Energy & Sustainability Statement

For

26 Netherhall Gardens

London Borough of Camden
London
NW3 5TL

Prepared for

Dome Assets Ltd

Issue No:	02
Issue Date:	December 2016
Reference:	C5697

ISSUE

Issue No.	Date of issue	Purpose of issue	Prepared by	Checked by	Changes
1.0	12.12.2016	Draft report for comments	A Kazantzis/ P Dalapas	N Dabidian	
2.0	13.12.2016	Final issue	A Kazantzis/ P Dalapas	N Dabidian	

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EXECUTIVE SUMMARY

Mecserve Ltd has been appointed by Atlas Property Lettings & Service Ltd to prepare an Energy and Sustainability Statement to support the planning application for the proposed scheme at 26 Netherhall Gardens in the London Borough of Camden. Building works on the site include the erection of a six-storey block of five residential units.

This Energy Statement, prepared in line with the Greater London Authority guidance on preparing energy assessments (March 2016), outlines the key features and strategies adopted by the development team to enhance the energy performance of the proposed redevelopment of 26 Netherhall Gardens. The scheme complies with all relevant policies in regards to Energy set by London Borough of Camden Local Plan. Sections 2 and 3 review these policies and demonstrate how design meets planning targets and requirements in terms of energy and carbon emissions.

The strategy for reducing energy use and associated carbon emissions through the design of the scheme follows the London Plan energy hierarchy, namely:

- Be Lean – Reduce energy demand through passive design strategies and best practice design of building services, lighting and controls;
- Be Clean – Reduce energy consumption further by connecting to an existing district heating system and exploit provision of Combined Heat and Power (CHP) systems;
- Be Green – Generate power on site through Renewable Energy Technologies.

The following passive and active energy efficiency features have been considered in the proposed strategy for 26 Netherhall Gardens:

- High performance building fabric of low U-values that exceed Part L minimum standards;
- Excellent air tightness to reduce heat losses through infiltration;
- All junctions will conform to Accredited Construction Details thus eliminating thermal bridging;
- Individual gas-fired condensing boilers of high efficiency with well insulated hot water cylinders will provide domestic hot water and heating to ancillary areas;
- All apartments will feature Mechanical Ventilation with Heat Recovery to make use of wasted heat of exhaust air by preheat incoming air;
- Light fittings will be of low energy types.

The following Low/Zero Carbon Technologies proposed for the 26 Netherhall Gardens scheme will generate renewable energy on site:

- Reverse cycle Air-Source-Heat-Pumps will provide heating and cooling to the main living areas.

Following the proposed energy strategy, the new flats achieve significant carbon savings that exceed both the Target Emission Rate (TER) set by Part L of current Building Regulations and the Code for Sustainable Homes (CSH) Level 4 Target in terms of CO_2 emissions i.e. 20% reduction over 2013 TER. The following sections present the CO_2 savings for the new erected storey in 26 Netherhall Gardens.

Table 1 demonstrates the overall reduction in the regulated carbon emission of the development after each stage of the London Plan Energy Hierarchy.

Table 1 Total CO_2 emissions reduction for the development

		Carbon dioxide emissions (Tonnes CO_2 per annum)
Baseline Emissions		15.01
Be Lean	After energy demand reduction	14.56
Be Clean	After CHP	14.56
Be Green	After renewable energy	11.38

Table 2 demonstrates the total regulated CO_2 savings from each stage of the Energy Hierarchy. As demonstrated below, an overall 24.2% reduction in carbon emissions can be achieved over Part L 2013 TER when applying the proposed strategy, which exceeds the 20% reduction required for CSH Level 4. The scheme also achieves a reduction of 21.8% due to the use of renewable energy technologies, thus complying with Camden Council's requirements in terms of carbon emissions.

Table 2 Total regulated carbon dioxide savings from each stage of the Energy Hierarchy

	Regulated carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	0.45	3.0
Savings from CHP	0.0	0.0
Savings from renewable energy	3.18	21.8
Total Cumulative Savings	**3.63**	**24.2**
Total Target Savings	**3.00**	**20.0**
Annual Surplus	**0.63**	

Figure 1 below illustrates the total carbon savings achieved at each stage of the London Plan Energy Hierarchy for 26 Netherhall Gardens. Overall, the scheme exceeds the carbon reduction required for a CSH Level 4 rating.

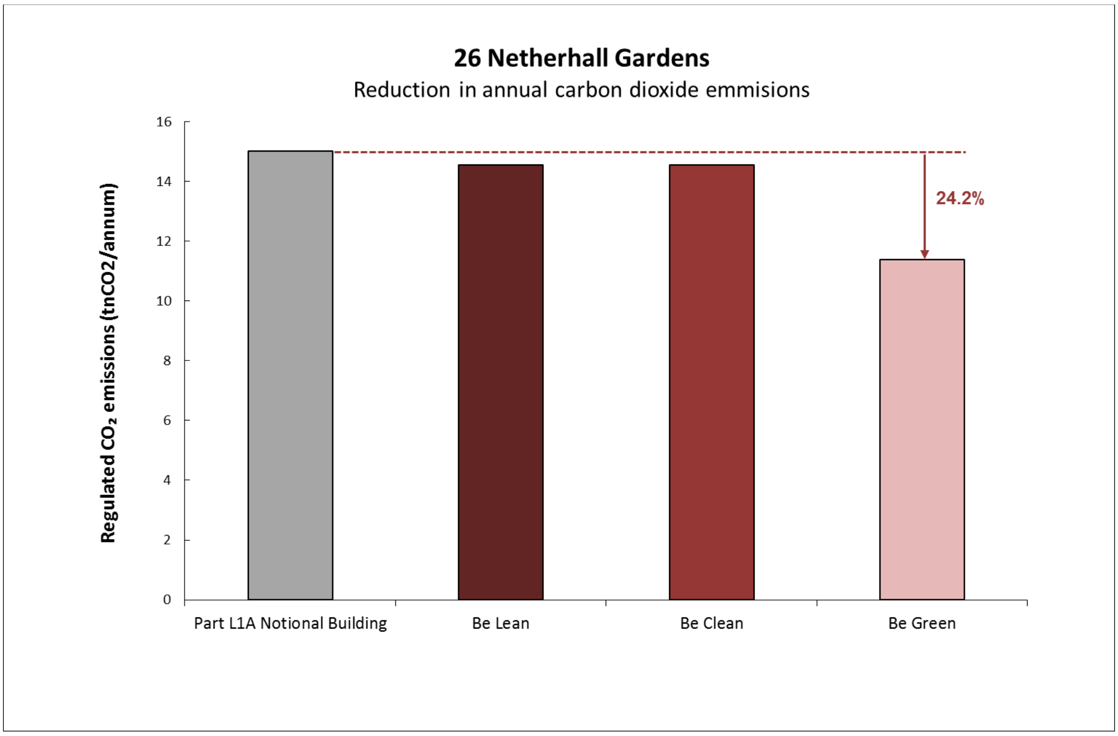

Figure 1 Total carbon savings achieved over Baseline Emissions

1. INTRODUCTION

Over recent years, global public opinion has been increasingly concerned with the state of the environment and the impact of climate change. Buildings are responsible for a significant proportion of the world's energy consumption. In the United Kingdom, domestic, commercial buildings and industry contribute 43%[1] of the total CO2 emissions. These figures highlight the need for building owners, developers and designers to design environmentally sustainable buildings.

This report provides a review of the sustainability and efficiency benchmarks for the scheme and sets out targets for the development in terms of both sustainability and energy. An overview of different sustainability and energy-efficiency technologies that are likely to be appropriate for the development are also included in this statement.

As the design progresses, the strategies outlined in this report will be further developed and subjected to detailed financial feasibility studies. The environmental strategies and options outlined in this report are based on the current information available and are likely to evolve with the design.

The energy calculations presented in this report will need to be continually updated through the detailed design stages to reflect any changes. The energy analysis presented here should be treated as preliminary information based on the currently available data.

1.1 PROPOSED DEVELOPMENT

The proposed development is located at 26 Netherhall Gardens in London Borough of Camden, within the Fitzjohns / Netherhall conservation area. The development proposed is the demolition of the existing property and redevelopment of the site to provide a four storey (plus basement storey and sub-basement for plant) detached property comprising five self-contained residential units (4 x 2 bedroom and 1 x 3 bedroom); the proposals also include hard and soft landscaping, new boundary treatment and the provision of off-street car parking.

This energy statement reflects the impact recent changes on the design of the 26 Netherhall Gardens scheme, following the appeal decision (Appeal Ref: APP/X5210/W/16/3145922), will have on the energy and sustainability performance of the development.

For a detailed description of the proposed design, please refer to the Design and Access Statement prepared by Squire & Partners Architects.

[1] Department for Environment, Food and Rural Affairs, http://www.defra.gov.uk/, 2008

Figure 2 Bird's eye view of existing Building

2. OVERVIEW OF ENVIRONMENTAL STANDARDS, TARGETS AND POLICIES

2.1 NATIONAL POLICIES

ENERGY WHITE PAPER

The Energy White Paper: Our Energy Future – Creating a Low Carbon Economy[2] is an energy policy in response to the increasing challenges faced by the UK, including climate change, decreasing domestic supplies of fossil fuel and escalating energy prices. The Energy White Paper sets four priorities:

- Cutting the UK's carbon dioxide emissions - the main contributor to global warming - by some 60% by about 2050, with real progress by 2020;
- Security of supply;
- A competitive market for the benefit of businesses, industries and households;
- Affordable energy for the poor.

CLIMATE CHANGE ACT 2008

Published in 2008 by the UK Government, Climate Change Act[3] is the world's first long-term legally binding framework to mitigate against climate change. The Act sets legally binding targets to increase greenhouse gas emission reductions through action in the UK and abroad from the 60% target to 80% by 2050.

In addition to the standards, targets and policies discussed above, the relevant British Standards and CIBSE Guidelines were used to assist in determining the most appropriate Ecologically Sustainable Design (ESD) initiatives for the development.

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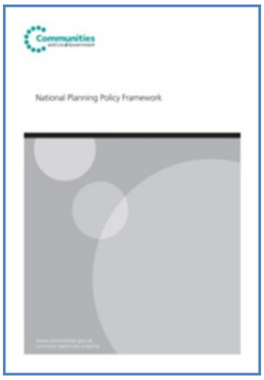
[2] Dti, (2003); Energy White Paper Our Energy Future - Creating a Low Carbon Economy. TSO.
[3] OPSI, (2008); Climate Change Act. HMSO.

NATIONAL PLANNING POLICY FRAMEWORK (NPPF) (MARCH 2012)



The Government has developed the National Planning Policy Framework (NPPF) which plays a key role in delivering the Government's objectives on sustainable development. The framework encourages ownership at the local level and provides guidance to promote effective environmental protection, economic growth and ensuring a better quality of life for all, both now and in future generations. Some of the main objectives of the Governments planning framework in relation to sustainability are:

- Build prosperous communities with opportunities for employment and economic growth across all areas of society;
- Reduce the need for car dependency and provide easy access to public transport;
- Maintain, and enhance or restore biodiversity and geological interests;
- Protect the condition of land, its use, and its development from potential hazards;
- Ensure that all new developments contribute to the Governments targets of carbon emission reductions.

2.2 REGIONAL POLICY

THE LONDON PLAN (INCLUDING FURTHER ALTERATIONS MARCH 2015)

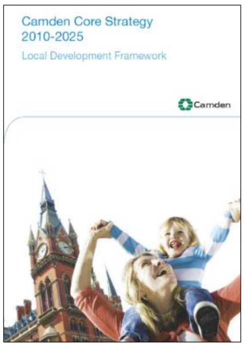
The London Plan, prepared by the Mayor of London's office, deals with matters that are of strategic importance to Greater London. The London Plan is the overall strategic plan setting out an integrated social, economic and environmental framework for the future development of London, looking forward until 2036.

Chapter 5 of the London Plan deals with matters related to climate change.

Supplementary Planning Guidance, Sustainable Design and Construction (April 2014) provides framework for implementing the London policies.

2.3 LOCAL POLICIES

CAMDEN CORE STRATEGY (NOVEMBER 2010)



Camden's Core Strategy sets out the key elements of the Council's planning vision and strategy of the borough. Along with other Local Development Framework documents and Mayor's London Plan for the statutory 'development plan' for Camden.

The following is the review of the London Plan and Camden Planning Policies for Climate Change mitigation and Climate Change Adaptation followed by measures implemented in the proposed development to meet the applicable policy requirements.

3. CLIMATE CHANGE MITIGATION AND ADAPTATION STRATEGY

Climate Change is the rise in average global temperature due to increasing levels of greenhouse gases in the earth's atmosphere (primarily CO2) that prevent the radiation of heat into space.

Buildings and spaces built today should respond to climate change issues and adapt to mitigation and adaptation measures. The London Plan through its policies addresses these issues and will require London Boroughs to consider how their developments will function in the future in the context of changing climate.

Through various policies, Camden Council encourages developments to meet the highest feasible environmental standards, where feasible and possible, in order to minimise the effects of and adapt to climate change. The climate change risks for the London Borough of Camden are summarised below:

- Hotter, drier summers;
- Milder, wetter winters;
- More frequent extreme high temperatures;
- More frequent heavy downpours of rain;
- Significant decreases in soil moisture content in summer;
- Sea level rise and increases in storm surge height;
- Possible higher wind speeds.

3.1 CLIMATE CHANGE MITIGATION

As per the definition of United Nations Environment Programme (UNEP), Climate Change Mitigation refers to efforts to reduce or prevent emission of greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behaviour.

The following policies from the London Plan and London Borough of Camden local policies relate to Climate Change Mitigation, in the context of this proposed development.

LONDON PLAN 2016 CLIMATE CHANGE MITIGATION POLICIES

- Policy 5.1 Climate change mitigation;
- Policy 5.2 Minimising carbon dioxide emissions;
- Policy 5.3 Sustainable design and construction;
- Policy 5.5 Decentralised Energy Networks;
- Policy 5.6 Decentralised energy in development proposals;
- Policy 5.7 Renewable energy;

CAMDEN CORE STRATEGY 2010-2025 CLIMATE CHANGE MITIGATION POLICIES

- Policy CS13 Tackling climate change through promoting higher environmental standards;

CAMDEN DEVELOPMENT POLICIES 2010-2025 CLIMATE CHANGE MITIGATION POLICIES

- Policy DP22 Promoting sustainable design and construction.

The policies above are explained and reviewed in detail below providing a response on measures implemented for this proposed development.

3.2 CLIMATE CHANGE MITIGATION – REVIEW AND MEASURES IMPLEMENTED

Policy 5.1 Climate Change Mitigation
A. The Mayor seeks to achieve an overall reduction in London's carbon dioxide emissions of 60 per cent (below 1990 levels) by 2025. It is expected that the GLA Group, London boroughs and other organisations will contribute to meeting this strategic reduction target, and the GLA will monitor progress towards its achievement annually. B. Within LDFs boroughs should develop detailed policies and proposals that promote and are consistent with the achievement of the Mayor's strategic carbon dioxide emissions reduction target for London.

Measures being considered in the project to meet the above policy requirements

The strategy for minimising carbon dioxide emissions is outlined in this Energy Statement, prepared in accordance with GLA Guidance on reporting energy assessments. The Energy sections of the report has taken into consideration both the requirements of London Plan Policy 5.2 and also Camden's Development Policy DP22 and demonstrates that the development exceeds the carbon dioxide target reduction by achieving a reduction of more than 20% over 2013 TER, as required for a CSH Level 4 rating.

Policy 5.2 Minimising Carbon Dioxide Emissions
A. Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy: • Be lean: use less energy; • Be clean: supply energy efficiently; • Be green: use renewable energy.

Measures being considered in the project to meet the above policy requirements

The proposed scheme, comprising 5 No. new built dwellings, is not classified as a major development according to London Plan. Therefore, Policy 5.2 is not applicable to the proposed development. The energy strategy proposed, however, follows London Plan Energy Hierarchy and this report is written in line with GLA guidance on reporting energy assessments.

In order to design an energy efficient, low carbon development, the design team has followed the London Plan Energy Hierarchy i.e.

- The development is designed to have highly efficient envelope and passive strategies, e.g. following Accredited Construction Details to minimise thermal bridging, have been incorporated in the design where possible. Efficient building services including MVHR and low energy lighting are proposed to reduce energy consumption;
- The design team has carried out a feasibility study to assess the potential of connecting the scheme to a district heating network or provide a Combined Heat and Power to meet heating demand;
- Renewable energy technologies are explored and the most feasible options are proposed the development.

As a result of the proposed strategy, the scheme achieves an overall reduction of 24.2% over 2013 TER.

Policy 5.3 Sustainable Design and Construction

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

B. Development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.

Measures being considered in the project to meet the above policy requirements

The strategy for minimising carbon dioxide emissions is outlined in the following sections of the Energy and Sustainability Statement, prepared in accordance with GLA guidance on assessing the energy performance. Due to Sustainable design features integrated in the design of the new 26 Netherhall Gardens units, the development exceeds the carbon dioxide target reduction set by Code for Sustainable Homes Level 4 thus achieving a reduction more than 20% over 2013 TER.

Passive design measures such as enhanced thermal performance of well insulated thermal elements and use of Accredited Construction Details as well as condensing boilers of high efficiency and Mechanical Ventilation with Heat Recovery (MVHR) will help reduce heating demand first and then energy consumption. During summer windows can be fully opened to allow for fresh air to remove excessive heat gains and reduce the risk of overheating. When external air temperature, however, is high, then comfort cooling can be provided by reverse cycle heat pumps. Low water use fittings will be installed to minimise water consumption on site targeting a daily consumption less than 105 litres/person. Materials of low environmental impact, which will be responsibly resourced, will be also specified for the scheme. More information can be found on the Design and Access Statement prepared by Squire & Partners Architects.

Policy 5.5 Decentralised Energy Networks

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

B. Development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.

A. The Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. In order to achieve this target, the Mayor prioritises the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

B. Within LDFs boroughs should develop policies and proposals to identify and establish decentralised energy network opportunities. Boroughs may choose to develop this as a supplementary planning document and work jointly with neighbouring boroughs to realise wider decentralised energy network opportunities. As a minimum, boroughs should:

a. identify and safeguard existing heating and cooling networks
b. identify opportunities for expanding existing networks and establishing new networks. Boroughs should use the London Heat Map tool and consider any new developments, planned major infrastructure works and energy supply opportunities which may arise
c. develop energy master plans for specific decentralised energy opportunities which identify:
- major heat loads (including anchor heat loads, with particular reference to sites such as universities, hospitals and social housing)
- major heat supply plant
- possible opportunities to utilise energy from waste
- possible heating and cooling network routes
- implementation options for delivering feasible projects, considering issues of procurement, funding and risk and the role of the public sector

d. require developers to prioritise connection to existing or planned decentralised energy networks where feasible.

Measures being considered in the project to meet the above policy requirements

The scheme, comprising of 5 new residential units, will have constant heating demand, mainly due to hot water usage, throughout the year. However, due to high performance building fabric performance proposed and low water use fittings to be specified, this is expected to be low. According to the London Heat Map (Figure 3), the site is not within a district heating opportunity area and there is no existing network in close proximity or one to become available in the future.

Therefore, given the small scale of the scheme and currently no availability in close proximity, it is not feasible or viable to connect to a district heat network.

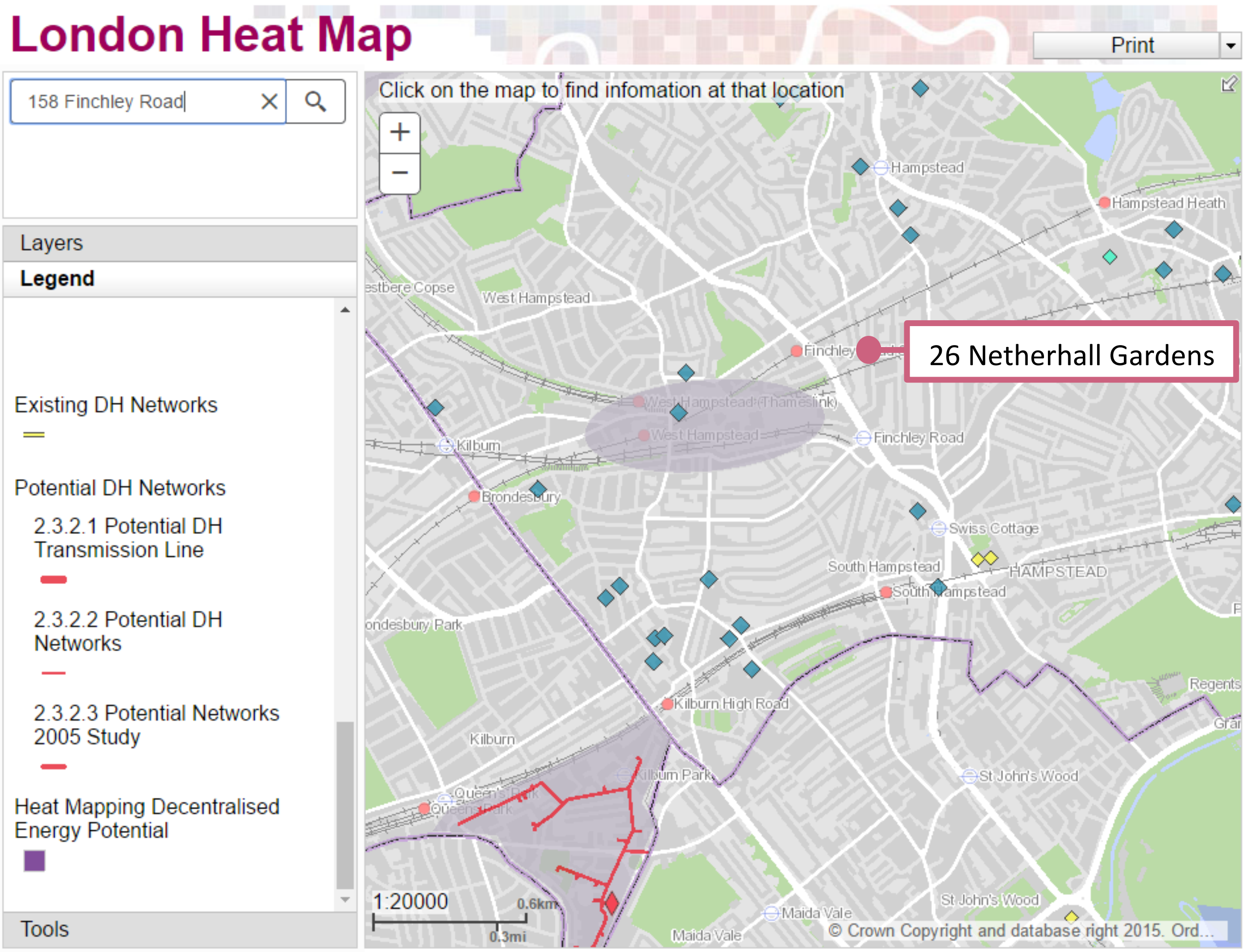


Figure 3 Image of London Heat Map (www.londonheatmap.org.uk)

Policy 5.6 Decentralised Energy in Development Proposals

A. Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

B. Major development proposals should select energy systems in accordance with the following hierarchy:

- Connection to existing heating or cooling networks;
- Site wide CHP network;
- Communal heating and cooling.

C. Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.

Measures being considered in the project to meet the above policy requirements

According to the London Heat Map, there is no available district heating in close proximity currently or in the future. Given the scale of the proposed scheme, consisting of 5 new flats, installation of Combined Heat and Power (CHP) is not considered to be feasible, as there is not high heating and hot water demand throughout the year to enable the CHP unit to run continuously for long period thus ensuring maximum carbon and cost savings. As per GLA guidance on energy assessments, a higher number of residential units is required to justify installation of a CHP unit.

Policy 5.7 Renewable Energy

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

B. Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

C. Within LDFs boroughs should, and other agencies may wish to, develop more detailed policies and proposals to support the development of renewable energy in London – in particular, to identify broad areas where specific renewable energy technologies, including large scale systems and the large-scale deployment of small scale systems, are appropriate. The identification of areas should be consistent with any guidelines and criteria outlined by the Mayor.

D. All renewable energy systems should be located and designed to minimise any potential adverse impacts on biodiversity, the natural environment and historical assets, and to avoid any adverse impacts on air quality.

Measures being considered in the project to meet the above policy requirements

Reverse cycle heat pumps will be installed in each dwelling to provide occupants with both space heating and comfort cooling. Air-source or aerothermal heat-pumps extract heat from the ambient air and transfer it through refrigerants acting as a medium to the hot water storage. Even though the system consumes electricity, which is a carbon intensive fuel, significant savings can be achieved mainly due to its high seasonal efficiency.. Air source heat pump internal and external units for the site are relatively small and could be well integrated within the design of the building. The system is capable of meeting the total heating and cooling requirement of the main living areas (living/dining room, kitchen and bedrooms) of each flat and therefore it is considered as the optimum option for the scheme.

The scheme achieves a 21.8% reduction in its annual carbon emissions due to the use of renewable energy technologies installed on site. The proposed technologies will have no impact on local biodiversity or air quality. An Air Quality Assessment has been prepared by Aether UK as part of the planning application.

Policy CS13 Tackling climate change through promoting higher environmental standards

Reducing the effects of and adapting to climate change

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

a. ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;
b. promoting the efficient use of land and buildings;
c. minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:
1. ensuring developments use less energy,
2. making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;
3. generating renewable energy on-site; and
d. ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

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

Local energy generation

The Council will promote local energy generation and networks by:

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

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

Water and surface water flooding

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

g. protecting our existing drinking water and foul water infrastructure, including Barrow Hill Reservoir, Hampstead Heath Reservoir, Highgate Reservoir and Kidderpore Reservoir;

h. making sure development incorporates efficient water and foul water infrastructure;

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

Measures being considered in the project to meet the above policy requirements

The development makes efficient use of land within the borough by providing additional residential units within the footprint of the existing site. The site is well served by public transportation links thus reducing car usage. More information can be found in the Design and Access Statement prepared by Squire & Partners Architects.

The development is designed to reduce carbon emission by more than 20% overall in line with Code for Sustainable Homes Level 4. Renewable energy will be generated on site using ASHP thus reducing carbon emissions by 20%. The energy section of this report outlines the proposed energy strategy developed for the scheme including enhanced building fabric performance, energy efficiency building services systems and renewable energy technologies.

The scheme has been designed to have mechanical ventilation and the façade has been carefully developed to balance between adequate daylighting, passive solar heat gains and risk of overheating in summer. The development incorporates water-efficient sanitary ware to reduce the use of potable water.

Policy DP22 Promoting Sustainable Design and Construction

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

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

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

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

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

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

Measures being considered in the project to meet the above policy requirements

The scheme is designed to reduce annual carbon emissions by more than 20% over the Target Emission Rate set by Part L 2013 thus complying with CSH Level 4 target in terms of carbon emissions. Code for Sustainable Homes scheme is now scrapped by the government, however, the following sections outline all the sustainable features integrated in the design of the new 26 Netherhall Gardens flats. Low water use will be specified to reduce daily water consumption beyond 105 litres per person. High-performance windows of low-g-value and mechanical ventilation is introduced to tackle overheating and provide occupants with a comfort indoor environment.

In regards to waste reduction, at least 10% of the total value of materials used for the construction of the new development will derive from recycled and reused sources. Appendix 4 provides more information on sustainable use of materials.

3.3 CLIMATE CHANGE ADAPTATION

For a long time, the main focus of climate change has been on mitigation, making sure we minimise our impact on the environment. Adaptation strategies are those that take into account climate change and ensure that the building is capable of dealing with future change in climate. Given the time lag associated with climate change, even if we change the way we live, there is likely to be noticeable change in the climate during the life of the building.

To ensure that buildings maintain their relevance, it is essential that adaptation strategies are addressed during the design phase. Adoption of these strategies will mean that, even as we undergo climate change, the buildings can still function as required.

The following policies from the London Plan and London Borough of Camden local policies relate to Climate Change Adaptation, in the context of this proposed development.

LONDON PLAN 2016 CLIMATE CHANGE ADAPTATION POLICIES

- Policy 5.9 Overheating and cooling;
- Policy 5.10 Urban greening;
- Policy 5.11 Green roofs and development site environs;
- Policy 5.12 Flood risk management;
- Policy 5.13 Sustainable drainage;
- Policy 5.15 Water use and supplies

CAMDEN DEVELOPMENT POLICIES 2010-2025 CLIMATE CHANGE ADAPTATION POLICIES

- Policy DP23 Water

Above policies are described and reviewed in detail below providing a response on measures implemented for this proposed development.

3.4 CLIMATE CHANGE ADAPTATION – POLICY REVIEW AND MEASURES IMPLEMENTED

Policy 5.9 Overheating and Cooling

A. The Mayor seeks to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating and excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis.

B. Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

- minimise internal heat generation through energy efficient design;
- reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;
- manage the heat within the building through exposed internal thermal mass and high ceilings;
- passive ventilation;
- mechanical ventilation;
- active cooling systems (ensuring they are the lowest carbon options).

C. Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible. Further details and guidance regarding overheating and cooling are outlined in the London Climate Change Adaptation Strategy.

D. Within LDFs boroughs should develop more detailed policies and proposals to support the avoidance of overheating and to support the cooling hierarchy.

Measures being considered in the project to meet the above policy requirements:

Even though the scheme is not classified as a major development, measures to eliminate the risk of overheating have been considered and integrated in the design of the new flats. The following will be applied to ensure comfort during summer within the main living areas of the units:

- well insulated fabric elements and high airtightness to prevent heat transfer from the external environment.
- Openable windows to allow for natural cross ventilation. Windows will be of low g-value to avoid heat transmittance during summer but allow for passive heating in the winter.
- When required, additional flow rates can be provided through whole house mechanical ventilation, bypassing heat recovery.
- Comfort cooling via a reverse cycle ASHP will be provided to main living areas to provide comfort cooling when external air temperature is high.
- Tenants will be advised to purchase A-rated appliances of low energy consumption to reduce internal heat gains. Energy efficiency light fittings that emit less heat than standard types thus reducing overheating will be also specified.

Policy 5.10 Urban Greening

A. The Mayor will promote and support urban greening, such as new planting in the public realm (including streets, squares and plazas) and multifunctional green infrastructure, to contribute to the adaptation to, and reduction of, the effects of climate change.

B. The Mayor seeks to increase the amount of surface area greened in the Central Activities Zone by at least five per cent by 2030, and a further five per cent by 2050,

C. Development proposals should integrate green infrastructure from the beginning of the design process to contribute to urban greening, including the public realm. Elements that can contribute to this include tree planting, green roofs and walls, and soft landscaping. Major development proposals within the Central Activities Zone should demonstrate how green infrastructure has been incorporated.

Measures being considered in the project to meet the above policy requirements:

The use of appropriate vegetation in the communal and private gardens and balconies aspires to enhance the ecological value of the site thus reducing urban island heat effect.

Further information can be found in the Design and Access Statement prepared by Squire & Partners Architects.

Policy 5.13 Sustainable Drainage

A. Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1. store rainwater for later use;
2. use infiltration techniques, such as porous surfaces in non-clay areas;
3. attenuate rainwater in ponds or open water features for gradual release;
4. attenuate rainwater;
5. discharge rainwater direct to a watercourse;
6. discharge rainwater to a surface water sewer/drain;
7. discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

B. Within LDFs boroughs should, in line with the Flood and Water Management Act 2010, utilise Surface Water Management Plans to identify areas where there are particular surface water management issues and develop actions and policy approaches aimed at reducing these risks.

Measures being considered in the project to meet the above policy requirements:

As a result of the proposed building works, the impermeable area of the development will not be increased thus reducing surface water run-off.

Policy 5.12 Flood Risk Management

A. The Mayor will work with all relevant agencies including the Environment Agency to address current and future flood issues and minimise risks in a sustainable and cost effective way.

B. Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF and the associated technical Guidance on flood risk [1] over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 (TE2100 – see paragraph 5.55) and Catchment Flood Management Plans.

C. Developments which are required to pass the Exceptions Test set out in the NPPF and the Technical Guidance will need to address flood resilient design and emergency planning by demonstrating that:

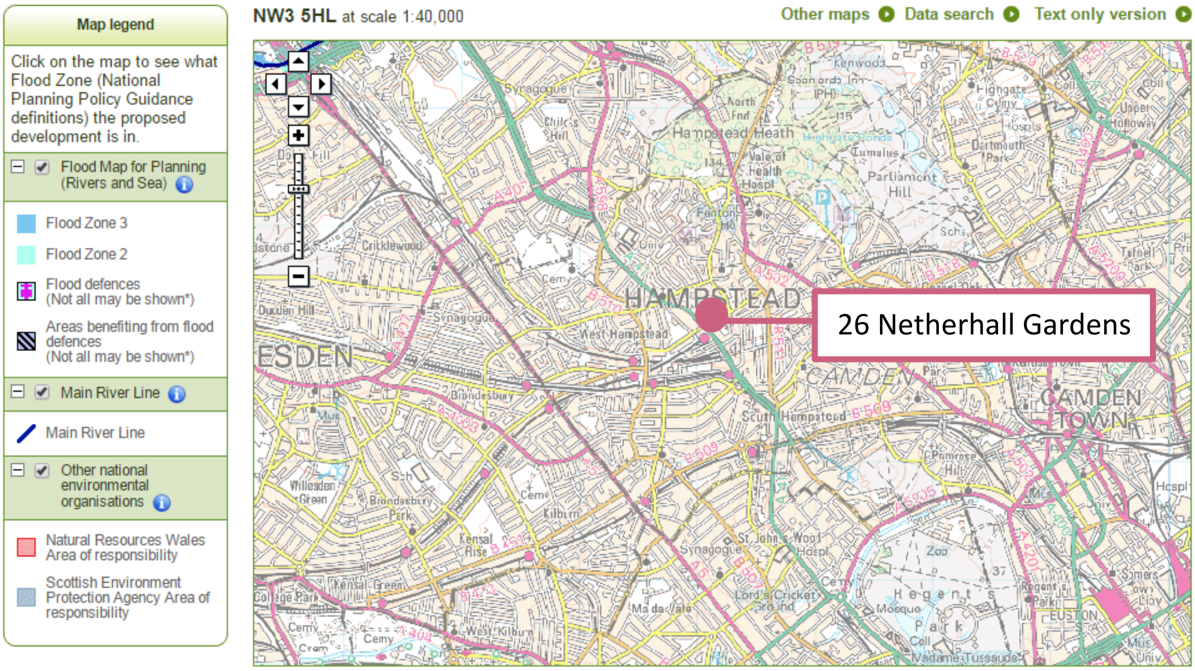
- the development will remain safe and operational under flood conditions;
- strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions;
- key services including electricity, water etc. will continue to be provided under flood conditions;
- buildings are designed for quick recovery following a flood.

D. Development adjacent to flood defences will be required to protect the integrity of existing flood defences and wherever possible should aim to be set back from the banks of watercourses and those defences to allow their management, maintenance and upgrading to be undertaken in a sustainable and cost effective way.

E. In line with the NPPF and the Technical Guidance, boroughs should, when preparing LDFs, utilise Strategic Flood Risk Assessments to identify areas where particular flood risk issues exist and develop actions and policy approaches aimed at reducing these risks, particularly through redevelopment of sites at risk of flooding and identifying specific opportunities for flood risk management measures.

Measures being considered in the project to meet the above policy requirements

The site is in a low flood risk zone according to the Environmental Agency Flood Map (Figure 4). Based on Map 5 of the Core Strategy, the site is close to those parts that have experienced significant sewer or surface water flooding and therefore considered to have the potential to be at risk of surface water flooding. As explained previously, however, the proposed development does not increase the impermeable area of the building.



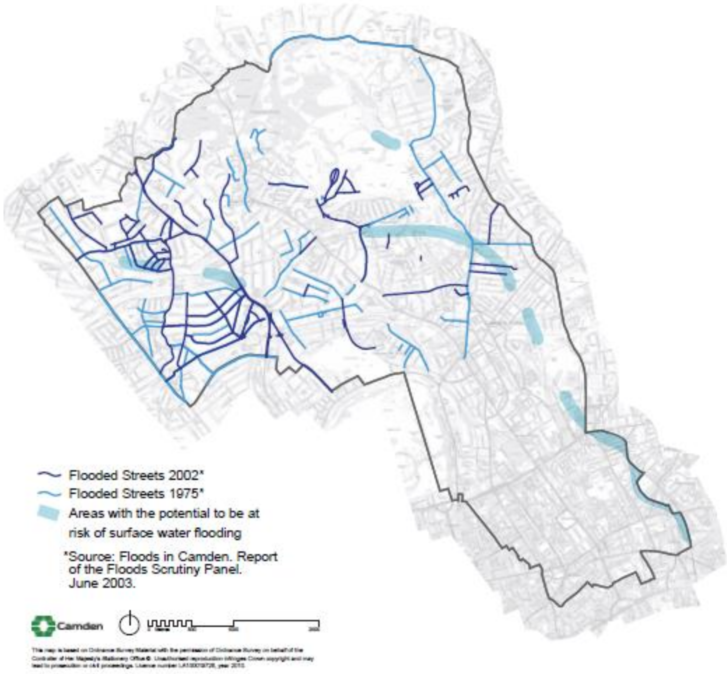


Figure 4 Environment Agency Flood Map & Map 5 of Camden's Core Strategy

Policy 5.15 Water Use Supplies

A. The Mayor will work in partnership with appropriate agencies within London and adjoining regional and local planning authorities to protect and conserve water supplies and resources in order to secure London's needs in a sustainable manner by:

- minimising use of mains water;
- reaching cost-effective minimum leakage levels;
- in conjunction with demand side measures, promoting the provision of additional sustainable water resources in a timely and efficient manner, reducing the water supply deficit and achieving security of supply in London;
- minimising the amount of energy consumed in water supply;
- promoting the use of rainwater harvesting and using dual potable and grey water recycling systems, where they are energy and cost-effective;
- maintaining and upgrading water supply infrastructure;
- ensuring the water supplied will not give rise to likely significant adverse effects to the environment particularly designated sites of European importance for nature conservation.

B. Development should minimise the use of mains water by:

- incorporating water saving measures and equipment;
- designing residential development so that mains water consumption would meet a target of 105 litres or less per head per day.

C. New development for sustainable water supply infrastructure, which has been selected within water companies' Water Resource Management Plans, will be supported.

Policy DP23. Water
The Council will require developments to reduce their water consumption, the pressure on the combined sewer network and the risk of flooding by: a. incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site; b. limiting the amount and rate of run-off and waste water entering the combined storm water and sewer network through the methods outlined in part a) and other sustainable urban drainage methods to reduce the risk of flooding; c. reducing the pressure placed in the combined storm water and sewer network from foul water and surface water run-off and ensuring developments in the areas identified by the North London Strategic Flood Risk Assessment and shown on Map 2 as being at risk of surface water flooding are designed to cope with the potential flooding; d. ensuring that developments are assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present; and e. encouraging the provision of attractive and efficient water features.

Measures being considered in the project to meet the above policy requirements

As required for CSH Level 4, all new apartments will have low water use fittings to reduce the water consumption and the energy consumption on site. Installation of low flow rate showers, taps and dual flush toilets, together with smaller baths (where applicable) will mean that all apartments will achieve a maximum internal water use of 105 litres per person/day, with an additional 5 litres person/day for external water use.

4. BUILDING REGULATION COMPLIANCE

The Building Regulations Part L (Conservation of Fuel and Power) applies to all components of the development. The most recent version of the regulations came into effect on the 6th April 2014. In order to meet the performance requirements of Part L, the design of the building must comply with the prescriptive provisions laid out in the Compliance Checklist. The development falls under the Building Regulations Part L category of L1A. The criteria of Part L are outlined in the table below.

Table 3: Part L1A 2013 Criteria

Part L Requirements	
A	Limiting heat gains and losses i. through thermal elements and other parts of the building fabric; and ii. from pipes, ducts and vessels used for space heating, space cooling and hot water services
B	Providing fixed building services which i. are energy efficient; ii. have effective controls; and iii. are commissioned by testing and adjusting as necessary to ensure they use no more fuel and power than is reasonable in the circumstances
C	Providing to the owner sufficient information about the building, the fixed building services and their maintenance requirements so that the building can be operated in such a way as to use no more fuel than is reasonable in the circumstances.

The development will comply with all the design limits on building fabric, heating, cooling, hot water and lighting efficiencies where feasible and practicable. Detailed energy calculations have been completed to assess the energy impact of this development.

4.1 BUILDING ENERGY MODEL

STROMA FSAP 2012 software (version 1.0.3.13), approved by BRE for full implementation of the Standard Assessment Procedure (SAP 2012) has been used to assess the energy performance and annual carbon emissions of the scheme after energy efficient measures have been applied. The energy assessment has been completed by Mecserve's energy modelling team who are accredited On Construction Dwelling Energy Assessors.

4.2 BASELINE CARBON EMISSION RATE

The building comprises five new-build flats. According to the GLA Guidance on preparing energy assessments (March 2016), the new build elements will be assessed against Part L1A standards. Therefore, the L1A Target Emission Rate (TER) will be used to determine the baseline CO2 emissions.

The following table (Table 4) presents the baseline CO2 emissions for the proposed scheme.

From 6 April 2014, Approved Document L1A has introduced a fabric energy efficiency standard (FEES). This is the maximum space heating and cooling energy demand for a new home. It is measured as the amount of energy which would normally be needed to maintain comfortable internal temperatures in a home and is measured in kWh per m^2 per annum. Table 4 also presents the Target Fabric Energy Efficiency (TFEE) calculated by FSAP 2012 software.

Table 4 Baseline Carbon Dioxide emissions

Regulated Carbon dioxide emissions	26 Netherhall Gardens
Baseline Carbon Emission Rate (Part L1A 2013 TER)	15.01 tnCO_2/annum
Part L1A 2013 Target Fabric Energy Efficiency Rate (TFEE)	58.12 kWh/sqm/annum

5. LONDON PLAN ENERGY HIERARCHY

To meet the requirements of Policy 5.2 Minimising Carbon Dioxide Emissions development proposals should minimise carbon dioxide emissions in accordance with the following energy hierarchy:

- Be lean: use less energy;
- Be clean: supply energy efficiently;
- Be green: use renewable energy.

The hierarchy provides the mechanism through which the carbon dioxide (CO_2) emission reduction targets in Policy 5.2 of the London Plan are achieved. It also contributes to the implementation of strategic energy policies relating to decentralised networks and ensures opportunities for building occupants to receive efficient, secure and affordable energy.

GLA guidance of preparing Energy assessments (March 2016) states that the energy assessment must clearly identify the carbon footprint of the development after each stage of the energy hierarchy. Regulated emissions must be provided and, separately, those emissions associated with uses not covered by Building Regulations i.e. unregulated energy uses.

Considering that the proposed development is a minor scheme, the following sections indicate the performance of the scheme in relation to the Code for Sustainable Homes Level 4 reduction target. The Code Level 4 equivalent reduction target in carbon dioxide emissions is 20% over Part L1A 2013 TER. New residential dwellings are required to demonstrate how this has been met by following the London Plan Energy Hierarchy described above.

6. BE LEAN – DEMAND REDUCTION

Be Lean measures is the first stage of the Energy Hierarchy where energy demand of the building is reduced through architectural and building fabric measures (passive design) and energy efficient services (active design). Be lean Measures should demonstrate the extent to which the energy demand meets or exceeds Building Regulations. The following sections demonstrates how the prosed development will achieve energy and CO_2 emissions reduction over the baseline emissions.

6.1 PASSIVE DESIGN

Passive design measures, including optimising orientation and site layout, natural ventilation and lighting, thermal mass and solar shading.

This will be achieved through:

- Building Orientation: The building's orientation is largely dictated by the shape of the site. The main façade is facing West. The internal layout of the dwelling has been set out to maximise the number of habitable rooms that can take advantage of solar gain and natural light;
- Passive Solar Design and Daylight: The make-up of the proposed façade has balanced proportion of solid wall to glazing, thus providing optimum amount of daylight and winter solar heating, without excessive solar gains during the summer;
- Thermal performance of the fabric: the proposed building fabric exceeds the requirements set in the Part L regulations;
- High performance windows: Glass of low g-value will be selected to reduce solar gains during summer;
- Thermal bridges: Accredited Construction Details will be used to minimise the impact of thermal bridges thus reducing heat losses;
- Air-tightness: Using enhanced construction skills and rigorous detailing to reduce the air permeability of the building and therefore eliminate heat losses through infiltration.

Table 5 below shows initial assumptions on building fabric specifications including air permeability. These will be thoroughly reviewed by the design team at later stage.

Table 5 Proposed building fabric specifications

Building Fabric	U-value [W/m^{2}K]	Wall	0.18
		Floor	0.15
		Roof	0.15
		Window	1.40 – Double-glazed (G-value: 0.63)
		Door	1.00 – Solid Door
	Air permeability		4 m^3/m^{2}hr @50Pa
	Thermal Bridging		All junctions need to conform with Accredited Construction Details

Achieving the above values will reduce the energy demand of the development in advance of adding any active energy efficiency measures or renewable energy systems to the development.

6.2 ACTIVE DESIGN

After reducing the energy demand of the development, the next stage would be to use energy efficient building services, lighting and controls throughout the scheme to reduce fuel consumption. Our proposed energy strategy includes the following:

- Heating: Individual gas-fired condensing boilers of high efficiency are proposed for each flat to provide heating to ancillary areas;
- Ventilation: Fresh air will be provided to the occupants via Mechanical Ventilation with Heat Recovery;
- Domestic Hot Water: A well-insulated hot water cylinder will be provided to every apartment with minimum storage losses fed by individual gas-fired boilers;
- Lighting: All light fittings will be dedicated low energy types i.e. either LED or fluorescent.

Table 6 Proposed building services systems

<table>
<tr><td rowspan="5">HVAC Systems</td><td>Secondary Main Heating System</td><td colspan="3">Individual gas-fired condensing boilers serving ancillary areas with efficiency of 89%</td></tr>
<tr><td>Secondary Heating System</td><td colspan="3">Not provided</td></tr>
<tr><td>Heating Controls</td><td colspan="3">Time and temperature zone control by suitable arrangement of plumbing and electrical services including a delayed start thermostat</td></tr>
<tr><td>Ventilation</td><td colspan="3">Whole house balanced mechanical ventilation with heat recovery of 94% and SFP of 0.45 W/l/s</td></tr>
<tr><td>Cooling</td><td colspan="3">Comfort cooling provided in each unit</td></tr>
<tr><td rowspan="4">DHW</td><td rowspan="3">Hot Water System</td><td colspan="3">Supplied by individual gas-fired boilers</td></tr>
<tr><td>Dwelling</td><td>Tank Volume (l)</td><td>Heat loss factor</td></tr>
<tr><td>Apartment 1-5</td><td>150</td><td>1.55 kWh/day</td></tr>
<tr><td>DHW Controls</td><td colspan="3">Cylinder in heated space with thermostat and separate timer for DHW. Primary pipework is fully insulated.</td></tr>
<tr><td>Lighting</td><td>Installed Light fittings</td><td colspan="3">All light fittings are dedicated low energy types i.e. either LED or fluorescent.</td></tr>
</table>

6.3 SAVINGS FROM BE LEAN MEASURES

After implementing all the passive and active energy efficiency measures listed in sections 6.1-6.2, the carbon dioxide emissions of the proposed scheme are reduced from 14.84 tnCO2 to 14.45 tnCO2 per year. Therefore, the reduction in Carbon Emission of the building at this stage is 3%, as the following table demonstrates.

Table 7 Carbon Dioxide emissions reduction for the development

Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)		26 Netherhall Gardens
Baseline Emissions		15.01
Be Lean	After energy demand reduction	14.56
Carbon Savings over Baseline		0.45
Carbon Reduction over Baseline		3%

Subsequently, the reduction in Fabric Energy Efficiency of the building is 6.2%, as the following table demonstrates.

Table 8 Fabric Energy Efficiency Rate reduction for the development

Fabric Energy Efficiency (kWh per m^2 per annum)	26 Netherhall Gardens
Part L1A Target Fabric Energy Efficiency (TFEE) Rate	58.12
Dwelling Fabric Energy Efficiency (DFEE) Rate	54.50
Reduction over 2013 TFEE	6.2%

7. BE CLEAN – SUPPLYING LOW CARBON ENERGY

In accordance with the Energy Hierarchy of London Plan 2016, connection to existing district heat networks, site wide Combined Heat and Power (CHP) and incorporation of CHP in the buildings has been considered for the scheme.

7.1 DISTRICT ENERGY NETWORK

In response to the second tier of the Energy Hierarchy and the GLA's requirement that developments seek to connect to optimise energy supply, a preliminary investigation into the adjacent heat loads and infrastructure has been undertaken. According to the London Heat Map, there is no district heating network in close proximity available currently or in the future. Therefore, given also the size and scale of the proposed scheme, connection to a district energy network is not considered feasible.

7.2 COMBINED HEAT AND POWER (CHP)

As there is not a viable source of heat that the development could connect to, the appropriateness of installing a Combined Heat and Power (CHP) engine within a communal heating system for the proposed development has been considered.

As CHP usually has significantly higher capital cost compared to conventional gas fired boilers, to maximise its efficiency it is it is important that the CHP plant operates for as many hours as possible and matches closely the base heat so that the generated heat is not wasted. Due to the number of flats been added to the existing block, the annual demand for space heating and domestic hot water for the scheme is expected to be low throughout the year.

There are Micro CHP units available in the market that can serve development of this scale but their numbers are very limited. Also, the on-site performance of such Micro CHP units is not considered as reliable as that of larger CHP units and they are generally less efficient. According to GLA guidance, a higher number of flats is required to justify installation of a CHP unit in a residential building. For these reasons, a CHP led heating and hot water system is not recommended for the development. Instead, individual gas-fired condensing boilers of high efficiency are proposed for the residential units.

8. BE GREEN- RENEWABLE ENERGY TECHNOLOGIES

In order to further reduce emissions from the development in accordance with the local authority policies and London Plan Energy Hierarchy, it is necessary to consider the introduction of renewable energy systems on site.

A high-level assessment of the following renewable technologies was carried out as part of the feasibility study. Photovoltaics were identified as the technology most appropriate to this site.

- Biomass Boilers;
- Wind Turbines;
- Solar Hot Water Heating (SHWH);
- Photovoltaics.
- Heat Pumps (Ground/Water/Air);

8.1 BIOMASS BOILER

A biomass boiler would work effectively against a consistent heating load. Within inner London areas, there are concerns about the effect of small scale biomass systems on air-quality particularly with respect to particulates released through the boiler flue. Within this constrained site, it would be difficult to provide sufficient space for biomass storage. For these reasons, we would not recommend a biomass boiler for this development.

8.2 WIND TURBINES

Wind turbines' performance in urban areas is normally not very good and unpredictable due to turbulences on air movement caused by the surrounding built environment. Wind turbines may also raise issues due to noise disturbance and their visual impact. Therefore, this technology is not suitable for this site.

8.3 SOLAR HOT WATER HEATING (SHWH)

Solar thermal hot water systems can work well on residential developments. Due to having very limited space inside the apartments for risers and hot water storage and for maintenance issues, it is decided that the limited space available on the roof will be used for installation of PV panels.

8.4 PHOTOVOLTAIC (PV) PANELS

The design team has reviewed the building roof space for the development. Photovoltaic panels work efficiently on flat or south facing roof areas. Given that the SE/SW facing parts of the roof are facing the main road, installation of PV panels would have a negative impact on the surroundings and the aesthetics of the neighbourhood where the building sits. Therefore, we would not recommend photovoltaic panels for this scheme.

8.5 HEAT PUMPS (GROUND/WATER/AIR)

GROUND SOURCE HEAT PUMP

Ground source heat pumps have been considered for the development. With a closed loop borehole system, it would be possible to drop loops beneath the basement of the buildings.

However, given that the building is an existing one, it is not feasible to install boreholes below ground. A ground source system would be complex, technically risky, costly and deliver limited carbon emissions savings. We would therefore not recommend this approach for the development.

AIR SOURCE HEAT PUMP

Air-source or aerothermal heat-pumps work on the same principals as a ground-source heating system but extract heat or coolth from the air. A typical coefficient of performance (CoP) for an air source heat pump is around 2.5 to 4.0. This means that for every unit of electricity between 2.5 and 4.0 units of heating or cooling are produced. An air-to-water system: uses the heat to warm water. Air-source or aerothermal heat-pumps extract heat from the ambient air and transfer it through refrigerants acting as a medium to the hot water storage. Even though the system consumes electricity, which is a carbon intensive fuel, significant savings can be achieved mainly due to its high seasonal efficiency.

Table 9 Proposed Renewable Energy Technology (ASHP)

ASHP	**COP**	4.74
	EER	3.45

The installation will result in a saving approximately 3.18 tonnes of carbon per year. Table 10 is a summary of the contribution of ASHP installation to the reduction in energy consumption and carbon emissions of the building.

Table 10 Carbon Dioxide emissions reduction for the development

Regulated Carbon dioxide emissions (Tonnes CO2 per annum)		26 Netherhall Gardens
Baseline Emissions		15.01
Be Lean	After energy demand reduction	14.56
Be Clean	After CHP	14.56
Be Green	After renewable energy	11.38
Carbon Savings over Clean stage		3.18
Carbon Reduction over Clean Stage		21.8%

9. CONCLUSIONS

This Energy Statement outlines the key features and strategies adopted by the development team to reduce energy use and carbon emissions for the scheme and demonstrate compliance with London Plan 2015 and London Borough of Camden Climate Change Mitigation and Adaptation Policies.

The strategy for reducing energy use and associated carbon emissions through the design of the scheme follows a three-step approach in line with the London Plan Energy Hierarchy.

- Reducing the energy demand through passive design strategies and provision of high quality building envelope;
- Reducing the energy consumption through best practice design of building services, lighting and control; and,
- Installation of on-site Low and Zero carbon technologies.

Passive and active energy efficiency features include:

- Building fabric of high thermal performance, in terms of U-values and air tightness, and use of Accredited Construction Details;
- Building services systems of high efficiency, including condensing boilers and MVHR units, and light fitting of low energy types;
- An Air-Source-Heat-Pump will provide heating and cooling to the main living areas, as the primary main heating system.

Renewable energy technologies, installed on site, will help reduce carbon emissions by more than 20% as required by Camden Council. Reverse cycle Heat Pumps will provide the main living areas of the dwellings with space heating and comfort cooling. This energy performance statement has demonstrated that the new development has achieved a carbon emission reduction in excess of 20% compared to the Code for Sustainable Home Level 4 Baseline Emission Rate. The following table (Table 11) provides a summary of the carbon savings achieved at each stage of the London Plan Energy Hierarchy as a result of the proposed energy strategy described in the report.

Table 11 Carbon Dioxide emissions reduction for the development

Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)		26 Netherhall Gardens
Baseline Emissions		15.01
Be Lean	After energy demand reduction	14.56
Be Clean	After CHP	14.56
Be Green	After renewable energy	11.38
Carbon Savings over Baseline Emissions		3.63
Carbon Reduction over Baseline Emissions		24.2%

Table 12 demonstrates the total regulated CO_2 savings from each stage of the Energy Hierarchy. As demonstrated below overall 24.2% reduction in carbon emission can be achieved applying the proposed strategies.

Table 12 Regulated carbon dioxide savings from each stage of the Energy Hierarchy

	Regulated carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	0.45	3.0
Savings from CHP	0.0	0.0
Savings from renewable energy	3.18	21.8
Total Cumulative Savings	**3.63**	**24.2**
Total Target Savings	**3.00**	**20.0**
Annual Surplus	**0.63**	

Figure 5 below illustrate the total carbon savings and the total reduction achieved at each stage of the proposed Energy Hierarchy respectively.

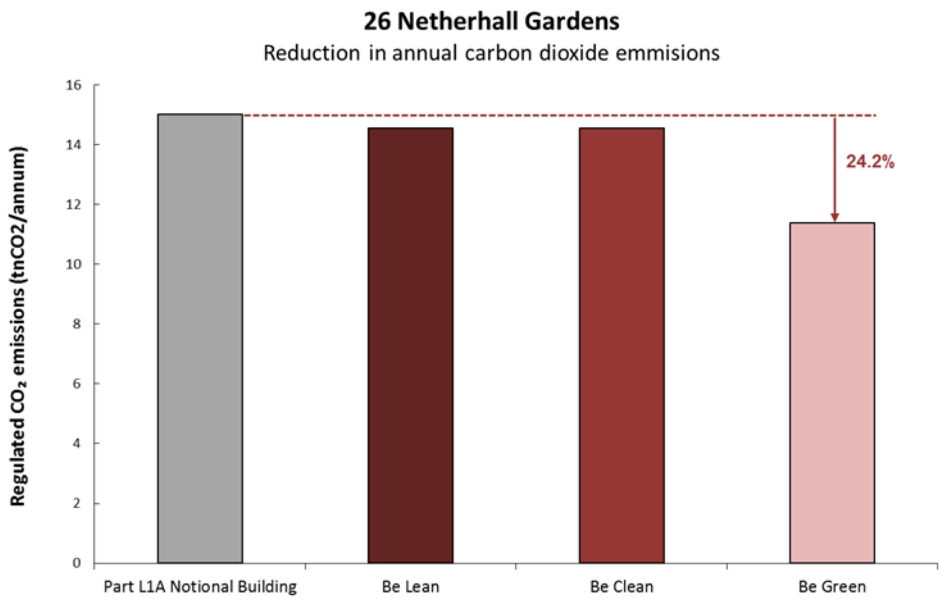


Figure 5 Total carbon savings achieved at each stage over Baseline Emissions

APPENDIX 1. TER WORKSHEET OF TYPICAL APARTMENT

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Alexandros Kazantzis	**Stroma Number:**	STRO030219
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.3.15

Property Address: Apt 1 - Be Green

Address : Flat 1, 26 Netherhall Gardens, LONDON, NW3 5TL

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Basement	113.7	(1a)	x	3.2	(2a)	=	363.84	(3a)
Ground floor	77.3	(1b)	x	3	(2b)	=	231.9	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	191	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	595.74	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.07	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)				
Number of storeys in the dwelling (ns)			0	(9)
Additional infiltration		[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35				
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0	(12)
If no draught lobby, enter 0.05, else enter 0			0	(13)
Percentage of windows and doors draught stripped			0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =		0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =		0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			5	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.32	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
Number of sides sheltered			4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =		0.7	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =		0.22	(21)

Infiltration rate modified for monthly wind speed

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

TER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.28	0.28	0.27	0.24	0.24	0.21	0.21	0.21	0.22	0.24	0.25	0.26

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

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

(25)m=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(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			14.2	x1/[1/(1.4)+ 0.04] =	18.83			(27)
Windows Type 2			8.1	x1/[1/(1.4)+ 0.04] =	10.74			(27)
Windows Type 3			10.6	x1/[1/(1.4)+ 0.04] =	14.05			(27)
Windows Type 4			2.5	x1/[1/(1.4)+ 0.04] =	3.31			(27)
Windows Type 5			2.5	x1/[1/(1.4)+ 0.04] =	3.31			(27)
Floor Type 1			110.3	x 0.13 =	14.339			(28)
Floor Type 2			5.5	x 0.13 =	0.715			(28)
Walls Type1	127	22.3	104.7	x 0.18 =	18.85			(29)
Walls Type2	86.7	15.6	71.1	x 0.18 =	12.8			(29)
Total area of elements, m²			329.5					(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 96.94 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 38915.5 (34)

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 13.03 (36)

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

Total fabric heat loss (33) + (36) = 109.98 (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=	106.17	105.87	105.57	104.16	103.9	102.67	102.67	102.44	103.14	103.9	104.43	104.99	(38)

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

(39)m=	216.15	215.84	215.55	214.14	213.87	212.65	212.65	212.42	213.12	213.87	214.41	214.96	

Average = $Sum(39)_{1...12}$ /12= 214.14 (39)

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

(40)m=	1.13	1.13	1.13	1.12	1.12	1.11	1.11	1.11	1.12	1.12	1.12	1.13	

Average = $Sum(40)_{1...12}$ /12= 1.12 (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 2.99 (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) + 36 105.22 (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=	115.74	111.53	107.32	103.11	98.9	94.7	94.7	98.9	103.11	107.32	111.53	115.74	

Total = $Sum(44)_{1...12}$ = 1262.61 (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=	171.64	150.12	154.91	135.05	129.58	111.82	103.62	118.9	120.32	140.23	153.07	166.22	

Total = $Sum(45)_{1...12}$ = 1655.48 (45)

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

(46)m=	25.75	22.52	23.24	20.26	19.44	16.77	15.54	17.84	18.05	21.03	22.96	24.93	(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): 1.39 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.75 (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) 0.75 (55)

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

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(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=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(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=	218.23	192.2	201.5	180.14	176.18	156.91	150.21	165.5	165.42	186.82	198.16	212.82	(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=	218.23	192.2	201.5	180.14	176.18	156.91	150.21	165.5	165.42	186.82	198.16	212.82

Output from water heater (annual)$_{1...12}$ 2204.09 (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=	94.35	83.58	88.78	80.98	80.36	73.25	71.73	76.81	76.08	83.9	86.97	92.54	(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=	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	(66)

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

(67)m=	33.12	29.42	23.93	18.11	13.54	11.43	12.35	16.06	21.55	27.36	31.94	34.04	(67)

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

(68)m=	362.41	366.17	356.69	336.52	311.05	287.12	271.13	267.36	276.84	297.02	322.48	346.42	(68)

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

(69)m=	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	(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=	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	(71)

Water heating gains (Table 5)

(72)m=	126.81	124.38	119.33	112.47	108.01	101.74	96.41	103.24	105.67	112.77	120.79	124.39	(72)

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

(73)m=	593.19	590.82	570.8	537.95	503.46	471.14	450.74	457.51	474.91	508	546.06	575.7	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x	0.77	x	2.5	x	10.63	x	0.63	x	0.7	=	8.12	(74)
North	0.9x	0.77	x	2.5	x	20.32	x	0.63	x	0.7	=	15.53	(74)
North	0.9x	0.77	x	2.5	x	34.53	x	0.63	x	0.7	=	26.38	(74)
North	0.9x	0.77	x	2.5	x	55.46	x	0.63	x	0.7	=	42.38	(74)
North	0.9x	0.77	x	2.5	x	74.72	x	0.63	x	0.7	=	57.09	(74)
North	0.9x	0.77	x	2.5	x	79.99	x	0.63	x	0.7	=	61.11	(74)
North	0.9x	0.77	x	2.5	x	74.68	x	0.63	x	0.7	=	57.06	(74)
North	0.9x	0.77	x	2.5	x	59.25	x	0.63	x	0.7	=	45.27	(74)
North	0.9x	0.77	x	2.5	x	41.52	x	0.63	x	0.7	=	31.72	(74)
North	0.9x	0.77	x	2.5	x	24.19	x	0.63	x	0.7	=	18.48	(74)
North	0.9x	0.77	x	2.5	x	13.12	x	0.63	x	0.7	=	10.02	(74)
North	0.9x	0.77	x	2.5	x	8.86	x	0.63	x	0.7	=	6.77	(74)
East	0.9x	1	x	8.1	x	19.64	x	0.63	x	0.7	=	34.1	(76)
East	0.9x	1	x	8.1	x	38.42	x	0.63	x	0.7	=	66.7	(76)
East	0.9x	1	x	8.1	x	63.27	x	0.63	x	0.7	=	109.84	(76)
East	0.9x	1	x	8.1	x	92.28	x	0.63	x	0.7	=	160.2	(76)
East	0.9x	1	x	8.1	x	113.09	x	0.63	x	0.7	=	196.33	(76)
East	0.9x	1	x	8.1	x	115.77	x	0.63	x	0.7	=	200.98	(76)
East	0.9x	1	x	8.1	x	110.22	x	0.63	x	0.7	=	191.34	(76)
East	0.9x	1	x	8.1	x	94.68	x	0.63	x	0.7	=	164.36	(76)
East	0.9x	1	x	8.1	x	73.59	x	0.63	x	0.7	=	127.75	(76)
East	0.9x	1	x	8.1	x	45.59	x	0.63	x	0.7	=	79.14	(76)
East	0.9x	1	x	8.1	x	24.49	x	0.63	x	0.7	=	42.51	(76)
East	0.9x	1	x	8.1	x	16.15	x	0.63	x	0.7	=	28.04	(76)
South	0.9x	0.77	x	2.5	x	46.75	x	0.63	x	0.7	=	35.72	(78)
South	0.9x	0.77	x	2.5	x	76.57	x	0.63	x	0.7	=	58.5	(78)
South	0.9x	0.77	x	2.5	x	97.53	x	0.63	x	0.7	=	74.52	(78)
South	0.9x	0.77	x	2.5	x	110.23	x	0.63	x	0.7	=	84.22	(78)
South	0.9x	0.77	x	2.5	x	114.87	x	0.63	x	0.7	=	87.77	(78)
South	0.9x	0.77	x	2.5	x	110.55	x	0.63	x	0.7	=	84.46	(78)
South	0.9x	0.77	x	2.5	x	108.01	x	0.63	x	0.7	=	82.52	(78)
South	0.9x	0.77	x	2.5	x	104.89	x	0.63	x	0.7	=	80.14	(78)
South	0.9x	0.77	x	2.5	x	101.89	x	0.63	x	0.7	=	77.84	(78)
South	0.9x	0.77	x	2.5	x	82.59	x	0.63	x	0.7	=	63.1	(78)
South	0.9x	0.77	x	2.5	x	55.42	x	0.63	x	0.7	=	42.34	(78)
South	0.9x	0.77	x	2.5	x	40.4	x	0.63	x	0.7	=	30.87	(78)
West	0.9x	0.54	x	14.2	x	19.64	x	0.63	x	0.7	=	59.77	(80)
West	0.9x	0.77	x	10.6	x	19.64	x	0.63	x	0.7	=	63.62	(80)
West	0.9x	0.54	x	14.2	x	38.42	x	0.63	x	0.7	=	116.93	(80)

West	0.9x	0.77	x	10.6	x	38.42	x	0.63	x	0.7	=	124.46	(80)
West	0.9x	0.54	x	14.2	x	63.27	x	0.63	x	0.7	=	192.57	(80)
West	0.9x	0.77	x	10.6	x	63.27	x	0.63	x	0.7	=	204.97	(80)
West	0.9x	0.54	x	14.2	x	92.28	x	0.63	x	0.7	=	280.85	(80)
West	0.9x	0.77	x	10.6	x	92.28	x	0.63	x	0.7	=	298.94	(80)
West	0.9x	0.54	x	14.2	x	113.09	x	0.63	x	0.7	=	344.19	(80)
West	0.9x	0.77	x	10.6	x	113.09	x	0.63	x	0.7	=	366.36	(80)
West	0.9x	0.54	x	14.2	x	115.77	x	0.63	x	0.7	=	352.34	(80)
West	0.9x	0.77	x	10.6	x	115.77	x	0.63	x	0.7	=	375.04	(80)
West	0.9x	0.54	x	14.2	x	110.22	x	0.63	x	0.7	=	335.44	(80)
West	0.9x	0.77	x	10.6	x	110.22	x	0.63	x	0.7	=	357.05	(80)
West	0.9x	0.54	x	14.2	x	94.68	x	0.63	x	0.7	=	288.14	(80)
West	0.9x	0.77	x	10.6	x	94.68	x	0.63	x	0.7	=	306.7	(80)
West	0.9x	0.54	x	14.2	x	73.59	x	0.63	x	0.7	=	223.96	(80)
West	0.9x	0.77	x	10.6	x	73.59	x	0.63	x	0.7	=	238.39	(80)
West	0.9x	0.54	x	14.2	x	45.59	x	0.63	x	0.7	=	138.75	(80)
West	0.9x	0.77	x	10.6	x	45.59	x	0.63	x	0.7	=	147.69	(80)
West	0.9x	0.54	x	14.2	x	24.49	x	0.63	x	0.7	=	74.53	(80)
West	0.9x	0.77	x	10.6	x	24.49	x	0.63	x	0.7	=	79.33	(80)
West	0.9x	0.54	x	14.2	x	16.15	x	0.63	x	0.7	=	49.16	(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=	201.34	382.12	608.29	866.59	1051.74	1073.93	1023.42	884.61	699.67	447.16	248.74	167.15	(83)

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

(84)m=	794.53	972.94	1179.09	1404.54	1555.2	1545.07	1474.16	1342.13	1174.59	955.16	794.8	742.86	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	1	0.98	0.92	0.78	0.61	0.68	0.92	0.99	1	1	(86)

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

(87)m=	19.61	19.76	20.04	20.4	20.72	20.92	20.98	20.97	20.8	20.37	19.92	19.58	(87)

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

(88)m=	19.98	19.98	19.98	19.98	19.98	19.99	19.99	19.99	19.99	19.98	19.98	19.98	(88)

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

(89)m=	1	1	0.99	0.97	0.89	0.69	0.48	0.55	0.86	0.99	1	1	(89)

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

(90)m=	18.1	18.33	18.72	19.25	19.7	19.94	19.98	19.98	19.81	19.21	18.56	18.06	(90)

fLA = Living area ÷ (4) = | 0.33 | (91)

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

(92)m=	18.6	18.8	19.16	19.63	20.04	20.26	20.31	20.3	20.14	19.59	19.01	18.56	(92)

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

(93)m=	18.6	18.8	19.16	19.63	20.04	20.26	20.31	20.3	20.14	19.59	19.01	18.56	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	1	0.99	0.97	0.89	0.72	0.53	0.6	0.87	0.99	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	793.95	970.82	1169.77	1358.58	1381.74	1110.27	774.49	801.57	1025.62	941.77	793.42	742.47	(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=	3090.54	3000.28	2728.11	2297.8	1783.14	1203.72	789.44	829.4	1287.26	1923.79	2552.81	3087.73	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1708.67	1363.79	1159.41	676.24	298.64	0	0	0	0	730.62	1266.77	1744.87	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 8949 (98)

Space heating requirement in kWh/m²/year 46.85 (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)													
	1708.67	1363.79	1159.41	676.24	298.64	0	0	0	0	730.62	1266.77	1744.87	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1827.45	1458.6	1240.01	723.25	319.4	0	0	0	0	781.41	1354.83	1866.17	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 9571.12 (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)

	218.23	192.2	201.5	180.14	176.18	156.91	150.21	165.5	165.42	186.82	198.16	212.82

Efficiency of water heater 79.8 (216)

(217)m=	89.15	89.03	88.74	88.02	86.21	79.8	79.8	79.8	79.8	88.09	88.89	89.2	(217)

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

(219)m=	244.8	215.89	227.07	204.67	204.36	196.63	188.24	207.39	207.29	212.07	222.93	238.58

Total = Sum(219a)$_{1...12}$ = 2569.93 (219)

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Annual totals		kWh/year	kWh/year	
Space heating fuel used, main system 1			9571.12	
Water heating fuel used			2569.93	
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			584.97	(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	=	2067.36	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	555.1	(264)
Space and water heating	(261) + (262) + (263) + (264) =				2622.47	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	303.6	(268)
Total CO2, kg/year			sum of (265)…(271) =		2964.99	(272)

TER = 15.52 (273)

APPENDIX 2. DER WORKSHEET OF TYPICAL APARTMENT – BE LEAN

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Alexandros Kazantzis	**Stroma Number:**	STRO030219
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.3.15

Property Address: Apt 1 - Be Lean

Address : Flat 1, 26 Netherhall Gardens, LONDON, NW3 5TL

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	113.7	(1a) x	3.2	(2a) =	363.84	(3a)
Ground floor	77.3	(1b) x	3	(2b) =	231.9	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	191	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	595.74	(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		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.14	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

DER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.18	0.18	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16

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) = 79.05 (23c)

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

(24a)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.23	0.24	0.26	0.26	0.27	(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	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=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.23	0.24	0.26	0.26	0.27	(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			14.2	x1/[1/(1.4)+ 0.04]		=	18.83			(27)
Windows Type 2			8.1	x1/[1/(1.4)+ 0.04]		=	10.74			(27)
Windows Type 3			10.6	x1/[1/(1.4)+ 0.04]		=	14.05			(27)
Windows Type 4			2.5	x1/[1/(1.4)+ 0.04]		=	3.31			(27)
Windows Type 5			2.5	x1/[1/(1.4)+ 0.04]		=	3.31			(27)
Floor Type 1			110.3	x	0.15	=	16.545			(28)
Floor Type 2			5.5	x	0.15	=	0.825			(28)
Walls Type1	127	22.3	104.7	x	0.18	=	18.85			(29)
Walls Type2	86.7	15.6	71.1	x	0.18	=	12.8			(29)
Total area of elements, m²			329.5							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 99.26 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 38915.5 (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 20.67 (36) *if details of thermal bridging are not known (36) = 0.15 x (31)*

Total fabric heat loss (33) + (36) = 119.93 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	55.69	55	54.31	50.87	50.18	46.74	46.74	46.05	48.12	50.18	51.56	52.93	(38)

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

(39)m=	175.61	174.92	174.24	170.8	170.11	166.67	166.67	165.98	168.04	170.11	171.48	172.86	

Average = Sum(39)1…12 /12= 170.62 (39)

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

(40)m=	0.92	0.92	0.91	0.89	0.89	0.87	0.87	0.87	0.88	0.89	0.9	0.91

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 2.99 (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) + 36 105.22 (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=	115.74	111.53	107.32	103.11	98.9	94.7	94.7	98.9	103.11	107.32	111.53	115.74	
										Total = Sum(44)1…12 =		1262.61	(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=	171.64	150.12	154.91	135.05	129.58	111.82	103.62	118.9	120.32	140.23	153.07	166.22	
										Total = Sum(45)1…12 =		1655.48	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	25.75	22.52	23.24	20.26	19.44	16.77	15.54	17.84	18.05	21.03	22.96	24.93	(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): 1.55 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.84 (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) 0.84 (55)

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

(56)m=	25.95	23.44	25.95	25.11	25.95	25.11	25.95	25.95	25.11	25.95	25.11	25.95	(56)

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

(57)m=	25.95	23.44	25.95	25.11	25.95	25.11	25.95	25.95	25.11	25.95	25.11	25.95	(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=	220.85	194.56	204.11	182.67	178.79	159.44	152.83	168.11	167.95	189.44	200.69	215.43	(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=	220.85	194.56	204.11	182.67	178.79	159.44	152.83	168.11	167.95	189.44	200.69	215.43

Output from water heater (annual)$_{1...12}$ — 2234.88 (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=	96.44	85.47	90.87	83	82.45	75.28	73.82	78.9	78.11	85.99	88.99	94.64	(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=	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	(66)

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

(67)m=	33.12	29.42	23.93	18.11	13.54	11.43	12.35	16.06	21.55	27.36	31.94	34.04	(67)

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

(68)m=	362.41	366.17	356.69	336.52	311.05	287.12	271.13	267.36	276.84	297.02	322.48	346.42	(68)

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

(69)m=	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	(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=	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	(71)

Water heating gains (Table 5)

(72)m=	129.62	127.19	122.14	115.28	110.83	104.55	99.22	106.05	108.48	115.58	123.6	127.2	(72)

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

(73)m=	596.01	593.63	573.61	540.77	506.27	473.95	453.55	460.33	477.72	510.81	548.87	578.52	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x	0.77	x	2.5	x	10.63	x	0.63	x	0.7	=	8.12	(74)
North	0.9x	0.77	x	2.5	x	20.32	x	0.63	x	0.7	=	15.53	(74)
North	0.9x	0.77	x	2.5	x	34.53	x	0.63	x	0.7	=	26.38	(74)
North	0.9x	0.77	x	2.5	x	55.46	x	0.63	x	0.7	=	42.38	(74)
North	0.9x	0.77	x	2.5	x	74.72	x	0.63	x	0.7	=	57.09	(74)
North	0.9x	0.77	x	2.5	x	79.99	x	0.63	x	0.7	=	61.11	(74)
North	0.9x	0.77	x	2.5	x	74.68	x	0.63	x	0.7	=	57.06	(74)
North	0.9x	0.77	x	2.5	x	59.25	x	0.63	x	0.7	=	45.27	(74)
North	0.9x	0.77	x	2.5	x	41.52	x	0.63	x	0.7	=	31.72	(74)
North	0.9x	0.77	x	2.5	x	24.19	x	0.63	x	0.7	=	18.48	(74)
North	0.9x	0.77	x	2.5	x	13.12	x	0.63	x	0.7	=	10.02	(74)
North	0.9x	0.77	x	2.5	x	8.86	x	0.63	x	0.7	=	6.77	(74)
East	0.9x	1	x	8.1	x	19.64	x	0.63	x	0.7	=	34.1	(76)
East	0.9x	1	x	8.1	x	38.42	x	0.63	x	0.7	=	66.7	(76)
East	0.9x	1	x	8.1	x	63.27	x	0.63	x	0.7	=	109.84	(76)
East	0.9x	1	x	8.1	x	92.28	x	0.63	x	0.7	=	160.2	(76)
East	0.9x	1	x	8.1	x	113.09	x	0.63	x	0.7	=	196.33	(76)
East	0.9x	1	x	8.1	x	115.77	x	0.63	x	0.7	=	200.98	(76)
East	0.9x	1	x	8.1	x	110.22	x	0.63	x	0.7	=	191.34	(76)
East	0.9x	1	x	8.1	x	94.68	x	0.63	x	0.7	=	164.36	(76)
East	0.9x	1	x	8.1	x	73.59	x	0.63	x	0.7	=	127.75	(76)
East	0.9x	1	x	8.1	x	45.59	x	0.63	x	0.7	=	79.14	(76)
East	0.9x	1	x	8.1	x	24.49	x	0.63	x	0.7	=	42.51	(76)
East	0.9x	1	x	8.1	x	16.15	x	0.63	x	0.7	=	28.04	(76)
South	0.9x	0.77	x	2.5	x	46.75	x	0.63	x	0.7	=	35.72	(78)
South	0.9x	0.77	x	2.5	x	76.57	x	0.63	x	0.7	=	58.5	(78)
South	0.9x	0.77	x	2.5	x	97.53	x	0.63	x	0.7	=	74.52	(78)
South	0.9x	0.77	x	2.5	x	110.23	x	0.63	x	0.7	=	84.22	(78)
South	0.9x	0.77	x	2.5	x	114.87	x	0.63	x	0.7	=	87.77	(78)
South	0.9x	0.77	x	2.5	x	110.55	x	0.63	x	0.7	=	84.46	(78)
South	0.9x	0.77	x	2.5	x	108.01	x	0.63	x	0.7	=	82.52	(78)
South	0.9x	0.77	x	2.5	x	104.89	x	0.63	x	0.7	=	80.14	(78)
South	0.9x	0.77	x	2.5	x	101.89	x	0.63	x	0.7	=	77.84	(78)
South	0.9x	0.77	x	2.5	x	82.59	x	0.63	x	0.7	=	63.1	(78)
South	0.9x	0.77	x	2.5	x	55.42	x	0.63	x	0.7	=	42.34	(78)
South	0.9x	0.77	x	2.5	x	40.4	x	0.63	x	0.7	=	30.87	(78)
West	0.9x	0.54	x	14.2	x	19.64	x	0.63	x	0.7	=	59.77	(80)
West	0.9x	0.77	x	10.6	x	19.64	x	0.63	x	0.7	=	63.62	(80)
West	0.9x	0.54	x	14.2	x	38.42	x	0.63	x	0.7	=	116.93	(80)

West	0.9x	0.77	x	10.6	x	38.42	x	0.63	x	0.7	=	124.46	(80)
West	0.9x	0.54	x	14.2	x	63.27	x	0.63	x	0.7	=	192.57	(80)
West	0.9x	0.77	x	10.6	x	63.27	x	0.63	x	0.7	=	204.97	(80)
West	0.9x	0.54	x	14.2	x	92.28	x	0.63	x	0.7	=	280.85	(80)
West	0.9x	0.77	x	10.6	x	92.28	x	0.63	x	0.7	=	298.94	(80)
West	0.9x	0.54	x	14.2	x	113.09	x	0.63	x	0.7	=	344.19	(80)
West	0.9x	0.77	x	10.6	x	113.09	x	0.63	x	0.7	=	366.36	(80)
West	0.9x	0.54	x	14.2	x	115.77	x	0.63	x	0.7	=	352.34	(80)
West	0.9x	0.77	x	10.6	x	115.77	x	0.63	x	0.7	=	375.04	(80)
West	0.9x	0.54	x	14.2	x	110.22	x	0.63	x	0.7	=	335.44	(80)
West	0.9x	0.77	x	10.6	x	110.22	x	0.63	x	0.7	=	357.05	(80)
West	0.9x	0.54	x	14.2	x	94.68	x	0.63	x	0.7	=	288.14	(80)
West	0.9x	0.77	x	10.6	x	94.68	x	0.63	x	0.7	=	306.7	(80)
West	0.9x	0.54	x	14.2	x	73.59	x	0.63	x	0.7	=	223.96	(80)
West	0.9x	0.77	x	10.6	x	73.59	x	0.63	x	0.7	=	238.39	(80)
West	0.9x	0.54	x	14.2	x	45.59	x	0.63	x	0.7	=	138.75	(80)
West	0.9x	0.77	x	10.6	x	45.59	x	0.63	x	0.7	=	147.69	(80)
West	0.9x	0.54	x	14.2	x	24.49	x	0.63	x	0.7	=	74.53	(80)
West	0.9x	0.77	x	10.6	x	24.49	x	0.63	x	0.7	=	79.33	(80)
West	0.9x	0.54	x	14.2	x	16.15	x	0.63	x	0.7	=	49.16	(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=	201.34	382.12	608.29	866.59	1051.74	1073.93	1023.42	884.61	699.67	447.16	248.74	167.15	(83)

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

(84)m=	797.34	975.75	1181.9	1407.36	1558.01	1547.89	1476.97	1344.94	1177.4	957.97	797.61	745.67	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.97	0.87	0.67	0.49	0.56	0.86	0.99	1	1	(86)

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

(87)m=	19.9	20.05	20.31	20.64	20.88	20.98	21	21	20.92	20.58	20.18	19.89	(87)

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

(88)m=	20.15	20.15	20.16	20.17	20.18	20.19	20.19	20.19	20.18	20.18	20.17	20.16	(88)

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

(89)m=	1	1	0.99	0.96	0.83	0.59	0.4	0.47	0.79	0.98	1	1	(89)

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

(90)m=	18.66	18.88	19.25	19.74	20.06	20.18	20.19	20.19	20.12	19.66	19.08	18.65	(90)

fLA = Living area ÷ (4) = 0.33 (91)

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

(92)m=	19.07	19.27	19.6	20.03	20.33	20.44	20.46	20.46	20.38	19.96	19.44	19.05	(92)

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

(93)m=	19.07	19.27	19.6	20.03	20.33	20.44	20.46	20.46	20.38	19.96	19.44	19.05	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	1	0.99	0.95	0.83	0.62	0.43	0.5	0.81	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	796.9	973.81	1171.33	1342.9	1299.61	953.82	640.75	669.04	955.09	941.17	796.39	745.39	(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=	2593.46	2513.06	2282	1901.32	1467.87	973.95	642.67	673.28	1055.86	1592.17	2116.52	2567.81	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1336.64	1034.38	826.33	402.06	125.19	0	0	0	0	484.35	950.5	1355.88	

Total per year (kWh/year) = Sum(98)1...5,9...12 = 6515.33 (98)

Space heating requirement in kWh/m²/year 34.11 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	1566.67	1233.34	1261.44	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.94	0.98	0.96	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	1479.77	1204.72	1212.96	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	2003.17	1913.85	1752.62	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	376.85	527.59	401.51	0	0	0	0	

Total = Sum(104)6...8 = 1305.95 (104)

Cooled fraction f C = cooled area ÷ (4) = 0.66 (105)

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104)6...8 = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

(107)m=	0	0	0	0	0	61.98	86.77	66.03	0	0	0	0

Total = Sum(107)6...8 = 214.78 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 1.12 (108)

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

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

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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		89.9	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)
Cooling System Energy Efficiency Ratio		4.32	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	1336.64	1034.38	826.33	402.06	125.19	0	0	0	0	484.35	950.5	1355.88		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1486.81	1150.59	919.17	447.23	139.25	0	0	0	0	538.76	1057.28	1508.21		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													7247.31	(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)	220.85	194.56	204.11	182.67	178.79	159.44	152.83	168.11	167.95	189.44	200.69	215.43		
Efficiency of water heater													79.8	(216)
(217)m=	88.32	88.13	87.7	86.48	83.67	79.8	79.8	79.8	79.8	86.81	87.96	88.37		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	250.07	220.76	232.74	211.23	213.69	199.8	191.51	210.67	210.46	218.22	228.16	243.79		
Total = Sum(219a)$_{1...12}$ =													2631.09	(219)

Space cooling fuel, kWh/month.

(221)m = (107)m÷ (209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(221)m=	0	0	0	0	0	14.35	20.09	15.29	0	0	0	0		
Total = Sum(221)$_{6...8}$ =													49.72	(221)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			7247.31	
Water heating fuel used			2631.09	
Space cooling fuel used			49.72	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		590.53		(230a)
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		665.53	(231)
Electricity for lighting			584.97	(232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year

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Space heating (main system 1)	(211) x	0.216	=	1565.42	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	568.32	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2133.73	(265)
Space cooling	(221) x	0.519	=	25.8	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	345.41	(267)
Electricity for lighting	(232) x	0.519	=	303.6	(268)
Total CO2, kg/year		sum of (265)…(271) =		2808.55	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		14.7	(273)
EI rating (section 14)				84	(274)

APPENDIX 3. DER WORKSHEET OF TYPICAL APARTMENT – BE GREEN

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Alexandros Kazantzis	**Stroma Number:**	STRO030219
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.3.15

Property Address: Apt 1 - Be Green

Address : Flat 1, 26 Netherhall Gardens, LONDON, NW3 5TL

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Basement	113.7	(1a)	x	3.2	(2a)	=	363.84	(3a)
Ground floor	77.3	(1b)	x	3	(2b)	=	231.9	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	191	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	595.74	(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		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.14	(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

0.18	0.18	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16

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) =	79.05	(23c)

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

(24a)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.23	0.24	0.26	0.26	0.27	(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	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=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.23	0.24	0.26	0.26	0.27	(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			14.2	x1/[1/(1.4)+ 0.04]		=	18.83			(27)
Windows Type 2			8.1	x1/[1/(1.4)+ 0.04]		=	10.74			(27)
Windows Type 3			10.6	x1/[1/(1.4)+ 0.04]		=	14.05			(27)
Windows Type 4			2.5	x1/[1/(1.4)+ 0.04]		=	3.31			(27)
Windows Type 5			2.5	x1/[1/(1.4)+ 0.04]		=	3.31			(27)
Floor Type 1			110.3	x	0.15	=	16.545			(28)
Floor Type 2			5.5	x	0.15	=	0.825			(28)
Walls Type1	127	22.3	104.7	x	0.18	=	18.85			(29)
Walls Type2	86.7	15.6	71.1	x	0.18	=	12.8			(29)
Total area of elements, m²			329.5							(31)

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

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	99.26	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	38915.5	(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	20.67	(36)

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

Total fabric heat loss (33) + (36) = 119.93 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	55.69	55	54.31	50.87	50.18	46.74	46.74	46.05	48.12	50.18	51.56	52.93	(38)

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

(39)m=	175.61	174.92	174.24	170.8	170.11	166.67	166.67	165.98	168.04	170.11	171.48	172.86	

Average = Sum(39)1…12 /12= 170.62 (39)

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

(40)m=	0.92	0.92	0.91	0.89	0.89	0.87	0.87	0.87	0.88	0.89	0.9	0.91

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 2.99 (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) + 36 105.22 (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=	115.74	111.53	107.32	103.11	98.9	94.7	94.7	98.9	103.11	107.32	111.53	115.74	
										Total = Sum(44)1…12 =		1262.61	(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=	171.64	150.12	154.91	135.05	129.58	111.82	103.62	118.9	120.32	140.23	153.07	166.22	
										Total = Sum(45)1…12 =		1655.48	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	25.75	22.52	23.24	20.26	19.44	16.77	15.54	17.84	18.05	21.03	22.96	24.93	(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): 1.55 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.84 (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) 0.84 (55)

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

(56)m=	25.95	23.44	25.95	25.11	25.95	25.11	25.95	25.95	25.11	25.95	25.11	25.95	(56)

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

(57)m=	25.95	23.44	25.95	25.11	25.95	25.11	25.95	25.95	25.11	25.95	25.11	25.95	(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=	220.85	194.56	204.11	182.67	178.79	159.44	152.83	168.11	167.95	189.44	200.69	215.43	(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=	220.85	194.56	204.11	182.67	178.79	159.44	152.83	168.11	167.95	189.44	200.69	215.43

Output from water heater (annual)$_{1...12}$ — 2234.88 (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=	96.44	85.47	90.87	83	82.45	75.28	73.82	78.9	78.11	85.99	88.99	94.64	(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=	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	149.51	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	33.12	29.42	23.93	18.11	13.54	11.43	12.35	16.06	21.55	27.36	31.94	34.04	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	362.41	366.17	356.69	336.52	311.05	287.12	271.13	267.36	276.84	297.02	322.48	346.42	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	37.95	(69)
Pumps and fans gains (Table 5a)													
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	-119.61	(71)
Water heating gains (Table 5)													
(72)m=	129.62	127.19	122.14	115.28	110.83	104.55	99.22	106.05	108.48	115.58	123.6	127.2	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	603.01	600.63	580.61	547.77	513.27	480.95	460.55	467.33	484.72	517.81	555.87	585.52	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x	0.77	x	2.5	x	10.63	x	0.63	x	0.7	=	8.12	(74)
North	0.9x	0.77	x	2.5	x	20.32	x	0.63	x	0.7	=	15.53	(74)
North	0.9x	0.77	x	2.5	x	34.53	x	0.63	x	0.7	=	26.38	(74)
North	0.9x	0.77	x	2.5	x	55.46	x	0.63	x	0.7	=	42.38	(74)
North	0.9x	0.77	x	2.5	x	74.72	x	0.63	x	0.7	=	57.09	(74)
North	0.9x	0.77	x	2.5	x	79.99	x	0.63	x	0.7	=	61.11	(74)
North	0.9x	0.77	x	2.5	x	74.68	x	0.63	x	0.7	=	57.06	(74)
North	0.9x	0.77	x	2.5	x	59.25	x	0.63	x	0.7	=	45.27	(74)
North	0.9x	0.77	x	2.5	x	41.52	x	0.63	x	0.7	=	31.72	(74)
North	0.9x	0.77	x	2.5	x	24.19	x	0.63	x	0.7	=	18.48	(74)
North	0.9x	0.77	x	2.5	x	13.12	x	0.63	x	0.7	=	10.02	(74)
North	0.9x	0.77	x	2.5	x	8.86	x	0.63	x	0.7	=	6.77	(74)
East	0.9x	1	x	8.1	x	19.64	x	0.63	x	0.7	=	34.1	(76)
East	0.9x	1	x	8.1	x	38.42	x	0.63	x	0.7	=	66.7	(76)
East	0.9x	1	x	8.1	x	63.27	x	0.63	x	0.7	=	109.84	(76)
East	0.9x	1	x	8.1	x	92.28	x	0.63	x	0.7	=	160.2	(76)
East	0.9x	1	x	8.1	x	113.09	x	0.63	x	0.7	=	196.33	(76)
East	0.9x	1	x	8.1	x	115.77	x	0.63	x	0.7	=	200.98	(76)
East	0.9x	1	x	8.1	x	110.22	x	0.63	x	0.7	=	191.34	(76)
East	0.9x	1	x	8.1	x	94.68	x	0.63	x	0.7	=	164.36	(76)
East	0.9x	1	x	8.1	x	73.59	x	0.63	x	0.7	=	127.75	(76)
East	0.9x	1	x	8.1	x	45.59	x	0.63	x	0.7	=	79.14	(76)
East	0.9x	1	x	8.1	x	24.49	x	0.63	x	0.7	=	42.51	(76)
East	0.9x	1	x	8.1	x	16.15	x	0.63	x	0.7	=	28.04	(76)
South	0.9x	0.77	x	2.5	x	46.75	x	0.63	x	0.7	=	35.72	(78)
South	0.9x	0.77	x	2.5	x	76.57	x	0.63	x	0.7	=	58.5	(78)
South	0.9x	0.77	x	2.5	x	97.53	x	0.63	x	0.7	=	74.52	(78)
South	0.9x	0.77	x	2.5	x	110.23	x	0.63	x	0.7	=	84.22	(78)
South	0.9x	0.77	x	2.5	x	114.87	x	0.63	x	0.7	=	87.77	(78)
South	0.9x	0.77	x	2.5	x	110.55	x	0.63	x	0.7	=	84.46	(78)
South	0.9x	0.77	x	2.5	x	108.01	x	0.63	x	0.7	=	82.52	(78)
South	0.9x	0.77	x	2.5	x	104.89	x	0.63	x	0.7	=	80.14	(78)
South	0.9x	0.77	x	2.5	x	101.89	x	0.63	x	0.7	=	77.84	(78)
South	0.9x	0.77	x	2.5	x	82.59	x	0.63	x	0.7	=	63.1	(78)
South	0.9x	0.77	x	2.5	x	55.42	x	0.63	x	0.7	=	42.34	(78)
South	0.9x	0.77	x	2.5	x	40.4	x	0.63	x	0.7	=	30.87	(78)
West	0.9x	0.54	x	14.2	x	19.64	x	0.63	x	0.7	=	59.77	(80)
West	0.9x	0.77	x	10.6	x	19.64	x	0.63	x	0.7	=	63.62	(80)
West	0.9x	0.54	x	14.2	x	38.42	x	0.63	x	0.7	=	116.93	(80)

West	0.9x	0.77	x	10.6	x	38.42	x	0.63	x	0.7	=	124.46	(80)
West	0.9x	0.54	x	14.2	x	63.27	x	0.63	x	0.7	=	192.57	(80)
West	0.9x	0.77	x	10.6	x	63.27	x	0.63	x	0.7	=	204.97	(80)
West	0.9x	0.54	x	14.2	x	92.28	x	0.63	x	0.7	=	280.85	(80)
West	0.9x	0.77	x	10.6	x	92.28	x	0.63	x	0.7	=	298.94	(80)
West	0.9x	0.54	x	14.2	x	113.09	x	0.63	x	0.7	=	344.19	(80)
West	0.9x	0.77	x	10.6	x	113.09	x	0.63	x	0.7	=	366.36	(80)
West	0.9x	0.54	x	14.2	x	115.77	x	0.63	x	0.7	=	352.34	(80)
West	0.9x	0.77	x	10.6	x	115.77	x	0.63	x	0.7	=	375.04	(80)
West	0.9x	0.54	x	14.2	x	110.22	x	0.63	x	0.7	=	335.44	(80)
West	0.9x	0.77	x	10.6	x	110.22	x	0.63	x	0.7	=	357.05	(80)
West	0.9x	0.54	x	14.2	x	94.68	x	0.63	x	0.7	=	288.14	(80)
West	0.9x	0.77	x	10.6	x	94.68	x	0.63	x	0.7	=	306.7	(80)
West	0.9x	0.54	x	14.2	x	73.59	x	0.63	x	0.7	=	223.96	(80)
West	0.9x	0.77	x	10.6	x	73.59	x	0.63	x	0.7	=	238.39	(80)
West	0.9x	0.54	x	14.2	x	45.59	x	0.63	x	0.7	=	138.75	(80)
West	0.9x	0.77	x	10.6	x	45.59	x	0.63	x	0.7	=	147.69	(80)
West	0.9x	0.54	x	14.2	x	24.49	x	0.63	x	0.7	=	74.53	(80)
West	0.9x	0.77	x	10.6	x	24.49	x	0.63	x	0.7	=	79.33	(80)
West	0.9x	0.54	x	14.2	x	16.15	x	0.63	x	0.7	=	49.16	(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=	201.34	382.12	608.29	866.59	1051.74	1073.93	1023.42	884.61	699.67	447.16	248.74	167.15	(83)

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

(84)m=	804.34	982.75	1188.9	1414.36	1565.01	1554.89	1483.97	1351.94	1184.4	964.97	804.61	752.67	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.97	0.87	0.66	0.49	0.56	0.85	0.99	1	1	(86)

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

(87)m=	21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

(88)m=	20.15	20.15	20.16	20.17	20.18	20.19	20.19	20.19	20.18	20.18	20.17	20.16	(88)

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

(89)m=	1	1	0.99	0.96	0.82	0.59	0.4	0.46	0.79	0.98	1	1	(89)

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

(90)m=	20.15	20.15	20.16	20.17	20.18	20.18	20.19	20.19	20.18	20.18	20.17	20.16	(90)

fLA = Living area ÷ (4) = 0.33 (91)

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

(92)m=	20.43	20.43	20.43	20.44	20.45	20.45	20.46	20.46	20.45	20.45	20.44	20.44	(92)

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

(93)m=	20.43	20.43	20.43	20.44	20.45	20.45	20.46	20.46	20.45	20.45	20.44	20.44	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	1	0.99	0.96	0.84	0.61	0.43	0.5	0.81	0.99	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	804.06	981.42	1180.92	1357.81	1312.13	955.5	641.03	669.63	963.83	951.31	803.77	752.49	(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=	2832.74	2717.05	2427.94	1971.84	1487.94	975.36	642.9	673.78	1067.62	1675.06	2288.1	2807.05	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1509.34	1166.34	927.78	442.1	130.81	0	0	0	0	538.47	1068.72	1528.59	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 7312.15 (98)

Space heating requirement in kWh/m²/year 38.28 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	1566.67	1233.34	1261.44	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.94	0.98	0.96	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	1479.77	1204.72	1212.96	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	2003.17	1913.85	1752.62	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	376.85	527.59	401.51	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 1305.95 (104)

Cooled fraction — f C = cooled area ÷ (4) = 0.66 (105)

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104)$_{6...8}$ = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

(107)m=	0	0	0	0	0	61.98	86.77	66.03	0	0	0	0

Total = Sum(107)$_{6...8}$ = 214.78 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 1.12 (108)

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

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

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Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of main heating from main system 2		0.34	(203)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	0.66	(204)
Fraction of total heating from main system 2	(205) = (202) × (203) =	0.34	(205)
Efficiency of main space heating system 1		404	(206)
Efficiency of main space heating system 2		89.9	(207)
Efficiency of secondary/supplementary heating system, %		0	(208)
Cooling System Energy Efficiency Ratio		4.32	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	1509.34	1166.34	927.78	442.1	130.81	0	0	0	0	538.47	1068.72	1528.59		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	246.57	190.54	151.57	72.22	21.37	0	0	0	0	87.97	174.59	249.72		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													1194.55	(211)
(213)m =(98)m x (203) x 100 ÷ (207)	570.83	441.11	350.88	167.2	49.47	0	0	0	0	203.65	404.19	578.11		
Total (kWh/year) =Sum(213)$_{1...5,10....12}$=													2765.44	(213)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208) (215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
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)	220.85	194.56	204.11	182.67	178.79	159.44	152.83	168.11	167.95	189.44	200.69	215.43		
Efficiency of water heater													79.8	(216)
(217)m=	232.55	222.02	200.43	157.56	108.03	79.8	79.8	79.8	79.8	167.46	212.64	235.59		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	94.97	87.63	101.84	115.94	165.51	199.8	191.51	210.67	210.46	113.13	94.38	91.44		
Total = Sum(219a)$_{1...12}$ =													1677.28	(219)

Space cooling fuel, kWh/month.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(221)m = (107)m÷ (209) (221)m=	0	0	0	0	0	14.35	20.09	15.29	0	0	0	0		
Total = Sum(221)$_{6...8}$ =													49.72	(221)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		1194.55	
Space heating fuel used, main system 2		2765.44	
Water heating fuel used		1677.28	
Space cooling fuel used		49.72	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	590.53		(230a)
central heating pump:	30		(230c)

Total electricity for the above, kWh/year	sum of (230a)…(230g) =		620.53	(231)
Electricity for lighting			584.97	(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	0.519	=	619.97	(261)
Space heating (main system 2)	(213) x	0.216	=	597.34	(262)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	362.29	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1579.6	(265)
Space cooling	(221) x	0.519	=	25.8	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	322.05	(267)
Electricity for lighting	(232) x	0.519	=	303.6	(268)
Total CO2, kg/year		sum of (265)…(271) =		2231.06	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		11.68	(273)
EI rating (section 14)				87	(274)

APPENDIX 4. SUSTAINABLE USE OF MATERIALS

More than 10% of the total value of materials used on site will be derived from recycled and reused sources. Following strategies will ensure that this target will be achieved:

1. High recycled content will be used in the main building elements including blockwork, plasterboard, chipboard and slabs. The project target for recycled content in each of these items is as below:
    a. Blockwork: 40%
    b. Plasterboard: 80%
    c. Chipboard: 50%
    d. Slabs: 10%

   This strategy will ensure that the target set by the council is achieved.

2. Take Back Schemes: the contractor will be required to use take back schemes to ensure the best use of the left over materials

3. During the design, the architects will implement modular design to ensure less off cut will be created on site from various materials

4. The materials will be stored in secure place on site to avoid any weather damage to the materials. The materials will also be handled properly to avoid any breakage and damage and to reduce the waste.