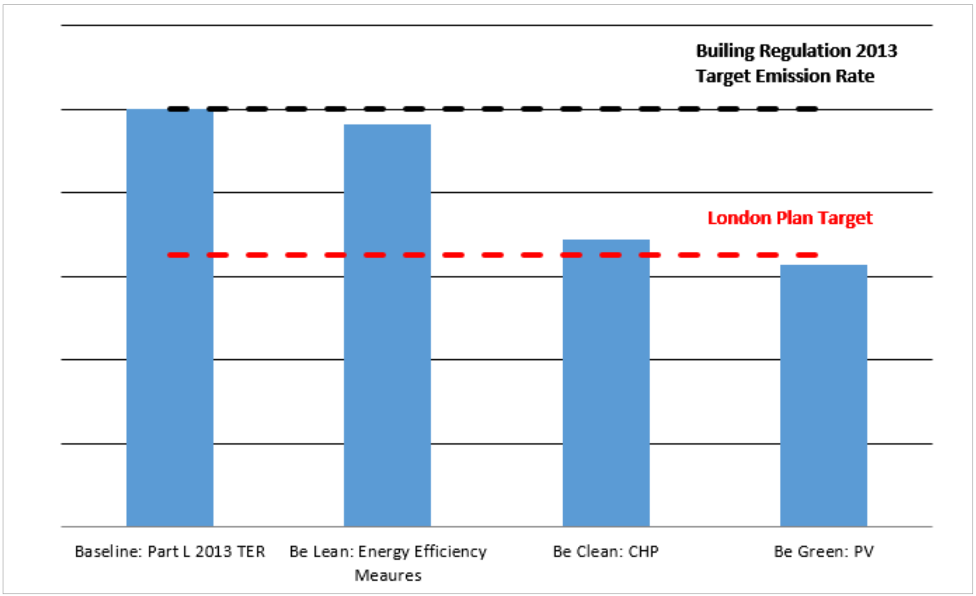
Table 5.2 Summary of CO_2 savings from each stage of the Energy Hierarchy

	Regulated Energy CO_2 savings	
	Tonnes per annum	**%**
Savings from energy demand reduction	7.9	3.7%
Savings from CHP	58.3	27.3%
Savings from renewables	13.1	6.2%
Total cumulative savings	**79.3**	**37.2%**
Total Target Savings	**74.7**	**35%**
Annual Shortage	**4.6**	**2.2%**

Table 5.2 shows that the proposed strategy can achieve regulated CO_2 savings of 79.3 tCO_2 which is equivalent to circa 37.2% reduction when compared to the baseline. The table also shows the annual CO_2 savings surplus which is expected to be 4.6 tCO_2.

The overall reduction in regulated carbon emissions associated with the proposed design is graphically illustrated in Figure 5.1.

Figure 5.1 Overall reduction in regulated CO_2 emissions compared to Part L baseline emissions



The summary of the overall reduction in CO_2 emissions after each stage of the energy hierarchy is presented in Table 5.3.

Table 5.3 Summary of CO_2 emissions after each stage of the Energy Hierarchy

	CO_2 emissions (tonnes per year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	213.4	239.5	452.9
After energy demand reduction	205.5	213.4	418.9
After use of CHP technology	147.1	213.4	360.5
After use of PV technology	134.0	213.4	347.4

Table 5.3 shows that the overall CO_2 emissions from both regulated and unregulated energy can be reduced by 105.5 tCO_2 per annum which is equivalent to circa 23.3%.

In summary, the proposed energy solution for the development:

1. Informs the built form and orientation of the buildings to respond to daylight and overheating issues.
2. Includes optimal fabric standards, energy efficient design of building services and energy efficient appliances
3. Complies with Part L 2013 Building Regulations and meets TFEE requirements.
4. Includes an efficient on-site heating network with a CHP system designed to meet the hot water and space heating demands of the development.
5. Includes PV renewable technology.
6. Meets the 35% regulated energy CO_2 emissions reduction requirement.
7. Achieves BREEAM 'Very Good' energy requirements.

Appendix A - Assessment of Renewable Energy Options

This appendix presents an assessment of the renewable technology options relative to site. This assessment demonstrates that the installation of PV systems is considered to be the most suitable renewable energy technology option for the development. All other renewable energy technology options are considered to be less suitable (or unsuitable).

Biomass Boilers

Biomass boilers are now regarded as a conventional form of technology with a wide range of sizes and types to meet renewable targets. Biomass boilers use biomass as a fuel source, which is an alternative solid fuel to the conventional fossil fuels and has carbon emissions close to zero. Various types of biomass fuel are in use, the most common being wood chips and pellets.

Although pellets are more expensive than chips, they have greater energy content per unit of weight and require a lower storage volume. Pellet boilers also require less maintenance and produce considerably less ash residue.

There are some local/regional as well as national biomass suppliers who can supply biomass for the site. Biomass would need to be delivered to site in large trucks and the arrangements for supply and storage of the biomass fuel would need careful consideration. It would also require a suitable biomass storage space, which given the space constraints on this site is likely to be restrictive.

Biomass boilers could provide heat for a community heating scheme supplying the remaining 20% thermal demand (space heating) after CHP.

The potential reduction in carbon emissions from the installation of biomass boilers can be considerable and this would likely meet the GLA's target for carbon emissions reduction from renewable energy sources. Also, biomass boilers are compatible with CHP units due to similarity in operating temperatures. However, although biomass systems have a number of advantages, in the context of this development, the following issues prevent the installation of biomass boilers:

- Potential negative effect on air quality;
- No space availability for fuel delivery and storage;
- Significantly higher capital costs in comparison with gas boiler system;
- Requirements of additional resources for management of the operation;
- The location of the development may not be suitable for large-scale fuel delivery; and,
- Security of biomass supply.

The conclusion is that biomass boilers can deliver additional CO_2 reductions but the solution is considered to be unsuitable and not cost effective for this development.

Air Source Heat Pumps

The Air Source Heat pumps (ASHP) can be used as both a source of heating and a source for cooling. ASHP use the same principle operation as GSHPs but the use air as a heat source. The downside is that the air temperature and therefore efficiency of the heat pump is reduced in cold weather when the heat is most needed. This means that one either needs to oversize ASHPs to take into account degradation in performance or, alternatively, provide an auxiliary electric heater.

Provision of an auxiliary heater reduces capital cost but adds to running costs and reduces carbon savings.

Outdoor air systems are widely implemented in the form of split systems, with indoor and outdoor units linked by refrigerant pipes running through the wall. Packaged air systems where outdoor air is ducted to an indoor package are also available.

Theoretically, ASHPs could provide heat for a community heating scheme supplying a portion of thermal demand by preheating the district heating water.

However because the ASHPs should be placed on the roofs of the building, it will likely have significant negative aesthetic impact on the development.

Installation of the ASHPs on the roofs would require higher installation costs associated with support and access to the plant and greater need to consider noise impacts.

In addition, they are not very compatible with higher temperature technologies and systems such as CHP systems. Integration of ASHPs in one system with CHP units has significant technical challenges and risks. Therefore, the ASHP system should ideally be installed separately from the CHP system. In either option, the overall heating supply system could become unnecessarily complicated, which would likely increase the costs of the system. Because of the aforementioned issues, this arrangement is unlikely be practical and cost effective and therefore, it is not recommended to provide heating for this development.

However, the VRF technology is using heat pump operational principles and has been proposed to supply cooling for the non-residential units.

Ground Source Heat Pumps

The ground can be used as both a source of heating and a source for cooling. Ground source heating involves heat pumps, drawing heat from underground, whereas ground source cooling can either use heat pumps or make use of low temperature groundwater directly. Ground Source Heat Pumps (GSHP) are a relatively mature technology and utilise the energy in the ground through a refrigeration cycle. Where GSHP are used for both heating and cooling, depending on the season, this can be a very efficient solution. GSHP can be open loop or closed loop.

Closed loop GSHP system comprises a sealed system of buried pipes normally containing brine or water/antifreeze solution. The solution is circulated continuously around a closed system.

Open Loop GSHP system uses groundwater which is taken from an aquifer to supply heating or cooling. The water is then returned to the ground (sometimes via a borehole or sometimes via storm water drainage). Open loop systems require abstraction and discharge licences from the Environment Agency (EA).

There should be sufficient area within the development to accommodate a sufficient number of boreholes to meet the heating demand with a closed-loop system. However, the ground conditions are currently unknown and may not be suitable to use an open-loop system.

GSHP systems which provide heating are most efficient when warming water to 35-40ºC. Theoretically, GSHPs could provide heat for a community heating scheme supplying the remaining 50% thermal demand by preheating the district heating water.

However, as the GSHPs operate at low temperatures, they are not very compatible with higher temperature technologies and systems such as CHP system. Integration of GSHPs in one system with CHP units has significant technical challenges and risks. The overall heating supply system may become unnecessarily complicated, which will likely to significantly increase the costs of the system and maintenance risks. In addition, due to space constraints it is unlikely be possible to accommodate the system within the proposed plantroom area. Because of the aforementioned issues, this arrangement is unlikely be practical and cost effective and therefore, it is not recommended for this development.

Wind turbines

The capacity of wind turbines can range from 500W to more than 2.5MW. Generally speaking, the larger the turbine, the more cost-effective, but also the more complex it is to find suitable space and obtain planning permission.

Installation of large/medium scale wind turbine(s) could meet the renewable energy and carbon reduction targets, however there is no appropriate space for installation of large/medium scale wind turbines within the site. The installation is unlikely to be permitted due to close proximity of the Heathrow airport.

Effective energy generation through small scale roof mounted wind turbines is not feasible due to the following:

- Location of the development in a densely populated area.
- The average wind speed at the site is estimated to be circa 5.6 m/s at 25 m above ground which is based on NOABLE Wind Map (the wind speed was taken from the Rensmart Wind Map). The wind speed is marginal for effective operation of a wind turbine.
- Issues such as noise, telecoms interference proximity to Heathrow airport and visual impact are likely to restrict installation of wind turbines.

Therefore, wind energy is not recommended for this development.

Solar Thermal systems

Solar water heating systems use the energy from the sun to heat water, most commonly for domestic hot water needs. Solar heating systems use a heat collector that is usually mounted on a roof in which a fluid is heated by the sun.

The use of solar thermal panels is inappropriate for this development on the basis that the technology is not compatible with the use of CHP as both technologies compete for the same summertime hot water load.

In addition, the system will produce relatively small CO_2 savings but will have significant negative impact of the cost of the heating system and its practicability. Therefore, solar thermal systems are not recommended for this development.

Appendix B - Sample SAP TERs and DERs, BRUKL output documents

The table below shows the simulated, sample flats selected as representative of the development:

Dwelling Ref.	Level	Orientation	Size (m^2)
GF 2B4P PS East Building	0	South / West	74
GF 1B2P SO West Building	0	East	52
MF 1B2P PS East Building	1-4	West	59
MF 2B4P SO West Building	1-4	North / West	79
MF 1B2P AR West Building	1-2	South / North	59
MF 3B6P AR West Building	2-4	West / East	100
TF 1B2P PS East Building	4	South	59
TF 2B4P SO West Building	5	East	70
TF 3B5P AR West Building	5	South / East	88

The average weighted formula has been devised to combine the TER and DER and produce the residential percentage reduction from the baseline for efficiency measures.

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.3.4

Property Address: GF 2B4P PS East Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	74	(1a) x	2.5	(2a) =	185	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	74	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		185	(5)

2. Ventilation rate:

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

DRAFT

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0 ÷ (5) =	0	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)			
Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.2	(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) =	0.17	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

DER WorkSheet: New dwelling design stage

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

0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.2

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	
Windows Type 1			7.95	x1/[1/(1.3)+ 0.04]		=	9.82			(27)
Windows Type 2			8.38	x1/[1/(1.3)+ 0.04]		=	10.36			(27)
Floor			74	x	0.15	=	11.1			(28)
Walls Type1	22.06	7.95	14.11	x	0.18	=	2.54			(29)
Walls Type2	24.23	8.38	15.85	x	0.18	=	2.85			(29)
Total area of elements, m²			120.29							(31)

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 36.67 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 9594.2 (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 9.1 (36)

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

Total fabric heat loss (33) + (36) = 45.77 (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=	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	(38)

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

(39)m=	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	

Average = Sum(39)$_{1…12}$ /12= 76.3 (39)

DER WorkSheet: New dwelling design stage

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

(40)m=	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03

Average = Sum(40)$_{1…12}$ /12= 1.03 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.34 (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 89.76 (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=	98.73	95.14	91.55	87.96	84.37	80.78	80.78	84.37	87.96	91.55	95.14	98.73	
										Total = Sum(44)$_{1…12}$ =		1077.07	(44)
Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)													
(45)m=	146.42	128.06	132.14	115.21	110.54	95.39	88.39	101.43	102.64	119.62	130.57	141.8	
										Total = Sum(45)$_{1…12}$ =		1412.21	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	21.96	19.21	19.82	17.28	16.58	14.31	13.26	15.21	15.4	17.94	19.59	21.27	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 5 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 5 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 2.88 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.24 (54)

Enter (50) or (54) in (55) 0.24 (55)

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

(56)m=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(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=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(57)

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

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

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

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

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

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

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

(62)m=	177.17	155.83	162.89	144.96	141.29	125.15	119.14	132.18	132.4	150.37	160.33	172.55	(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=	177.17	155.83	162.89	144.96	141.29	125.15	119.14	132.18	132.4	150.37	160.33	172.55

Output from water heater (annual)$_{1...12}$ 1774.28 (64)

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

(65)m=	73.28	64.8	68.54	62.11	61.36	55.52	53.99	58.33	57.94	64.37	67.22	71.75	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	18.41	16.35	13.3	10.07	7.53	6.35	6.86	8.92	11.98	15.21	17.75	18.92	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	206.45	208.59	203.19	191.7	177.19	163.56	154.45	152.3	157.7	169.2	183.7	197.34	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	(69)
Pumps and fans gains (Table 5a)													
(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	(71)
Water heating gains (Table 5)													
(72)m=	98.5	96.43	92.12	86.27	82.47	77.12	72.57	78.4	80.47	86.53	93.37	96.44	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	381.45	379.46	366.7	346.12	325.27	305.11	291.97	297.71	308.23	329.02	352.91	370.78	(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)	
South	0.9x	0.77	x	8.38	x	46.75	x	0.63	x	0.7	=	119.73	(78)
South	0.9x	0.77	x	8.38	x	76.57	x	0.63	x	0.7	=	196.09	(78)
South	0.9x	0.77	x	8.38	x	97.53	x	0.63	x	0.7	=	249.79	(78)
South	0.9x	0.77	x	8.38	x	110.23	x	0.63	x	0.7	=	282.31	(78)
South	0.9x	0.77	x	8.38	x	114.87	x	0.63	x	0.7	=	294.19	(78)

South	0.9x	0.77	x	8.38	x	110.55	x	0.63	x	0.7	=	283.12	(78)
South	0.9x	0.77	x	8.38	x	108.01	x	0.63	x	0.7	=	276.62	(78)
South	0.9x	0.77	x	8.38	x	104.89	x	0.63	x	0.7	=	268.64	(78)
South	0.9x	0.77	x	8.38	x	101.89	x	0.63	x	0.7	=	260.93	(78)
South	0.9x	0.77	x	8.38	x	82.59	x	0.63	x	0.7	=	211.5	(78)
South	0.9x	0.77	x	8.38	x	55.42	x	0.63	x	0.7	=	141.93	(78)
South	0.9x	0.77	x	8.38	x	40.4	x	0.63	x	0.7	=	103.46	(78)
West	0.9x	0.77	x	7.95	x	19.64	x	0.63	x	0.7	=	47.72	(80)
West	0.9x	0.77	x	7.95	x	38.42	x	0.63	x	0.7	=	93.35	(80)
West	0.9x	0.77	x	7.95	x	63.27	x	0.63	x	0.7	=	153.73	(80)
West	0.9x	0.77	x	7.95	x	92.28	x	0.63	x	0.7	=	224.21	(80)
West	0.9x	0.77	x	7.95	x	113.09	x	0.63	x	0.7	=	274.77	(80)
West	0.9x	0.77	x	7.95	x	115.77	x	0.63	x	0.7	=	281.28	(80)
West	0.9x	0.77	x	7.95	x	110.22	x	0.63	x	0.7	=	267.79	(80)
West	0.9x	0.77	x	7.95	x	94.68	x	0.63	x	0.7	=	230.03	(80)
West	0.9x	0.77	x	7.95	x	73.59	x	0.63	x	0.7	=	178.79	(80)
West	0.9x	0.77	x	7.95	x	45.59	x	0.63	x	0.7	=	110.76	(80)
West	0.9x	0.77	x	7.95	x	24.49	x	0.63	x	0.7	=	59.5	(80)
West	0.9x	0.77	x	7.95	x	16.15	x	0.63	x	0.7	=	39.24	(80)

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

(83)m=	167.45	289.44	403.52	506.52	568.96	564.4	544.41	498.67	439.73	322.27	201.42	142.7	(83)

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

(84)m=	548.9	668.9	770.22	852.64	894.23	869.51	836.38	796.38	747.96	651.29	554.33	513.49	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.98	0.95	0.88	0.73	0.55	0.4	0.44	0.67	0.92	0.99	1	(86)

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

(87)m=	20.06	20.26	20.52	20.77	20.93	20.99	21	21	20.97	20.74	20.33	20	(87)

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

(88)m=	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	(88)

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

(89)m=	0.99	0.98	0.94	0.85	0.68	0.47	0.32	0.35	0.59	0.89	0.98	0.99	(89)

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

(90)m=	18.81	19.1	19.47	19.81	20	20.05	20.06	20.06	20.03	19.78	19.21	18.73	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	19.35	19.6	19.92	20.23	20.4	20.46	20.46	20.46	20.44	20.2	19.7	19.28	(92)

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

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(93)m=	19.35	19.6	19.92	20.23	20.4	20.46	20.46	20.46	20.44	20.2	19.7	19.28	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.94	0.85	0.7	0.51	0.35	0.39	0.62	0.89	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	543.87	652.53	722.79	726.05	624.88	441.09	294.19	308.95	467	580.25	542.57	510.08	(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=	1148.08	1121.85	1024.1	864.14	663.84	446.78	294.81	310.01	483.56	732.35	961.14	1150.49	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	449.53	315.38	224.17	99.43	28.98	0	0	0	0	113.16	301.37	476.47	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2008.49 (98)

Space heating requirement in kWh/m²/year 27.14 (99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers		1	(303a)
Fraction of total space heat from Community boilers	(302) x (303a) =	1	(304a)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)
Space heating		**kWh/year**	
Annual space heating requirement		2008.49	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	2108.91	(307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)
Water heating			
Annual water heating requirement		1774.28	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	1862.99	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	39.72	(313)
Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		49.88	(330a)

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warm air heating system fans		0	(330b)
pump for solar water heating		0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =	49.88	(331)
Energy for lighting (calculated in Appendix L)		325.12	(332)

12b. CO2 Emissions – Community heating scheme

		Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP)						
Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel				89.5	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0	=	958.58	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	20.61	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	979.2	(373)
CO2 associated with space heating (secondary)	(309) x		0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x		0.22	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =				979.2	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	25.89	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	168.74	(379)
Total CO2, kg/year	sum of (376)…(382) =				1173.82	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				15.86	(384)
EI rating (section 14)					86.78	(385)

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User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.3.4

Property Address: GF 2B4P PS East Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	74	(1a) x	2.5	(2a) =	185	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	74	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	185	(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							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.16	(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)	0.41	(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) =	0.35	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.45	0.44	0.43	0.39	0.38	0.33	0.33	0.32	0.35	0.38	0.39	0.41

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=	0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.58	(24d)

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

(25)m=	0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.58	(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	
Windows Type 1			7.95	x1/[1/(1.4)+ 0.04]		=	10.54			(27)
Windows Type 2			8.38	x1/[1/(1.4)+ 0.04]		=	11.11			(27)
Floor			74	x	0.13	=	9.62			(28)
Walls Type1	22.06	7.95	14.11	x	0.18	=	2.54			(29)
Walls Type2	24.23	8.38	15.85	x	0.18	=	2.85			(29)
Total area of elements, m²			120.29							(31)

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 36.66 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 9594.2 (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 4.6 (36)

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

Total fabric heat loss (33) + (36) = 41.26 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	36.62	36.38	36.15	35.06	34.85	33.91	33.91	33.73	34.27	34.85	35.27	35.7	(38)

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

(39)m=	77.88	77.64	77.41	76.32	76.12	75.17	75.17	74.99	75.53	76.12	76.53	76.96	

Average = Sum(39)$_{1…12}$ /12= 76.32 (39)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(40)m=	1.05	1.05	1.05	1.03	1.03	1.02	1.02	1.01	1.02	1.03	1.03	1.04		
											Average = Sum(40)$_{1…12}$ /12=		1.03	(40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N — 2.34 (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 — 89.76 (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=	98.73	95.14	91.55	87.96	84.37	80.78	80.78	84.37	87.96	91.55	95.14	98.73		
											Total = Sum(44)$_{1…12}$ =		1077.07	(44)
Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)														
(45)m=	146.42	128.06	132.14	115.21	110.54	95.39	88.39	101.43	102.64	119.62	130.57	141.8		
											Total = Sum(45)$_{1…12}$ =		1412.21	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)														
(46)m=	21.96	19.21	19.82	17.28	16.58	14.31	13.26	15.21	15.4	17.94	19.59	21.27		(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0.3 (48)

Temperature factor from Table 2b — 0.54 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 0.16 (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) — 0.16 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

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

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

(62)m=	174.65	153.55	160.37	142.52	138.77	122.71	116.62	129.66	129.96	147.85	157.89	170.03	(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=	174.65	153.55	160.37	142.52	138.77	122.71	116.62	129.66	129.96	147.85	157.89	170.03	

Output from water heater (annual)$_{1...12}$ 1744.6 (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=	71.27	62.98	66.52	60.16	59.34	53.57	51.97	56.31	55.98	62.36	65.27	69.73	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	18.41	16.35	13.3	10.07	7.53	6.35	6.86	8.92	11.98	15.21	17.75	18.92	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	206.45	208.59	203.19	191.7	177.19	163.56	154.45	152.3	157.7	169.2	183.7	197.34	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	(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=	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	(71)
Water heating gains (Table 5)													
(72)m=	95.79	93.72	89.41	83.56	79.76	74.41	69.86	75.69	77.76	83.81	90.66	93.72	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	381.73	379.74	366.99	346.41	325.56	305.4	292.26	298	308.52	329.31	353.2	371.07	(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)	
South	0.9x	0.77	x	8.38	x	46.75	x	0.63	x	0.7	=	119.73	(78)
South	0.9x	0.77	x	8.38	x	76.57	x	0.63	x	0.7	=	196.09	(78)
South	0.9x	0.77	x	8.38	x	97.53	x	0.63	x	0.7	=	249.79	(78)
South	0.9x	0.77	x	8.38	x	110.23	x	0.63	x	0.7	=	282.31	(78)
South	0.9x	0.77	x	8.38	x	114.87	x	0.63	x	0.7	=	294.19	(78)

South	0.9x	0.77	x	8.38	x	110.55	x	0.63	x	0.7	=	283.12	(78)
South	0.9x	0.77	x	8.38	x	108.01	x	0.63	x	0.7	=	276.62	(78)
South	0.9x	0.77	x	8.38	x	104.89	x	0.63	x	0.7	=	268.64	(78)
South	0.9x	0.77	x	8.38	x	101.89	x	0.63	x	0.7	=	260.93	(78)
South	0.9x	0.77	x	8.38	x	82.59	x	0.63	x	0.7	=	211.5	(78)
South	0.9x	0.77	x	8.38	x	55.42	x	0.63	x	0.7	=	141.93	(78)
South	0.9x	0.77	x	8.38	x	40.4	x	0.63	x	0.7	=	103.46	(78)
West	0.9x	0.77	x	7.95	x	19.64	x	0.63	x	0.7	=	47.72	(80)
West	0.9x	0.77	x	7.95	x	38.42	x	0.63	x	0.7	=	93.35	(80)
West	0.9x	0.77	x	7.95	x	63.27	x	0.63	x	0.7	=	153.73	(80)
West	0.9x	0.77	x	7.95	x	92.28	x	0.63	x	0.7	=	224.21	(80)
West	0.9x	0.77	x	7.95	x	113.09	x	0.63	x	0.7	=	274.77	(80)
West	0.9x	0.77	x	7.95	x	115.77	x	0.63	x	0.7	=	281.28	(80)
West	0.9x	0.77	x	7.95	x	110.22	x	0.63	x	0.7	=	267.79	(80)
West	0.9x	0.77	x	7.95	x	94.68	x	0.63	x	0.7	=	230.03	(80)
West	0.9x	0.77	x	7.95	x	73.59	x	0.63	x	0.7	=	178.79	(80)
West	0.9x	0.77	x	7.95	x	45.59	x	0.63	x	0.7	=	110.76	(80)
West	0.9x	0.77	x	7.95	x	24.49	x	0.63	x	0.7	=	59.5	(80)
West	0.9x	0.77	x	7.95	x	16.15	x	0.63	x	0.7	=	39.24	(80)

DRAFT

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

(83)m=	167.45	289.44	403.52	506.52	568.96	564.4	544.41	498.67	439.73	322.27	201.42	142.7	(83)

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

(84)m=	549.19	669.19	770.5	852.93	894.52	869.8	836.67	796.67	748.25	651.57	554.62	513.77	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.98	0.96	0.88	0.73	0.54	0.39	0.43	0.67	0.92	0.99	1	(86)

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

(87)m=	20.03	20.24	20.5	20.77	20.93	20.99	21	21	20.97	20.75	20.33	19.99	(87)

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

(88)m=	20.04	20.04	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.05	20.05	(88)

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

(89)m=	0.99	0.98	0.94	0.85	0.68	0.47	0.31	0.35	0.59	0.89	0.98	0.99	(89)

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

(90)m=	18.75	19.06	19.43	19.81	20	20.06	20.07	20.07	20.04	19.79	19.21	18.71	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	19.3	19.57	19.9	20.23	20.4	20.46	20.47	20.47	20.44	20.2	19.69	19.26	(92)

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

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(93)m=	19.3	19.57	19.9	20.23	20.4	20.46	20.47	20.47	20.44	20.2	19.69	19.26	(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=	0.99	0.98	0.94	0.85	0.7	0.5	0.35	0.38	0.62	0.89	0.98	0.99		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	544.21	653.12	724.1	726.25	624.05	435.75	290.46	304.45	463.76	580.13	542.87	510.37		(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=	1168.36	1138.71	1036.9	864.39	662.43	440.79	291	305.36	479.23	730.88	963.64	1159.04		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	464.37	326.32	232.72	99.46	28.55	0	0	0	0	112.16	302.96	482.61		
									Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =				2049.15	(98)
Space heating requirement in kWh/m²/year													27.69	(99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)														
	464.37	326.32	232.72	99.46	28.55	0	0	0	0	112.16	302.96	482.61		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	496.65	349	248.9	106.37	30.54	0	0	0	0	119.96	324.02	516.16		
									Total (kWh/year) =Sum(211)$_{1...5,10...12}$=				2191.61	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
									Total (kWh/year) =Sum(215)$_{1...5,10...12}$=				0	(215)

Water heating

Output from water heater (calculated above)														
	174.65	153.55	160.37	142.52	138.77	122.71	116.62	129.66	129.96	147.85	157.89	170.03		
Efficiency of water heater													79.8	(216)
(217)m=	87.3	86.78	85.81	83.88	81.44	79.8	79.8	79.8	79.8	84.09	86.53	87.45		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	200.05	176.95	186.9	169.92	170.39	153.77	146.14	162.48	162.86	175.83	182.48	194.44		
									Total = Sum(219a)$_{1...12}$ =				2082.22	(219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		2191.61

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Water heating fuel used			2082.22	
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			325.12	(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	=	473.39	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	449.76	(264)
Space and water heating	(261) + (262) + (263) + (264) =			923.15	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	168.74	(268)
Total CO2, kg/year		sum of (265)…(271) =		1130.81	(272)
TER =				15.28	(273)

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User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.3.4

Property Address: MF 2B4P SO West Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	79	(1a) x	2.5	(2a) =	197.5	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	79	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	197.5	(5)

2. Ventilation rate:

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

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

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.2	(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) =	0.17	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.2

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0.5	(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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	
Windows Type 1			7.14	x1/[1/(1.3)+ 0.04]	=	8.82			(27)
Windows Type 2			13.2	x1/[1/(1.3)+ 0.04]	=	16.31			(27)
Walls Type1	20.62	13.2	7.42	x 0.18	=	1.34			(29)
Walls Type2	18.04	7.14	10.9	x 0.18	=	1.96			(29)
Total area of elements, m²			38.66						(31)

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

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

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	28.43	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	2472.79	(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		2.7	(36)

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

Total fabric heat loss	(33) + (36) =	31.13	(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=	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	(38)

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

(39)m=	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	

Average = Sum(39)$_{1…12}$ /12= 63.72 (39)

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

(40)m=	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	

Average = Sum(40)$_{1…12}$ /12= 0.81 (40)

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Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.44 (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 92.24 (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=	101.46	97.77	94.08	90.39	86.7	83.01	83.01	86.7	90.39	94.08	97.77	101.46	
Total = Sum(44)$_{1...12}$ =												1106.83	(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=	150.46	131.59	135.79	118.39	113.6	98.02	90.83	104.23	105.48	122.93	134.18	145.71	
Total = Sum(45)$_{1...12}$ =												1451.23	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	22.57	19.74	20.37	17.76	17.04	14.7	13.63	15.64	15.82	18.44	20.13	21.86	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 5 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 5 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 2.88 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.24 (54)

Enter (50) or (54) in (55) 0.24 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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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=	181.21	159.37	166.54	148.15	144.35	127.78	121.59	134.99	135.24	153.68	163.94	176.47	(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=	181.21	159.37	166.54	148.15	144.35	127.78	121.59	134.99	135.24	153.68	163.94	176.47	

Output from water heater (annual)$_{1...12}$ 1813.3 (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=	74.63	65.98	69.75	63.17	62.37	56.4	54.8	59.26	58.88	65.47	68.42	73.05	(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=	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	(66)

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

(67)m=	19.38	17.21	14	10.6	7.92	6.69	7.23	9.39	12.61	16.01	18.68	19.91	(67)

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

(68)m=	217.34	219.59	213.91	201.81	186.54	172.18	162.59	160.34	166.02	178.12	193.39	207.75	(68)

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

(69)m=	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	(71)

Water heating gains (Table 5)

(72)m=	100.31	98.18	93.75	87.74	83.83	78.33	73.66	79.65	81.78	88	95.03	98.19	(72)

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

(73)m=	396.68	394.63	381.31	359.8	337.95	316.86	303.13	309.03	320.06	341.78	366.76	385.5	(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	7.14	x	10.63	x	0.63	x	0.7	=	23.2	(74)
North	0.9x	0.77	x	7.14	x	20.32	x	0.63	x	0.7	=	44.34	(74)
North	0.9x	0.77	x	7.14	x	34.53	x	0.63	x	0.7	=	75.35	(74)
North	0.9x	0.77	x	7.14	x	55.46	x	0.63	x	0.7	=	121.03	(74)
North	0.9x	0.77	x	7.14	x	74.72	x	0.63	x	0.7	=	163.04	(74)
North	0.9x	0.77	x	7.14	x	79.99	x	0.63	x	0.7	=	174.53	(74)
North	0.9x	0.77	x	7.14	x	74.68	x	0.63	x	0.7	=	162.95	(74)
North	0.9x	0.77	x	7.14	x	59.25	x	0.63	x	0.7	=	129.28	(74)

North	0.9x	0.77	x	7.14	x	41.52	x	0.63	x	0.7	=	90.59	(74)
North	0.9x	0.77	x	7.14	x	24.19	x	0.63	x	0.7	=	52.78	(74)
North	0.9x	0.77	x	7.14	x	13.12	x	0.63	x	0.7	=	28.62	(74)
North	0.9x	0.77	x	7.14	x	8.86	x	0.63	x	0.7	=	19.34	(74)
South	0.9x	0.77	x	13.2	x	46.75	x	0.63	x	0.7	=	188.6	(78)
South	0.9x	0.77	x	13.2	x	76.57	x	0.63	x	0.7	=	308.88	(78)
South	0.9x	0.77	x	13.2	x	97.53	x	0.63	x	0.7	=	393.46	(78)
South	0.9x	0.77	x	13.2	x	110.23	x	0.63	x	0.7	=	444.7	(78)
South	0.9x	0.77	x	13.2	x	114.87	x	0.63	x	0.7	=	463.4	(78)
South	0.9x	0.77	x	13.2	x	110.55	x	0.63	x	0.7	=	445.96	(78)
South	0.9x	0.77	x	13.2	x	108.01	x	0.63	x	0.7	=	435.73	(78)
South	0.9x	0.77	x	13.2	x	104.89	x	0.63	x	0.7	=	423.15	(78)
South	0.9x	0.77	x	13.2	x	101.89	x	0.63	x	0.7	=	411.02	(78)
South	0.9x	0.77	x	13.2	x	82.59	x	0.63	x	0.7	=	333.16	(78)
South	0.9x	0.77	x	13.2	x	55.42	x	0.63	x	0.7	=	223.56	(78)
South	0.9x	0.77	x	13.2	x	40.4	x	0.63	x	0.7	=	162.97	(78)

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

(83)m=	211.8	353.22	468.81	565.72	626.44	620.49	598.68	552.43	501.61	385.94	252.18	182.31	(83)

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

(84)m=	608.48	747.86	850.12	925.52	964.38	937.35	901.81	861.47	821.67	727.72	618.94	567.82	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.96	0.9	0.78	0.61	0.43	0.31	0.34	0.53	0.83	0.97	0.99	(86)

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

(87)m=	20.41	20.61	20.8	20.94	20.99	21	21	21	21	20.92	20.64	20.36	(87)

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

(88)m=	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	(88)

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

(89)m=	0.99	0.96	0.88	0.74	0.56	0.38	0.26	0.28	0.48	0.79	0.96	0.99	(89)

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

(90)m=	19.48	19.76	20.02	20.18	20.24	20.25	20.25	20.25	20.25	20.17	19.8	19.39	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	19.86	20.11	20.33	20.49	20.54	20.55	20.55	20.55	20.55	20.47	20.14	19.78	(92)

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

(93)m=	19.86	20.11	20.33	20.49	20.54	20.55	20.55	20.55	20.55	20.47	20.14	19.78	(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

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Utilisation factor for gains, hm:

(94)m=	0.99	0.95	0.89	0.76	0.58	0.4	0.28	0.31	0.5	0.8	0.96	0.99	(94)

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

(95)m=	599.51	713.43	753.24	698.95	557.07	378.72	251.81	264.52	409.01	581.91	594.77	562.12	(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=	991.22	968.88	881.53	738.38	563.42	379.23	251.84	264.58	410.95	629.2	830.82	993.03	(97)

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

(98)m=	291.43	171.66	95.45	28.39	4.73	0	0	0	0	35.19	169.96	320.6	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1117.42 (98)

Space heating requirement in kWh/m²/year 14.14 (99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme. Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers		1	(303a)
Fraction of total space heat from Community boilers	(302) x (303a) =	1	(304a)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)
Space heating		**kWh/year**	
Annual space heating requirement		1117.42	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	1173.29	(307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)
Water heating			
Annual water heating requirement		1813.3	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	1903.96	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	30.77	(313)
Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		57.35	(330a)
warm air heating system fans		0	(330b)
pump for solar water heating		0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =	57.35	(331)

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Energy for lighting (calculated in Appendix L)				342.18	(332)

12b. CO2 Emissions – Community heating scheme

		Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP)					
Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel			89.5	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0 =	742.67	(367)
Electrical energy for heat distribution	[(313) x		0.52 =	15.97	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)		=	758.64	(373)
CO2 associated with space heating (secondary)	(309) x		0 =	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x		0.22 =	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =			758.64	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52 =	29.76	(378)
CO2 associated with electricity for lighting	(332))) x		0.52 =	177.59	(379)
Total CO2, kg/year	sum of (376)…(382) =			965.99	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =			12.23	(384)
EI rating (section 14)				89.56	(385)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.3.4

Property Address: MF 2B4P SO West Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	79	(1a) x	2.5	(2a) =	197.5	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	79	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		197.5	(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							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30 ÷ (5) =	0.15	(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)	0.4	(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) =	0.34	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.44	0.43	0.42	0.38	0.37	0.32	0.32	0.32	0.34	0.37	0.38	0.4

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=	0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(24d)

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

(25)m=	0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(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	
Windows Type 1			6.93	x1/[1/(1.4)+ 0.04]	=	9.19			(27)
Windows Type 2			12.82	x1/[1/(1.4)+ 0.04]	=	17			(27)
Walls Type1	20.62	12.82	7.8	x 0.18	=	1.4			(29)
Walls Type2	18.04	6.93	11.11	x 0.18	=	2			(29)
Total area of elements, m²			38.66						(31)

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

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

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	29.59	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	2552.45	(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		1.5	(36)

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

Total fabric heat loss	(33) + (36) =	31.09	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	38.77	38.53	38.29	37.19	36.98	36.02	36.02	35.84	36.39	36.98	37.4	37.84	(38)

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

(39)m=	69.86	69.62	69.38	68.28	68.07	67.11	67.11	66.93	67.48	68.07	68.49	68.92	

Average = Sum(39)$_{1…12}$ /12= 68.28 (39)

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

(40)m=	0.88	0.88	0.88	0.86	0.86	0.85	0.85	0.85	0.85	0.86	0.87	0.87	

Average = Sum(40)$_{1…12}$ /12= 0.86 (40)

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Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N — 2.44 (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 — 92.24 (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=	101.46	97.77	94.08	90.39	86.7	83.01	83.01	86.7	90.39	94.08	97.77	101.46	
										Total = Sum(44)$_{1...12}$ =		1106.83	(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=	150.46	131.59	135.79	118.39	113.6	98.02	90.83	104.23	105.48	122.93	134.18	145.71	
										Total = Sum(45)$_{1...12}$ =		1451.23	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	22.57	19.74	20.37	17.76	17.04	14.7	13.63	15.64	15.82	18.44	20.13	21.86	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0.3 (48)

Temperature factor from Table 2b — 0.54 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 0.16 (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) — 0.16 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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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=	178.69	157.09	164.02	145.71	141.83	125.34	119.06	132.46	132.8	151.16	161.5	173.94	(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=	178.69	157.09	164.02	145.71	141.83	125.34	119.06	132.46	132.8	151.16	161.5	173.94	

Output from water heater (annual)$_{1...12}$ 1783.62 (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=	72.61	64.15	67.74	61.22	60.35	54.45	52.79	57.24	56.93	63.46	66.47	71.03	(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=	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	19.38	17.21	14	10.6	7.92	6.69	7.23	9.39	12.61	16.01	18.68	19.91	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	217.34	219.59	213.91	201.81	186.54	172.18	162.59	160.34	166.02	178.12	193.39	207.75	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	(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=	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	(71)
Water heating gains (Table 5)													
(72)m=	97.6	95.47	91.04	85.03	81.12	75.62	70.95	76.94	79.07	85.29	92.32	95.48	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	396.97	394.92	381.6	360.09	338.23	317.15	303.42	309.32	320.35	342.07	367.05	385.79	(73)

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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	6.93	x	10.63	x	0.63	x	0.7	=	22.52	(74)
North	0.9x	0.77	x	6.93	x	20.32	x	0.63	x	0.7	=	43.04	(74)
North	0.9x	0.77	x	6.93	x	34.53	x	0.63	x	0.7	=	73.13	(74)
North	0.9x	0.77	x	6.93	x	55.46	x	0.63	x	0.7	=	117.47	(74)
North	0.9x	0.77	x	6.93	x	74.72	x	0.63	x	0.7	=	158.24	(74)
North	0.9x	0.77	x	6.93	x	79.99	x	0.63	x	0.7	=	169.4	(74)
North	0.9x	0.77	x	6.93	x	74.68	x	0.63	x	0.7	=	158.16	(74)
North	0.9x	0.77	x	6.93	x	59.25	x	0.63	x	0.7	=	125.48	(74)

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North	0.9x	0.77	x	6.93	x	41.52	x	0.63	x	0.7	=	87.93	(74)
North	0.9x	0.77	x	6.93	x	24.19	x	0.63	x	0.7	=	51.23	(74)
North	0.9x	0.77	x	6.93	x	13.12	x	0.63	x	0.7	=	27.78	(74)
North	0.9x	0.77	x	6.93	x	8.86	x	0.63	x	0.7	=	18.77	(74)
South	0.9x	0.77	x	12.82	x	46.75	x	0.63	x	0.7	=	183.17	(78)
South	0.9x	0.77	x	12.82	x	76.57	x	0.63	x	0.7	=	299.99	(78)
South	0.9x	0.77	x	12.82	x	97.53	x	0.63	x	0.7	=	382.13	(78)
South	0.9x	0.77	x	12.82	x	110.23	x	0.63	x	0.7	=	431.89	(78)
South	0.9x	0.77	x	12.82	x	114.87	x	0.63	x	0.7	=	450.06	(78)
South	0.9x	0.77	x	12.82	x	110.55	x	0.63	x	0.7	=	433.12	(78)
South	0.9x	0.77	x	12.82	x	108.01	x	0.63	x	0.7	=	423.19	(78)
South	0.9x	0.77	x	12.82	x	104.89	x	0.63	x	0.7	=	410.97	(78)
South	0.9x	0.77	x	12.82	x	101.89	x	0.63	x	0.7	=	399.18	(78)
South	0.9x	0.77	x	12.82	x	82.59	x	0.63	x	0.7	=	323.57	(78)
South	0.9x	0.77	x	12.82	x	55.42	x	0.63	x	0.7	=	217.12	(78)
South	0.9x	0.77	x	12.82	x	40.4	x	0.63	x	0.7	=	158.28	(78)

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

(83)m=	205.69	343.03	455.27	549.36	608.3	602.52	581.34	536.45	487.11	374.8	244.9	177.05	(83)

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

(84)m=	602.66	737.95	836.87	909.45	946.54	919.67	884.77	845.77	807.46	716.87	611.95	562.84	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.97	0.93	0.82	0.65	0.47	0.33	0.36	0.57	0.86	0.98	0.99	(86)

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

(87)m=	20.29	20.5	20.71	20.9	20.98	21	21	21	20.99	20.88	20.56	20.25	(87)

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

(88)m=	20.18	20.18	20.19	20.2	20.2	20.21	20.21	20.21	20.21	20.2	20.2	20.19	(88)

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

(89)m=	0.99	0.97	0.91	0.78	0.6	0.41	0.27	0.3	0.51	0.82	0.97	0.99	(89)

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

(90)m=	19.24	19.54	19.84	20.09	20.18	20.21	20.21	20.21	20.2	20.08	19.64	19.19	(90)

fLA = Living area ÷ (4) = | 0.41 | (91)

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

(92)m=	19.67	19.93	20.2	20.42	20.5	20.53	20.53	20.53	20.52	20.41	20.01	19.62	(92)

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

(93)m=	19.67	19.93	20.2	20.42	20.5	20.53	20.53	20.53	20.52	20.41	20.01	19.62	(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

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Utilisation factor for gains, hm:

(94)m=	0.99	0.96	0.91	0.79	0.62	0.43	0.3	0.33	0.53	0.83	0.97	0.99	(94)

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

(95)m=	595.32	711.33	762.21	722.1	586.95	396.84	263.67	276.37	429.61	596.2	592.37	558	(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=	1073.45	1046.24	950.19	786.38	599.32	397.86	263.75	276.5	433.34	667.52	884.22	1062.99	(97)

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

(98)m=	355.73	225.06	139.86	46.29	9.2	0	0	0	0	53.06	210.13	375.72

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1415.05 (98)

Space heating requirement in kWh/m²/year 17.91 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)	355.73	225.06	139.86	46.29	9.2	0	0	0	0	53.06	210.13	375.72		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	380.46	240.7	149.58	49.5	9.84	0	0	0	0	56.75	224.74	401.84		(211)

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 1513.42 (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)

178.69	157.09	164.02	145.71	141.83	125.34	119.06	132.46	132.8	151.16	161.5	173.94

Efficiency of water heater 79.8 (216)

(217)m=	86.62	85.77	84.39	82.14	80.38	79.8	79.8	79.8	79.8	82.33	85.52	86.82	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	206.3	183.15	194.36	177.39	176.45	157.07	149.2	166	166.41	183.6	188.85	200.36

Total = Sum(219a)$_{1...12}$ = 2149.14 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		1513.42
Water heating fuel used		2149.14
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		342.18	(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	=	326.9	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	464.21	(264)
Space and water heating	(261) + (262) + (263) + (264) =				791.11	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	177.59	(268)
Total CO2, kg/year			sum of (265)…(271) =		1007.63	(272)

TER = 12.75 (273)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.3.4

Property Address: TF 3B5P AR West Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	88	(1a) x	2.5	(2a) =	220	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	88	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	220	(5)

2. Ventilation rate:

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

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

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

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

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.2	(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) =	0.17	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.2

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.5	x	1	=	2.5			(26)
Windows Type 1			5.45	x1/[1/(1.3)+ 0.04]		=	6.73			(27)
Windows Type 2			10.6	x1/[1/(1.3)+ 0.04]		=	13.1			(27)
Walls Type1	24.73	7.95	16.78	x	0.18	=	3.02			(29)
Walls Type2	21.17	10.6	10.57	x	0.18	=	1.9			(29)
Roof	59	0	59	x	0.15	=	8.85			(30)
Total area of elements, m²			104.9							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 36.11 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4223.11 (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 0.66 (36)

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

Total fabric heat loss (33) + (36) = 36.77 (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=	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	(38)

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

(39)m=	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	

Average = Sum(39)$_{1…12}$ /12= 73.07 (39)

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

(40)m=	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83

Average = Sum(40)$_{1...12}$ /12= 0.83 (40)

Number of days in month (Table 1a)

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

(41)

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.6 (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 95.89 (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=	105.48	101.64	97.8	93.97	90.13	86.3	86.3	90.13	93.97	97.8	101.64	105.48

Total = Sum(44)$_{1...12}$ = 1150.64 (44)

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

(45)m=	156.42	136.8	141.17	123.07	118.09	101.91	94.43	108.36	109.65	127.79	139.49	151.48

Total = Sum(45)$_{1...12}$ = 1508.67 (45)

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

(46)m=	23.46	20.52	21.18	18.46	17.71	15.29	14.16	16.25	16.45	19.17	20.92	22.72

(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 5 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 5 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 2.88 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.24 (54)

Enter (50) or (54) in (55) 0.24 (55)

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

(56)m=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49

(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=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49

(57)

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

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

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

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

(59)

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

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

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

(62)m=	187.17	164.58	171.92	152.83	148.84	131.66	125.18	139.11	139.41	158.54	169.25	182.23	(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=	187.17	164.58	171.92	152.83	148.84	131.66	125.18	139.11	139.41	158.54	169.25	182.23	

Output from water heater (annual)$_{1...12}$ 1870.75 (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=	76.61	67.71	71.54	64.73	63.87	57.69	56	60.63	60.27	67.09	70.19	74.97	(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=	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	(66)

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

(67)m=	21.39	18.99	15.45	11.69	8.74	7.38	7.97	10.37	13.91	17.67	20.62	21.98	(67)

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

(68)m=	235.35	237.79	231.64	218.54	202	186.45	176.07	173.63	179.78	192.88	209.42	224.97	(68)

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

(69)m=	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	(71)

Water heating gains (Table 5)

(72)m=	102.97	100.76	96.16	89.9	85.84	80.13	75.27	81.49	83.7	90.18	97.49	100.76	(72)

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

(73)m=	421.67	419.5	405.2	382.09	358.54	335.92	321.27	327.45	339.36	362.69	389.49	409.67	(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)	
East	0.9x	1	x	5.45	x	19.64	x	0.63	x	0.7	=	32.71	(76)
East	0.9x	1	x	5.45	x	38.42	x	0.63	x	0.7	=	63.99	(76)
East	0.9x	1	x	5.45	x	63.27	x	0.63	x	0.7	=	105.39	(76)
East	0.9x	1	x	5.45	x	92.28	x	0.63	x	0.7	=	153.7	(76)
East	0.9x	1	x	5.45	x	113.09	x	0.63	x	0.7	=	188.37	(76)

East	0.9x	1	x	5.45	x	115.77	x	0.63	x	0.7	=	192.83	(76)
East	0.9x	1	x	5.45	x	110.22	x	0.63	x	0.7	=	183.58	(76)
East	0.9x	1	x	5.45	x	94.68	x	0.63	x	0.7	=	157.69	(76)
East	0.9x	1	x	5.45	x	73.59	x	0.63	x	0.7	=	122.57	(76)
East	0.9x	1	x	5.45	x	45.59	x	0.63	x	0.7	=	75.93	(76)
East	0.9x	1	x	5.45	x	24.49	x	0.63	x	0.7	=	40.79	(76)
East	0.9x	1	x	5.45	x	16.15	x	0.63	x	0.7	=	26.9	(76)
West	0.9x	0.77	x	10.6	x	19.64	x	0.63	x	0.7	=	63.62	(80)
West	0.9x	0.77	x	10.6	x	38.42	x	0.63	x	0.7	=	124.46	(80)
West	0.9x	0.77	x	10.6	x	63.27	x	0.63	x	0.7	=	204.97	(80)
West	0.9x	0.77	x	10.6	x	92.28	x	0.63	x	0.7	=	298.94	(80)
West	0.9x	0.77	x	10.6	x	113.09	x	0.63	x	0.7	=	366.36	(80)
West	0.9x	0.77	x	10.6	x	115.77	x	0.63	x	0.7	=	375.04	(80)
West	0.9x	0.77	x	10.6	x	110.22	x	0.63	x	0.7	=	357.05	(80)
West	0.9x	0.77	x	10.6	x	94.68	x	0.63	x	0.7	=	306.7	(80)
West	0.9x	0.77	x	10.6	x	73.59	x	0.63	x	0.7	=	238.39	(80)
West	0.9x	0.77	x	10.6	x	45.59	x	0.63	x	0.7	=	147.69	(80)
West	0.9x	0.77	x	10.6	x	24.49	x	0.63	x	0.7	=	79.33	(80)
West	0.9x	0.77	x	10.6	x	16.15	x	0.63	x	0.7	=	52.32	(80)

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

(83)m=	96.34	188.46	310.36	452.64	554.73	567.86	540.63	464.39	360.96	223.62	120.12	79.22	(83)

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

(84)m=	518	607.96	715.56	834.74	913.27	903.79	861.9	791.84	700.32	586.3	509.61	488.89	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.97	0.89	0.71	0.51	0.37	0.42	0.69	0.95	0.99	1	(86)

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

(87)m=	20.2	20.35	20.59	20.84	20.97	21	21	21	20.98	20.77	20.42	20.16	(87)

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

(88)m=	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	(88)

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

(89)m=	1	0.99	0.97	0.86	0.66	0.45	0.31	0.35	0.63	0.93	0.99	1	(89)

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

(90)m=	19.15	19.37	19.71	20.05	20.2	20.23	20.23	20.23	20.21	19.97	19.47	19.09	(90)

fLA = Living area ÷ (4) = 0.25 (91)

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

(92)m=	19.42	19.61	19.93	20.25	20.39	20.42	20.42	20.42	20.4	20.17	19.71	19.36	(92)

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

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(93)m=	19.42	19.61	19.93	20.25	20.39	20.42	20.42	20.42	20.4	20.17	19.71	19.36	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.96	0.87	0.67	0.47	0.32	0.37	0.64	0.93	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	516.1	601.65	688.83	722.12	616.1	423.51	279.01	293.45	450.17	545.92	504.92	487.63	(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=	1104.44	1075.15	981.27	829.2	635.05	425.1	279.13	293.72	460.64	699.13	921.51	1107.73	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	437.72	318.19	217.58	77.09	14.1	0	0	0	0	113.99	299.94	461.36	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =	1939.97	(98)
Space heating requirement in kWh/m²/year	22.05	(99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers		1	(303a)
Fraction of total space heat from Community boilers	(302) x (303a) =	1	(304a)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)
Space heating		**kWh/year**	
Annual space heating requirement		1939.97	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	2036.96	(307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)
Water heating			
Annual water heating requirement		1870.75	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	1964.28	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	40.01	(313)
Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		63.88	(330a)

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warm air heating system fans			0	(330b)
pump for solar water heating			0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =		63.88	(331)
Energy for lighting (calculated in Appendix L)			377.67	(332)

12b. CO2 Emissions – Community heating scheme

		Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP)						
Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel				89.5	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0	=	965.66	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	20.77	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	986.43	(373)
CO2 associated with space heating (secondary)	(309) x		0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x		0.22	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =				986.43	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	33.15	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	196.01	(379)
Total CO2, kg/year	sum of (376)…(382) =				1215.6	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				13.81	(384)
EI rating (section 14)					87.75	(385)

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User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.3.4

Property Address: TF 3B5P AR West Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	88	(1a) x	2.5	(2a) =	220	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	88	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	220	(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							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

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			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.14	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction *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*		0	(11)
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)	0.39	(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) =	0.33	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.42	0.41	0.4	0.36	0.35	0.31	0.31	0.3	0.33	0.35	0.37	0.39

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=	0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57	(24d)

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

(25)m=	0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.5	x	1	=	2.5			(26)
Windows Type 1			5.45	x1/[1/(1.4)+ 0.04]		=	7.23			(27)
Windows Type 2			10.6	x1/[1/(1.4)+ 0.04]		=	14.05			(27)
Walls Type1	24.73	7.95	16.78	x	0.18	=	3.02			(29)
Walls Type2	21.17	10.6	10.57	x	0.18	=	1.9			(29)
Roof	59	0	59	x	0.13	=	7.67			(30)
Total area of elements, m²			104.9							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 36.37 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4223.11 (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 0.55 (36)

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

Total fabric heat loss (33) + (36) = 36.92 (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=	42.66	42.42	42.18	41.04	40.82	39.83	39.83	39.65	40.22	40.82	41.25	41.71	(38)

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

(39)m=	79.59	79.34	79.1	77.96	77.75	76.75	76.75	76.57	77.14	77.75	78.18	78.63	

Average = Sum(39)$_{1…12}$ /12= 77.96 (39)

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

(40)m=	0.9	0.9	0.9	0.89	0.88	0.87	0.87	0.87	0.88	0.88	0.89	0.89

Average = Sum(40)$_{1…12}$ /12= 0.89 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.6 (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 95.89 (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=	105.48	101.64	97.8	93.97	90.13	86.3	86.3	90.13	93.97	97.8	101.64	105.48

Total = Sum(44)$_{1…12}$ = 1150.64 (44)

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

(45)m=	156.42	136.8	141.17	123.07	118.09	101.91	94.43	108.36	109.65	127.79	139.49	151.48

Total = Sum(45)$_{1…12}$ = 1508.67 (45)

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

(46)m=	23.46	20.52	21.18	18.46	17.71	15.29	14.16	16.25	16.45	19.17	20.92	22.72	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.3 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.16 (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) 0.16 (55)

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

(56)m=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(57)

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

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

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

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

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

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

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

(62)m=	184.65	162.3	169.4	150.39	146.32	129.22	122.66	136.59	136.97	156.02	166.81	179.71	(62)

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

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

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

Output from water heater

(64)m=	184.65	162.3	169.4	150.39	146.32	129.22	122.66	136.59	136.97	156.02	166.81	179.71	

Output from water heater (annual)$_{1...12}$ 1841.06 (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=	74.59	65.89	69.52	62.78	61.85	55.74	53.98	58.61	58.32	65.07	68.24	72.95	(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=	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	21.39	18.99	15.45	11.69	8.74	7.38	7.97	10.37	13.91	17.67	20.62	21.98	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	235.35	237.79	231.64	218.54	202	186.45	176.07	173.63	179.78	192.88	209.42	224.97	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	(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=	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	(71)
Water heating gains (Table 5)													
(72)m=	100.26	98.04	93.44	87.19	83.13	77.42	72.56	78.78	80.99	87.47	94.77	98.05	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	421.95	419.79	405.49	382.38	358.83	336.21	321.56	327.74	339.65	362.97	389.77	409.96	(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)	
East	0.9x	1	x	5.45	x	19.64	x	0.63	x	0.7	=	32.71	(76)
East	0.9x	1	x	5.45	x	38.42	x	0.63	x	0.7	=	63.99	(76)
East	0.9x	1	x	5.45	x	63.27	x	0.63	x	0.7	=	105.39	(76)
East	0.9x	1	x	5.45	x	92.28	x	0.63	x	0.7	=	153.7	(76)
East	0.9x	1	x	5.45	x	113.09	x	0.63	x	0.7	=	188.37	(76)

East	0.9x	1	x	5.45	x	115.77	x	0.63	x	0.7	=	192.83	(76)
East	0.9x	1	x	5.45	x	110.22	x	0.63	x	0.7	=	183.58	(76)
East	0.9x	1	x	5.45	x	94.68	x	0.63	x	0.7	=	157.69	(76)
East	0.9x	1	x	5.45	x	73.59	x	0.63	x	0.7	=	122.57	(76)
East	0.9x	1	x	5.45	x	45.59	x	0.63	x	0.7	=	75.93	(76)
East	0.9x	1	x	5.45	x	24.49	x	0.63	x	0.7	=	40.79	(76)
East	0.9x	1	x	5.45	x	16.15	x	0.63	x	0.7	=	26.9	(76)
West	0.9x	0.77	x	10.6	x	19.64	x	0.63	x	0.7	=	63.62	(80)
West	0.9x	0.77	x	10.6	x	38.42	x	0.63	x	0.7	=	124.46	(80)
West	0.9x	0.77	x	10.6	x	63.27	x	0.63	x	0.7	=	204.97	(80)
West	0.9x	0.77	x	10.6	x	92.28	x	0.63	x	0.7	=	298.94	(80)
West	0.9x	0.77	x	10.6	x	113.09	x	0.63	x	0.7	=	366.36	(80)
West	0.9x	0.77	x	10.6	x	115.77	x	0.63	x	0.7	=	375.04	(80)
West	0.9x	0.77	x	10.6	x	110.22	x	0.63	x	0.7	=	357.05	(80)
West	0.9x	0.77	x	10.6	x	94.68	x	0.63	x	0.7	=	306.7	(80)
West	0.9x	0.77	x	10.6	x	73.59	x	0.63	x	0.7	=	238.39	(80)
West	0.9x	0.77	x	10.6	x	45.59	x	0.63	x	0.7	=	147.69	(80)
West	0.9x	0.77	x	10.6	x	24.49	x	0.63	x	0.7	=	79.33	(80)
West	0.9x	0.77	x	10.6	x	16.15	x	0.63	x	0.7	=	52.32	(80)

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

(83)m=	96.34	188.46	310.36	452.64	554.73	567.86	540.63	464.39	360.96	223.62	120.12	79.22	(83)

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

(84)m=	518.29	608.25	715.85	835.02	913.56	904.07	862.19	792.13	700.61	586.59	509.9	489.18	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.91	0.74	0.54	0.39	0.44	0.72	0.96	1	1	(86)

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

(87)m=	20.09	20.25	20.5	20.79	20.95	20.99	21	21	20.97	20.72	20.35	20.07	(87)

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

(88)m=	20.16	20.17	20.17	20.18	20.18	20.19	20.19	20.19	20.19	20.18	20.18	20.17	(88)

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

(89)m=	1	0.99	0.97	0.88	0.69	0.47	0.32	0.37	0.65	0.94	0.99	1	(89)

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

(90)m=	18.94	19.17	19.54	19.95	20.14	20.19	20.19	20.19	20.17	19.87	19.33	18.91	(90)

fLA = Living area ÷ (4) = 0.25 (91)

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

(92)m=	19.23	19.44	19.78	20.16	20.34	20.39	20.39	20.39	20.37	20.08	19.59	19.2	(92)

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

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(93)m=	19.23	19.44	19.78	20.16	20.34	20.39	20.39	20.39	20.37	20.08	19.59	19.2		(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, hm:														
(94)m=	1	0.99	0.97	0.88	0.7	0.49	0.34	0.39	0.67	0.94	0.99	1		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	516.46	602.52	692.79	736.57	642.56	441.79	290.93	305.37	467.79	550.96	505.54	487.94		(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=	1188.3	1153.65	1050.24	877.64	671.84	444.37	291.13	305.82	483.4	737.03	976.09	1179.62		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	499.85	370.36	265.94	101.57	21.79	0	0	0	0	138.43	338.79	514.61		
Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =													2251.34	(98)
Space heating requirement in kWh/m²/year													25.58	(99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)														
	499.85	370.36	265.94	101.57	21.79	0	0	0	0	138.43	338.79	514.61		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	534.6	396.11	284.43	108.63	23.3	0	0	0	0	148.06	362.35	550.38		
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													2407.85	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)														
	184.65	162.3	169.4	150.39	146.32	129.22	122.66	136.59	136.97	156.02	166.81	179.71		
Efficiency of water heater													79.8	(216)
(217)m=	87.34	86.95	86.01	83.79	81.04	79.8	79.8	79.8	79.8	84.5	86.67	87.46		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	211.41	186.67	196.95	179.48	180.55	161.94	153.71	171.17	171.65	184.65	192.48	205.47		
Total = Sum(219a)$_{1...12}$ =													2196.11	(219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		2407.85

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Water heating fuel used			2196.11	
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			377.67	(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	=	520.1	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	474.36	(264)
Space and water heating	(261) + (262) + (263) + (264) =			994.45	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	196.01	(268)
Total CO2, kg/year		sum of (265)…(271) =		1229.39	(272)

TER =	13.97	(273)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

West End Lane_SBEM

As built

Date: Mon May 16 17:49:19 2016

Administrative information

Building Details

Address: Address 1, Address 2, City, Postcode

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.g.3

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.5

BRUKL compliance check version: v5.2.g.3

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	34.6
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	34.6
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	32.1
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	GF000003_W1_-1
Floor	0.25	0.08	0.15	GF000018_F_-1
Roof	0.25	0.15	0.15	1F000001_C_-1
Windows***, roof windows, and rooflights	2.2	1.31	1.31	GF000017_W2-W0
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	4

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Main system

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	3.35	-	-	-
Standard value	0.91*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

1- SYST0000-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	-
Standard value	N/A	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
GF_Office Entrance	-	-	-	-	-	-	-	-	-	-	N/A
GF_Community Room	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Community Room (Office)	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Community Room (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
GF_Community Room (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
1F_Core	-	-	-	-	-	-	-	-	-	-	N/A
1F_Staircore	-	-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Storage)		-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Meeting Room)			-	1.4	-	-	-	-	-	0.7	0.5
1F_Flexible Employment Space	-	-	-	1.4	-	-	-	-	-	0.7	0.5
1F_Flexible Employment Space (Eating/Drinking)			-	1.4	-	-	-	-	-	0.7	0.5
GF_Commercial Unit (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
GF_Commercial Unit (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Commercial Unit (Office)	-	-	-	1.4	-	-	-	-	-	0.7	0.5

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
GF_Commercial Unit	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 4 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 4	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 3 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 3	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 2 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 2	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 1 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 1	-	-	-	1.4	-	-	-	-	-	0.7	0.5

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GF_Office Entrance	-	62	-	445
GF_Community Room	-	62	40	755
GF_Community Room (Office)	62	-	-	39
GF_Community Room (Toilets)	-	62	-	74
GF_Community Room (Storage)	63	-	-	31
1F_Core	-	63	-	432
1F_Staircore	-	62	-	60
1F_Flexible Employment Space (Toilets)	-	63	-	365
1F_Flexible Employment Space (Storage)	62	-	-	75
1F_Flexible Employment Space (Meeting Room)	63	-	-	134
1F_Flexible Employment Space	63	-	-	3239
1F_Flexible Employment Space (Eating/Drinking)	-	63	-	317
GF_Commercial Unit (Toilets)	-	62	-	218
GF_Commercial Unit (Storage)	62	-	-	86
GF_Commercial Unit (Office)	63	-	-	254
GF_Commercial Unit	-	63	40	14056
GF_Start-up unit 4 (Storage)	62	-	-	37
GF_Start-up unit 4	-	62	40	1311
GF_Start-up unit 3 (Storage)	62	-	-	34
GF_Start-up unit 3	-	63	40	1231
GF_Start-up unit 2 (Storage)	63	-	-	36
GF_Start-up unit 2	-	62	40	1292
GF_Start-up unit 1 (Storage)	62	-	-	26
GF_Start-up unit 1	-	63	40	1082

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GF_Office Entrance	N/A	N/A
GF_Community Room	NO (-37.7%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GF_Community Room (Office)	N/A	N/A
GF_Community Room (Toilets)	N/A	N/A
GF_Community Room (Storage)	N/A	N/A
1F_Core	N/A	N/A
1F_Staircore	N/A	N/A
1F_Flexible Employment Space (Toilets)	N/A	N/A
1F_Flexible Employment Space (Storage)	N/A	N/A
1F_Flexible Employment Space (Meeting Room)	N/A	N/A
1F_Flexible Employment Space	NO (-69.4%)	NO
1F_Flexible Employment Space (Eating/Drinking)	NO (-85.7%)	NO
GF_Commercial Unit (Toilets)	N/A	N/A
GF_Commercial Unit (Storage)	N/A	N/A
GF_Commercial Unit (Office)	N/A	N/A
GF_Commercial Unit	NO (-56.2%)	NO
GF_Start-up unit 4 (Storage)	N/A	N/A
GF_Start-up unit 4	NO (-61.9%)	NO
GF_Start-up unit 3 (Storage)	N/A	N/A
GF_Start-up unit 3	NO (-36.4%)	NO
GF_Start-up unit 2 (Storage)	N/A	N/A
GF_Start-up unit 2	NO (-41.5%)	NO
GF_Start-up unit 1 (Storage)	N/A	N/A
GF_Start-up unit 1	NO (-45.7%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	1653.5	1653.5
External area [m^2]	2658.2	2658.2
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	4	3
Average conductance [W/K]	568.63	826.4
Average U-value [W/m^{2}K]	0.21	0.31
Alpha value* [%]	26	14.21

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
64	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
32	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
4	**D1 Non-residential Inst.: Community/Day Centre**
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	5.57	6.44
Cooling	13.73	14.85
Auxiliary	5.7	3.15
Lighting	40.27	46.25
Hot water	2.98	2.98
Equipment*	25.57	25.57
TOTAL**	**68.25**	**73.68**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	221.47	211.41
Primary energy* [kWh/m^2]	189.12	203.83
Total emissions [kg/m^2]	32.1	34.6

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	17.9	203.6	5.6	13.7	5.7	0.89	4.12	0.91	5.51
	Notional	19	192.4	6.4	14.8	3.2	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	GF000003_W1_-1
Floor	0.2	0.07	GF000022_F_-1
Roof	0.15	0.15	1F000001_C_-1
Windows, roof windows, and rooflights	1.5	1.31	GF000017_W2-W0
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)]

$U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	4

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.3.4

Property Address: GF 2B4P PS East Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	74	(1a) x	2.5	(2a) =	185	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	74	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	185	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0 ÷ (5) =	0	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)			
Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.2	(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) =	0.17	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

DER WorkSheet: New dwelling design stage

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

0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.2

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	
Windows Type 1			7.95	x1/[1/(1.3)+ 0.04]		=	9.82			(27)
Windows Type 2			8.38	x1/[1/(1.3)+ 0.04]		=	10.36			(27)
Floor			74	x	0.15	=	11.1			(28)
Walls Type1	22.06	7.95	14.11	x	0.18	=	2.54			(29)
Walls Type2	24.23	8.38	15.85	x	0.18	=	2.85			(29)
Total area of elements, m²			120.29							(31)

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 36.67 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 9594.2 (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 9.1 (36)

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

Total fabric heat loss (33) + (36) = 45.77 (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=	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	30.52	(38)

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

(39)m=	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	

Average = $Sum(39)_{1...12}$ /12= 76.3 (39)

DER WorkSheet: New dwelling design stage

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

(40)m=	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03

Average = Sum(40)$_{1…12}$ /12= 1.03 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.34 (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 89.76 (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=	98.73	95.14	91.55	87.96	84.37	80.78	80.78	84.37	87.96	91.55	95.14	98.73	
										Total = Sum(44)$_{1…12}$ =		1077.07	(44)
Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)													
(45)m=	146.42	128.06	132.14	115.21	110.54	95.39	88.39	101.43	102.64	119.62	130.57	141.8	
										Total = Sum(45)$_{1…12}$ =		1412.21	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	21.96	19.21	19.82	17.28	16.58	14.31	13.26	15.21	15.4	17.94	19.59	21.27	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 5 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 5 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 2.88 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.24 (54)

Enter (50) or (54) in (55) 0.24 (55)

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

(56)m=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(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=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(57)

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

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

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

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

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

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

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

(62)m=	177.17	155.83	162.89	144.96	141.29	125.15	119.14	132.18	132.4	150.37	160.33	172.55	(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=	177.17	155.83	162.89	144.96	141.29	125.15	119.14	132.18	132.4	150.37	160.33	172.55	

Output from water heater (annual)$_{1...12}$ 1774.28 (64)

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

(65)m=	73.28	64.8	68.54	62.11	61.36	55.52	53.99	58.33	57.94	64.37	67.22	71.75	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	18.41	16.35	13.3	10.07	7.53	6.35	6.86	8.92	11.98	15.21	17.75	18.92	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	206.45	208.59	203.19	191.7	177.19	163.56	154.45	152.3	157.7	169.2	183.7	197.34	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	(69)
Pumps and fans gains (Table 5a)													
(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	(71)
Water heating gains (Table 5)													
(72)m=	98.5	96.43	92.12	86.27	82.47	77.12	72.57	78.4	80.47	86.53	93.37	96.44	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	381.45	379.46	366.7	346.12	325.27	305.11	291.97	297.71	308.23	329.02	352.91	370.78	(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)	
South	0.9x	0.77	x	8.38	x	46.75	x	0.63	x	0.7	=	119.73	(78)
South	0.9x	0.77	x	8.38	x	76.57	x	0.63	x	0.7	=	196.09	(78)
South	0.9x	0.77	x	8.38	x	97.53	x	0.63	x	0.7	=	249.79	(78)
South	0.9x	0.77	x	8.38	x	110.23	x	0.63	x	0.7	=	282.31	(78)
South	0.9x	0.77	x	8.38	x	114.87	x	0.63	x	0.7	=	294.19	(78)

South	0.9x	0.77	x	8.38	x	110.55	x	0.63	x	0.7	=	283.12	(78)
South	0.9x	0.77	x	8.38	x	108.01	x	0.63	x	0.7	=	276.62	(78)
South	0.9x	0.77	x	8.38	x	104.89	x	0.63	x	0.7	=	268.64	(78)
South	0.9x	0.77	x	8.38	x	101.89	x	0.63	x	0.7	=	260.93	(78)
South	0.9x	0.77	x	8.38	x	82.59	x	0.63	x	0.7	=	211.5	(78)
South	0.9x	0.77	x	8.38	x	55.42	x	0.63	x	0.7	=	141.93	(78)
South	0.9x	0.77	x	8.38	x	40.4	x	0.63	x	0.7	=	103.46	(78)
West	0.9x	0.77	x	7.95	x	19.64	x	0.63	x	0.7	=	47.72	(80)
West	0.9x	0.77	x	7.95	x	38.42	x	0.63	x	0.7	=	93.35	(80)
West	0.9x	0.77	x	7.95	x	63.27	x	0.63	x	0.7	=	153.73	(80)
West	0.9x	0.77	x	7.95	x	92.28	x	0.63	x	0.7	=	224.21	(80)
West	0.9x	0.77	x	7.95	x	113.09	x	0.63	x	0.7	=	274.77	(80)
West	0.9x	0.77	x	7.95	x	115.77	x	0.63	x	0.7	=	281.28	(80)
West	0.9x	0.77	x	7.95	x	110.22	x	0.63	x	0.7	=	267.79	(80)
West	0.9x	0.77	x	7.95	x	94.68	x	0.63	x	0.7	=	230.03	(80)
West	0.9x	0.77	x	7.95	x	73.59	x	0.63	x	0.7	=	178.79	(80)
West	0.9x	0.77	x	7.95	x	45.59	x	0.63	x	0.7	=	110.76	(80)
West	0.9x	0.77	x	7.95	x	24.49	x	0.63	x	0.7	=	59.5	(80)
West	0.9x	0.77	x	7.95	x	16.15	x	0.63	x	0.7	=	39.24	(80)

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

(83)m=	167.45	289.44	403.52	506.52	568.96	564.4	544.41	498.67	439.73	322.27	201.42	142.7	(83)

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

(84)m=	548.9	668.9	770.22	852.64	894.23	869.51	836.38	796.38	747.96	651.29	554.33	513.49	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.98	0.95	0.88	0.73	0.55	0.4	0.44	0.67	0.92	0.99	1	(86)

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

(87)m=	20.06	20.26	20.52	20.77	20.93	20.99	21	21	20.97	20.74	20.33	20	(87)

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

(88)m=	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	(88)

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

(89)m=	0.99	0.98	0.94	0.85	0.68	0.47	0.32	0.35	0.59	0.89	0.98	0.99	(89)

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

(90)m=	18.81	19.1	19.47	19.81	20	20.05	20.06	20.06	20.03	19.78	19.21	18.73	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	19.35	19.6	19.92	20.23	20.4	20.46	20.46	20.46	20.44	20.2	19.7	19.28	(92)

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

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(93)m=	19.35	19.6	19.92	20.23	20.4	20.46	20.46	20.46	20.44	20.2	19.7	19.28	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.94	0.85	0.7	0.51	0.35	0.39	0.62	0.89	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	543.87	652.53	722.79	726.05	624.88	441.09	294.19	308.95	467	580.25	542.57	510.08	(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=	1148.08	1121.85	1024.1	864.14	663.84	446.78	294.81	310.01	483.56	732.35	961.14	1150.49	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	449.53	315.38	224.17	99.43	28.98	0	0	0	0	113.16	301.37	476.47	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2008.49 (98)

Space heating requirement in kWh/m²/year 27.14 (99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community CHP		0.8	(303a)
Fraction of community heat from heat source 2		0.2	(303b)
Fraction of total space heat from Community CHP	(302) x (303a) =	0.8	(304a)
Fraction of total space heat from community heat source 2	(302) x (303b) =	0.2	(304b)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)
Space heating		**kWh/year**	
Annual space heating requirement		2008.49	
Space heat from Community CHP	(98) x (304a) x (305) x (306) =	1687.13	(307a)
Space heat from heat source 2	(98) x (304b) x (305) x (306) =	421.78	(307b)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)
Water heating			
Annual water heating requirement		1774.28	
If DHW from community scheme:			
Water heat from Community CHP	(64) x (303a) x (305) x (306) =	1490.4	(310a)
Water heat from heat source 2	(64) x (303b) x (305) x (306) =	372.6	(310b)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	39.72	(313)

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Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		49.88	(330a)
warm air heating system fans		0	(330b)
pump for solar water heating		0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =	49.88	(331)
Energy for lighting (calculated in Appendix L)		325.12	(332)

12b. CO_2 Emissions – Community heating scheme

Electrical efficiency of CHP unit						30	(361)
Heat efficiency of CHP unit						57.5	(362)
		Energy kWh/year		**Emission factor kg CO2/kWh**		**Emissions kg CO2/year**	
Space heating from CHP)	(307a) × 100 ÷ (362) =	2934.14	x	0.22		633.77	(363)
less credit emissions for electricity	–(307a) × (361) ÷ (362) =	880.24	x	0.52		-456.84	(364)
Water heated by CHP	(310a) × 100 ÷ (362) =	2591.99	x	0.22		559.87	(365)
less credit emissions for electricity	–(310a) × (361) ÷ (362) =	777.6	x	0.52		-403.57	(366)
Efficiency of heat source 2 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel					89.5	(367b)
CO2 associated with heat source 2	[(307b)+(310b)] x 100 ÷ (367b) x			0.22	=	191.72	(368)
Electrical energy for heat distribution	[(313) x			0.52	=	20.61	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)				=	545.56	(373)
CO2 associated with space heating (secondary)	(309) x			0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x			0.22	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =					545.56	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x			0.52	=	25.89	(378)
CO2 associated with electricity for lighting	(332))) x			0.52	=	168.74	(379)
Total CO2, kg/year	sum of (376)…(382) =					740.18	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =					10	(384)
EI rating (section 14)						91.67	(385)

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User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.4

Property Address: GF 2B4P PS East Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	74	(1a) x	2.5	(2a) =	185	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	74	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	185	(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							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.16	(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)	0.41	(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) =	0.35	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.45	0.44	0.43	0.39	0.38	0.33	0.33	0.32	0.35	0.38	0.39	0.41

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=	0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.58	(24d)

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

(25)m=	0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.58	(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	
Windows Type 1			7.95	x1/[1/(1.4)+ 0.04]		=	10.54			(27)
Windows Type 2			8.38	x1/[1/(1.4)+ 0.04]		=	11.11			(27)
Floor			74	x	0.13	=	9.62			(28)
Walls Type1	22.06	7.95	14.11	x	0.18	=	2.54			(29)
Walls Type2	24.23	8.38	15.85	x	0.18	=	2.85			(29)
Total area of elements, m²			120.29							(31)

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 36.66 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 9594.2 (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 4.6 (36)

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

Total fabric heat loss (33) + (36) = 41.26 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	36.62	36.38	36.15	35.06	34.85	33.91	33.91	33.73	34.27	34.85	35.27	35.7	(38)

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

(39)m=	77.88	77.64	77.41	76.32	76.12	75.17	75.17	74.99	75.53	76.12	76.53	76.96	

Average = Sum(39)$_{1…12}$ /12= 76.32 (39)

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

(40)m=	1.05	1.05	1.05	1.03	1.03	1.02	1.02	1.01	1.02	1.03	1.03	1.04

Average = Sum(40)$_{1…12}$ /12= 1.03 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.34 (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 89.76 (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=	98.73	95.14	91.55	87.96	84.37	80.78	80.78	84.37	87.96	91.55	95.14	98.73

Total = Sum(44)$_{1…12}$ = 1077.07 (44)

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

(45)m=	146.42	128.06	132.14	115.21	110.54	95.39	88.39	101.43	102.64	119.62	130.57	141.8

Total = Sum(45)$_{1…12}$ = 1412.21 (45)

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

(46)m=	21.96	19.21	19.82	17.28	16.58	14.31	13.26	15.21	15.4	17.94	19.59	21.27	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 0.3 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.16 (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) 0.16 (55)

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

(56)m=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(57)

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

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

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

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

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

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

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

(62)m=	174.65	153.55	160.37	142.52	138.77	122.71	116.62	129.66	129.96	147.85	157.89	170.03	(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=	174.65	153.55	160.37	142.52	138.77	122.71	116.62	129.66	129.96	147.85	157.89	170.03	

Output from water heater (annual)1…12 1744.6 (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=	71.27	62.98	66.52	60.16	59.34	53.57	51.97	56.31	55.98	62.36	65.27	69.73	(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=	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	116.96	(66)

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

(67)m=	18.41	16.35	13.3	10.07	7.53	6.35	6.86	8.92	11.98	15.21	17.75	18.92	(67)

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

(68)m=	206.45	208.59	203.19	191.7	177.19	163.56	154.45	152.3	157.7	169.2	183.7	197.34	(68)

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

(69)m=	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	(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=	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	-93.57	(71)

Water heating gains (Table 5)

(72)m=	95.79	93.72	89.41	83.56	79.76	74.41	69.86	75.69	77.76	83.81	90.66	93.72	(72)

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

(73)m=	381.73	379.74	366.99	346.41	325.56	305.4	292.26	298	308.52	329.31	353.2	371.07	(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)	
South	0.9x	0.77	x	8.38	x	46.75	x	0.63	x	0.7	=	119.73	(78)
South	0.9x	0.77	x	8.38	x	76.57	x	0.63	x	0.7	=	196.09	(78)
South	0.9x	0.77	x	8.38	x	97.53	x	0.63	x	0.7	=	249.79	(78)
South	0.9x	0.77	x	8.38	x	110.23	x	0.63	x	0.7	=	282.31	(78)
South	0.9x	0.77	x	8.38	x	114.87	x	0.63	x	0.7	=	294.19	(78)

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South	0.9x	0.77	x	8.38	x	110.55	x	0.63	x	0.7	=	283.12	(78)
South	0.9x	0.77	x	8.38	x	108.01	x	0.63	x	0.7	=	276.62	(78)
South	0.9x	0.77	x	8.38	x	104.89	x	0.63	x	0.7	=	268.64	(78)
South	0.9x	0.77	x	8.38	x	101.89	x	0.63	x	0.7	=	260.93	(78)
South	0.9x	0.77	x	8.38	x	82.59	x	0.63	x	0.7	=	211.5	(78)
South	0.9x	0.77	x	8.38	x	55.42	x	0.63	x	0.7	=	141.93	(78)
South	0.9x	0.77	x	8.38	x	40.4	x	0.63	x	0.7	=	103.46	(78)
West	0.9x	0.77	x	7.95	x	19.64	x	0.63	x	0.7	=	47.72	(80)
West	0.9x	0.77	x	7.95	x	38.42	x	0.63	x	0.7	=	93.35	(80)
West	0.9x	0.77	x	7.95	x	63.27	x	0.63	x	0.7	=	153.73	(80)
West	0.9x	0.77	x	7.95	x	92.28	x	0.63	x	0.7	=	224.21	(80)
West	0.9x	0.77	x	7.95	x	113.09	x	0.63	x	0.7	=	274.77	(80)
West	0.9x	0.77	x	7.95	x	115.77	x	0.63	x	0.7	=	281.28	(80)
West	0.9x	0.77	x	7.95	x	110.22	x	0.63	x	0.7	=	267.79	(80)
West	0.9x	0.77	x	7.95	x	94.68	x	0.63	x	0.7	=	230.03	(80)
West	0.9x	0.77	x	7.95	x	73.59	x	0.63	x	0.7	=	178.79	(80)
West	0.9x	0.77	x	7.95	x	45.59	x	0.63	x	0.7	=	110.76	(80)
West	0.9x	0.77	x	7.95	x	24.49	x	0.63	x	0.7	=	59.5	(80)
West	0.9x	0.77	x	7.95	x	16.15	x	0.63	x	0.7	=	39.24	(80)

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

(83)m=	167.45	289.44	403.52	506.52	568.96	564.4	544.41	498.67	439.73	322.27	201.42	142.7	(83)

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

(84)m=	549.19	669.19	770.5	852.93	894.52	869.8	836.67	796.67	748.25	651.57	554.62	513.77	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.98	0.96	0.88	0.73	0.54	0.39	0.43	0.67	0.92	0.99	1	(86)

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

(87)m=	20.03	20.24	20.5	20.77	20.93	20.99	21	21	20.97	20.75	20.33	19.99	(87)

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

(88)m=	20.04	20.04	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.05	20.05	(88)

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

(89)m=	0.99	0.98	0.94	0.85	0.68	0.47	0.31	0.35	0.59	0.89	0.98	0.99	(89)

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

(90)m=	18.75	19.06	19.43	19.81	20	20.06	20.07	20.07	20.04	19.79	19.21	18.71	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	19.3	19.57	19.9	20.23	20.4	20.46	20.47	20.47	20.44	20.2	19.69	19.26	(92)

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

(93)m=	19.3	19.57	19.9	20.23	20.4	20.46	20.47	20.47	20.44	20.2	19.69	19.26	(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=	0.99	0.98	0.94	0.85	0.7	0.5	0.35	0.38	0.62	0.89	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	544.21	653.12	724.1	726.25	624.05	435.75	290.46	304.45	463.76	580.13	542.87	510.37	(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=	1168.36	1138.71	1036.9	864.39	662.43	440.79	291	305.36	479.23	730.88	963.64	1159.04	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	464.37	326.32	232.72	99.46	28.55	0	0	0	0	112.16	302.96	482.61	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2049.15 (98)

Space heating requirement in kWh/m²/year 27.69 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)														
	464.37	326.32	232.72	99.46	28.55	0	0	0	0	112.16	302.96	482.61		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	496.65	349	248.9	106.37	30.54	0	0	0	0	119.96	324.02	516.16		
Total (kWh/year) =Sum(211)$_{1...5,10...12}$=													2191.61	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10...12}$=													0	(215)

Water heating

Output from water heater (calculated above)														
	174.65	153.55	160.37	142.52	138.77	122.71	116.62	129.66	129.96	147.85	157.89	170.03		
Efficiency of water heater													79.8	(216)
(217)m=	87.3	86.78	85.81	83.88	81.44	79.8	79.8	79.8	79.8	84.09	86.53	87.45		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	200.05	176.95	186.9	169.92	170.39	153.77	146.14	162.48	162.86	175.83	182.48	194.44		
Total = Sum(219a)$_{1...12}$ =													2082.22	(219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		2191.61

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Water heating fuel used			2082.22	
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			325.12	(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	=	473.39	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	449.76	(264)
Space and water heating	(261) + (262) + (263) + (264) =			923.15	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	168.74	(268)
Total CO2, kg/year		sum of (265)…(271) =		1130.81	(272)

TER =	15.28	(273)

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User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.4

Property Address: MF 2B4P SO West Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	79	(1a) x	2.5	(2a) =	197.5	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	79	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	197.5	(5)

2. Ventilation rate:

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

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

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

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

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.2	(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) =	0.17	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.2

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0.5	(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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	
Windows Type 1			7.14	x1/[1/(1.3)+ 0.04] =	8.82			(27)
Windows Type 2			13.2	x1/[1/(1.3)+ 0.04] =	16.31			(27)
Walls Type1	20.62	13.2	7.42	x 0.18 =	1.34			(29)
Walls Type2	18.04	7.14	10.9	x 0.18 =	1.96			(29)
Total area of elements, m²			38.66					(31)

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

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

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	28.43	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	2472.79	(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		2.7	(36)

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

Total fabric heat loss	(33) + (36) =	31.13	(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=	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	32.59	(38)

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

(39)m=	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	63.72	

Average = Sum(39)$_{1…12}$ /12= 63.72 (39)

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

(40)m=	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	

Average = Sum(40)$_{1…12}$ /12= 0.81 (40)

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Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N — 2.44 (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 — 92.24 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	101.46	97.77	94.08	90.39	86.7	83.01	83.01	86.7	90.39	94.08	97.77	101.46	

Total = Sum(44)$_{1...12}$ = 1106.83 (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=	150.46	131.59	135.79	118.39	113.6	98.02	90.83	104.23	105.48	122.93	134.18	145.71	

Total = Sum(45)$_{1...12}$ = 1451.23 (45)

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

(46)m=	22.57	19.74	20.37	17.76	17.04	14.7	13.63	15.64	15.82	18.44	20.13	21.86	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 5 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 5 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a — 2.88 (52)

Temperature factor from Table 2b — 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.24 (54)

Enter (50) or (54) in (55) — 0.24 (55)

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

(56)m=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(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=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(57)

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

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

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

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

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

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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=	181.21	159.37	166.54	148.15	144.35	127.78	121.59	134.99	135.24	153.68	163.94	176.47	(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=	181.21	159.37	166.54	148.15	144.35	127.78	121.59	134.99	135.24	153.68	163.94	176.47

Output from water heater (annual)$_{1...12}$ | 1813.3 | (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=	74.63	65.98	69.75	63.17	62.37	56.4	54.8	59.26	58.88	65.47	68.42	73.05	(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=	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	19.38	17.21	14	10.6	7.92	6.69	7.23	9.39	12.61	16.01	18.68	19.91	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	217.34	219.59	213.91	201.81	186.54	172.18	162.59	160.34	166.02	178.12	193.39	207.75	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	(69)
Pumps and fans gains (Table 5a)													
(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	(71)
Water heating gains (Table 5)													
(72)m=	100.31	98.18	93.75	87.74	83.83	78.33	73.66	79.65	81.78	88	95.03	98.19	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	396.68	394.63	381.31	359.8	337.95	316.86	303.13	309.03	320.06	341.78	366.76	385.5	(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	7.14	x	10.63	x	0.63	x	0.7	=	23.2	(74)
North	0.9x	0.77	x	7.14	x	20.32	x	0.63	x	0.7	=	44.34	(74)
North	0.9x	0.77	x	7.14	x	34.53	x	0.63	x	0.7	=	75.35	(74)
North	0.9x	0.77	x	7.14	x	55.46	x	0.63	x	0.7	=	121.03	(74)
North	0.9x	0.77	x	7.14	x	74.72	x	0.63	x	0.7	=	163.04	(74)
North	0.9x	0.77	x	7.14	x	79.99	x	0.63	x	0.7	=	174.53	(74)
North	0.9x	0.77	x	7.14	x	74.68	x	0.63	x	0.7	=	162.95	(74)
North	0.9x	0.77	x	7.14	x	59.25	x	0.63	x	0.7	=	129.28	(74)

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North	0.9x	0.77	x	7.14	x	41.52	x	0.63	x	0.7	=	90.59	(74)
North	0.9x	0.77	x	7.14	x	24.19	x	0.63	x	0.7	=	52.78	(74)
North	0.9x	0.77	x	7.14	x	13.12	x	0.63	x	0.7	=	28.62	(74)
North	0.9x	0.77	x	7.14	x	8.86	x	0.63	x	0.7	=	19.34	(74)
South	0.9x	0.77	x	13.2	x	46.75	x	0.63	x	0.7	=	188.6	(78)
South	0.9x	0.77	x	13.2	x	76.57	x	0.63	x	0.7	=	308.88	(78)
South	0.9x	0.77	x	13.2	x	97.53	x	0.63	x	0.7	=	393.46	(78)
South	0.9x	0.77	x	13.2	x	110.23	x	0.63	x	0.7	=	444.7	(78)
South	0.9x	0.77	x	13.2	x	114.87	x	0.63	x	0.7	=	463.4	(78)
South	0.9x	0.77	x	13.2	x	110.55	x	0.63	x	0.7	=	445.96	(78)
South	0.9x	0.77	x	13.2	x	108.01	x	0.63	x	0.7	=	435.73	(78)
South	0.9x	0.77	x	13.2	x	104.89	x	0.63	x	0.7	=	423.15	(78)
South	0.9x	0.77	x	13.2	x	101.89	x	0.63	x	0.7	=	411.02	(78)
South	0.9x	0.77	x	13.2	x	82.59	x	0.63	x	0.7	=	333.16	(78)
South	0.9x	0.77	x	13.2	x	55.42	x	0.63	x	0.7	=	223.56	(78)
South	0.9x	0.77	x	13.2	x	40.4	x	0.63	x	0.7	=	162.97	(78)

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

(83)m=	211.8	353.22	468.81	565.72	626.44	620.49	598.68	552.43	501.61	385.94	252.18	182.31	(83)

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

(84)m=	608.48	747.86	850.12	925.52	964.38	937.35	901.81	861.47	821.67	727.72	618.94	567.82	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.96	0.9	0.78	0.61	0.43	0.31	0.34	0.53	0.83	0.97	0.99	(86)

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

(87)m=	20.41	20.61	20.8	20.94	20.99	21	21	21	21	20.92	20.64	20.36	(87)

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

(88)m=	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25	(88)

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

(89)m=	0.99	0.96	0.88	0.74	0.56	0.38	0.26	0.28	0.48	0.79	0.96	0.99	(89)

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

(90)m=	19.48	19.76	20.02	20.18	20.24	20.25	20.25	20.25	20.25	20.17	19.8	19.39	(90)

fLA = Living area ÷ (4) = | 0.41 | (91)

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

(92)m=	19.86	20.11	20.33	20.49	20.54	20.55	20.55	20.55	20.55	20.47	20.14	19.78	(92)

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

(93)m=	19.86	20.11	20.33	20.49	20.54	20.55	20.55	20.55	20.55	20.47	20.14	19.78	(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

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Utilisation factor for gains, hm:

(94)m=	0.99	0.95	0.89	0.76	0.58	0.4	0.28	0.31	0.5	0.8	0.96	0.99	(94)

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

(95)m=	599.51	713.43	753.24	698.95	557.07	378.72	251.81	264.52	409.01	581.91	594.77	562.12	(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=	991.22	968.88	881.53	738.38	563.42	379.23	251.84	264.58	410.95	629.2	830.82	993.03	(97)

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

(98)m=	291.43	171.66	95.45	28.39	4.73	0	0	0	0	35.19	169.96	320.6

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1117.42 (98)

Space heating requirement in kWh/m²/year 14.14 (99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community CHP		0.8	(303a)
Fraction of community heat from heat source 2		0.2	(303b)
Fraction of total space heat from Community CHP	(302) x (303a) =	0.8	(304a)
Fraction of total space heat from community heat source 2	(302) x (303b) =	0.2	(304b)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

Space heating		**kWh/year**	
Annual space heating requirement		1117.42	
Space heat from Community CHP	(98) x (304a) x (305) x (306) =	938.63	(307a)
Space heat from heat source 2	(98) x (304b) x (305) x (306) =	234.66	(307b)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)

Water heating			
Annual water heating requirement		1813.3	
If DHW from community scheme: Water heat from Community CHP	(64) x (303a) x (305) x (306) =	1523.17	(310a)
Water heat from heat source 2	(64) x (303b) x (305) x (306) =	380.79	(310b)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	30.77	(313)
Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		57.35	(330a)

warm air heating system fans						0	(330b)
pump for solar water heating						0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =					57.35	(331)
Energy for lighting (calculated in Appendix L)						342.18	(332)

12b. CO_2 Emissions – Community heating scheme

		Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Electrical efficiency of CHP unit						30	(361)
Heat efficiency of CHP unit						57.5	(362)
Space heating from CHP)	(307a) × 100 ÷ (362) =	1632.4	x	0.22		352.6	(363)
less credit emissions for electricity	–(307a) × (361) ÷ (362) =	489.72	x	0.52		-254.17	(364)
Water heated by CHP	(310a) × 100 ÷ (362) =	2648.99	x	0.22		572.18	(365)
less credit emissions for electricity	–(310a) × (361) ÷ (362) =	794.7	x	0.52		-412.45	(366)
Efficiency of heat source 2 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel					89.5	(367b)
CO2 associated with heat source 2	[(307b)+(310b)] x 100 ÷ (367b) x			0.22	=	148.53	(368)
Electrical energy for heat distribution	[(313) x			0.52	=	15.97	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)				=	422.67	(373)
CO2 associated with space heating (secondary)	(309) x			0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x			0.22	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =					422.67	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x			0.52	=	29.76	(378)
CO2 associated with electricity for lighting	(332))) x			0.52	=	177.59	(379)
Total CO2, kg/year	sum of (376)…(382) =					630.03	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =					7.98	(384)
EI rating (section 14)						93.19	(385)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.4

Property Address: MF 2B4P SO West Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	79	(1a) x	2.5	(2a) =	197.5	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	79	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	197.5	(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							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.15	(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 *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*		0	(11)
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)	0.4	(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) =	0.34	(21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.44	0.43	0.42	0.38	0.37	0.32	0.32	0.32	0.34	0.37	0.38	0.4

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=	0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(24d)

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

(25)m=	0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(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	
Windows Type 1			6.93	x1/[1/(1.4)+ 0.04]	=	9.19			(27)
Windows Type 2			12.82	x1/[1/(1.4)+ 0.04]	=	17			(27)
Walls Type1	20.62	12.82	7.8	x 0.18	=	1.4			(29)
Walls Type2	18.04	6.93	11.11	x 0.18	=	2			(29)
Total area of elements, m²			38.66						(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 29.59 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 2552.45 (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 1.5 (36)

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

Total fabric heat loss (33) + (36) = 31.09 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	38.77	38.53	38.29	37.19	36.98	36.02	36.02	35.84	36.39	36.98	37.4	37.84	(38)

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

(39)m=	69.86	69.62	69.38	68.28	68.07	67.11	67.11	66.93	67.48	68.07	68.49	68.92	

Average = Sum(39)$_{1…12}$ /12= 68.28 (39)

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

(40)m=	0.88	0.88	0.88	0.86	0.86	0.85	0.85	0.85	0.85	0.86	0.87	0.87

Average = Sum(40)$_{1…12}$ /12= 0.86 (40)

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Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N — 2.44 (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 — 92.24 (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=	101.46	97.77	94.08	90.39	86.7	83.01	83.01	86.7	90.39	94.08	97.77	101.46	
Total = Sum(44)$_{1...12}$ =												1106.83	(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=	150.46	131.59	135.79	118.39	113.6	98.02	90.83	104.23	105.48	122.93	134.18	145.71	
Total = Sum(45)$_{1...12}$ =												1451.23	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	22.57	19.74	20.37	17.76	17.04	14.7	13.63	15.64	15.82	18.44	20.13	21.86	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0.3 (48)

Temperature factor from Table 2b — 0.54 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 0.16 (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) — 0.16 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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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=	178.69	157.09	164.02	145.71	141.83	125.34	119.06	132.46	132.8	151.16	161.5	173.94	(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=	178.69	157.09	164.02	145.71	141.83	125.34	119.06	132.46	132.8	151.16	161.5	173.94	

Output from water heater (annual)$_{1...12}$ 1783.62 (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=	72.61	64.15	67.74	61.22	60.35	54.45	52.79	57.24	56.93	63.46	66.47	71.03	(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=	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	122.18	(66)

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

(67)m=	19.38	17.21	14	10.6	7.92	6.69	7.23	9.39	12.61	16.01	18.68	19.91	(67)

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

(68)m=	217.34	219.59	213.91	201.81	186.54	172.18	162.59	160.34	166.02	178.12	193.39	207.75	(68)

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

(69)m=	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	35.22	(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=	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	-97.74	(71)

Water heating gains (Table 5)

(72)m=	97.6	95.47	91.04	85.03	81.12	75.62	70.95	76.94	79.07	85.29	92.32	95.48	(72)

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

(73)m=	396.97	394.92	381.6	360.09	338.23	317.15	303.42	309.32	320.35	342.07	367.05	385.79	(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	6.93	x	10.63	x	0.63	x	0.7	=	22.52	(74)
North	0.9x	0.77	x	6.93	x	20.32	x	0.63	x	0.7	=	43.04	(74)
North	0.9x	0.77	x	6.93	x	34.53	x	0.63	x	0.7	=	73.13	(74)
North	0.9x	0.77	x	6.93	x	55.46	x	0.63	x	0.7	=	117.47	(74)
North	0.9x	0.77	x	6.93	x	74.72	x	0.63	x	0.7	=	158.24	(74)
North	0.9x	0.77	x	6.93	x	79.99	x	0.63	x	0.7	=	169.4	(74)
North	0.9x	0.77	x	6.93	x	74.68	x	0.63	x	0.7	=	158.16	(74)
North	0.9x	0.77	x	6.93	x	59.25	x	0.63	x	0.7	=	125.48	(74)

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North	0.9x	0.77	x	6.93	x	41.52	x	0.63	x	0.7	=	87.93	(74)
North	0.9x	0.77	x	6.93	x	24.19	x	0.63	x	0.7	=	51.23	(74)
North	0.9x	0.77	x	6.93	x	13.12	x	0.63	x	0.7	=	27.78	(74)
North	0.9x	0.77	x	6.93	x	8.86	x	0.63	x	0.7	=	18.77	(74)
South	0.9x	0.77	x	12.82	x	46.75	x	0.63	x	0.7	=	183.17	(78)
South	0.9x	0.77	x	12.82	x	76.57	x	0.63	x	0.7	=	299.99	(78)
South	0.9x	0.77	x	12.82	x	97.53	x	0.63	x	0.7	=	382.13	(78)
South	0.9x	0.77	x	12.82	x	110.23	x	0.63	x	0.7	=	431.89	(78)
South	0.9x	0.77	x	12.82	x	114.87	x	0.63	x	0.7	=	450.06	(78)
South	0.9x	0.77	x	12.82	x	110.55	x	0.63	x	0.7	=	433.12	(78)
South	0.9x	0.77	x	12.82	x	108.01	x	0.63	x	0.7	=	423.19	(78)
South	0.9x	0.77	x	12.82	x	104.89	x	0.63	x	0.7	=	410.97	(78)
South	0.9x	0.77	x	12.82	x	101.89	x	0.63	x	0.7	=	399.18	(78)
South	0.9x	0.77	x	12.82	x	82.59	x	0.63	x	0.7	=	323.57	(78)
South	0.9x	0.77	x	12.82	x	55.42	x	0.63	x	0.7	=	217.12	(78)
South	0.9x	0.77	x	12.82	x	40.4	x	0.63	x	0.7	=	158.28	(78)

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

(83)m=	205.69	343.03	455.27	549.36	608.3	602.52	581.34	536.45	487.11	374.8	244.9	177.05	(83)

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

(84)m=	602.66	737.95	836.87	909.45	946.54	919.67	884.77	845.77	807.46	716.87	611.95	562.84	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.97	0.93	0.82	0.65	0.47	0.33	0.36	0.57	0.86	0.98	0.99	(86)

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

(87)m=	20.29	20.5	20.71	20.9	20.98	21	21	21	20.99	20.88	20.56	20.25	(87)

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

(88)m=	20.18	20.18	20.19	20.2	20.2	20.21	20.21	20.21	20.21	20.2	20.2	20.19	(88)

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

(89)m=	0.99	0.97	0.91	0.78	0.6	0.41	0.27	0.3	0.51	0.82	0.97	0.99	(89)

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

(90)m=	19.24	19.54	19.84	20.09	20.18	20.21	20.21	20.21	20.2	20.08	19.64	19.19	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	19.67	19.93	20.2	20.42	20.5	20.53	20.53	20.53	20.52	20.41	20.01	19.62	(92)

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

(93)m=	19.67	19.93	20.2	20.42	20.5	20.53	20.53	20.53	20.52	20.41	20.01	19.62	(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:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m=	0.99	0.96	0.91	0.79	0.62	0.43	0.3	0.33	0.53	0.83	0.97	0.99	(94)

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

(95)m=	595.32	711.33	762.21	722.1	586.95	396.84	263.67	276.37	429.61	596.2	592.37	558	(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=	1073.45	1046.24	950.19	786.38	599.32	397.86	263.75	276.5	433.34	667.52	884.22	1062.99	(97)

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

(98)m=	355.73	225.06	139.86	46.29	9.2	0	0	0	0	53.06	210.13	375.72

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1415.05 (98)

Space heating requirement in kWh/m²/year 17.91 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)	355.73	225.06	139.86	46.29	9.2	0	0	0	0	53.06	210.13	375.72		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	380.46	240.7	149.58	49.5	9.84	0	0	0	0	56.75	224.74	401.84		(211)
Total (kWh/year) =Sum(211)$_{1...5,10...12}$=													1513.42	(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)	178.69	157.09	164.02	145.71	141.83	125.34	119.06	132.46	132.8	151.16	161.5	173.94		
Efficiency of water heater													79.8	(216)
(217)m=	86.62	85.77	84.39	82.14	80.38	79.8	79.8	79.8	79.8	82.33	85.52	86.82		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	206.3	183.15	194.36	177.39	176.45	157.07	149.2	166	166.41	183.6	188.85	200.36		
Total = Sum(219a)$_{1...12}$ =													2149.14	(219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		1513.42
Water heating fuel used		2149.14
Electricity for pumps, fans and electric keep-hot		

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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		342.18	(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	=	326.9	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	464.21	(264)
Space and water heating	(261) + (262) + (263) + (264) =				791.11	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	177.59	(268)
Total CO2, kg/year			sum of (265)…(271) =		1007.63	(272)

TER = 12.75 (273)

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User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.4

Property Address: TF 3B5P AR West Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	88	(1a) x	2.5	(2a) =	220	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	88	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	220	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0 ÷ (5) =	0	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)			
Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.2	(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) =	0.17	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.2

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.5	x	1	=	2.5			(26)
Windows Type 1			5.45	x1/[1/(1.3)+ 0.04]		=	6.73			(27)
Windows Type 2			10.6	x1/[1/(1.3)+ 0.04]		=	13.1			(27)
Walls Type1	24.73	7.95	16.78	x	0.18	=	3.02			(29)
Walls Type2	21.17	10.6	10.57	x	0.18	=	1.9			(29)
Roof	59	0	59	x	0.15	=	8.85			(30)
Total area of elements, m²			104.9							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 36.11 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4223.11 (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 0.66 (36)

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

Total fabric heat loss (33) + (36) = 36.77 (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=	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	(38)

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

(39)m=	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	73.07	

Average = Sum(39)1…12 /12= 73.07 (39)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(40)m=	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	

Average = Sum(40)$_{1…12}$ /12= 0.83 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.6 (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 95.89 (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=	105.48	101.64	97.8	93.97	90.13	86.3	86.3	90.13	93.97	97.8	101.64	105.48	
										Total = Sum(44)$_{1…12}$ =		1150.64	(44)
Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)													
(45)m=	156.42	136.8	141.17	123.07	118.09	101.91	94.43	108.36	109.65	127.79	139.49	151.48	
										Total = Sum(45)$_{1…12}$ =		1508.67	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	23.46	20.52	21.18	18.46	17.71	15.29	14.16	16.25	16.45	19.17	20.92	22.72	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 5 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 5 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 2.88 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.24 (54)

Enter (50) or (54) in (55) 0.24 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(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=	7.49	6.76	7.49	7.25	7.49	7.25	7.49	7.49	7.25	7.49	7.25	7.49	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

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

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

(62)m=	187.17	164.58	171.92	152.83	148.84	131.66	125.18	139.11	139.41	158.54	169.25	182.23	(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=	187.17	164.58	171.92	152.83	148.84	131.66	125.18	139.11	139.41	158.54	169.25	182.23	

Output from water heater (annual)$_{1...12}$ 1870.75 (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=	76.61	67.71	71.54	64.73	63.87	57.69	56	60.63	60.27	67.09	70.19	74.97	(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=	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	(66)

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

(67)m=	21.39	18.99	15.45	11.69	8.74	7.38	7.97	10.37	13.91	17.67	20.62	21.98	(67)

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

(68)m=	235.35	237.79	231.64	218.54	202	186.45	176.07	173.63	179.78	192.88	209.42	224.97	(68)

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

(69)m=	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	(71)

Water heating gains (Table 5)

(72)m=	102.97	100.76	96.16	89.9	85.84	80.13	75.27	81.49	83.7	90.18	97.49	100.76	(72)

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

(73)m=	421.67	419.5	405.2	382.09	358.54	335.92	321.27	327.45	339.36	362.69	389.49	409.67	(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)	
East	0.9x	1	x	5.45	x	19.64	x	0.63	x	0.7	=	32.71	(76)
East	0.9x	1	x	5.45	x	38.42	x	0.63	x	0.7	=	63.99	(76)
East	0.9x	1	x	5.45	x	63.27	x	0.63	x	0.7	=	105.39	(76)
East	0.9x	1	x	5.45	x	92.28	x	0.63	x	0.7	=	153.7	(76)
East	0.9x	1	x	5.45	x	113.09	x	0.63	x	0.7	=	188.37	(76)

East	0.9x	1	x	5.45	x	115.77	x	0.63	x	0.7	=	192.83	(76)
East	0.9x	1	x	5.45	x	110.22	x	0.63	x	0.7	=	183.58	(76)
East	0.9x	1	x	5.45	x	94.68	x	0.63	x	0.7	=	157.69	(76)
East	0.9x	1	x	5.45	x	73.59	x	0.63	x	0.7	=	122.57	(76)
East	0.9x	1	x	5.45	x	45.59	x	0.63	x	0.7	=	75.93	(76)
East	0.9x	1	x	5.45	x	24.49	x	0.63	x	0.7	=	40.79	(76)
East	0.9x	1	x	5.45	x	16.15	x	0.63	x	0.7	=	26.9	(76)
West	0.9x	0.77	x	10.6	x	19.64	x	0.63	x	0.7	=	63.62	(80)
West	0.9x	0.77	x	10.6	x	38.42	x	0.63	x	0.7	=	124.46	(80)
West	0.9x	0.77	x	10.6	x	63.27	x	0.63	x	0.7	=	204.97	(80)
West	0.9x	0.77	x	10.6	x	92.28	x	0.63	x	0.7	=	298.94	(80)
West	0.9x	0.77	x	10.6	x	113.09	x	0.63	x	0.7	=	366.36	(80)
West	0.9x	0.77	x	10.6	x	115.77	x	0.63	x	0.7	=	375.04	(80)
West	0.9x	0.77	x	10.6	x	110.22	x	0.63	x	0.7	=	357.05	(80)
West	0.9x	0.77	x	10.6	x	94.68	x	0.63	x	0.7	=	306.7	(80)
West	0.9x	0.77	x	10.6	x	73.59	x	0.63	x	0.7	=	238.39	(80)
West	0.9x	0.77	x	10.6	x	45.59	x	0.63	x	0.7	=	147.69	(80)
West	0.9x	0.77	x	10.6	x	24.49	x	0.63	x	0.7	=	79.33	(80)
West	0.9x	0.77	x	10.6	x	16.15	x	0.63	x	0.7	=	52.32	(80)

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

(83)m=	96.34	188.46	310.36	452.64	554.73	567.86	540.63	464.39	360.96	223.62	120.12	79.22	(83)

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

(84)m=	518	607.96	715.56	834.74	913.27	903.79	861.9	791.84	700.32	586.3	509.61	488.89	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.97	0.89	0.71	0.51	0.37	0.42	0.69	0.95	0.99	1	(86)

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

(87)m=	20.2	20.35	20.59	20.84	20.97	21	21	21	20.98	20.77	20.42	20.16	(87)

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

(88)m=	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	20.23	(88)

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

(89)m=	1	0.99	0.97	0.86	0.66	0.45	0.31	0.35	0.63	0.93	0.99	1	(89)

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

(90)m=	19.15	19.37	19.71	20.05	20.2	20.23	20.23	20.23	20.21	19.97	19.47	19.09	(90)

fLA = Living area ÷ (4) = | 0.25 | (91)

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

(92)m=	19.42	19.61	19.93	20.25	20.39	20.42	20.42	20.42	20.4	20.17	19.71	19.36	(92)

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

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(93)m=	19.42	19.61	19.93	20.25	20.39	20.42	20.42	20.42	20.4	20.17	19.71	19.36	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.96	0.87	0.67	0.47	0.32	0.37	0.64	0.93	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	516.1	601.65	688.83	722.12	616.1	423.51	279.01	293.45	450.17	545.92	504.92	487.63	(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=	1104.44	1075.15	981.27	829.2	635.05	425.1	279.13	293.72	460.64	699.13	921.51	1107.73	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	437.72	318.19	217.58	77.09	14.1	0	0	0	0	113.99	299.94	461.36	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1939.97 (98)

Space heating requirement in kWh/m²/year 22.05 (99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community CHP		0.8	(303a)
Fraction of community heat from heat source 2		0.2	(303b)
Fraction of total space heat from Community CHP	(302) x (303a) =	0.8	(304a)
Fraction of total space heat from community heat source 2	(302) x (303b) =	0.2	(304b)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)
Space heating		**kWh/year**	
Annual space heating requirement		1939.97	
Space heat from Community CHP	(98) x (304a) x (305) x (306) =	1629.57	(307a)
Space heat from heat source 2	(98) x (304b) x (305) x (306) =	407.39	(307b)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)
Water heating			
Annual water heating requirement		1870.75	
If DHW from community scheme: Water heat from Community CHP	(64) x (303a) x (305) x (306) =	1571.43	(310a)
Water heat from heat source 2	(64) x (303b) x (305) x (306) =	392.86	(310b)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	40.01	(313)

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Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		63.88	(330a)
warm air heating system fans		0	(330b)
pump for solar water heating		0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =	63.88	(331)
Energy for lighting (calculated in Appendix L)		377.67	(332)

12b. CO_2 Emissions – Community heating scheme

Electrical efficiency of CHP unit						30	(361)
Heat efficiency of CHP unit						57.5	(362)
		Energy kWh/year		**Emission factor kg CO2/kWh**		**Emissions kg CO2/year**	
Space heating from CHP)	(307a) × 100 ÷ (362) =	2834.04	x	0.22		612.15	(363)
less credit emissions for electricity	–(307a) × (361) ÷ (362) =	850.21	x	0.52		-441.26	(364)
Water heated by CHP	(310a) × 100 ÷ (362) =	2732.92	x	0.22		590.31	(365)
less credit emissions for electricity	–(310a) × (361) ÷ (362) =	819.87	x	0.52		-425.51	(366)
Efficiency of heat source 2 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel					89.5	(367b)
CO2 associated with heat source 2	[(307b)+(310b)] x 100 ÷ (367b) x			0.22	=	193.13	(368)
Electrical energy for heat distribution	[(313) x			0.52	=	20.77	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)				=	549.59	(373)
CO2 associated with space heating (secondary)	(309) x			0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x			0.22	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =					549.59	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x			0.52	=	33.15	(378)
CO2 associated with electricity for lighting	(332))) x			0.52	=	196.01	(379)
Total CO2, kg/year	sum of (376)…(382) =					778.75	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =					8.85	(384)
EI rating (section 14)						92.15	(385)

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User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.3.4

Property Address: TF 3B5P AR West Building

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	88	(1a) x	2.5	(2a) =	220	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	88	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	220	(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							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.14	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.39	(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) =	0.33	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.42	0.41	0.4	0.36	0.35	0.31	0.31	0.3	0.33	0.35	0.37	0.39

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=	0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57	(24d)

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

(25)m=	0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.5	x	1	=	2.5			(26)
Windows Type 1			5.45	x1/[1/(1.4)+ 0.04]		=	7.23			(27)
Windows Type 2			10.6	x1/[1/(1.4)+ 0.04]		=	14.05			(27)
Walls Type1	24.73	7.95	16.78	x	0.18	=	3.02			(29)
Walls Type2	21.17	10.6	10.57	x	0.18	=	1.9			(29)
Roof	59	0	59	x	0.13	=	7.67			(30)
Total area of elements, m²			104.9							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 36.37 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4223.11 (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 0.55 (36)

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

Total fabric heat loss (33) + (36) = 36.92 (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=	42.66	42.42	42.18	41.04	40.82	39.83	39.83	39.65	40.22	40.82	41.25	41.71	(38)

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

(39)m=	79.59	79.34	79.1	77.96	77.75	76.75	76.75	76.57	77.14	77.75	78.18	78.63	

Average = $Sum(39)_{1...12}$ /12= 77.96 (39)

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

(40)m=	0.9	0.9	0.9	0.89	0.88	0.87	0.87	0.87	0.88	0.88	0.89	0.89

Average = Sum(40)$_{1...12}$ /12= 0.89 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.6 (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 95.89 (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=	105.48	101.64	97.8	93.97	90.13	86.3	86.3	90.13	93.97	97.8	101.64	105.48

Total = Sum(44)$_{1...12}$ = 1150.64 (44)

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

(45)m=	156.42	136.8	141.17	123.07	118.09	101.91	94.43	108.36	109.65	127.79	139.49	151.48

Total = Sum(45)$_{1...12}$ = 1508.67 (45)

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

(46)m=	23.46	20.52	21.18	18.46	17.71	15.29	14.16	16.25	16.45	19.17	20.92	22.72	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.3 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.16 (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) 0.16 (55)

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

(56)m=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(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=	4.97	4.49	4.97	4.81	4.97	4.81	4.97	4.97	4.81	4.97	4.81	4.97	(57)

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

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

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

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

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

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

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

(62)m=	184.65	162.3	169.4	150.39	146.32	129.22	122.66	136.59	136.97	156.02	166.81	179.71	(62)

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

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

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

Output from water heater

(64)m=	184.65	162.3	169.4	150.39	146.32	129.22	122.66	136.59	136.97	156.02	166.81	179.71	

Output from water heater (annual)$_{1...12}$ 1841.06 (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=	74.59	65.89	69.52	62.78	61.85	55.74	53.98	58.61	58.32	65.07	68.24	72.95	(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=	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	129.87	(66)

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

(67)m=	21.39	18.99	15.45	11.69	8.74	7.38	7.97	10.37	13.91	17.67	20.62	21.98	(67)

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

(68)m=	235.35	237.79	231.64	218.54	202	186.45	176.07	173.63	179.78	192.88	209.42	224.97	(68)

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

(69)m=	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	35.99	(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=	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	(71)

Water heating gains (Table 5)

(72)m=	100.26	98.04	93.44	87.19	83.13	77.42	72.56	78.78	80.99	87.47	94.77	98.05	(72)

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

(73)m=	421.95	419.79	405.49	382.38	358.83	336.21	321.56	327.74	339.65	362.97	389.77	409.96	(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)	
East	0.9x	1	x	5.45	x	19.64	x	0.63	x	0.7	=	32.71	(76)
East	0.9x	1	x	5.45	x	38.42	x	0.63	x	0.7	=	63.99	(76)
East	0.9x	1	x	5.45	x	63.27	x	0.63	x	0.7	=	105.39	(76)
East	0.9x	1	x	5.45	x	92.28	x	0.63	x	0.7	=	153.7	(76)
East	0.9x	1	x	5.45	x	113.09	x	0.63	x	0.7	=	188.37	(76)

East	0.9x	1	x	5.45	x	115.77	x	0.63	x	0.7	=	192.83	(76)
East	0.9x	1	x	5.45	x	110.22	x	0.63	x	0.7	=	183.58	(76)
East	0.9x	1	x	5.45	x	94.68	x	0.63	x	0.7	=	157.69	(76)
East	0.9x	1	x	5.45	x	73.59	x	0.63	x	0.7	=	122.57	(76)
East	0.9x	1	x	5.45	x	45.59	x	0.63	x	0.7	=	75.93	(76)
East	0.9x	1	x	5.45	x	24.49	x	0.63	x	0.7	=	40.79	(76)
East	0.9x	1	x	5.45	x	16.15	x	0.63	x	0.7	=	26.9	(76)
West	0.9x	0.77	x	10.6	x	19.64	x	0.63	x	0.7	=	63.62	(80)
West	0.9x	0.77	x	10.6	x	38.42	x	0.63	x	0.7	=	124.46	(80)
West	0.9x	0.77	x	10.6	x	63.27	x	0.63	x	0.7	=	204.97	(80)
West	0.9x	0.77	x	10.6	x	92.28	x	0.63	x	0.7	=	298.94	(80)
West	0.9x	0.77	x	10.6	x	113.09	x	0.63	x	0.7	=	366.36	(80)
West	0.9x	0.77	x	10.6	x	115.77	x	0.63	x	0.7	=	375.04	(80)
West	0.9x	0.77	x	10.6	x	110.22	x	0.63	x	0.7	=	357.05	(80)
West	0.9x	0.77	x	10.6	x	94.68	x	0.63	x	0.7	=	306.7	(80)
West	0.9x	0.77	x	10.6	x	73.59	x	0.63	x	0.7	=	238.39	(80)
West	0.9x	0.77	x	10.6	x	45.59	x	0.63	x	0.7	=	147.69	(80)
West	0.9x	0.77	x	10.6	x	24.49	x	0.63	x	0.7	=	79.33	(80)
West	0.9x	0.77	x	10.6	x	16.15	x	0.63	x	0.7	=	52.32	(80)

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

(83)m=	96.34	188.46	310.36	452.64	554.73	567.86	540.63	464.39	360.96	223.62	120.12	79.22	(83)

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

(84)m=	518.29	608.25	715.85	835.02	913.56	904.07	862.19	792.13	700.61	586.59	509.9	489.18	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.91	0.74	0.54	0.39	0.44	0.72	0.96	1	1	(86)

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

(87)m=	20.09	20.25	20.5	20.79	20.95	20.99	21	21	20.97	20.72	20.35	20.07	(87)

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

(88)m=	20.16	20.17	20.17	20.18	20.18	20.19	20.19	20.19	20.19	20.18	20.18	20.17	(88)

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

(89)m=	1	0.99	0.97	0.88	0.69	0.47	0.32	0.37	0.65	0.94	0.99	1	(89)

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

(90)m=	18.94	19.17	19.54	19.95	20.14	20.19	20.19	20.19	20.17	19.87	19.33	18.91	(90)

fLA = Living area ÷ (4) = | 0.25 | (91)

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

(92)m=	19.23	19.44	19.78	20.16	20.34	20.39	20.39	20.39	20.37	20.08	19.59	19.2	(92)

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

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(93)m=	19.23	19.44	19.78	20.16	20.34	20.39	20.39	20.39	20.37	20.08	19.59	19.2		(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, hm:														
(94)m=	1	0.99	0.97	0.88	0.7	0.49	0.34	0.39	0.67	0.94	0.99	1		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	516.46	602.52	692.79	736.57	642.56	441.79	290.93	305.37	467.79	550.96	505.54	487.94		(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=	1188.3	1153.65	1050.24	877.64	671.84	444.37	291.13	305.82	483.4	737.03	976.09	1179.62		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	499.85	370.36	265.94	101.57	21.79	0	0	0	0	138.43	338.79	514.61		
Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =													2251.34	(98)
Space heating requirement in kWh/m²/year													25.58	(99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)														
	499.85	370.36	265.94	101.57	21.79	0	0	0	0	138.43	338.79	514.61		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	534.6	396.11	284.43	108.63	23.3	0	0	0	0	148.06	362.35	550.38		
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													2407.85	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)														
	184.65	162.3	169.4	150.39	146.32	129.22	122.66	136.59	136.97	156.02	166.81	179.71		
Efficiency of water heater													79.8	(216)
(217)m=	87.34	86.95	86.01	83.79	81.04	79.8	79.8	79.8	79.8	84.5	86.67	87.46		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	211.41	186.67	196.95	179.48	180.55	161.94	153.71	171.17	171.65	184.65	192.48	205.47		
Total = Sum(219a)$_{1...12}$ =													2196.11	(219)

Annual totals	kWh/year	kWh/year
Space heating fuel used, main system 1		2407.85

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Water heating fuel used			2196.11	
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			377.67	(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	=	520.1	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	474.36	(264)
Space and water heating	(261) + (262) + (263) + (264) =			994.45	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	196.01	(268)
Total CO2, kg/year		sum of (265)…(271) =		1229.39	(272)

TER = 13.97 (273)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

West End Lane_SBEM

As built

Date: Tue May 17 11:59:24 2016

Administrative information

Building Details

Address: Address 1, Address 2, City, Postcode

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.g.3

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.5

BRUKL compliance check version: v5.2.g.3

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	34.6
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	34.6
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	31.2
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	GF000003_W1_-1
Floor	0.25	0.08	0.15	GF000018_F_-1
Roof	0.25	0.15	0.15	1F000001_C_-1
Windows***, roof windows, and rooflights	2.2	1.31	1.31	GF000017_W2-W0
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	4

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Main system

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	3.35	-	-	-
Standard value	0.91*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

1- SYST0000-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	-
Standard value	N/A	N/A

1- CCHP Generator

	CHPQA quality index	CHP electrical efficiency
This building	-	0.3
Standard value	Not provided	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
GF_Office Entrance	-	-	-	-	-	-	-	-	-	-	N/A
GF_Community Room	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Community Room (Office)	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Community Room (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
GF_Community Room (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
1F_Core	-	-	-	-	-	-	-	-	-	-	N/A
1F_Staircore	-	-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Meeting Room)	-	-	-	1.4	-	-	-	-	-	0.7	0.5

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
1F_Flexible Employment Space	-	-	-	1.4	-	-	-	-	-	0.7	0.5
1F_Flexible Employment Space (Eating/Drinking)	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Commercial Unit (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
GF_Commercial Unit (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Commercial Unit (Office)	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Commercial Unit	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 4 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 4	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 3 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 3	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 2 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 2	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 1 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 1	-	-	-	1.4	-	-	-	-	-	0.7	0.5

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GF_Office Entrance	-	62	-	445
GF_Community Room	-	62	40	755
GF_Community Room (Office)	62	-	-	39
GF_Community Room (Toilets)	-	62	-	74
GF_Community Room (Storage)	63	-	-	31
1F_Core	-	63	-	432
1F_Staircore	-	62	-	60
1F_Flexible Employment Space (Toilets)	-	63	-	365
1F_Flexible Employment Space (Storage)	62	-	-	75
1F_Flexible Employment Space (Meeting Room)	63	-	-	134
1F_Flexible Employment Space	63	-	-	3239
1F_Flexible Employment Space (Eating/Drinking)	-	63	-	317
GF_Commercial Unit (Toilets)	-	62	-	218
GF_Commercial Unit (Storage)	62	-	-	86
GF_Commercial Unit (Office)	63	-	-	254
GF_Commercial Unit	-	63	40	14056
GF_Start-up unit 4 (Storage)	62	-	-	37
GF_Start-up unit 4	-	62	40	1311
GF_Start-up unit 3 (Storage)	62	-	-	34
GF_Start-up unit 3	-	63	40	1231
GF_Start-up unit 2 (Storage)	63	-	-	36
GF_Start-up unit 2	-	62	40	1292
GF_Start-up unit 1 (Storage)	62	-	-	26
GF_Start-up unit 1	-	63	40	1082

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GF_Office Entrance	N/A	N/A
GF_Community Room	NO (-37.7%)	NO
GF_Community Room (Office)	N/A	N/A
GF_Community Room (Toilets)	N/A	N/A
GF_Community Room (Storage)	N/A	N/A
1F_Core	N/A	N/A
1F_Staircore	N/A	N/A
1F_Flexible Employment Space (Toilets)	N/A	N/A
1F_Flexible Employment Space (Storage)	N/A	N/A
1F_Flexible Employment Space (Meeting Room)	N/A	N/A
1F_Flexible Employment Space	NO (-69.4%)	NO
1F_Flexible Employment Space (Eating/Drinking)	NO (-85.7%)	NO
GF_Commercial Unit (Toilets)	N/A	N/A
GF_Commercial Unit (Storage)	N/A	N/A
GF_Commercial Unit (Office)	N/A	N/A
GF_Commercial Unit	NO (-56.2%)	NO
GF_Start-up unit 4 (Storage)	N/A	N/A
GF_Start-up unit 4	NO (-61.9%)	NO
GF_Start-up unit 3 (Storage)	N/A	N/A
GF_Start-up unit 3	NO (-36.4%)	NO
GF_Start-up unit 2 (Storage)	N/A	N/A
GF_Start-up unit 2	NO (-41.5%)	NO
GF_Start-up unit 1 (Storage)	N/A	N/A
GF_Start-up unit 1	NO (-45.7%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1653.5	1653.5
External area [m²]	2658.2	2658.2
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	4	3
Average conductance [W/K]	568.63	826.4
Average U-value [W/m²K]	0.21	0.31
Alpha value* [%]	26	14.21

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
64	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
32	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
4	**D1 Non-residential Inst.: Community/Day Centre**
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	8.03	6.44
Cooling	13.73	14.85
Auxiliary	5.7	3.15
Lighting	40.27	46.25
Hot water	4.48	2.98
Equipment*	25.57	25.57
TOTAL**	**68.83**	**73.68**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	3.38	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	221.47	211.41
Primary energy* [kWh/m²]	183.58	203.83
Total emissions [kg/m²]	31.2	34.6

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	3.6	203.6	1.1	13.7	5.7	0.89	4.12	0.91	5.51
	Notional	19	192.4	6.4	14.8	3.2	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	GF000003_W1_-1
Floor	0.2	0.07	GF000022_F_-1
Roof	0.15	0.15	1F000001_C_-1
Windows, roof windows, and rooflights	1.5	1.31	GF000017_W2-W0
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)]

$U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	4

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

West End Lane_SBEM

As built

Date: Tue May 17 12:06:40 2016

Administrative information

Building Details

Address: Address 1, Address 2, City, Postcode

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.g.3

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.5

BRUKL compliance check version: v5.2.g.3

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	34.6
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	34.6
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	23.9
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	GF000003_W1_-1
Floor	0.25	0.08	0.15	GF000018_F_-1
Roof	0.25	0.15	0.15	1F000001_C_-1
Windows***, roof windows, and rooflights	2.2	1.31	1.31	GF000017_W2-W0
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	4

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Main system

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	3.35	-	-	-
Standard value	0.91*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- SYST0000-DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	-
Standard value	N/A	N/A

1- CCHP Generator

	CHPQA quality index	CHP electrical efficiency
This building	-	0.3
Standard value	Not provided	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
GF_Office Entrance	-	-	-	-	-	-	-	-	-	-	N/A
GF_Community Room	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Community Room (Office)	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Community Room (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
GF_Community Room (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
1F_Core	-	-	-	-	-	-	-	-	-	-	N/A
1F_Staircore	-	-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
1F_Flexible Employment Space (Meeting Room)	-	-	-	1.4	-	-	-	-	-	0.7	0.5

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
1F_Flexible Employment Space	-	-	-	1.4	-	-	-	-	-	0.7	0.5
1F_Flexible Employment Space (Eating/Drinking)	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Commercial Unit (Toilets)	0.3	-	-	-	-	-	-	-	-	-	N/A
GF_Commercial Unit (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Commercial Unit (Office)	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Commercial Unit	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 4 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 4	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 3 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 3	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 2 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 2	-	-	-	1.4	-	-	-	-	-	0.7	0.5
GF_Start-up unit 1 (Storage)	-	-	-	-	-	-	-	-	-	-	N/A
GF_Start-up unit 1	-	-	-	1.4	-	-	-	-	-	0.7	0.5

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GF_Office Entrance	-	62	-	445
GF_Community Room	-	62	40	755
GF_Community Room (Office)	62	-	-	39
GF_Community Room (Toilets)	-	62	-	74
GF_Community Room (Storage)	63	-	-	31
1F_Core	-	63	-	432
1F_Staircore	-	62	-	60
1F_Flexible Employment Space (Toilets)	-	63	-	365
1F_Flexible Employment Space (Storage)	62	-	-	75
1F_Flexible Employment Space (Meeting Room)	63	-	-	134
1F_Flexible Employment Space	63	-	-	3239
1F_Flexible Employment Space (Eating/Drinking)	-	63	-	317
GF_Commercial Unit (Toilets)	-	62	-	218
GF_Commercial Unit (Storage)	62	-	-	86
GF_Commercial Unit (Office)	63	-	-	254
GF_Commercial Unit	-	63	40	14056
GF_Start-up unit 4 (Storage)	62	-	-	37
GF_Start-up unit 4	-	62	40	1311
GF_Start-up unit 3 (Storage)	62	-	-	34
GF_Start-up unit 3	-	63	40	1231
GF_Start-up unit 2 (Storage)	63	-	-	36
GF_Start-up unit 2	-	62	40	1292
GF_Start-up unit 1 (Storage)	62	-	-	26
GF_Start-up unit 1	-	63	40	1082

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GF_Office Entrance	N/A	N/A
GF_Community Room	NO (-37.7%)	NO
GF_Community Room (Office)	N/A	N/A
GF_Community Room (Toilets)	N/A	N/A
GF_Community Room (Storage)	N/A	N/A
1F_Core	N/A	N/A
1F_Staircore	N/A	N/A
1F_Flexible Employment Space (Toilets)	N/A	N/A
1F_Flexible Employment Space (Storage)	N/A	N/A
1F_Flexible Employment Space (Meeting Room)	N/A	N/A
1F_Flexible Employment Space	NO (-69.4%)	NO
1F_Flexible Employment Space (Eating/Drinking)	NO (-85.7%)	NO
GF_Commercial Unit (Toilets)	N/A	N/A
GF_Commercial Unit (Storage)	N/A	N/A
GF_Commercial Unit (Office)	N/A	N/A
GF_Commercial Unit	NO (-56.2%)	NO
GF_Start-up unit 4 (Storage)	N/A	N/A
GF_Start-up unit 4	NO (-61.9%)	NO
GF_Start-up unit 3 (Storage)	N/A	N/A
GF_Start-up unit 3	NO (-36.4%)	NO
GF_Start-up unit 2 (Storage)	N/A	N/A
GF_Start-up unit 2	NO (-41.5%)	NO
GF_Start-up unit 1 (Storage)	N/A	N/A
GF_Start-up unit 1	NO (-45.7%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1653.5	1653.5
External area [m²]	2658.2	2658.2
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	4	3
Average conductance [W/K]	568.63	826.4
Average U-value [W/m²K]	0.21	0.31
Alpha value* [%]	26	14.21

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
64	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
32	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
4	**D1 Non-residential Inst.: Community/Day Centre**
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	8.03	6.44
Cooling	13.73	14.85
Auxiliary	5.7	3.15
Lighting	40.27	46.25
Hot water	4.48	2.98
Equipment*	25.57	25.57
TOTAL**	**68.83**	**73.68**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	14.03	0
Wind turbines	0	0
CHP generators	3.38	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	221.47	211.41
Primary energy* [kWh/m²]	183.58	203.83
Total emissions [kg/m²]	23.9	34.6

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	3.6	203.6	1.1	13.7	5.7	0.89	4.12	0.91	5.51
	Notional	19	192.4	6.4	14.8	3.2	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	**U_{i-Typ}**	**U_{i-Min}**	**Surface where the minimum value occurs***
Wall	0.23	0.18	GF000003_W1_-1
Floor	0.2	0.07	GF000022_F_-1
Roof	0.15	0.15	1F000001_C_-1
Windows, roof windows, and rooflights	1.5	1.31	GF000017_W2-W0
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

U_{i-Typ} = Typical individual element U-values [W/(m²K)] U_{i-Min} = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
$m^3/(h.m^2)$ at 50 Pa	5	4

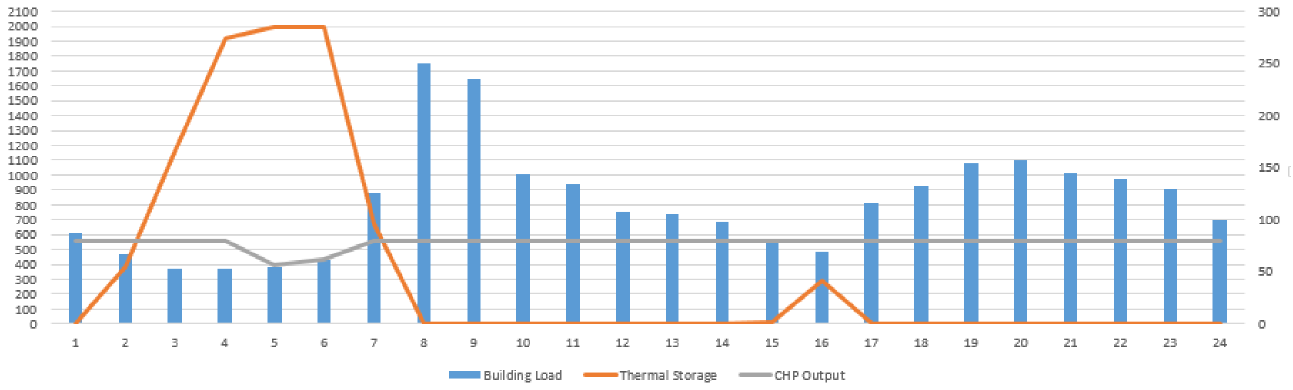
Appendix C – CHP Preliminary sizing and Technical Details

	Jan	Feb	Mar	Apr	May
Daily Total Output	1879.12	1819.48	1698.81	1332.34	915.66
Maximum output from CHP	1920.00	1920.00	1920.00	1920.00	1920.00
Utilisation	0.98	0.95	0.88	0.69	0.48
Days	31	28	31	30	31
Monthly Total Output	58253	50946	52663	39970	28385
Maximum monthly output from CHP	59520	53760	59520	57600	59520

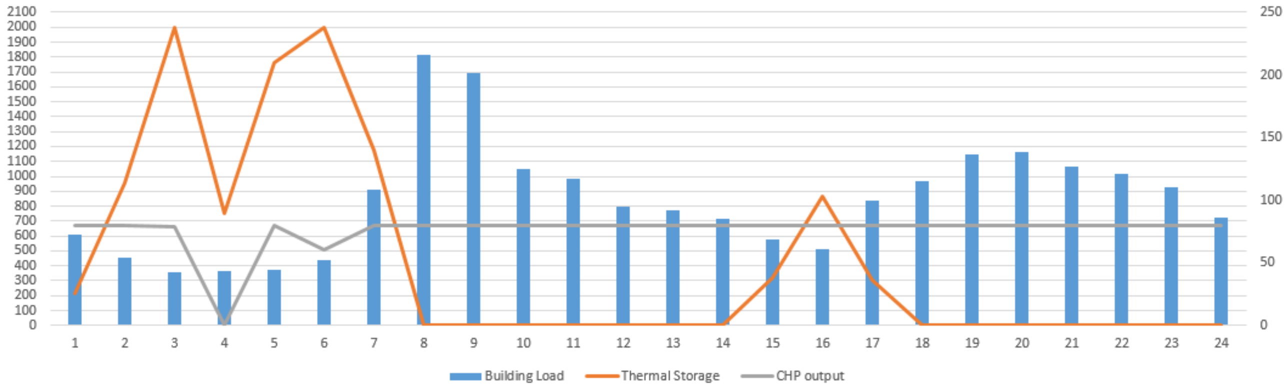
	Jun	Jul	Aug	Sep	Oct
Daily Total Output	726.07	683.63	738.01	757.36	1249.69
Maximum output from CHP	1920.00	1920.00	1920.00	1920.00	1920.00
Utilisation	0.38	0.36	0.38	0.39	0.65
Days	30	31	31	30	31
Monthly Total Output	21782	21193	22878	22721	38740
Maximum monthly output from CHP	57600	59520	59520	57600	59520

	Nov	Dec	Total
Daily Total Output	1730.27	1871.98	
Maximum output from CHP	1920.00	1920.00	
Utilisation	0.90	0.97	**0.67**
Days	30	31	
Monthly Total Output	51908	58031	**467471**
Maximum monthly output from CHP	57600	59520	**700800**

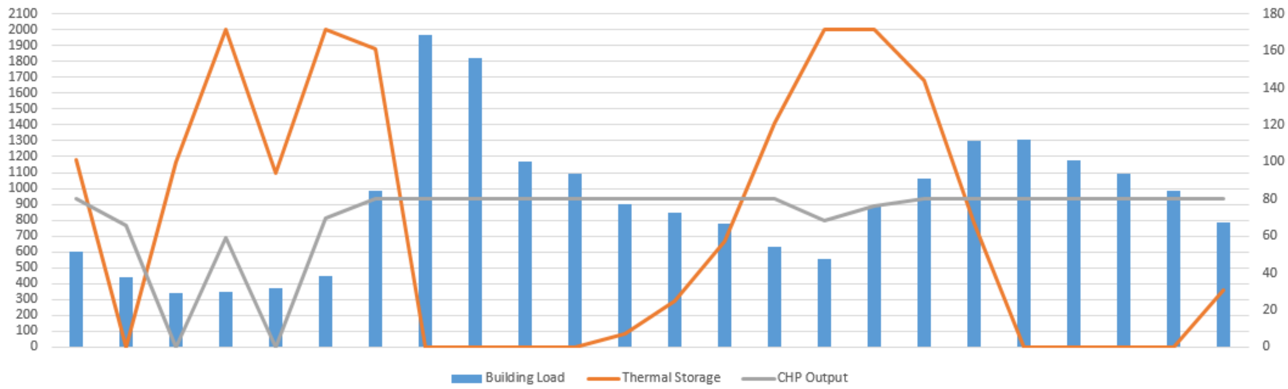
January CHP and Storage Operation



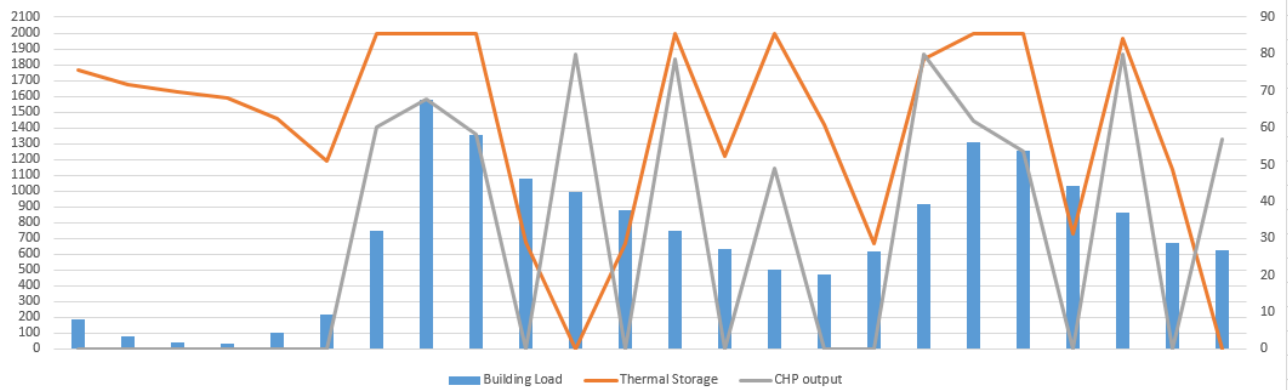
February CHP and Storage Operation

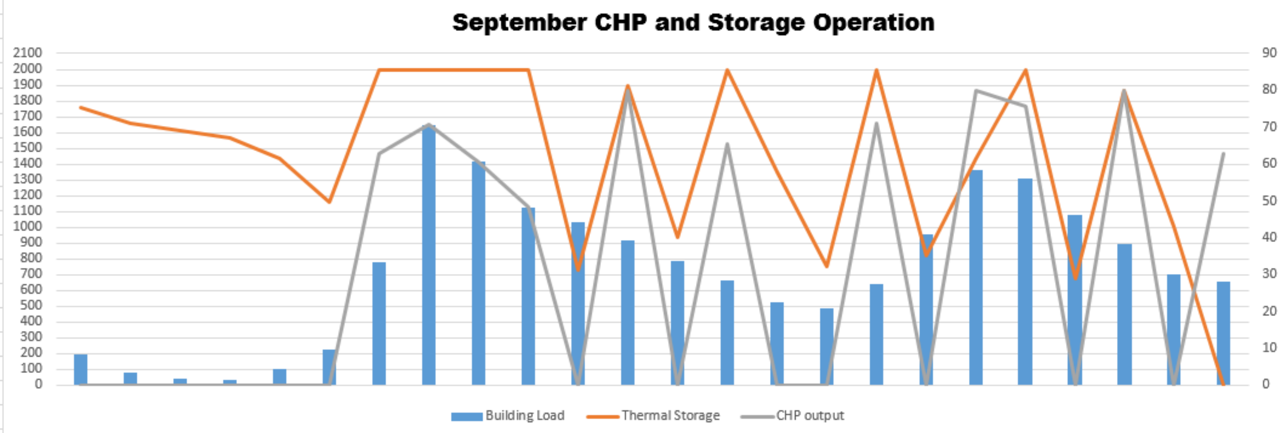


March CHP and Storage Operation

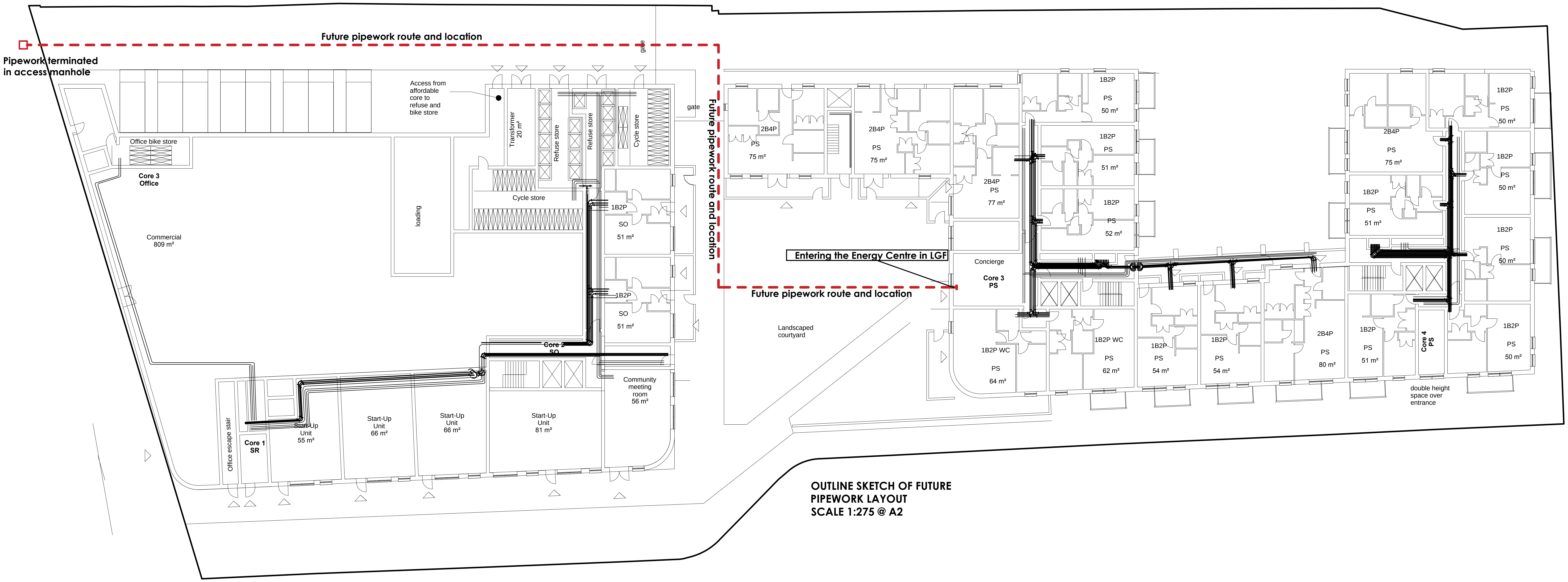


June CHP and Storage Operation




September CHP and Storage Operation
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
90
80
70
60
50
40
30
20
10
0
Building Load
Thermal Storage
CHP output

Appendix D – Outline Sketch of future pipework AND PV layouts



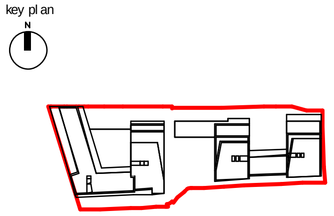
OUTLINE SKETCH OF FUTURE
PIPEWORK LAYOUT
SCALE 1:275 @ A2

NOTES
- Do not scale from this drawing, except for planning purposes.
- Check all dimensions on site.
- Subject to survey.
- Subject to site inspection.
- Site boundary lines are indicative only.

Rev	Date	By	Description
-	13/11/15	AB	Planning Issue

Revision Schedule

key plan



a2dominion

project
156 WEST END LANE
WEST HAMPSTEAD

title
ROOF PLAN - WEST BUILDING

drawing status
PLANNING

contract no.	scale 1 : 250 @ A3
client ref. A2 DOMINION	date 11/05/15
drawn by Author	checked by Checker

project no.	drawing number	revision
13119	PL(06)P026	P-

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