Energy & Sustainability Statement

For

26 Netherhall Gardens

London Borough of Camden
London
NW3 5TL

Prepared for

Atlas Property Lettings & Services Ltd

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ISSUE

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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 a 4-storey extension to the existing building to provide four new residential units.

This Energy and Sustainability Statement, prepared in line with the Energy Assessment Guidance (October 2018) published by the Greater London Authority, outlines the key features and strategies adopted by the development team to enhance the energy performance of the proposed development at 26 Netherhall Gardens. The scheme complies with all relevant policies with regards to energy and carbon emissions, set by the Camden Local Plan (2017). Sections 2 and 3 review these policies and demonstrate how the proposed design meets the planning targets and requirements to minimise its environmental impact.

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;
- Double-glazed windows of low U-values will help reduce the heating demand further;
- All junctions will conform to Accredited Construction Details thus eliminating thermal bridging;
- Individual gas-fired condensing boilers of high efficiency will provide heating and domestic hot water to the newly built apartments;
- All apartments will feature Mechanical Ventilation with Heat Recovery (MVHR) to make use of wasted heat of the exhaust air by preheating the incoming air;
- Light fittings will be of low energy types;
- Photovoltaic (PV) panels will be installed to generate renewable energy on site.

Following the proposed energy strategy, the new flats achieve significant carbon savings and comply with the Target Emission Rate (TER) set by Part L of current Building Regulations and Council carbon target i.e. a 19% reduction over 2013 TER. The following sections present the CO_2 savings for the new extension at 26 Netherhall Gardens. As recommended by the GLA Energy Guidance Assessment, the updated SAP 10 emission factors have been used to reflect the fact that grid electricity has significantly decarbonised since the last update of Part L in April 2014. Appendix 6 of the report presents the carbon savings achieved using the SAP 2012 emission factors for comparison, calculated using the GLA carbon emission reporting spreadsheet.

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		6
Be Lean	After energy demand reduction	5
Be Clean	After CHP	5
Be Green	After renewable energy	5

Table 2 demonstrates the total regulated CO_2 savings from each stage of the Energy Hierarchy. As demonstrated below, an overall 19% reduction in carbon emissions can be achieved over Part L 2013 TER when applying the proposed strategy, which exceeds the 19% reduction set in the Camden Local Plan.

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	1	11%
Savings from CHP	0	0%
Savings from renewable energy	0	8%
Total Cumulative Savings	**1**	**19%**

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 19% carbon reduction required by the Camden Council.

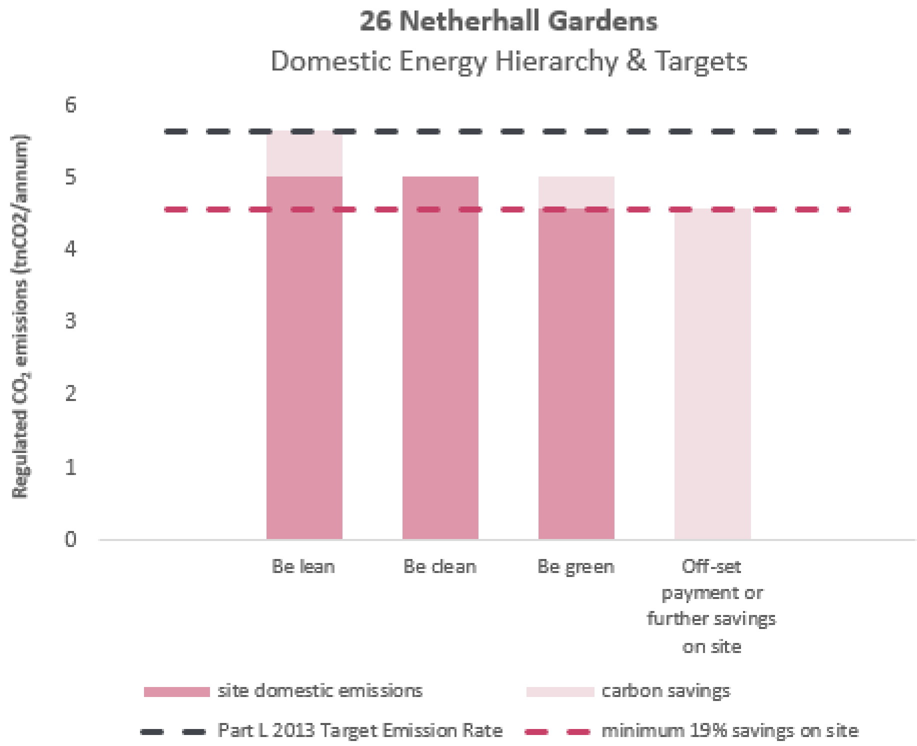


Figure 1 Total carbon savings achieved over Baseline Emissions

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. Building works on the site include a 4-storey extension to the existing building to provide four new residential units (2 x 1-Bed apartments, 1 x 2-Bed apartment and 1 x 2-Bed duplex).

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

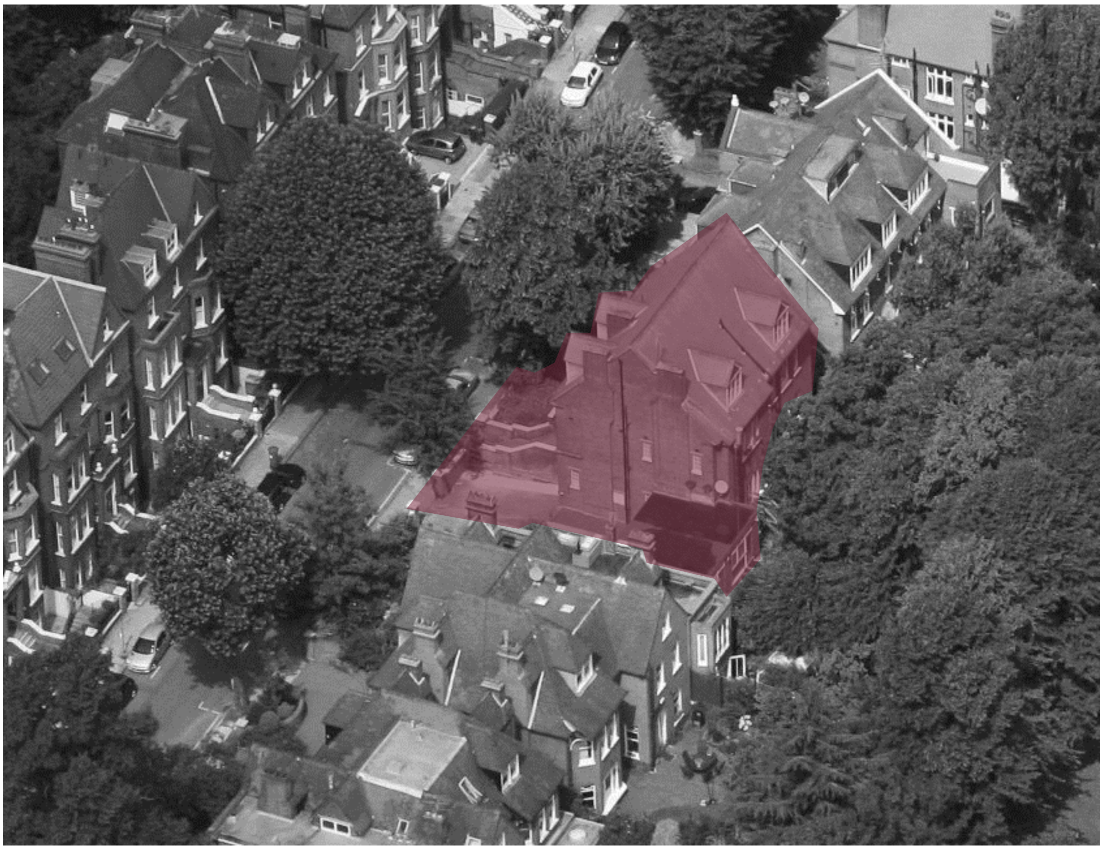


Figure 2 Bird's eye view of existing Building

Figure 3 Proposed scheme – 26 Netherhall Gardens Road view

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.

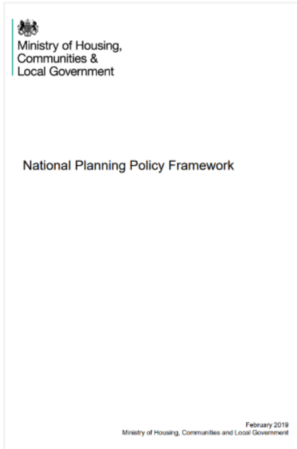
CLIMATE CHANGE ACT 2008

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.

[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) (FEBRUARY 2019)



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 (MARCH 2016)

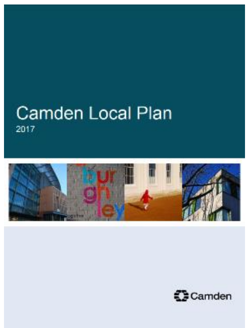
The London Plan, prepared by the Mayor of London's office, deals with matters that are of strategic importance to Greater London. The London Plan is the overall strategic plan setting out an integrated social, economic and environmental framework for the future development of London, looking forward 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 LOCAL PLAN (2017)



The Camden Local Plan sets out the Council's planning policies and replaces the Core Strategy and Development Policies planning documents (adopted in 2010). This sets out the key elements of the Council's planning vision and strategy of the borough.

Through its Camden Planning Guidance (CPG) on Energy efficiency and adaptation (Draft November 2018) the council provides additional information on key energy and resource issues within the borough.

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 LOCAL PLAN (2017) CLIMATE CHANGE MITIGATION POLICIES

Policy CC1 Climate change mitigation;

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 5.2 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 an extension with 4 No. new 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 Energy Assessment Guidance.

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. building fabric of high thermal performance and applying 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;
- A feasibility study to identify the most suitable renewable energy technologies has been carried out and presented in this report.

As a result of the proposed strategy, the scheme achieves an overall reduction of 19% over the 2013 TER, exceeding the reduction target set by the Camden Council.

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 Energy Assessment Guidance. Due to Sustainable design features integrated in the design of the proposed units, the development exceeds the carbon dioxide target reduction set by the council thus achieving a reduction of more than 19% 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. 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 4 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, BFRC-rated double-glazed windows and low water use fittings to be specified, this is expected to be low. According to the London Heat Map (Figure 4), 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.

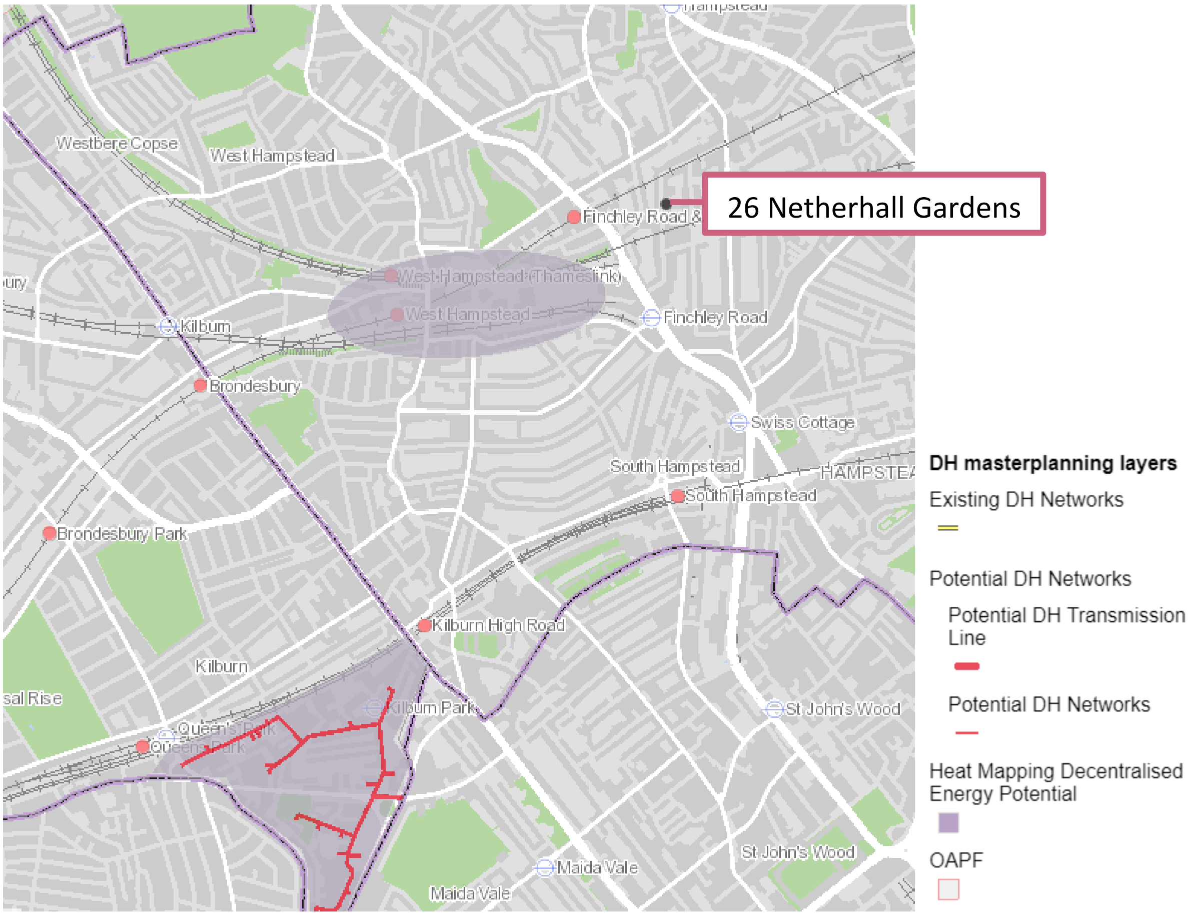


Figure 4 Image of London Heat Map (www.londonheatmap.org.uk)

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 4 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

A feasibility study has been carried out to assess renewable energy technologies that could be appropriate for the proposed development (please refer to Section 8).

Policy CC1 Climate change mitigation
The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation. We will:

a. promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy;
b. require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met;
c. ensure that the location of development and mix of land uses minimise the need to travel by car and help to support decentralised energy networks;
d. support and encourage sensitive energy efficiency improvements to existing buildings;
e. require all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building; and
f. expect all developments to optimise resource efficiency.

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

g. working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them;
h. protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes; and
i. requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network.

To ensure that the Council can monitor the effectiveness of renewable and low carbon technologies, major developments will be required to install appropriate monitoring equipment.

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 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 19% overall in line with the Camden Local Plan. 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 photovoltaic panels thus reducing carbon emissions by 19%.

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.

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 5.15 Water use and supplies;

CAMDEN LOCAL PLAN (2017) CLIMATE CHANGE MITIGATION POLICIES

Policy CC2 Adapting to climate change;
Policy CC3 Water and flooding;
Policy CC4 Air quality;
Policy CC5 Waste;

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.

- 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 5.12 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 6). Based on Map 6: Historic flooding and Local Flood Risk Zones of the Local Plan, 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.

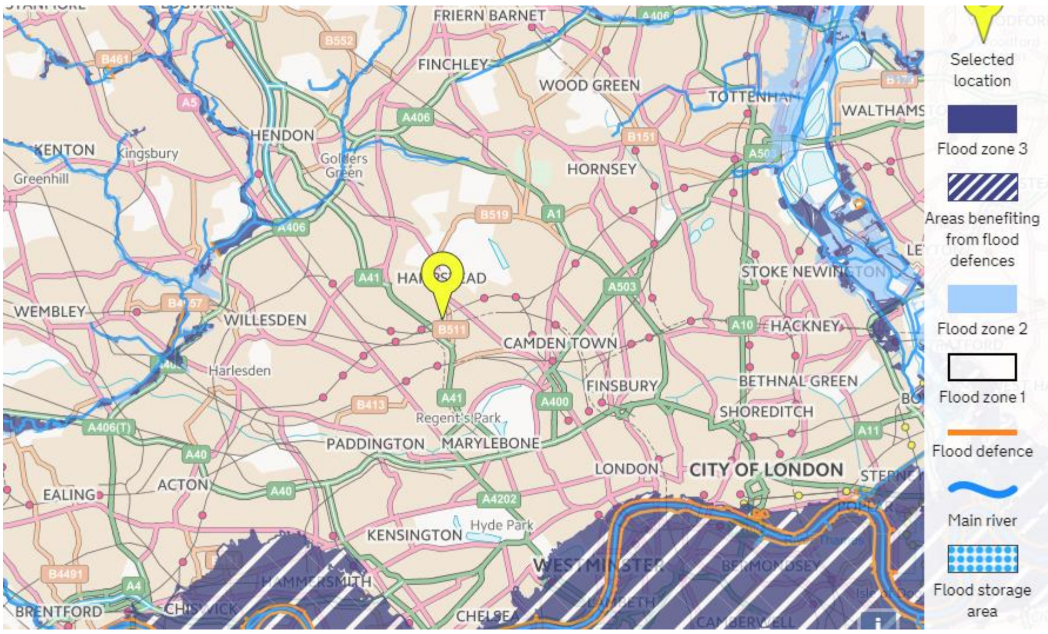


Figure 5 Environment Agency Flood Map

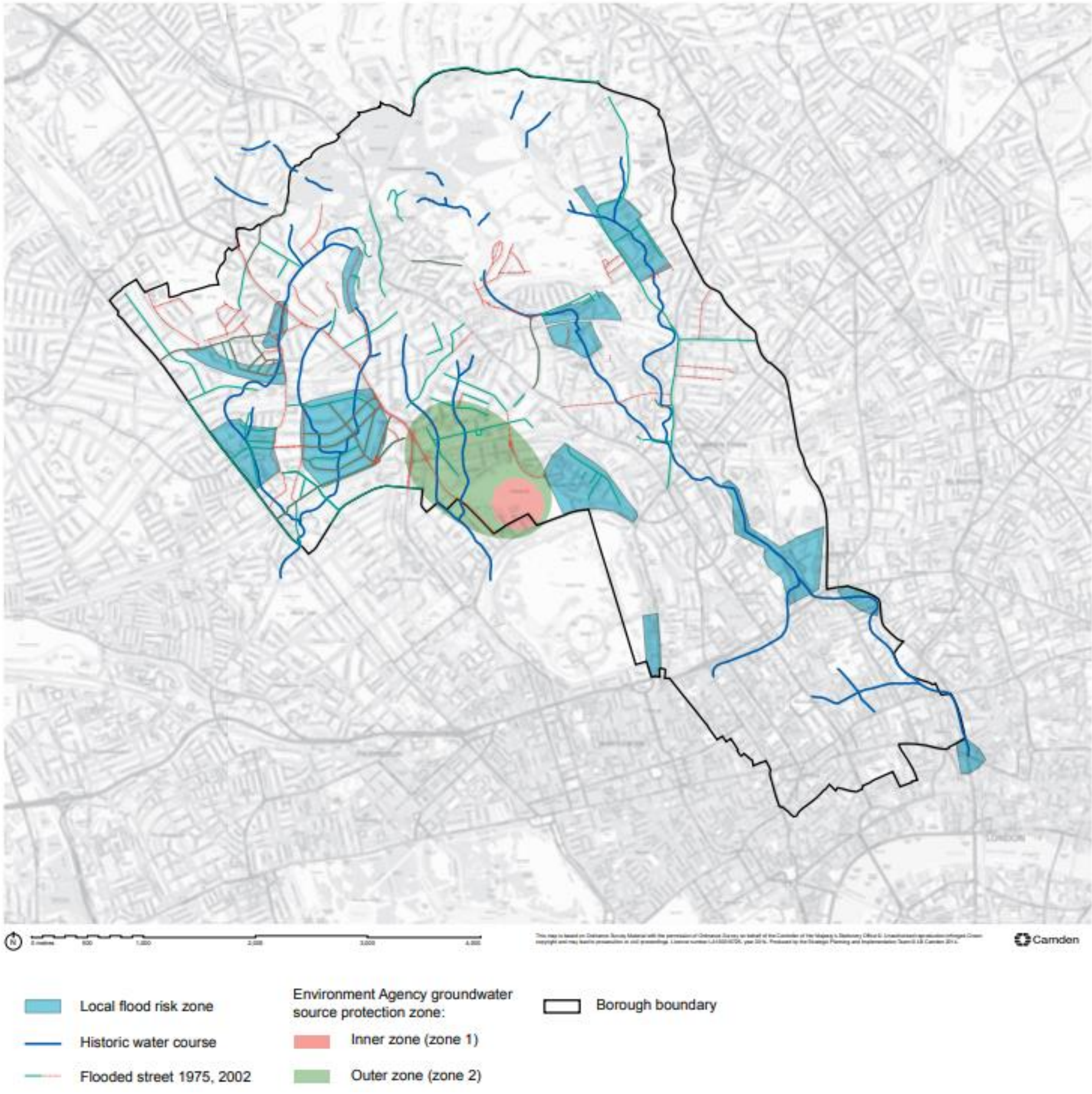


Figure 6 Map 6: Historic flooding and Local Flood Risk Zones of Camden's Local Plan

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.

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

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.

Policy CC2 Adapting to climate change

The Council will require development to be resilient to climate change.

All development should adopt appropriate climate change adaptation measures such as:

a. the protection of existing green spaces and promoting new appropriate green infrastructure;
b. not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems;
c. incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and
d. measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

Any development involving 5 or more residential units or 500 sqm or more of any additional floorspace is required to demonstrate the above in a Sustainability Statement.

Sustainable design and construction measures

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

e. ensuring development schemes demonstrate how adaptation measures and sustainable development principles have been incorporated into the design and proposed implementation;
f. encourage new build residential development to use the Home Quality Mark and Passivhaus design standards;
g. encouraging conversions and extensions of 500 sqm of residential floorspace or above or five or more dwellings to achieve “excellent” in BREEAM domestic refurbishment; and
h. expecting non-domestic developments of 500 sqm of floorspace or above to achieve “excellent” in BREEAM assessments and encouraging zero carbon in new development from 2019.

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

As the proposed extension consists of 4 new residential units only, Policy CC2 does not apply. However, wherever practical and feasible for a development of this type and scale, good practice sustainable development principles will be incorporated in the design to minimise the environmental impact of the scheme.

Policy CC3 Water and flooding
The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible. We will require development to: a. incorporate water efficiency measures; b. avoid harm to the water environment and improve water quality; c. consider the impact of development in areas at risk of flooding (including drainage); d. incorporate flood resilient measures in areas prone to flooding; e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible; and f. not locate vulnerable development in flood-prone areas. Where an assessment of flood risk is required, developments should consider surface water flooding in detail and groundwater flooding where applicable. The Council will protect the borough's existing drinking water and foul water infrastructure, including the reservoirs at Barrow Hill, Hampstead Heath, Highgate and Kidderpore.

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 6). Based on Map 6: Historic flooding and Local Flood Risk Zones of the Local Plan, 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.

Policy CC4 Air quality
The Council will ensure that the impact of development on air quality is mitigated and ensure that exposure to poor air quality is reduced in the borough. The Council will take into account the impact of air quality when assessing development proposals, through the consideration of both the exposure of occupants to air pollution and the effect of the development on air quality. Consideration must be taken to the actions identified in the Council's Air Quality Action Plan. Air Quality Assessments (AQAs) are required where development is likely to expose residents to high levels of air pollution. Where the AQA shows that a development would cause harm to air quality, the Council will not grant planning permission unless measures are adopted to mitigate

the impact. Similarly, developments that introduce sensitive receptors (i.e. housing, schools) in locations of poor air quality will not be acceptable unless designed to mitigate the impact.

Development that involves significant demolition, construction or earthworks will also be required to assess the risk of dust and emissions impacts in an AQA and include appropriate mitigation measures to be secured in a Construction Management Plan.

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

The proposed scheme will provide 4 additional dwellings in the existing site surrounded mainly by residential buildings. Low NOx individual gas-fired boilers are proposed to provide heating to the new apartments, therefore, any impact on the air quality will be minimal.

Policy CC5 Waste

The Council will seek to make Camden a low waste borough.

We will:

a. aim to reduce the amount of waste produced in the borough and increase recycling and the reuse of materials to meet the London Plan targets of 50% of household waste recycled/composted by 2020 and aspiring to achieve 60% by 2031;
b. deal with North London's waste by working with our partner boroughs in North London to produce a Waste Plan, which will ensure that sufficient land is allocated to manage the amount of waste apportioned to the area in the London Plan;
c. safeguard Camden's existing waste site at Regis Road unless a suitable compensatory waste site is provided that replaces the maximum throughput achievable at the existing site; and
d. make sure that developments include facilities for the storage and collection of waste and recycling.

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

Recycling and composting will be promoted by e.g. providing relevant facilities and information to the future tenants through a Home User Guide.

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 1.0.4.16), 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. As recommended by the GLA Energy Guidance Assessment, the updated SAP 10 emission factors have been used to reflect the fact that grid electricity has significantly decarbonised since the last update of Part L in April 2014. Appendix 6 of the report presents the carbon savings achieved using the SAP 2012 emission factors for comparison, calculated using the GLA carbon emission reporting spreadsheet.

4.2 BASELINE CARBON EMISSION RATE

The building comprises four new dwellings. According to the GLA Energy Assessment Guidance (October 2018) and the Camden Local Plan (2017), 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)	5 $tnCO_2$/annum
Part L1A 2013 Target Fabric Energy Efficiency Rate (TFEE)	72.60 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 Energy Assessment Guidance (October 2018) 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 describe the proposed energy strategy developed for the scheme to meet the carbon savings target set by the Camden Council i.e. 19% 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 orientation of the new extension is largely dictated by the shape of the existing 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;
- 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/m²K]	Wall	0.18
		Floor	0.15
		Roof	0.15
		Window	1.40 – Double-glazed (g-value: 0.63)
	Air permeability		5 m^3/m^2hr @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 combi boilers with automatic ignition of high efficiency are proposed for each flat to provide heating;
- 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="7">HVAC Systems</td><td>Primary Heating System</td><td colspan="3">Individual gas-fired condensing combi boilers with automatic ignition of 89.7% efficiency</td></tr>
<tr><td>Heating Controls</td><td colspan="3">Programmer, thermostat and TRVs
Boiler interlock
Delayed start thermostat</td></tr>
<tr><td>Ventilation</td><td colspan="3">Whole house balanced mechanical ventilation with heat recovery as per below table (Approved installation scheme)</td></tr>
<tr><td rowspan="3"></td><td>Number of wet rooms</td><td>SFP (W/l/s)</td><td>Heat exchanger efficiency (%)</td></tr>
<tr><td>1 + kitchen</td><td>0.40</td><td>94</td></tr>
<tr><td>2 + kitchen</td><td>0.43</td><td>94</td></tr>
<tr><td>Comfort Cooling</td><td colspan="3">Not provided</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 and 6.2, the carbon dioxide emissions of the proposed scheme are reduced from 6 tnCO2 to 5 tnCO2 per year. Therefore, the reduction in Carbon Emission of the building at this stage is 11%, 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		6
Be Lean	After energy demand reduction	5
Carbon Savings over Baseline		1
Carbon Reduction over Baseline		11%

Subsequently, the reduction in Fabric Energy Efficiency of the building is 15%, 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	72.60
Dwelling Fabric Energy Efficiency (DFEE) Rate	61.52
Reduction over 2013 TFEE	15%

6.4 NON-REGULATED ENERGY USE

The Camden Planning Guidance on Energy efficiency and adaptation (November 2018) requires that the energy demand and carbon dioxide emissions of the nonregulated end uses should also be calculated and reported in the energy assessments. In accordance with BRE SAP calculation procedures for estimating the non-regulated carbon emissions, the carbon emission from appliances in the development will be circa 2 $tnCO_2$ per year and total emissions from cooking in all dwellings are approximately 0.7 $tnCO_2$ per year. The total carbon emissions of the residential units from non-regulated energy use is therefore 2.7 $tnCO_2$ per year.

The following strategies are proposed to reduce the non-regulated energy demand of the development:

- A rated appliance: The kitchens will be fitted out with highly efficient A-rated appliances or alternatively information about high efficiency units will be provided to future owners.
- Installation of energy meters with display monitors for each flat. This will encourage the occupants to become more interested and involved in how energy is being used in their flat.
- Information will be provided to occupants which will explain the operations of the installed systems and PV panels and how energy efficient behaviour can reduce the cost/carbon emissions of the development

It is estimated that proposed strategies may reduce the unregulated carbon emission by at least 10% down to 2.4 $tnCO_2$ per year. However, at this stage, this can only be an assumption as small power consumption depends mainly on occupant's behaviour.

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 apartments been added to the existing site, 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 combi 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.

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

8.1 PHOTOVOLTAIC (PV) PANELS SOLAR HOT WATER HEATING

The design team has reviewed the building roof space for the development. Photovoltaic panels work efficiently on flat or south facing unobstructed roof areas. A photovoltaic panel (PV) array with the following characteristics is proposed for the new extension to generate renewable energy on site thus reducing the electricity demand of the dwellings. Figure 7 shows the indicative position of the panels on the roof of the new extension. These should be installed at 10 degrees to allow for self-cleaning from rainwater and make sure these are not visible from the street level.

Table 9 Proposed building fabric specifications

Photovoltaic (PV) panels	No.	10
	Power output	2.5 kWp (250Wp each)
	Efficiency	$\geq$ 15.5%
	Area	circa 1.63 sqm per panel (16.3 sqm in total)
	Orientation	South
	Inclination	10 degrees to allow for self-cleaning from rainwater

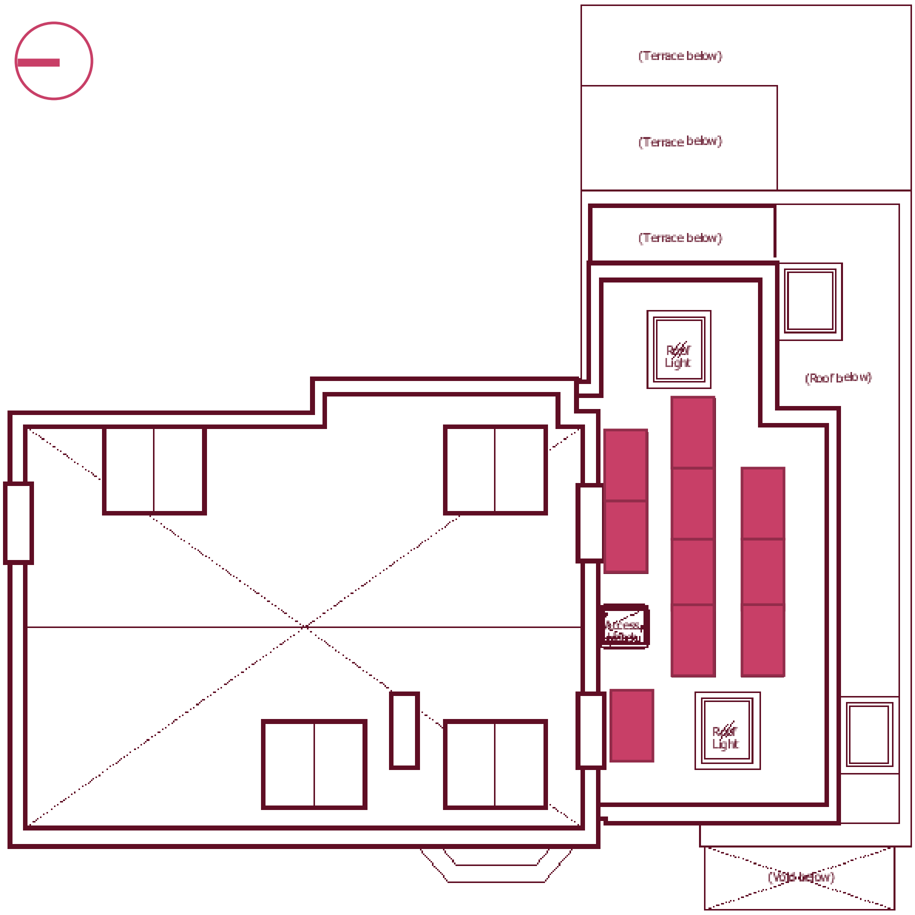


Figure 7 Indicative position of the PV array on the roof

9. CONCLUSION

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 2016 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;
- Photovoltaic (PV) panels will be installed to generate renewable energy on site.

This energy performance statement has demonstrated that the new development has achieved a carbon emission reduction in excess of 19% over the Part L1A Target Emission Rate, as required by the Camden Council. The following table (Table 10) 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. As recommended by the GLA Energy Guidance Assessment, the updated SAP 10 emission factors have been used to reflect the fact that grid electricity has significantly decarbonised since the last update of Part L in April 2014. Appendix 6 of the report presents the carbon savings achieved using the SAP 2012 emission factors for comparison.

Table 10 Carbon Dioxide emissions reduction for the development

Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)		26 Netherhall Gardens
Baseline Emissions		6
Be Lean	After energy demand reduction	5
Be Clean	After CHP	5
Be Green	After renewable energy	5
Carbon Savings over Baseline Emissions		1
Carbon Reduction over Baseline Emissions		19%

Table 11 demonstrates the total regulated CO_2 savings from each stage of the Energy Hierarchy. As demonstrated below overall 19% reduction in carbon emission can be achieved applying the proposed strategies.

Table 11 Regulated carbon dioxide savings from each stage of the Energy Hierarchy

	Regulated carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	1	11%
Savings from CHP	0	0%
Savings from renewable energy	1	8%
Total Cumulative Savings	**1**	**19%**

Figure 8 below illustrate the total carbon savings and the total reduction achieved at each stage of the proposed Energy Hierarchy respectively.

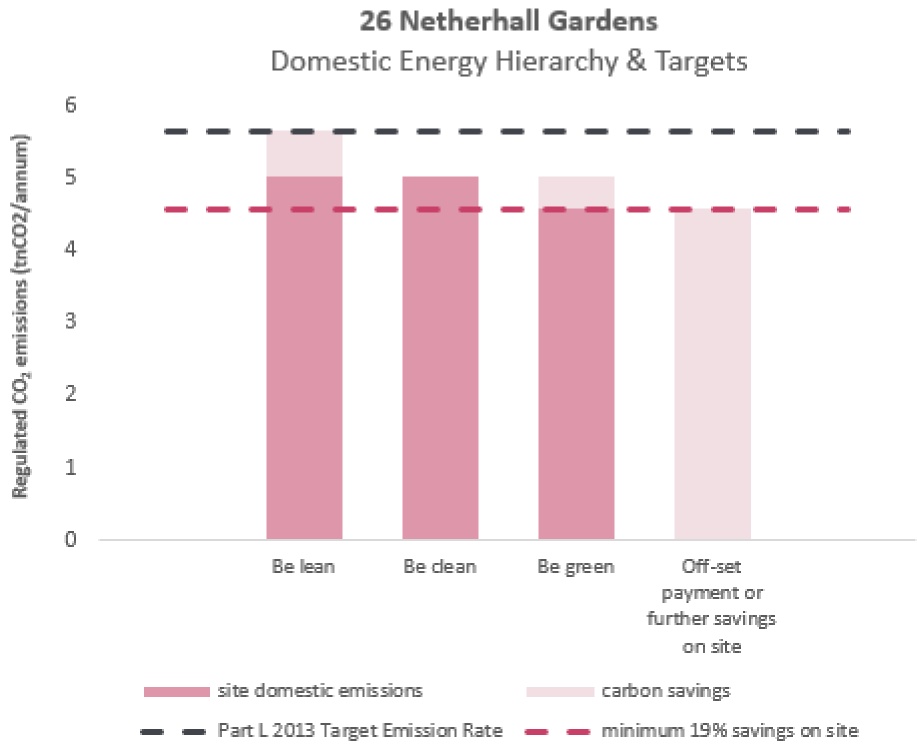


Figure 8 Total carbon savings achieved at each stage over Baseline Emissions

APPENDIX 1. LOW/ZERO CARBON TECHNOLOGIES

- **BIOMASS BOILER**

A biomass boiler works effectively against a consistent heating load, however, adequate space dedicated for storing the fuel is required. 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. For this reason, we would not recommend a biomass boiler for this development.

- **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.

- **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 proposed extension. However, given that the heating demand for this development is low, the cost of installing a ground source heat pump would not make this system financially viable. Therefore, given that 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. ASHPs perform better when connected to an underfloor heating system that requires lower water temperature. ASHPs have low maintenance costs and they are simple to install compared to a GSHP. ASHPs, however, tend to drop their efficiencies when ambient air temperature is low during wintertime as there is no heat to absorb. Even though they are considered as Low carbon Technologies they run on electricity which is a carbon intensive fuel. For this reason, we would not recommend ASHPs for this development.

- **SOLAR HOT WATER HEATING**

Solar thermal hot water systems can work well on residential developments. However, compared to PV panels, they require higher maintenance and more space inside the apartments for risers and hot water storage. Therefore, we would recommend that the available roof space is utilised for the installation of a PV array.

APPENDIX 2. TER WORKSHEET OF TYPICAL APARTMENT

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MECSERVE

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: Apartment 3-Be Lean

Address : Apartment 3, 26, Netherhall Gardens, LONDON, NW3 5TL

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	86.86	(1a)	x	2.8	(2a)	=	243.21	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	86.86	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			243.21	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans =	(6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.12	(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)	0.37	(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) =	0.26	(21)

Infiltration rate modified for monthly wind speed

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

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MECSERVE

TER WorkSheet: New dwelling design stage

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

0.33	0.33	0.32	0.29	0.28	0.25	0.25	0.24	0.26	0.28	0.29	0.31

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

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

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

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

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.92	x	1	=	1.92			(26)
Windows Type 1			1.62	x1/[1/(1.4)+ 0.04]		=	2.15			(27)
Windows Type 2			1.59	x1/[1/(1.4)+ 0.04]		=	2.11			(27)
Windows Type 3			4.39	x1/[1/(1.4)+ 0.04]		=	5.82			(27)
Windows Type 4			1.2	x1/[1/(1.4)+ 0.04]		=	1.59			(27)
Windows Type 5			1.2	x1/[1/(1.4)+ 0.04]		=	1.59			(27)
Windows Type 6			1.2	x1/[1/(1.4)+ 0.04]		=	1.59			(27)
Windows Type 7			1.2	x1/[1/(1.4)+ 0.04]		=	1.59			(27)
Windows Type 8			3	x1/[1/(1.4)+ 0.04]		=	3.98			(27)
Windows Type 9			4.39	x1/[1/(1.4)+ 0.04]		=	5.82			(27)
Floor			8.57	x	0.13	=	1.1141			(28)
Walls Type1	96.43	19.79	76.64	x	0.18	=	13.8			(29)
Walls Type2	27.89	1.92	25.97	x	0.18	=	4.67			(29)
Roof	38.42	0	38.42	x	0.13	=	4.99			(30)
Total area of elements, m²			171.31							(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) = 52.74 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 16380.03 (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

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K — 36.23 (36)

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

Total fabric heat loss (33) + (36) = 88.96 (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=	44.58	44.41	44.24	43.45	43.3	42.6	42.6	42.47	42.87	43.3	43.6	43.91	(38)

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

(39)m=	133.55	133.37	133.2	132.41	132.26	131.56	131.56	131.44	131.83	132.26	132.56	132.88	

Average = Sum(39)$_{1...12}$ /12= 132.41 (39)

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

(40)m=	1.54	1.54	1.53	1.52	1.52	1.51	1.51	1.51	1.52	1.52	1.53	1.53	

Average = Sum(40)$_{1...12}$ /12= 1.52 (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 — 2.58 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 95.48 (43)

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

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

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

(44)m=	105.03	101.21	97.39	93.57	89.75	85.93	85.93	89.75	93.57	97.39	101.21	105.03

Total = Sum(44)$_{1...12}$ = 1145.77 (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=	155.76	136.22	140.57	122.55	117.59	101.47	94.03	107.9	109.19	127.25	138.9	150.84

Total = Sum(45)$_{1...12}$ = 1502.29 (45)

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

(46)m=	23.36	20.43	21.09	18.38	17.64	15.22	14.1	16.19	16.38	19.09	20.84	22.63	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

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

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

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Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

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

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

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

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

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

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

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

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

(61)m=	50.96	46.03	49.63	46.14	45.74	42.38	43.79	45.74	46.14	49.63	49.32	50.96	(61)

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

(62)m=	206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8	(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=	206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8

Output from water heater (annual)$_{1...12}$ 2068.74 (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=	64.53	56.8	59.15	52.29	50.53	44.33	42.21	47.31	47.84	54.72	58.51	62.89	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	(66)

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

(67)m=	20.79	18.46	15.02	11.37	8.5	7.17	7.75	10.08	13.52	17.17	20.04	21.37	(67)

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

(68)m=	233.18	235.6	229.5	216.52	200.14	184.74	174.45	172.03	178.12	191.11	207.49	222.89	(68)

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

(69)m=	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	(71)

Water heating gains (Table 5)

(72)m=	86.73	84.53	79.5	72.62	67.92	61.58	56.74	63.59	66.45	73.55	81.27	84.54	(72)

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

(73)m=	405.4	403.29	388.72	365.21	341.26	318.19	303.64	310.4	322.8	346.53	373.51	393.5	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	3	x	19.64	x	0.63	x	0.7	=	18.01	(76)
East	0.9x	1	x	4.39	x	19.64	x	0.63	x	0.7	=	26.35	(76)
East	0.9x	1	x	3	x	38.42	x	0.63	x	0.7	=	35.23	(76)
East	0.9x	1	x	4.39	x	38.42	x	0.63	x	0.7	=	51.55	(76)
East	0.9x	1	x	3	x	63.27	x	0.63	x	0.7	=	58.01	(76)
East	0.9x	1	x	4.39	x	63.27	x	0.63	x	0.7	=	84.89	(76)
East	0.9x	1	x	3	x	92.28	x	0.63	x	0.7	=	84.61	(76)
East	0.9x	1	x	4.39	x	92.28	x	0.63	x	0.7	=	123.81	(76)
East	0.9x	1	x	3	x	113.09	x	0.63	x	0.7	=	103.69	(76)
East	0.9x	1	x	4.39	x	113.09	x	0.63	x	0.7	=	151.73	(76)
East	0.9x	1	x	3	x	115.77	x	0.63	x	0.7	=	106.14	(76)
East	0.9x	1	x	4.39	x	115.77	x	0.63	x	0.7	=	155.32	(76)
East	0.9x	1	x	3	x	110.22	x	0.63	x	0.7	=	101.05	(76)
East	0.9x	1	x	4.39	x	110.22	x	0.63	x	0.7	=	147.87	(76)
East	0.9x	1	x	3	x	94.68	x	0.63	x	0.7	=	86.8	(76)
East	0.9x	1	x	4.39	x	94.68	x	0.63	x	0.7	=	127.02	(76)
East	0.9x	1	x	3	x	73.59	x	0.63	x	0.7	=	67.47	(76)
East	0.9x	1	x	4.39	x	73.59	x	0.63	x	0.7	=	98.73	(76)
East	0.9x	1	x	3	x	45.59	x	0.63	x	0.7	=	41.8	(76)
East	0.9x	1	x	4.39	x	45.59	x	0.63	x	0.7	=	61.16	(76)
East	0.9x	1	x	3	x	24.49	x	0.63	x	0.7	=	22.45	(76)
East	0.9x	1	x	4.39	x	24.49	x	0.63	x	0.7	=	32.86	(76)
East	0.9x	1	x	3	x	16.15	x	0.63	x	0.7	=	14.81	(76)
East	0.9x	1	x	4.39	x	16.15	x	0.63	x	0.7	=	21.67	(76)
South	0.9x	0.77	x	1.2	x	46.75	x	0.63	x	0.7	=	17.15	(78)
South	0.9x	0.77	x	1.2	x	46.75	x	0.63	x	0.7	=	17.15	(78)
South	0.9x	0.77	x	1.2	x	46.75	x	0.63	x	0.7	=	17.15	(78)
South	0.9x	0.77	x	1.2	x	46.75	x	0.63	x	0.7	=	17.15	(78)
South	0.9x	0.77	x	1.2	x	76.57	x	0.63	x	0.7	=	28.08	(78)
South	0.9x	0.77	x	1.2	x	76.57	x	0.63	x	0.7	=	28.08	(78)
South	0.9x	0.77	x	1.2	x	76.57	x	0.63	x	0.7	=	28.08	(78)
South	0.9x	0.77	x	1.2	x	76.57	x	0.63	x	0.7	=	28.08	(78)
South	0.9x	0.77	x	1.2	x	97.53	x	0.63	x	0.7	=	35.77	(78)
South	0.9x	0.77	x	1.2	x	97.53	x	0.63	x	0.7	=	35.77	(78)
South	0.9x	0.77	x	1.2	x	97.53	x	0.63	x	0.7	=	35.77	(78)
South	0.9x	0.77	x	1.2	x	97.53	x	0.63	x	0.7	=	35.77	(78)
South	0.9x	0.77	x	1.2	x	110.23	x	0.63	x	0.7	=	40.43	(78)
South	0.9x	0.77	x	1.2	x	110.23	x	0.63	x	0.7	=	40.43	(78)
South	0.9x	0.77	x	1.2	x	110.23	x	0.63	x	0.7	=	40.43	(78)

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South	0.9x	0.77	x	1.2	x	110.23	x	0.63	x	0.7	=	40.43	(78)
South	0.9x	0.77	x	1.2	x	114.87	x	0.63	x	0.7	=	42.13	(78)
South	0.9x	0.77	x	1.2	x	114.87	x	0.63	x	0.7	=	42.13	(78)
South	0.9x	0.77	x	1.2	x	114.87	x	0.63	x	0.7	=	42.13	(78)
South	0.9x	0.77	x	1.2	x	114.87	x	0.63	x	0.7	=	42.13	(78)
South	0.9x	0.77	x	1.2	x	110.55	x	0.63	x	0.7	=	40.54	(78)
South	0.9x	0.77	x	1.2	x	110.55	x	0.63	x	0.7	=	40.54	(78)
South	0.9x	0.77	x	1.2	x	110.55	x	0.63	x	0.7	=	40.54	(78)
South	0.9x	0.77	x	1.2	x	110.55	x	0.63	x	0.7	=	40.54	(78)
South	0.9x	0.77	x	1.2	x	108.01	x	0.63	x	0.7	=	39.61	(78)
South	0.9x	0.77	x	1.2	x	108.01	x	0.63	x	0.7	=	39.61	(78)
South	0.9x	0.77	x	1.2	x	108.01	x	0.63	x	0.7	=	39.61	(78)
South	0.9x	0.77	x	1.2	x	108.01	x	0.63	x	0.7	=	39.61	(78)
South	0.9x	0.77	x	1.2	x	104.89	x	0.63	x	0.7	=	38.47	(78)
South	0.9x	0.77	x	1.2	x	104.89	x	0.63	x	0.7	=	38.47	(78)
South	0.9x	0.77	x	1.2	x	104.89	x	0.63	x	0.7	=	38.47	(78)
South	0.9x	0.77	x	1.2	x	104.89	x	0.63	x	0.7	=	38.47	(78)
South	0.9x	0.77	x	1.2	x	101.89	x	0.63	x	0.7	=	37.37	(78)
South	0.9x	0.77	x	1.2	x	101.89	x	0.63	x	0.7	=	37.37	(78)
South	0.9x	0.77	x	1.2	x	101.89	x	0.63	x	0.7	=	37.37	(78)
South	0.9x	0.77	x	1.2	x	101.89	x	0.63	x	0.7	=	37.37	(78)
South	0.9x	0.77	x	1.2	x	82.59	x	0.63	x	0.7	=	30.29	(78)
South	0.9x	0.77	x	1.2	x	82.59	x	0.63	x	0.7	=	30.29	(78)
South	0.9x	0.77	x	1.2	x	82.59	x	0.63	x	0.7	=	30.29	(78)
South	0.9x	0.77	x	1.2	x	82.59	x	0.63	x	0.7	=	30.29	(78)
South	0.9x	0.77	x	1.2	x	55.42	x	0.63	x	0.7	=	20.32	(78)
South	0.9x	0.77	x	1.2	x	55.42	x	0.63	x	0.7	=	20.32	(78)
South	0.9x	0.77	x	1.2	x	55.42	x	0.63	x	0.7	=	20.32	(78)
South	0.9x	0.77	x	1.2	x	55.42	x	0.63	x	0.7	=	20.32	(78)
South	0.9x	0.77	x	1.2	x	40.4	x	0.63	x	0.7	=	14.82	(78)
South	0.9x	0.77	x	1.2	x	40.4	x	0.63	x	0.7	=	14.82	(78)
South	0.9x	0.77	x	1.2	x	40.4	x	0.63	x	0.7	=	14.82	(78)
South	0.9x	0.77	x	1.2	x	40.4	x	0.63	x	0.7	=	14.82	(78)
West	0.9x	0.77	x	1.62	x	19.64	x	0.63	x	0.7	=	9.72	(80)
West	0.9x	0.77	x	1.59	x	19.64	x	0.63	x	0.7	=	9.54	(80)
West	0.9x	0.77	x	4.39	x	19.64	x	0.63	x	0.7	=	26.35	(80)
West	0.9x	0.77	x	1.62	x	38.42	x	0.63	x	0.7	=	19.02	(80)
West	0.9x	0.77	x	1.59	x	38.42	x	0.63	x	0.7	=	18.67	(80)
West	0.9x	0.77	x	4.39	x	38.42	x	0.63	x	0.7	=	51.55	(80)
West	0.9x	0.77	x	1.62	x	63.27	x	0.63	x	0.7	=	31.33	(80)
West	0.9x	0.77	x	1.59	x	63.27	x	0.63	x	0.7	=	30.75	(80)

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West	0.9x	0.77	x	4.39	x	63.27	x	0.63	x	0.7	=	84.89	(80)
West	0.9x	0.77	x	1.62	x	92.28	x	0.63	x	0.7	=	45.69	(80)
West	0.9x	0.77	x	1.59	x	92.28	x	0.63	x	0.7	=	44.84	(80)
West	0.9x	0.77	x	4.39	x	92.28	x	0.63	x	0.7	=	123.81	(80)
West	0.9x	0.77	x	1.62	x	113.09	x	0.63	x	0.7	=	55.99	(80)
West	0.9x	0.77	x	1.59	x	113.09	x	0.63	x	0.7	=	54.95	(80)
West	0.9x	0.77	x	4.39	x	113.09	x	0.63	x	0.7	=	151.73	(80)
West	0.9x	0.77	x	1.62	x	115.77	x	0.63	x	0.7	=	57.32	(80)
West	0.9x	0.77	x	1.59	x	115.77	x	0.63	x	0.7	=	56.26	(80)
West	0.9x	0.77	x	4.39	x	115.77	x	0.63	x	0.7	=	155.32	(80)
West	0.9x	0.77	x	1.62	x	110.22	x	0.63	x	0.7	=	54.57	(80)
West	0.9x	0.77	x	1.59	x	110.22	x	0.63	x	0.7	=	53.56	(80)
West	0.9x	0.77	x	4.39	x	110.22	x	0.63	x	0.7	=	147.87	(80)
West	0.9x	0.77	x	1.62	x	94.68	x	0.63	x	0.7	=	46.87	(80)
West	0.9x	0.77	x	1.59	x	94.68	x	0.63	x	0.7	=	46.01	(80)
West	0.9x	0.77	x	4.39	x	94.68	x	0.63	x	0.7	=	127.02	(80)
West	0.9x	0.77	x	1.62	x	73.59	x	0.63	x	0.7	=	36.43	(80)
West	0.9x	0.77	x	1.59	x	73.59	x	0.63	x	0.7	=	35.76	(80)
West	0.9x	0.77	x	4.39	x	73.59	x	0.63	x	0.7	=	98.73	(80)
West	0.9x	0.77	x	1.62	x	45.59	x	0.63	x	0.7	=	22.57	(80)
West	0.9x	0.77	x	1.59	x	45.59	x	0.63	x	0.7	=	22.15	(80)
West	0.9x	0.77	x	4.39	x	45.59	x	0.63	x	0.7	=	61.16	(80)
West	0.9x	0.77	x	1.62	x	24.49	x	0.63	x	0.7	=	12.12	(80)
West	0.9x	0.77	x	1.59	x	24.49	x	0.63	x	0.7	=	11.9	(80)
West	0.9x	0.77	x	4.39	x	24.49	x	0.63	x	0.7	=	32.86	(80)
West	0.9x	0.77	x	1.62	x	16.15	x	0.63	x	0.7	=	8	(80)
West	0.9x	0.77	x	1.59	x	16.15	x	0.63	x	0.7	=	7.85	(80)
West	0.9x	0.77	x	4.39	x	16.15	x	0.63	x	0.7	=	21.67	(80)

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

(83)m=	158.56	288.33	432.94	584.46	686.6	692.53	663.37	587.6	486.58	330	193.48	133.25	(83)

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

(84)m=	563.96	691.62	821.66	949.67	1027.86	1010.72	967.01	898	809.38	676.53	566.99	526.75	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.95	0.87	0.72	0.57	0.62	0.85	0.97	0.99	1	(86)

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

(87)m=	19.32	19.52	19.86	20.29	20.66	20.89	20.97	20.95	20.77	20.27	19.71	19.27	(87)

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

(88)m=	19.66	19.66	19.66	19.67	19.67	19.68	19.68	19.68	19.67	19.67	19.67	19.67	(88)

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

(89)m=	1	0.99	0.97	0.93	0.81	0.61	0.41	0.47	0.76	0.95	0.99	1	(89)

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

(90)m=	17.46	17.76	18.25	18.86	19.34	19.61	19.67	19.66	19.5	18.85	18.03	17.4	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	18.25	18.51	18.94	19.47	19.91	20.15	20.22	20.21	20.04	19.46	18.75	18.2	(92)

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

(93)m=	18.25	18.51	18.94	19.47	19.91	20.15	20.22	20.21	20.04	19.46	18.75	18.2	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.97	0.92	0.82	0.66	0.48	0.53	0.79	0.95	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	560.7	682.67	796.2	875.33	845.67	663.28	462.53	479.28	638.38	643.35	560.64	524.4	(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=	1863.1	1815.87	1657.13	1399.52	1085.2	730.6	476.63	501.18	783.45	1171.45	1543.98	1860.34	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	968.99	761.51	640.54	377.42	178.21	0	0	0	0	392.91	708.01	993.94	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5021.52 (98)

Space heating requirement in kWh/m²/year 57.81 (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		93.4	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	968.99	761.51	640.54	377.42	178.21	0	0	0	0	392.91	708.01	993.94	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1037.46	815.32	685.8	404.09	190.81	0	0	0	0	420.67	758.04	1064.18	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 5376.36 (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)

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Water heating

Output from water heater (calculated above)

	206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8

Efficiency of water heater: 80.3 (216)

(217)m=	88.44	88.26	87.87	87.02	85.27	80.3	80.3	80.3	80.3	87	88.07	88.52	(217)

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

(219)m=	233.72	206.5	216.46	193.86	191.54	179.14	171.63	191.33	193.44	203.3	213.71	227.97

Total = $Sum(219a)_{1...12}$ = 2422.62 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		5376.36	
Water heating fuel used		2422.62	
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		367.13	(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 =	1161.29	(261)
Space heating (secondary)	(215) x	0.519 =	0	(263)
Water heating	(219) x	0.216 =	523.29	(264)
Space and water heating	(261) + (262) + (263) + (264) =		1684.58	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519 =	38.93	(267)
Electricity for lighting	(232) x	0.519 =	190.54	(268)
Total CO2, kg/year		sum of (265)…(271) =	1914.04	(272)

TER = 22.04 (273)

APPENDIX 3. TFEE WORKSHEET OF TYPICAL APARTMENT

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User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: Apartment 3-Be Lean

Address : Apartment 3, 26, Netherhall Gardens, LONDON, NW3 5TL

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	86.86	(1a)	x	2.8	(2a)	=	243.21	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	86.86	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	243.21	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.12	(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)	0.37	(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) =	0.26	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.33	0.33	0.32	0.29	0.28	0.25	0.25	0.24	0.26	0.28	0.29	0.31

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

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

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

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

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

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.92	x	1	=	1.92			(26)
Windows Type 1			1.62	x1/[1/(1.4)+ 0.04]		=	2.15			(27)
Windows Type 2			1.59	x1/[1/(1.4)+ 0.04]		=	2.11			(27)
Windows Type 3			4.39	x1/[1/(1.4)+ 0.04]		=	5.82			(27)
Windows Type 4			1.2	x1/[1/(1.4)+ 0.04]		=	1.59			(27)
Windows Type 5			1.2	x1/[1/(1.4)+ 0.04]		=	1.59			(27)
Windows Type 6			1.2	x1/[1/(1.4)+ 0.04]		=	1.59			(27)
Windows Type 7			1.2	x1/[1/(1.4)+ 0.04]		=	1.59			(27)
Windows Type 8			3	x1/[1/(1.4)+ 0.04]		=	3.98			(27)
Windows Type 9			4.39	x1/[1/(1.4)+ 0.04]		=	5.82			(27)
Floor			8.57	x	0.13	=	1.1141			(28)
Walls Type1	96.43	19.79	76.64	x	0.18	=	13.8			(29)
Walls Type2	27.89	1.92	25.97	x	0.18	=	4.67			(29)
Roof	38.42	0	38.42	x	0.13	=	4.99			(30)
Total area of elements, m²			171.31							(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) = 52.74 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 16380.03 (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

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K — 36.23 (36)

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

Total fabric heat loss (33) + (36) = 88.96 (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=	44.58	44.41	44.24	43.45	43.3	42.6	42.6	42.47	42.87	43.3	43.6	43.91	(38)

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

(39)m=	133.55	133.37	133.2	132.41	132.26	131.56	131.56	131.44	131.83	132.26	132.56	132.88	

Average = Sum(39)$_{1…12}$ /12= 132.41 (39)

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

(40)m=	1.54	1.54	1.53	1.52	1.52	1.51	1.51	1.51	1.52	1.52	1.53	1.53	

Average = Sum(40)$_{1…12}$ /12= 1.52 (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 — 2.58 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 95.48 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	105.03	101.21	97.39	93.57	89.75	85.93	85.93	89.75	93.57	97.39	101.21	105.03	

Total = Sum(44)$_{1…12}$ = 1145.77 (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=	155.76	136.22	140.57	122.55	117.59	101.47	94.03	107.9	109.19	127.25	138.9	150.84	

Total = Sum(45)$_{1…12}$ = 1502.29 (45)

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

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

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

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

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

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

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

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

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

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

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

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

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

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

(61)m=	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=	132.39	115.79	119.49	104.17	99.95	86.25	79.93	91.72	92.81	108.16	118.07	128.21	(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=	132.39	115.79	119.49	104.17	99.95	86.25	79.93	91.72	92.81	108.16	118.07	128.21	

Output from water heater (annual)$_{1...12}$ | 1276.95 | (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=	33.1	28.95	29.87	26.04	24.99	21.56	19.98	22.93	23.2	27.04	29.52	32.05	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	(66)

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

(67)m=	20.79	18.46	15.02	11.37	8.5	7.17	7.75	10.08	13.52	17.17	20.04	21.37	(67)

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

(68)m=	233.18	235.6	229.5	216.52	200.14	184.74	174.45	172.03	178.12	191.11	207.49	222.89	(68)

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

(69)m=	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	(71)

Water heating gains (Table 5)

(72)m=	44.49	43.08	40.15	36.17	33.59	29.95	26.86	30.82	32.23	36.35	41	43.08	(72)

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

(73)m=	360.16	358.85	346.37	325.76	303.92	283.56	270.76	274.63	285.58	306.33	330.23	349.05	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	3	x	19.64	x	0.63	x	0.7	=	18.01	(76)
East	0.9x	1	x	4.39	x	19.64	x	0.63	x	0.7	=	26.35	(76)
East	0.9x	1	x	3	x	38.42	x	0.63	x	0.7	=	35.23	(76)
East	0.9x	1	x	4.39	x	38.42	x	0.63	x	0.7	=	51.55	(76)
East	0.9x	1	x	3	x	63.27	x	0.63	x	0.7	=	58.01	(76)
East	0.9x	1	x	4.39	x	63.27	x	0.63	x	0.7	=	84.89	(76)
East	0.9x	1	x	3	x	92.28	x	0.63	x	0.7	=	84.61	(76)
East	0.9x	1	x	4.39	x	92.28	x	0.63	x	0.7	=	123.81	(76)
East	0.9x	1	x	3	x	113.09	x	0.63	x	0.7	=	103.69	(76)
East	0.9x	1	x	4.39	x	113.09	x	0.63	x	0.7	=	151.73	(76)
East	0.9x	1	x	3	x	115.77	x	0.63	x	0.7	=	106.14	(76)
East	0.9x	1	x	4.39	x	115.77	x	0.63	x	0.7	=	155.32	(76)
East	0.9x	1	x	3	x	110.22	x	0.63	x	0.7	=	101.05	(76)
East	0.9x	1	x	4.39	x	110.22	x	0.63	x	0.7	=	147.87	(76)
East	0.9x	1	x	3	x	94.68	x	0.63	x	0.7	=	86.8	(76)
East	0.9x	1	x	4.39	x	94.68	x	0.63	x	0.7	=	127.02	(76)
East	0.9x	1	x	3	x	73.59	x	0.63	x	0.7	=	67.47	(76)
East	0.9x	1	x	4.39	x	73.59	x	0.63	x	0.7	=	98.73	(76)
East	0.9x	1	x	3	x	45.59	x	0.63	x	0.7	=	41.8	(76)
East	0.9x	1	x	4.39	x	45.59	x	0.63	x	0.7	=	61.16	(76)
East	0.9x	1	x	3	x	24.49	x	0.63	x	0.7	=	22.45	(76)
East	0.9x	1	x	4.39	x	24.49	x	0.63	x	0.7	=	32.86	(76)
East	0.9x	1	x	3	x	16.15	x	0.63	x	0.7	=	14.81	(76)
East	0.9x	1	x	4.39	x	16.15	x	0.63	x	0.7	=	21.67	(76)
South	0.9x	0.77	x	1.2	x	46.75	x	0.63	x	0.7	=	17.15	(78)
South	0.9x	0.77	x	1.2	x	46.75	x	0.63	x	0.7	=	17.15	(78)
South	0.9x	0.77	x	1.2	x	46.75	x	0.63	x	0.7	=	17.15	(78)
South	0.9x	0.77	x	1.2	x	46.75	x	0.63	x	0.7	=	17.15	(78)
South	0.9x	0.77	x	1.2	x	76.57	x	0.63	x	0.7	=	28.08	(78)
South	0.9x	0.77	x	1.2	x	76.57	x	0.63	x	0.7	=	28.08	(78)
South	0.9x	0.77	x	1.2	x	76.57	x	0.63	x	0.7	=	28.08	(78)
South	0.9x	0.77	x	1.2	x	76.57	x	0.63	x	0.7	=	28.08	(78)
South	0.9x	0.77	x	1.2	x	97.53	x	0.63	x	0.7	=	35.77	(78)
South	0.9x	0.77	x	1.2	x	97.53	x	0.63	x	0.7	=	35.77	(78)
South	0.9x	0.77	x	1.2	x	97.53	x	0.63	x	0.7	=	35.77	(78)
South	0.9x	0.77	x	1.2	x	97.53	x	0.63	x	0.7	=	35.77	(78)
South	0.9x	0.77	x	1.2	x	110.23	x	0.63	x	0.7	=	40.43	(78)
South	0.9x	0.77	x	1.2	x	110.23	x	0.63	x	0.7	=	40.43	(78)
South	0.9x	0.77	x	1.2	x	110.23	x	0.63	x	0.7	=	40.43	(78)

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South	0.9x	0.77	x	1.2	x	110.23	x	0.63	x	0.7	=	40.43	(78)
South	0.9x	0.77	x	1.2	x	114.87	x	0.63	x	0.7	=	42.13	(78)
South	0.9x	0.77	x	1.2	x	114.87	x	0.63	x	0.7	=	42.13	(78)
South	0.9x	0.77	x	1.2	x	114.87	x	0.63	x	0.7	=	42.13	(78)
South	0.9x	0.77	x	1.2	x	114.87	x	0.63	x	0.7	=	42.13	(78)
South	0.9x	0.77	x	1.2	x	110.55	x	0.63	x	0.7	=	40.54	(78)
South	0.9x	0.77	x	1.2	x	110.55	x	0.63	x	0.7	=	40.54	(78)
South	0.9x	0.77	x	1.2	x	110.55	x	0.63	x	0.7	=	40.54	(78)
South	0.9x	0.77	x	1.2	x	110.55	x	0.63	x	0.7	=	40.54	(78)
South	0.9x	0.77	x	1.2	x	108.01	x	0.63	x	0.7	=	39.61	(78)
South	0.9x	0.77	x	1.2	x	108.01	x	0.63	x	0.7	=	39.61	(78)
South	0.9x	0.77	x	1.2	x	108.01	x	0.63	x	0.7	=	39.61	(78)
South	0.9x	0.77	x	1.2	x	108.01	x	0.63	x	0.7	=	39.61	(78)
South	0.9x	0.77	x	1.2	x	104.89	x	0.63	x	0.7	=	38.47	(78)
South	0.9x	0.77	x	1.2	x	104.89	x	0.63	x	0.7	=	38.47	(78)
South	0.9x	0.77	x	1.2	x	104.89	x	0.63	x	0.7	=	38.47	(78)
South	0.9x	0.77	x	1.2	x	104.89	x	0.63	x	0.7	=	38.47	(78)
South	0.9x	0.77	x	1.2	x	101.89	x	0.63	x	0.7	=	37.37	(78)
South	0.9x	0.77	x	1.2	x	101.89	x	0.63	x	0.7	=	37.37	(78)
South	0.9x	0.77	x	1.2	x	101.89	x	0.63	x	0.7	=	37.37	(78)
South	0.9x	0.77	x	1.2	x	101.89	x	0.63	x	0.7	=	37.37	(78)
South	0.9x	0.77	x	1.2	x	82.59	x	0.63	x	0.7	=	30.29	(78)
South	0.9x	0.77	x	1.2	x	82.59	x	0.63	x	0.7	=	30.29	(78)
South	0.9x	0.77	x	1.2	x	82.59	x	0.63	x	0.7	=	30.29	(78)
South	0.9x	0.77	x	1.2	x	82.59	x	0.63	x	0.7	=	30.29	(78)
South	0.9x	0.77	x	1.2	x	55.42	x	0.63	x	0.7	=	20.32	(78)
South	0.9x	0.77	x	1.2	x	55.42	x	0.63	x	0.7	=	20.32	(78)
South	0.9x	0.77	x	1.2	x	55.42	x	0.63	x	0.7	=	20.32	(78)
South	0.9x	0.77	x	1.2	x	55.42	x	0.63	x	0.7	=	20.32	(78)
South	0.9x	0.77	x	1.2	x	40.4	x	0.63	x	0.7	=	14.82	(78)
South	0.9x	0.77	x	1.2	x	40.4	x	0.63	x	0.7	=	14.82	(78)
South	0.9x	0.77	x	1.2	x	40.4	x	0.63	x	0.7	=	14.82	(78)
South	0.9x	0.77	x	1.2	x	40.4	x	0.63	x	0.7	=	14.82	(78)
West	0.9x	0.77	x	1.62	x	19.64	x	0.63	x	0.7	=	9.72	(80)
West	0.9x	0.77	x	1.59	x	19.64	x	0.63	x	0.7	=	9.54	(80)
West	0.9x	0.77	x	4.39	x	19.64	x	0.63	x	0.7	=	26.35	(80)
West	0.9x	0.77	x	1.62	x	38.42	x	0.63	x	0.7	=	19.02	(80)
West	0.9x	0.77	x	1.59	x	38.42	x	0.63	x	0.7	=	18.67	(80)
West	0.9x	0.77	x	4.39	x	38.42	x	0.63	x	0.7	=	51.55	(80)
West	0.9x	0.77	x	1.62	x	63.27	x	0.63	x	0.7	=	31.33	(80)
West	0.9x	0.77	x	1.59	x	63.27	x	0.63	x	0.7	=	30.75	(80)

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West	0.9x	0.77	x	4.39	x	63.27	x	0.63	x	0.7	=	84.89	(80)
West	0.9x	0.77	x	1.62	x	92.28	x	0.63	x	0.7	=	45.69	(80)
West	0.9x	0.77	x	1.59	x	92.28	x	0.63	x	0.7	=	44.84	(80)
West	0.9x	0.77	x	4.39	x	92.28	x	0.63	x	0.7	=	123.81	(80)
West	0.9x	0.77	x	1.62	x	113.09	x	0.63	x	0.7	=	55.99	(80)
West	0.9x	0.77	x	1.59	x	113.09	x	0.63	x	0.7	=	54.95	(80)
West	0.9x	0.77	x	4.39	x	113.09	x	0.63	x	0.7	=	151.73	(80)
West	0.9x	0.77	x	1.62	x	115.77	x	0.63	x	0.7	=	57.32	(80)
West	0.9x	0.77	x	1.59	x	115.77	x	0.63	x	0.7	=	56.26	(80)
West	0.9x	0.77	x	4.39	x	115.77	x	0.63	x	0.7	=	155.32	(80)
West	0.9x	0.77	x	1.62	x	110.22	x	0.63	x	0.7	=	54.57	(80)
West	0.9x	0.77	x	1.59	x	110.22	x	0.63	x	0.7	=	53.56	(80)
West	0.9x	0.77	x	4.39	x	110.22	x	0.63	x	0.7	=	147.87	(80)
West	0.9x	0.77	x	1.62	x	94.68	x	0.63	x	0.7	=	46.87	(80)
West	0.9x	0.77	x	1.59	x	94.68	x	0.63	x	0.7	=	46.01	(80)
West	0.9x	0.77	x	4.39	x	94.68	x	0.63	x	0.7	=	127.02	(80)
West	0.9x	0.77	x	1.62	x	73.59	x	0.63	x	0.7	=	36.43	(80)
West	0.9x	0.77	x	1.59	x	73.59	x	0.63	x	0.7	=	35.76	(80)
West	0.9x	0.77	x	4.39	x	73.59	x	0.63	x	0.7	=	98.73	(80)
West	0.9x	0.77	x	1.62	x	45.59	x	0.63	x	0.7	=	22.57	(80)
West	0.9x	0.77	x	1.59	x	45.59	x	0.63	x	0.7	=	22.15	(80)
West	0.9x	0.77	x	4.39	x	45.59	x	0.63	x	0.7	=	61.16	(80)
West	0.9x	0.77	x	1.62	x	24.49	x	0.63	x	0.7	=	12.12	(80)
West	0.9x	0.77	x	1.59	x	24.49	x	0.63	x	0.7	=	11.9	(80)
West	0.9x	0.77	x	4.39	x	24.49	x	0.63	x	0.7	=	32.86	(80)
West	0.9x	0.77	x	1.62	x	16.15	x	0.63	x	0.7	=	8	(80)
West	0.9x	0.77	x	1.59	x	16.15	x	0.63	x	0.7	=	7.85	(80)
West	0.9x	0.77	x	4.39	x	16.15	x	0.63	x	0.7	=	21.67	(80)

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

(83)m=	158.56	288.33	432.94	584.46	686.6	692.53	663.37	587.6	486.58	330	193.48	133.25	(83)

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

(84)m=	518.72	647.18	779.31	910.22	990.53	976.09	934.13	862.22	772.16	636.33	523.72	482.3	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.95	0.88	0.74	0.58	0.64	0.86	0.98	1	1	(86)

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

(87)m=	19.27	19.48	19.82	20.26	20.63	20.88	20.96	20.95	20.75	20.24	19.66	19.23	(87)

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

(88)m=	19.66	19.66	19.66	19.67	19.67	19.68	19.68	19.68	19.67	19.67	19.67	19.67	(88)

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

(89)m=	1	0.99	0.98	0.93	0.83	0.63	0.42	0.48	0.78	0.96	0.99	1	(89)

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

(90)m=	18.11	18.32	18.66	19.09	19.43	19.62	19.67	19.66	19.54	19.08	18.51	18.07	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	18.61	18.82	19.16	19.59	19.95	20.16	20.22	20.21	20.06	19.57	19	18.57	(92)

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

(93)m=	18.61	18.82	19.16	19.59	19.95	20.16	20.22	20.21	20.06	19.57	19	18.57	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.98	0.93	0.84	0.67	0.49	0.55	0.81	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	516.69	641.01	760.06	848.88	830.25	657.31	460.86	476.38	624.56	611.45	519.61	480.88	(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=	1910.53	1856.11	1686.07	1415	1090.59	731.39	476.62	501.16	785.58	1186.59	1577.74	1909.12	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1037.02	816.54	688.95	407.61	193.69	0	0	0	0	427.9	761.86	1062.61	

Total per year (kWh/year) = Sum$(98)_{1...5,9...12}$ = 5396.18 (98)

Space heating requirement in kWh/m²/year 62.13 (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	1236.71	973.58	998.92	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.8	0.87	0.84	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	992.54	849.72	839.48	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	1237.72	1186.64	1104.24	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	176.53	250.67	196.98	0	0	0	0	

Total = Sum$(104)_{6...8}$ = 624.19 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (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)

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

(107)m=	0	0	0	0	0	44.13	62.67	49.25	0	0	0	0

	Total = Sum(107) =	156.05	(107)
Space cooling requirement in kWh/m²/year	(107) ÷ (4) =	1.8	(108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency	(99) + (108) =	63.92	(109)
Target Fabric Energy Efficiency (TFEE)		73.51	(109)

APPENDIX 4. DER WORKSHEET OF TYPICAL APARTMENT (BE LEAN)

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DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: Apartment 3-Be Lean

Address : Apartment 3, 26, Netherhall Gardens, LONDON, NW3 5TL

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	86.86	(1a) x	2.8	(2a) =	243.21	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	86.86	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	243.21	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.25	(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) =	0.18	(21)

Infiltration rate modified for monthly wind speed

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

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

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

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) = 79.9 (23c)

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

(24a)m=	0.32	0.32	0.31	0.29	0.29	0.27	0.27	0.26	0.28	0.29	0.3	0.31	(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=	0.32	0.32	0.31	0.29	0.29	0.27	0.27	0.26	0.28	0.29	0.3	0.31	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.92	x	1	=	1.92			(26)
Windows Type 1			2.11	x1/[1/(1.4)+ 0.04]		=	2.8			(27)
Windows Type 2			2.08	x1/[1/(1.4)+ 0.04]		=	2.76			(27)
Windows Type 3			5.73	x1/[1/(1.4)+ 0.04]		=	7.6			(27)
Windows Type 4			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 5			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 6			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 7			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 8			3.91	x1/[1/(1.4)+ 0.04]		=	5.18			(27)
Windows Type 9			5.73	x1/[1/(1.4)+ 0.04]		=	7.6			(27)
Floor			8.57	x	0.15	=	1.2855			(28)
Walls Type1	96.43	25.84	70.59	x	0.18	=	12.71			(29)
Walls Type2	27.89	1.92	25.97	x	0.2	=	5.21			(29)
Roof	38.42	0	38.42	x	0.15	=	5.76			(30)
Total area of elements, m²			171.31							(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) = 61.14 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15472.53 (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

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K | 27.28 | (36)

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

Total fabric heat loss (33) + (36) = | 88.42 | (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=	25.97	25.62	25.27	23.52	23.16	21.41	21.41	21.06	22.11	23.16	23.87	24.57	(38)

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

(39)m=	114.39	114.04	113.69	111.93	111.58	109.82	109.82	109.47	110.53	111.58	112.28	112.98	

Average = Sum(39)1...12 /12= | 111.84 | (39)

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

(40)m=	1.32	1.31	1.31	1.29	1.28	1.26	1.26	1.26	1.27	1.28	1.29	1.3

Average = Sum(40)1...12 /12= | 1.29 | (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 | 2.58 | (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 95.48 | (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	105.03	101.21	97.39	93.57	89.75	85.93	85.93	89.75	93.57	97.39	101.21	105.03

Total = Sum(44)1...12 = | 1145.77 | (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=	155.76	136.22	140.57	122.55	117.59	101.47	94.03	107.9	109.19	127.25	138.9	150.84

Total = Sum(45)1...12 = | 1502.29 | (45)

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

(46)m=	23.36	20.43	21.09	18.38	17.64	15.22	14.1	16.19	16.38	19.09	20.84	22.63	(46)

Water storage loss:

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

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

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

Water storage loss:

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

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

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

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

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

If community heating see section 4.3

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

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

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Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

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

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

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

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

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

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

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

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

(61)m=	50.96	46.03	49.63	46.14	45.74	42.38	43.79	45.74	46.14	49.63	49.32	50.96	(61)

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

(62)m=	206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8	(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=	206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8

Output from water heater (annual)$_{1...12}$ 2068.74 (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=	64.53	56.8	59.15	52.29	50.53	44.33	42.21	47.31	47.84	54.72	58.51	62.89	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	(66)

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

(67)m=	20.79	18.46	15.02	11.37	8.5	7.17	7.75	10.08	13.52	17.17	20.04	21.37	(67)

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

(68)m=	233.18	235.6	229.5	216.52	200.14	184.74	174.45	172.03	178.12	191.11	207.49	222.89	(68)

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

(69)m=	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	(71)

Water heating gains (Table 5)

(72)m=	86.73	84.53	79.5	72.62	67.92	61.58	56.74	63.59	66.45	73.55	81.27	84.54	(72)

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

(73)m=	405.4	403.29	388.72	365.21	341.26	318.19	303.64	310.4	322.8	346.53	373.51	393.5	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	3.91	x	19.64	x	0.63	x	0.7	=	23.47	(76)
East	0.9x	1	x	5.73	x	19.64	x	0.63	x	0.7	=	34.39	(76)
East	0.9x	1	x	3.91	x	38.42	x	0.63	x	0.7	=	45.91	(76)
East	0.9x	1	x	5.73	x	38.42	x	0.63	x	0.7	=	67.28	(76)
East	0.9x	1	x	3.91	x	63.27	x	0.63	x	0.7	=	75.61	(76)
East	0.9x	1	x	5.73	x	63.27	x	0.63	x	0.7	=	110.8	(76)
East	0.9x	1	x	3.91	x	92.28	x	0.63	x	0.7	=	110.27	(76)
East	0.9x	1	x	5.73	x	92.28	x	0.63	x	0.7	=	161.6	(76)
East	0.9x	1	x	3.91	x	113.09	x	0.63	x	0.7	=	135.14	(76)
East	0.9x	1	x	5.73	x	113.09	x	0.63	x	0.7	=	198.04	(76)
East	0.9x	1	x	3.91	x	115.77	x	0.63	x	0.7	=	138.34	(76)
East	0.9x	1	x	5.73	x	115.77	x	0.63	x	0.7	=	202.73	(76)
East	0.9x	1	x	3.91	x	110.22	x	0.63	x	0.7	=	131.7	(76)
East	0.9x	1	x	5.73	x	110.22	x	0.63	x	0.7	=	193.01	(76)
East	0.9x	1	x	3.91	x	94.68	x	0.63	x	0.7	=	113.13	(76)
East	0.9x	1	x	5.73	x	94.68	x	0.63	x	0.7	=	165.79	(76)
East	0.9x	1	x	3.91	x	73.59	x	0.63	x	0.7	=	87.94	(76)
East	0.9x	1	x	5.73	x	73.59	x	0.63	x	0.7	=	128.87	(76)
East	0.9x	1	x	3.91	x	45.59	x	0.63	x	0.7	=	54.48	(76)
East	0.9x	1	x	5.73	x	45.59	x	0.63	x	0.7	=	79.83	(76)
East	0.9x	1	x	3.91	x	24.49	x	0.63	x	0.7	=	29.26	(76)
East	0.9x	1	x	5.73	x	24.49	x	0.63	x	0.7	=	42.88	(76)
East	0.9x	1	x	3.91	x	16.15	x	0.63	x	0.7	=	19.3	(76)
East	0.9x	1	x	5.73	x	16.15	x	0.63	x	0.7	=	28.28	(76)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)

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South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
West	0.9x	0.77	x	2.11	x	19.64	x	0.63	x	0.7	=	12.66	(80)
West	0.9x	0.77	x	2.08	x	19.64	x	0.63	x	0.7	=	12.48	(80)
West	0.9x	0.77	x	5.73	x	19.64	x	0.63	x	0.7	=	34.39	(80)
West	0.9x	0.77	x	2.11	x	38.42	x	0.63	x	0.7	=	24.78	(80)
West	0.9x	0.77	x	2.08	x	38.42	x	0.63	x	0.7	=	24.42	(80)
West	0.9x	0.77	x	5.73	x	38.42	x	0.63	x	0.7	=	67.28	(80)
West	0.9x	0.77	x	2.11	x	63.27	x	0.63	x	0.7	=	40.8	(80)
West	0.9x	0.77	x	2.08	x	63.27	x	0.63	x	0.7	=	40.22	(80)

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West	0.9x	0.77	x	5.73	x	63.27	x	0.63	x	0.7	=	110.8	(80)
West	0.9x	0.77	x	2.11	x	92.28	x	0.63	x	0.7	=	59.51	(80)
West	0.9x	0.77	x	2.08	x	92.28	x	0.63	x	0.7	=	58.66	(80)
West	0.9x	0.77	x	5.73	x	92.28	x	0.63	x	0.7	=	161.6	(80)
West	0.9x	0.77	x	2.11	x	113.09	x	0.63	x	0.7	=	72.93	(80)
West	0.9x	0.77	x	2.08	x	113.09	x	0.63	x	0.7	=	71.89	(80)
West	0.9x	0.77	x	5.73	x	113.09	x	0.63	x	0.7	=	198.04	(80)
West	0.9x	0.77	x	2.11	x	115.77	x	0.63	x	0.7	=	74.65	(80)
West	0.9x	0.77	x	2.08	x	115.77	x	0.63	x	0.7	=	73.59	(80)
West	0.9x	0.77	x	5.73	x	115.77	x	0.63	x	0.7	=	202.73	(80)
West	0.9x	0.77	x	2.11	x	110.22	x	0.63	x	0.7	=	71.07	(80)
West	0.9x	0.77	x	2.08	x	110.22	x	0.63	x	0.7	=	70.06	(80)
West	0.9x	0.77	x	5.73	x	110.22	x	0.63	x	0.7	=	193.01	(80)
West	0.9x	0.77	x	2.11	x	94.68	x	0.63	x	0.7	=	61.05	(80)
West	0.9x	0.77	x	2.08	x	94.68	x	0.63	x	0.7	=	60.18	(80)
West	0.9x	0.77	x	5.73	x	94.68	x	0.63	x	0.7	=	165.79	(80)
West	0.9x	0.77	x	2.11	x	73.59	x	0.63	x	0.7	=	47.45	(80)
West	0.9x	0.77	x	2.08	x	73.59	x	0.63	x	0.7	=	46.78	(80)
West	0.9x	0.77	x	5.73	x	73.59	x	0.63	x	0.7	=	128.87	(80)
West	0.9x	0.77	x	2.11	x	45.59	x	0.63	x	0.7	=	29.4	(80)
West	0.9x	0.77	x	2.08	x	45.59	x	0.63	x	0.7	=	28.98	(80)
West	0.9x	0.77	x	5.73	x	45.59	x	0.63	x	0.7	=	79.83	(80)
West	0.9x	0.77	x	2.11	x	24.49	x	0.63	x	0.7	=	15.79	(80)
West	0.9x	0.77	x	2.08	x	24.49	x	0.63	x	0.7	=	15.57	(80)
West	0.9x	0.77	x	5.73	x	24.49	x	0.63	x	0.7	=	42.88	(80)
West	0.9x	0.77	x	2.11	x	16.15	x	0.63	x	0.7	=	10.41	(80)
West	0.9x	0.77	x	2.08	x	16.15	x	0.63	x	0.7	=	10.27	(80)
West	0.9x	0.77	x	5.73	x	16.15	x	0.63	x	0.7	=	28.28	(80)

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

(83)m=	207.13	376.62	565.43	763.2	896.51	904.22	866.16	767.27	635.45	431.02	252.75	174.08	(83)

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

(84)m=	612.54	779.92	954.15	1128.41	1237.77	1222.41	1169.8	1077.67	958.25	777.55	626.26	567.58	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.96	0.89	0.74	0.56	0.41	0.46	0.72	0.94	0.99	1	(86)

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

(87)m=	19.64	19.88	20.23	20.63	20.87	20.97	21	20.99	20.92	20.55	20.01	19.6	(87)

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

(88)m=	19.83	19.83	19.83	19.85	19.85	19.87	19.87	19.87	19.86	19.85	19.85	19.84	(88)

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

(89)m=	0.99	0.98	0.95	0.85	0.68	0.47	0.31	0.35	0.63	0.92	0.99	1	(89)

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

(90)m=	18.6	18.85	19.19	19.57	19.78	19.86	19.87	19.87	19.82	19.51	18.99	18.58	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	19.04	19.29	19.64	20.02	20.25	20.34	20.35	20.35	20.29	19.96	19.43	19.01	(92)

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

(93)m=	18.89	19.14	19.49	19.87	20.1	20.19	20.2	20.2	20.14	19.81	19.28	18.86	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.95	0.85	0.69	0.49	0.34	0.38	0.65	0.91	0.98	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	608.33	765	903.04	963.85	856.93	600.93	393.66	412.95	624.31	711.18	616.64	564.75	(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=	1669.45	1623.9	1476.61	1228.29	936.91	613.47	395.33	415.95	667.96	1027.26	1367.1	1656.66	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	789.47	577.18	426.74	190.4	59.51	0	0	0	0	235.17	540.33	812.38	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3631.17 (98)

Space heating requirement in kWh/m²/year 41.8 (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 90.5 (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)													
	789.47	577.18	426.74	190.4	59.51	0	0	0	0	235.17	540.33	812.38	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	872.34	637.77	471.53	210.38	65.75	0	0	0	0	259.85	597.05	897.66	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 4012.35 (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)

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Water heating

Output from water heater (calculated above)

206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8

Efficiency of water heater 81.2 (216)

(217)m=	88.4	88.08	87.41	85.88	83.49	81.2	81.2	81.2	81.2	86.26	87.9	88.48	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	233.84	206.92	217.59	196.44	195.63	177.16	169.73	189.21	191.3	205.06	214.13	228.06

Total = Sum(219a)$_{1...12}$ = 2425.06 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		4012.35	
Water heating fuel used		2425.06	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	159.48		(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) =		234.48	(231)
Electricity for lighting		367.13	(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	=	866.67	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	523.81	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1390.48	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	121.7	(267)
Electricity for lighting	(232) x	0.519	=	190.54	(268)
Total CO2, kg/year		sum of (265)…(271) =		1702.72	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		19.6	(273)
EI rating (section 14)				83	(274)

APPENDIX 5. DER WORKSHEET OF TYPICAL APARTMENT (BE GREEN)

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User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: Apartment 3-Be Green

Address : Apartment 3, 26, Netherhall Gardens, LONDON, NW3 5TL

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	86.86	(1a)	x	2.8	(2a)	=	243.21	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	86.86	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			243.21	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.25	(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) =	0.18	(21)

Infiltration rate modified for monthly wind speed

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

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

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

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) = 79.9 (23c)

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

(24a)m=	0.32	0.32	0.31	0.29	0.29	0.27	0.27	0.26	0.28	0.29	0.3	0.31	(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=	0.32	0.32	0.31	0.29	0.29	0.27	0.27	0.26	0.28	0.29	0.3	0.31	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.92	x	1	=	1.92			(26)
Windows Type 1			2.11	x1/[1/(1.4)+ 0.04]		=	2.8			(27)
Windows Type 2			2.08	x1/[1/(1.4)+ 0.04]		=	2.76			(27)
Windows Type 3			5.73	x1/[1/(1.4)+ 0.04]		=	7.6			(27)
Windows Type 4			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 5			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 6			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 7			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 8			3.91	x1/[1/(1.4)+ 0.04]		=	5.18			(27)
Windows Type 9			5.73	x1/[1/(1.4)+ 0.04]		=	7.6			(27)
Floor			8.57	x	0.15	=	1.2855			(28)
Walls Type1	96.43	25.84	70.59	x	0.18	=	12.71			(29)
Walls Type2	27.89	1.92	25.97	x	0.2	=	5.21			(29)
Roof	38.42	0	38.42	x	0.15	=	5.76			(30)
Total area of elements, m²			171.31							(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) = 61.14 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15472.53 (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

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K — 27.28 (36)

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

Total fabric heat loss (33) + (36) = 88.42 (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=	25.97	25.62	25.27	23.52	23.16	21.41	21.41	21.06	22.11	23.16	23.87	24.57	(38)

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

(39)m=	114.39	114.04	113.69	111.93	111.58	109.82	109.82	109.47	110.53	111.58	112.28	112.98	

Average = $Sum(39)_{1...12}$ /12= 111.84 (39)

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

(40)m=	1.32	1.31	1.31	1.29	1.28	1.26	1.26	1.26	1.27	1.28	1.29	1.3	

Average = $Sum(40)_{1...12}$ /12= 1.29 (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 — 2.58 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 95.48 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	105.03	101.21	97.39	93.57	89.75	85.93	85.93	89.75	93.57	97.39	101.21	105.03	

Total = $Sum(44)_{1...12}$ = 1145.77 (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=	155.76	136.22	140.57	122.55	117.59	101.47	94.03	107.9	109.19	127.25	138.9	150.84	

Total = $Sum(45)_{1...12}$ = 1502.29 (45)

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

(46)m=	23.36	20.43	21.09	18.38	17.64	15.22	14.1	16.19	16.38	19.09	20.84	22.63	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

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

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

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Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

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

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

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

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

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

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

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

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

(61)m=	50.96	46.03	49.63	46.14	45.74	42.38	43.79	45.74	46.14	49.63	49.32	50.96	(61)

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

(62)m=	206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8	(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=	206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8

Output from water heater (annual)$_{1...12}$ 2068.74 (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=	64.53	56.8	59.15	52.29	50.53	44.33	42.21	47.31	47.84	54.72	58.51	62.89	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	(66)

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

(67)m=	20.79	18.46	15.02	11.37	8.5	7.17	7.75	10.08	13.52	17.17	20.04	21.37	(67)

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

(68)m=	233.18	235.6	229.5	216.52	200.14	184.74	174.45	172.03	178.12	191.11	207.49	222.89	(68)

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

(69)m=	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	(71)

Water heating gains (Table 5)

(72)m=	86.73	84.53	79.5	72.62	67.92	61.58	56.74	63.59	66.45	73.55	81.27	84.54	(72)

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

(73)m=	405.4	403.29	388.72	365.21	341.26	318.19	303.64	310.4	322.8	346.53	373.51	393.5	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	3.91	x	19.64	x	0.63	x	0.7	=	23.47	(76)
East	0.9x	1	x	5.73	x	19.64	x	0.63	x	0.7	=	34.39	(76)
East	0.9x	1	x	3.91	x	38.42	x	0.63	x	0.7	=	45.91	(76)
East	0.9x	1	x	5.73	x	38.42	x	0.63	x	0.7	=	67.28	(76)
East	0.9x	1	x	3.91	x	63.27	x	0.63	x	0.7	=	75.61	(76)
East	0.9x	1	x	5.73	x	63.27	x	0.63	x	0.7	=	110.8	(76)
East	0.9x	1	x	3.91	x	92.28	x	0.63	x	0.7	=	110.27	(76)
East	0.9x	1	x	5.73	x	92.28	x	0.63	x	0.7	=	161.6	(76)
East	0.9x	1	x	3.91	x	113.09	x	0.63	x	0.7	=	135.14	(76)
East	0.9x	1	x	5.73	x	113.09	x	0.63	x	0.7	=	198.04	(76)
East	0.9x	1	x	3.91	x	115.77	x	0.63	x	0.7	=	138.34	(76)
East	0.9x	1	x	5.73	x	115.77	x	0.63	x	0.7	=	202.73	(76)
East	0.9x	1	x	3.91	x	110.22	x	0.63	x	0.7	=	131.7	(76)
East	0.9x	1	x	5.73	x	110.22	x	0.63	x	0.7	=	193.01	(76)
East	0.9x	1	x	3.91	x	94.68	x	0.63	x	0.7	=	113.13	(76)
East	0.9x	1	x	5.73	x	94.68	x	0.63	x	0.7	=	165.79	(76)
East	0.9x	1	x	3.91	x	73.59	x	0.63	x	0.7	=	87.94	(76)
East	0.9x	1	x	5.73	x	73.59	x	0.63	x	0.7	=	128.87	(76)
East	0.9x	1	x	3.91	x	45.59	x	0.63	x	0.7	=	54.48	(76)
East	0.9x	1	x	5.73	x	45.59	x	0.63	x	0.7	=	79.83	(76)
East	0.9x	1	x	3.91	x	24.49	x	0.63	x	0.7	=	29.26	(76)
East	0.9x	1	x	5.73	x	24.49	x	0.63	x	0.7	=	42.88	(76)
East	0.9x	1	x	3.91	x	16.15	x	0.63	x	0.7	=	19.3	(76)
East	0.9x	1	x	5.73	x	16.15	x	0.63	x	0.7	=	28.28	(76)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)

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South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
West	0.9x	0.77	x	2.11	x	19.64	x	0.63	x	0.7	=	12.66	(80)
West	0.9x	0.77	x	2.08	x	19.64	x	0.63	x	0.7	=	12.48	(80)
West	0.9x	0.77	x	5.73	x	19.64	x	0.63	x	0.7	=	34.39	(80)
West	0.9x	0.77	x	2.11	x	38.42	x	0.63	x	0.7	=	24.78	(80)
West	0.9x	0.77	x	2.08	x	38.42	x	0.63	x	0.7	=	24.42	(80)
West	0.9x	0.77	x	5.73	x	38.42	x	0.63	x	0.7	=	67.28	(80)
West	0.9x	0.77	x	2.11	x	63.27	x	0.63	x	0.7	=	40.8	(80)
West	0.9x	0.77	x	2.08	x	63.27	x	0.63	x	0.7	=	40.22	(80)

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West	0.9x	0.77	x	5.73	x	63.27	x	0.63	x	0.7	=	110.8	(80)
West	0.9x	0.77	x	2.11	x	92.28	x	0.63	x	0.7	=	59.51	(80)
West	0.9x	0.77	x	2.08	x	92.28	x	0.63	x	0.7	=	58.66	(80)
West	0.9x	0.77	x	5.73	x	92.28	x	0.63	x	0.7	=	161.6	(80)
West	0.9x	0.77	x	2.11	x	113.09	x	0.63	x	0.7	=	72.93	(80)
West	0.9x	0.77	x	2.08	x	113.09	x	0.63	x	0.7	=	71.89	(80)
West	0.9x	0.77	x	5.73	x	113.09	x	0.63	x	0.7	=	198.04	(80)
West	0.9x	0.77	x	2.11	x	115.77	x	0.63	x	0.7	=	74.65	(80)
West	0.9x	0.77	x	2.08	x	115.77	x	0.63	x	0.7	=	73.59	(80)
West	0.9x	0.77	x	5.73	x	115.77	x	0.63	x	0.7	=	202.73	(80)
West	0.9x	0.77	x	2.11	x	110.22	x	0.63	x	0.7	=	71.07	(80)
West	0.9x	0.77	x	2.08	x	110.22	x	0.63	x	0.7	=	70.06	(80)
West	0.9x	0.77	x	5.73	x	110.22	x	0.63	x	0.7	=	193.01	(80)
West	0.9x	0.77	x	2.11	x	94.68	x	0.63	x	0.7	=	61.05	(80)
West	0.9x	0.77	x	2.08	x	94.68	x	0.63	x	0.7	=	60.18	(80)
West	0.9x	0.77	x	5.73	x	94.68	x	0.63	x	0.7	=	165.79	(80)
West	0.9x	0.77	x	2.11	x	73.59	x	0.63	x	0.7	=	47.45	(80)
West	0.9x	0.77	x	2.08	x	73.59	x	0.63	x	0.7	=	46.78	(80)
West	0.9x	0.77	x	5.73	x	73.59	x	0.63	x	0.7	=	128.87	(80)
West	0.9x	0.77	x	2.11	x	45.59	x	0.63	x	0.7	=	29.4	(80)
West	0.9x	0.77	x	2.08	x	45.59	x	0.63	x	0.7	=	28.98	(80)
West	0.9x	0.77	x	5.73	x	45.59	x	0.63	x	0.7	=	79.83	(80)
West	0.9x	0.77	x	2.11	x	24.49	x	0.63	x	0.7	=	15.79	(80)
West	0.9x	0.77	x	2.08	x	24.49	x	0.63	x	0.7	=	15.57	(80)
West	0.9x	0.77	x	5.73	x	24.49	x	0.63	x	0.7	=	42.88	(80)
West	0.9x	0.77	x	2.11	x	16.15	x	0.63	x	0.7	=	10.41	(80)
West	0.9x	0.77	x	2.08	x	16.15	x	0.63	x	0.7	=	10.27	(80)
West	0.9x	0.77	x	5.73	x	16.15	x	0.63	x	0.7	=	28.28	(80)

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

(83)m=	207.13	376.62	565.43	763.2	896.51	904.22	866.16	767.27	635.45	431.02	252.75	174.08	(83)

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

(84)m=	612.54	779.92	954.15	1128.41	1237.77	1222.41	1169.8	1077.67	958.25	777.55	626.26	567.58	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.96	0.89	0.74	0.56	0.41	0.46	0.72	0.94	0.99	1	(86)

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

(87)m=	19.64	19.88	20.23	20.63	20.87	20.97	21	20.99	20.92	20.55	20.01	19.6	(87)

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

(88)m=	19.83	19.83	19.83	19.85	19.85	19.87	19.87	19.87	19.86	19.85	19.85	19.84	(88)

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

(89)m=	0.99	0.98	0.95	0.85	0.68	0.47	0.31	0.35	0.63	0.92	0.99	1	(89)

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

(90)m=	18.6	18.85	19.19	19.57	19.78	19.86	19.87	19.87	19.82	19.51	18.99	18.58	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	19.04	19.29	19.64	20.02	20.25	20.34	20.35	20.35	20.29	19.96	19.43	19.01	(92)

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

(93)m=	18.89	19.14	19.49	19.87	20.1	20.19	20.2	20.2	20.14	19.81	19.28	18.86	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.95	0.85	0.69	0.49	0.34	0.38	0.65	0.91	0.98	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	608.33	765	903.04	963.85	856.93	600.93	393.66	412.95	624.31	711.18	616.64	564.75	(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=	1669.45	1623.9	1476.61	1228.29	936.91	613.47	395.33	415.95	667.96	1027.26	1367.1	1656.66	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	789.47	577.18	426.74	190.4	59.51	0	0	0	0	235.17	540.33	812.38	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3631.17 (98)

Space heating requirement in kWh/m²/year 41.8 (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		90.5	(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)													
	789.47	577.18	426.74	190.4	59.51	0	0	0	0	235.17	540.33	812.38	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	872.34	637.77	471.53	210.38	65.75	0	0	0	0	259.85	597.05	897.66	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 4012.35 (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)

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Water heating

Output from water heater (calculated above)

206.71	182.25	190.2	168.7	163.33	143.85	137.82	153.64	155.33	176.88	188.22	201.8

Efficiency of water heater: 81.2 (216)

(217)m=	88.4	88.08	87.41	85.88	83.49	81.2	81.2	81.2	81.2	86.26	87.9	88.48	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	233.84	206.92	217.59	196.44	195.63	177.16	169.73	189.21	191.3	205.06	214.13	228.06

Total = Sum(219a)$_{1...12}$ = 2425.06 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		4012.35	
Water heating fuel used		2425.06	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	159.48		(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) =		234.48	(231)
Electricity for lighting		367.13	(232)
Electricity generated by PVs		-600.79	(233)

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	=	866.67	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	523.81	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1390.48	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	121.7	(267)
Electricity for lighting	(232) x	0.519	=	190.54	(268)
Energy saving/generation technologies					
Item 1		0.519	=	-311.81	(269)
Total CO2, kg/year	sum of (265)…(271) =			1390.91	(272)
Dwelling CO2 Emission Rate	(272) ÷ (4) =			16.01	(273)
EI rating (section 14)				86	(274)

APPENDIX 6. DFEE WORKSHEET OF TYPICAL APARTMENT

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User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: Apartment 3-Be Lean

Address : Apartment 3, 26, Netherhall Gardens, LONDON, NW3 5TL

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	86.86	(1a)	x	2.8	(2a)	=	243.21	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	86.86	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	243.21	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.12	(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)	0.37	(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) =	0.26	(21)

Infiltration rate modified for monthly wind speed

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

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

0.33	0.33	0.32	0.29	0.28	0.25	0.25	0.24	0.26	0.28	0.29	0.31

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

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

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

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

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

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			1.92	x	1	=	1.92			(26)
Windows Type 1			2.11	x1/[1/(1.4)+ 0.04]		=	2.8			(27)
Windows Type 2			2.08	x1/[1/(1.4)+ 0.04]		=	2.76			(27)
Windows Type 3			5.73	x1/[1/(1.4)+ 0.04]		=	7.6			(27)
Windows Type 4			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 5			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 6			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 7			1.57	x1/[1/(1.4)+ 0.04]		=	2.08			(27)
Windows Type 8			3.91	x1/[1/(1.4)+ 0.04]		=	5.18			(27)
Windows Type 9			5.73	x1/[1/(1.4)+ 0.04]		=	7.6			(27)
Floor			8.57	x	0.15	=	1.2855			(28)
Walls Type1	96.43	25.84	70.59	x	0.18	=	12.71			(29)
Walls Type2	27.89	1.92	25.97	x	0.2	=	5.21			(29)
Roof	38.42	0	38.42	x	0.15	=	5.76			(30)
Total area of elements, m²			171.31							(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) = 61.14 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15472.53 (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

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K — 27.28 (36)

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

Total fabric heat loss (33) + (36) = 88.42 (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=	44.58	44.41	44.24	43.45	43.3	42.6	42.6	42.47	42.87	43.3	43.6	43.91	(38)

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

(39)m=	133	132.83	132.66	131.86	131.71	131.02	131.02	130.89	131.29	131.71	132.01	132.33	

Average = Sum(39)$_{1…12}$ /12= 131.86 (39)

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

(40)m=	1.53	1.53	1.53	1.52	1.52	1.51	1.51	1.51	1.51	1.52	1.52	1.52	

Average = Sum(40)$_{1…12}$ /12= 1.52 (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 — 2.58 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 95.48 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	105.03	101.21	97.39	93.57	89.75	85.93	85.93	89.75	93.57	97.39	101.21	105.03	

Total = Sum(44)$_{1…12}$ = 1145.77 (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=	155.76	136.22	140.57	122.55	117.59	101.47	94.03	107.9	109.19	127.25	138.9	150.84	

Total = Sum(45)$_{1…12}$ = 1502.29 (45)

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

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

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

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

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Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

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

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

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

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

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

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

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

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

(61)m=	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=	132.39	115.79	119.49	104.17	99.95	86.25	79.93	91.72	92.81	108.16	118.07	128.21	(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=	132.39	115.79	119.49	104.17	99.95	86.25	79.93	91.72	92.81	108.16	118.07	128.21

Output from water heater (annual)$_{1...12}$ 1276.95 (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=	33.1	28.95	29.87	26.04	24.99	21.56	19.98	22.93	23.2	27.04	29.52	32.05	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	129.01	(66)

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

(67)m=	20.79	18.46	15.02	11.37	8.5	7.17	7.75	10.08	13.52	17.17	20.04	21.37	(67)

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

(68)m=	233.18	235.6	229.5	216.52	200.14	184.74	174.45	172.03	178.12	191.11	207.49	222.89	(68)

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

(69)m=	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	-103.21	(71)

Water heating gains (Table 5)

(72)m=	44.49	43.08	40.15	36.17	33.59	29.95	26.86	30.82	32.23	36.35	41	43.08	(72)

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

(73)m=	360.16	358.85	346.37	325.76	303.92	283.56	270.76	274.63	285.58	306.33	330.23	349.05	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	3.91	x	19.64	x	0.63	x	0.7	=	23.47	(76)
East	0.9x	1	x	5.73	x	19.64	x	0.63	x	0.7	=	34.39	(76)
East	0.9x	1	x	3.91	x	38.42	x	0.63	x	0.7	=	45.91	(76)
East	0.9x	1	x	5.73	x	38.42	x	0.63	x	0.7	=	67.28	(76)
East	0.9x	1	x	3.91	x	63.27	x	0.63	x	0.7	=	75.61	(76)
East	0.9x	1	x	5.73	x	63.27	x	0.63	x	0.7	=	110.8	(76)
East	0.9x	1	x	3.91	x	92.28	x	0.63	x	0.7	=	110.27	(76)
East	0.9x	1	x	5.73	x	92.28	x	0.63	x	0.7	=	161.6	(76)
East	0.9x	1	x	3.91	x	113.09	x	0.63	x	0.7	=	135.14	(76)
East	0.9x	1	x	5.73	x	113.09	x	0.63	x	0.7	=	198.04	(76)
East	0.9x	1	x	3.91	x	115.77	x	0.63	x	0.7	=	138.34	(76)
East	0.9x	1	x	5.73	x	115.77	x	0.63	x	0.7	=	202.73	(76)
East	0.9x	1	x	3.91	x	110.22	x	0.63	x	0.7	=	131.7	(76)
East	0.9x	1	x	5.73	x	110.22	x	0.63	x	0.7	=	193.01	(76)
East	0.9x	1	x	3.91	x	94.68	x	0.63	x	0.7	=	113.13	(76)
East	0.9x	1	x	5.73	x	94.68	x	0.63	x	0.7	=	165.79	(76)
East	0.9x	1	x	3.91	x	73.59	x	0.63	x	0.7	=	87.94	(76)
East	0.9x	1	x	5.73	x	73.59	x	0.63	x	0.7	=	128.87	(76)
East	0.9x	1	x	3.91	x	45.59	x	0.63	x	0.7	=	54.48	(76)
East	0.9x	1	x	5.73	x	45.59	x	0.63	x	0.7	=	79.83	(76)
East	0.9x	1	x	3.91	x	24.49	x	0.63	x	0.7	=	29.26	(76)
East	0.9x	1	x	5.73	x	24.49	x	0.63	x	0.7	=	42.88	(76)
East	0.9x	1	x	3.91	x	16.15	x	0.63	x	0.7	=	19.3	(76)
East	0.9x	1	x	5.73	x	16.15	x	0.63	x	0.7	=	28.28	(76)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	46.75	x	0.63	x	0.7	=	22.43	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	76.57	x	0.63	x	0.7	=	36.74	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	97.53	x	0.63	x	0.7	=	46.8	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)

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South	0.9x	0.77	x	1.57	x	110.23	x	0.63	x	0.7	=	52.89	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	114.87	x	0.63	x	0.7	=	55.12	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	110.55	x	0.63	x	0.7	=	53.04	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	108.01	x	0.63	x	0.7	=	51.83	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	104.89	x	0.63	x	0.7	=	50.33	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	101.89	x	0.63	x	0.7	=	48.89	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	82.59	x	0.63	x	0.7	=	39.63	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	55.42	x	0.63	x	0.7	=	26.59	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
South	0.9x	0.77	x	1.57	x	40.4	x	0.63	x	0.7	=	19.38	(78)
West	0.9x	0.77	x	2.11	x	19.64	x	0.63	x	0.7	=	12.66	(80)
West	0.9x	0.77	x	2.08	x	19.64	x	0.63	x	0.7	=	12.48	(80)
West	0.9x	0.77	x	5.73	x	19.64	x	0.63	x	0.7	=	34.39	(80)
West	0.9x	0.77	x	2.11	x	38.42	x	0.63	x	0.7	=	24.78	(80)
West	0.9x	0.77	x	2.08	x	38.42	x	0.63	x	0.7	=	24.42	(80)
West	0.9x	0.77	x	5.73	x	38.42	x	0.63	x	0.7	=	67.28	(80)
West	0.9x	0.77	x	2.11	x	63.27	x	0.63	x	0.7	=	40.8	(80)
West	0.9x	0.77	x	2.08	x	63.27	x	0.63	x	0.7	=	40.22	(80)

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West	0.9x	0.77	x	5.73	x	63.27	x	0.63	x	0.7	=	110.8	(80)
West	0.9x	0.77	x	2.11	x	92.28	x	0.63	x	0.7	=	59.51	(80)
West	0.9x	0.77	x	2.08	x	92.28	x	0.63	x	0.7	=	58.66	(80)
West	0.9x	0.77	x	5.73	x	92.28	x	0.63	x	0.7	=	161.6	(80)
West	0.9x	0.77	x	2.11	x	113.09	x	0.63	x	0.7	=	72.93	(80)
West	0.9x	0.77	x	2.08	x	113.09	x	0.63	x	0.7	=	71.89	(80)
West	0.9x	0.77	x	5.73	x	113.09	x	0.63	x	0.7	=	198.04	(80)
West	0.9x	0.77	x	2.11	x	115.77	x	0.63	x	0.7	=	74.65	(80)
West	0.9x	0.77	x	2.08	x	115.77	x	0.63	x	0.7	=	73.59	(80)
West	0.9x	0.77	x	5.73	x	115.77	x	0.63	x	0.7	=	202.73	(80)
West	0.9x	0.77	x	2.11	x	110.22	x	0.63	x	0.7	=	71.07	(80)
West	0.9x	0.77	x	2.08	x	110.22	x	0.63	x	0.7	=	70.06	(80)
West	0.9x	0.77	x	5.73	x	110.22	x	0.63	x	0.7	=	193.01	(80)
West	0.9x	0.77	x	2.11	x	94.68	x	0.63	x	0.7	=	61.05	(80)
West	0.9x	0.77	x	2.08	x	94.68	x	0.63	x	0.7	=	60.18	(80)
West	0.9x	0.77	x	5.73	x	94.68	x	0.63	x	0.7	=	165.79	(80)
West	0.9x	0.77	x	2.11	x	73.59	x	0.63	x	0.7	=	47.45	(80)
West	0.9x	0.77	x	2.08	x	73.59	x	0.63	x	0.7	=	46.78	(80)
West	0.9x	0.77	x	5.73	x	73.59	x	0.63	x	0.7	=	128.87	(80)
West	0.9x	0.77	x	2.11	x	45.59	x	0.63	x	0.7	=	29.4	(80)
West	0.9x	0.77	x	2.08	x	45.59	x	0.63	x	0.7	=	28.98	(80)
West	0.9x	0.77	x	5.73	x	45.59	x	0.63	x	0.7	=	79.83	(80)
West	0.9x	0.77	x	2.11	x	24.49	x	0.63	x	0.7	=	15.79	(80)
West	0.9x	0.77	x	2.08	x	24.49	x	0.63	x	0.7	=	15.57	(80)
West	0.9x	0.77	x	5.73	x	24.49	x	0.63	x	0.7	=	42.88	(80)
West	0.9x	0.77	x	2.11	x	16.15	x	0.63	x	0.7	=	10.41	(80)
West	0.9x	0.77	x	2.08	x	16.15	x	0.63	x	0.7	=	10.27	(80)
West	0.9x	0.77	x	5.73	x	16.15	x	0.63	x	0.7	=	28.28	(80)

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

(83)m=	207.13	376.62	565.43	763.2	896.51	904.22	866.16	767.27	635.45	431.02	252.75	174.08	(83)

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

(84)m=	567.29	735.47	911.8	1088.96	1200.44	1187.78	1136.92	1041.9	921.02	737.35	582.98	523.13	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.97	0.92	0.81	0.65	0.49	0.55	0.8	0.96	0.99	1	(86)

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

(87)m=	19.33	19.57	19.95	20.4	20.74	20.93	20.98	20.97	20.82	20.33	19.73	19.28	(87)

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

(88)m=	19.66	19.67	19.67	19.67	19.68	19.68	19.68	19.68	19.68	19.68	19.67	19.67	(88)

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

(89)m=	1	0.99	0.96	0.89	0.75	0.54	0.35	0.41	0.7	0.94	0.99	1	(89)

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

(90)m=	18.17	18.42	18.79	19.22	19.52	19.65	19.68	19.68	19.59	19.17	18.58	18.13	(90)

fLA = Living area ÷ (4) = 0.43 (91)

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

(92)m=	18.66	18.91	19.29	19.72	20.04	20.2	20.23	20.23	20.12	19.66	19.07	18.62	(92)

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

(93)m=	18.66	18.91	19.29	19.72	20.04	20.2	20.23	20.23	20.12	19.66	19.07	18.62	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.96	0.89	0.77	0.58	0.41	0.47	0.74	0.94	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	564.27	724.79	875.68	973.1	918.44	690.11	468.09	487.63	678.55	693.52	576.43	521.08	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1910.4	1861.13	1696.18	1427.22	1098.71	733.26	476.21	501.17	790.16	1193.82	1580.01	1907.93	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1001.52	763.62	610.46	326.97	134.12	0	0	0	0	372.22	722.58	1031.81	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4963.29 (98)

Space heating requirement in kWh/m²/year 57.14 (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	1231.57	969.54	994.76	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.87	0.92	0.9	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	1071.42	893.99	891.94	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	1485.16	1423.67	1314.24	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	297.89	394.09	314.2	0	0	0	0

Total = Sum(104)$_{6...8}$ = 1006.17 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (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)

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

(107)m=	0	0	0	0	0	74.47	98.52	78.55	0	0	0	0

Total = Sum(107)$_{6...8}$ = 251.54 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 2.9 (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency (99) + (108) = 60.04 (109)

APPENDIX 7. SAP 2012 CARBON EMISSION FACTORS

As recommended by the GLA Energy Guidance Assessment, the updated SAP 10 emission factors have been used to reflect the fact that grid electricity has significantly decarbonised since the last update of Part L in April 2014. The following table presents the carbon savings achieved using the SAP 2012 emission factors for comparison, calculated using the GLA carbon emission reporting spreadsheet.

Table 12 Carbon Dioxide emissions reduction for the development

Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)		26 Netherhall Gardens (SAP 2012 carbon factors)
Baseline Emissions		6
Be Lean	After energy demand reduction	6
Be Clean	After CHP	6
Be Green	After renewable energy	5
Carbon Savings over Baseline Emissions		1
Carbon Reduction over Baseline Emissions		24%

Table 13 Regulated carbon dioxide savings from each stage of the Energy Hierarchy

Regulated carbon dioxide savings	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	1	8%
Savings from CHP	0	0%
Savings from renewable energy	1	16%
Total Cumulative Savings	**1**	**24%**